Maintaining Central Bank Credibility

By Anne Sibert and Stuart E. Weiner

Central banks throughout the world have increasingly recognized the importance of maintaining public confidence in the commitment of governments to controlling inflation. This recognition has resulted in part from the worldwide inflation in the 1970s. Whether because of oil supply shocks, excessive wage demands, or unduly expansionary government policies, inflation ratcheted upward throughout the 1970s in most industrial countries. As a result of this experience, households and businesses may have become skeptical about the ability and willingness of governments to maintain a reasonably stable price level.

Recent economic research has focused on the implications of such skepticism and what can be done to keep the public's confidence in monetary policy. One major conclusion of this research is that the credibility of a central bank's commitment to price stability can be undermined by

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public perceptions that keeping unemployment at an unrealistically low level is an overriding goal of monetary policy. Such perceptions can lead the public to expect an inflationary monetary policy even when the central bank announces its commitment to price stability.

Moreover, the public's fear of an inflationary policy may be particularly acute if the central bank does not conduct policy according to a fixed rule but instead exercises judgment depending on a variety of economic variables. Exercising judgment in this way is often referred to as a discretionary policy procedure. A possible problem with this procedure is that what a central bank promises to do in the future may be inconsistent with what it in fact does when the time comes for it to act. For that reason, the problem arising from discretionary monetary policies is referred to as the time-inconsistency problem, which causes a related credibility problem for a central bank in convincing the public of its commitment to price stability.

Some economists have concluded from this line of reasoning that central banks should avoid discretion and be required to adopt monetary

growth rules that will relieve the public's anxiety about the prospect of inflationary monetary policy in the future. Recognizing the possible shortcomings of these monetary growth rules, other economists have proposed alternative solutions to the time-inconsistency and credibility problems faced by central banks.

This article argues that neither monetary growth rules nor other proposed solutions to the time-inconsistency problem are costless. The first section explains why discretionary conduct of monetary policy may make it difficult to establish the credibility of a central bank's commitment to price stability. The second section shows why monetary growth rules are not a costless solution to the credibility problem. And the third section demonstrates why alternative proposals are also problematical.

Time inconsistency and central bank credibility

The credibility problem arises if the public is skeptical about a central bank's intention to pursue noninflationary monetary policies. Individuals and businesses might be skeptical, for example, if they perceive that the central bank would like to lower unemployment temporarily below the rate that can be achieved in a noninflationary environment. Even if the public and the central bank understand that attempting to temporarily lower unemployment may not be successful and will result in permanently higher inflation that will damage the economy, the public may distrust a central bank's assertions that it will not succumb to this temptation to inflate. Ironically, the public's skepticism arises in large part because private citizens realize that they might well pursue such an inflationary policy if placed in the position of central bankers.[1]

The tradeoff between unemployment and inflation

Society and central banks would like to achieve both low inflation and low unemployment. Inflation is considered undesirable because it contributes to social strains by creating the perception that a market economy can lead to arbitrary and unfair redistribution of wealth. Moreover, inflation imposes real economic costs by causing an inefficient allocation of society's scarce resources.[2] Unemployment is considered undesirable because it means that an important scarce resource, labor, is being underutilized. Consequently, both unemployment and inflation reduce society's overall economic welfare.

But lowering unemployment and inflation simultaneously may not be possible in the short run. An unexpected expansionary monetary policy, for example, not only leads firms to hire more workers but also causes inflation to worsen as demand for output increases. The level of inflation is thus inversely related to the level of unemployment in the short run. This inverse relationship is embodied in the short-run Phillips curve, which shows that lowering unemployment is typically associated with higher inflation.

Over longer run periods, trying to keep unemployment low through expansionary macroeconomic policies also leads to higher inflation. Not only do prices of goods rise throughout the

[1] The seminal paper in the time-inconsistency literature is Finn Kydland and Edward Prescott, "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, June 1977, pp. 473-492. The idea was popularized by Robert Barro and David Gordon in "A Positive Theory of Monetary Policy in a Natural Rate Model," *Journal of Political Economy*, August 1983, pp. 589-610. Shortcomings of this literature are examined by Torsten Persson, "Credibility of Macroeconomic Policy: An Introduction and a Broad Survey," *European Economic Review*, 1988, pp. 519-532.

[2] For further discussion of the costs of inflation see Stanley Fischer, "The Benefits of Price Stability," *Price Stability and Public Policy*, proceedings of an economic symposium sponsored by the Federal Reserve Bank of Kansas City, 1984.

economy, but wages rise as well as labor contracts are renegotiated.

The amount of unemployment that is consistent with stable inflation is called the natural level of unemployment. Some unemployment is inevitable in a market economy in which workers are free to change jobs and take time off between jobs. The natural level of unemployment is thus positive.

The natural level of unemployment may nonetheless be above the socially optimal level of unemployment because of labor market distortions. Income taxes and social security taxes provide an example. Such taxes reduce workers' after-tax wages. By driving a wedge between what employers pay and what employees receive, income and social security taxes keep some workers from working as much as they otherwise would. As a result of such distortions, the level of unemployment that is consistent with stable inflation in the long run may well be higher than is socially desirable in a broader sense.[3]

Central banks and society thus face the dilemma of accepting undesirably high unemployment or lowering unemployment through inflationary monetary policies. The dilemma arises because society cannot achieve both of its major macroeconomic objectives simultaneously. One or the other must be sacrificed unless labor market imperfections are eliminated.

Moreover, a central bank cannot lower unemployment by pursuing inflationary policies that are fully anticipated by firms and workers. Firms decide how many workers to hire based on the real, or inflation-adjusted, wage they must pay. Similarly, workers decide whether to take a job based on the real purchasing power of the wages they are offered. Inflation that is fully anticipated would thus not alter employment decisions. Instead, anticipated inflation merely lowers social welfare because of the associated inefficiencies without any compensating reduction in unemployment.

The only way for a central bank to lower unemployment is to pursue monetary policies that cause inflation to rise unexpectedly.[4] If workers and firms initially expect no inflation and enter into long-term wage contracts based on this expectation, an unexpected rise in inflation can change the real wage and thus the level of employment. To see how a central bank can lower unemployment by generating surprise inflation, consider the labor market diagram in Figure 1. The real wage is measured along the vertical axis, and the employment level is measured along the horizontal axis. The real wage is the nominal wage (W) deflated by the price level (P). The labor demand curve, D_1, shows the amount of labor that firms want to hire at any given real wage. It slopes downward and to the right because firms want to hire more workers as the real wage falls, that is, as labor becomes cheaper. The labor supply curve, S_1, shows the amount of labor that workers want to supply at any given real wage. It slopes upward and to the right because more individuals

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[3] Income taxes reduce the amount of pay that workers take home but also provide revenue for government services. Given a certain tax level, workers will collectively choose to supply labor along a given labor supply curve, and overall employment will be at its natural level. Any individual worker, however, would prefer that overall employment be greater than this natural level because tax revenues, and hence government services, would be correspondingly higher. Individual workers will not increase their work effort, however, because they would view the increased government services resulting from this effort as negligible. Consequently, the higher level of "optimal" employment will not be achieved.

Other labor market features that impede the attainment of optimal employment (though not necessarily strictly within the context of the above model) include skill mismatches, location mismatches, institutional barriers, imperfect information flows, and transfer payment disincentives. For discussion, see Stuart E. Weiner, "The Natural Rate of Unemployment: Concepts and Issues," *Economic Review*, Federal Reserve Bank of Kansas City, January 1986, pp. 11-24.

[4] This description follows Kydland and Prescott, "Rules Rather Than Discretion . . . ."

FIGURE 1
The labor market
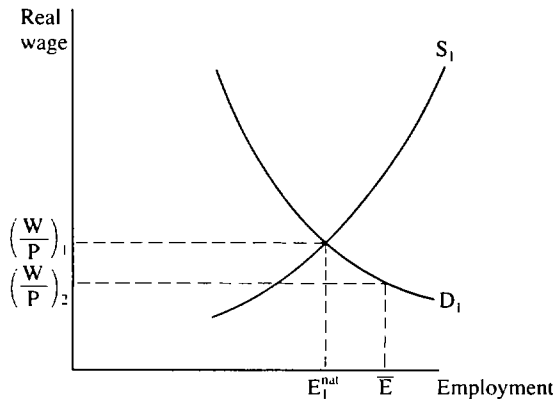
want to work as the real wage rises, that is, as workers are paid more.

Assume that workers and firms enter into a contract in which workers are paid a fixed nominal wage over a certain period of time. Workers and firms agree on this nominal wage without knowing the future price level. Once the actual price level is known, firms decide how much labor to employ based on the resulting real wage. By assumption, workers are obligated to supply this labor according to the terms of the labor agreement. Thus, the level of employment is determined by the demand for labor by firms.[5]

Suppose that the nominal wage agreed on and the associated price level yield a real wage of $(\frac{w}{p})_1$. At this real wage, the labor demand and labor supply curves intersect, so the amount of

labor demanded is equal to the amount of labor supplied. Firms are on their labor demand curve, and workers are on their labor supply curve. The resulting employment level, denoted E_1^{nat}, is called the "natural level of employment." It is the employment counterpart to the natural level of unemployment discussed above.

A central bank that is allowed discretion in conducting policy can temporarily raise employment by generating surprise inflation through an unexpected increase in the money supply. Suppose that some labor market distortion, such as income taxes, causes the natural level of employment to be below the optimal level of employment (and, correspondingly, causes the natural level of unemployment to be above the optimal level of unemployment). A central bank could increase employment to the optimal level by unexpectedly pursuing an inflationary monetary policy. The unexpected rise in the price level would lower real wages because nominal wages are assumed to be fixed. In Figure 1, the real wage would decline from $(\frac{w}{p})_1$ to $(\frac{w}{p})_2$, and employment would rise from E_1^{nat} to $\bar{E}$.

The rise in employment will only be temporary, however, because workers are supplying more labor than they want to. Workers are not on their labor supply curve. If workers believe that higher prices will continue, they will compensate by negotiating higher nominal wages in the next contract negotiation. The real wage will eventually retrace its path, settling again at $(\frac{w}{p})_1$. In the end, the price level will be higher, nominal wages will be higher, and employment will be back at the natural level.

The temptation to inflate

The discussion above demonstrates that a central bank can temporarily increase employment by generating surprise inflation. This possibility causes a credibility problem for the central bank and can introduce an inflationary bias into

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[5] This assumption that employment is demand-determined is reasonable for unionized U.S. labor markets and follows that of Jo Anna Gray, "Wage Indexation: A Macroeconomic Approach," *Journal of Monetary Economics*, April 1976, pp. 221-235.

monetary policy.[6] Even if a central bank announces a strict anti-inflation policy and has every intention of adhering to it, the central bank has an incentive to renege once nominal wages are fixed. This temptation to inflate once nominal wages are set is the essence of the time-inconsistency problem. Workers and firms understand the central bank's incentives and are thus skeptical about its policy announcements. Lacking credibility, the central bank is unable to increase employment and, indeed, must tolerate higher inflation to maintain existing employment.

To understand this argument, consider again the firms and workers depicted in Figure 1. Suppose the central bank announced that it would not inflate and that workers and firms negotiated a nominal wage expected to yield a real wage of $(\frac{W}{P})_1$ and a corresponding employment level of E_1^{nat}. With the nominal wage fixed, the central bank would now have an incentive to renege on its anti-inflation promise. By driving prices higher and real wages lower, the central bank is able to attain a higher level of employment, say $\bar{E}$. Workers and firms recognize this ability, however, and in fact would not agree to a nominal wage that permits it to happen. Rather, expecting inflation, workers and firms will negotiate a higher nominal wage that compensates for the expected inflation. The central bank will then have to inflate just to ensure that the real wage does not go *above* $(\frac{W}{P})_1$ and employment go *below* E_1^{nat}. The end result is higher inflation with no compensating reduction in unemployment.

In summary, the time-inconsistency and credibility problems arise when the public comes to doubt a central bank's commitment to price stability. The doubt arises when the public believes the central bank can and will sacrifice price stability in order to lower unemployment, even if only temporarily. A central bank can do so if it conducts monetary policy using discretion rather than rules and if real wages and thus employment are affected by unexpected inflation. A central bank may be willing to make the trade-off if labor market distortions make it impossible to achieve the socially desirable level of employment without creating unexpected inflation. Recognizing the incentive to promise low inflation but deliver high inflation, the public could become skeptical of a central bank's commitment to price stability. Such skepticism would lead workers and firms to expect inflation in the future and seek to protect themselves by building an inflation premium into wage contracts. When this occurs, the inflation expectations become a self-fulfilling prophecy. This process may be reversed if the central bank follows a monetary policy restrictive enough to cause unemployment to remain high long enough to change the public's expectations.[7] Lack of central bank credibility can thus result in either higher inflation, higher unemployment, or both. For this reason, it is important to analyze how monetary policy can be conducted to maintain public confidence in the central bank's commitment to price stability.

Caveats

The assumption that a central bank is perceived as wanting to keep unemployment artificially low is a critical element in the argument that central banks face a serious credibility problem. If,

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[6] A government might also be tempted to inflate for reasons other than generating employment gains. See, for example, Kenneth Rogoff and Anne Sibert, "Elections and Macroeconomic Policy Cycles," *Review of Economic Studies,* February 1988, pp. 1-16, and Guillermo Calvo, "On the Time Consistency of Optimal Policy in a Monetary Economy," *Econometrica,* November 1978, pp. 1411-1428.

[7] This is the conclusion reached by David Backus and John Driffill, "Rational Expectations and Policy Credibility Following a Change in Regime," *Review of Economic Studies,* April 1985, pp. 211-222. If the private sector is uncertain of the preferences of the central bank, it may revise its beliefs about the credibility of the bank after observing the bank carrying out an anti-inflation policy.

instead, it is assumed that the public believes monetary policy is directed toward maintaining price stability and keeping the unemployment rate near the natural level, the conclusion that central banks face a serious credibility problem is much weaker. Indeed, one study in the professional literature shows that the credibility problem vanishes if the public believes the central bank's objectives do not include keeping the unemployment rate below the natural level.[8]

The authors of this important study do not attempt to provide a compelling case for why a central bank would try to reduce unemployment below the natural level. Rather, they conjecture that the socially desirable unemployment level is probably below the natural level due to labor market distortions of the type described above. That the unemployment level is kept above the socially desirable level by various microeconomic distortions does not in itself prove, however, that the central bank would be perceived as trying to remedy the problem through macroeconomic policy. It might be argued, for example, that the public and the central bank would both recognize the advisability of using policies other than monetary expansion to compensate for distortions in labor markets.

The extent to which central banks do try to keep unemployment below the natural level may well vary. The institutional arrangements of and legislative mandates for central banks vary widely. Such variation may lead some central banks to have different priorities than others. Moreover, the central bank of any particular country may emphasize certain goals more in some circumstances than in others, leading the public's skepticism about the central bank's commitment to control inflation to vary accordingly.

For these and other reasons, the conclusions of the time-inconsistency literature have by no

means been universally accepted. No consensus has emerged on the practical importance of the time-inconsistency problem in explaining inflation in industrial countries. In addition, some ambiguities remain in the fundamental analysis, and several theoretical issues are unresolved.[9] Nevertheless, this literature does provide insight into the potential inflationary bias of a society and its central bank. And it provides insight into the importance of credibility.

Monetary growth rules

The principal conclusion of the central bank credibility literature is that central banks will tend

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[8] See Barro and Gordon, "A Positive Theory . . . . "

[9] One unresolved issue involves the compatibility of social welfare with individual preferences. The time-inconsistency problem assumes that social welfare depends negatively upon deviations from optimal levels of employment and inflation. Thus, social welfare must be increasing in unanticipated inflation (until the optimal level of employment is reached) and decreasing in actual inflation. However, it is not obvious that this is the case. One reason is that unanticipated inflation may be costly as well as beneficial. Suppose, for example, that suppliers see their own prices rise before they observe that the general price level has risen. Then they may incorrectly conclude that the demand for their product has increased, and they may produce more than they would if their information was perfect. Another problem is that it is not clear that economic welfare is decreasing in actual inflation. The usual arguments for why this is the case are that the tax system must be changed and individuals must hold higher money balances. However, in the above arguments, it is expected inflation rather than actual inflation that is costly. For discussion, see Robert Lucas, "Expectations and the Neutrality of Money," *Journal of Economic Theory*, April 1972, pp. 103-124, and Herschel Grossman, "A General Model of Monetary Policy, Inflation, and Reputation," mimeo, 1987.

A second unresolved issue involves labor market distortions. The root of the time-inconsistency problem is the tax-induced distortions in the labor market that keep employment below its socially optimal level. But these distortionary taxes finance public goods. Suppose that at the natural level of employment tax revenue is below the socially optimal amount. Then the government will want to increase revenues. Should it do this by increasing or decreasing employment? It may be that less employment at a higher real wage leads to increased tax revenues. Thus, the government may not wish to inflate. See Alex Cukierman and Allan Drazen, "Do Distortionary Taxes Induce Policies Biased Towards Inflation? A Macroeconomic Analysis," Tel-Aviv University, August 1986.

to adopt inflationary policies unless a way can be found to limit their discretion. A rule that limits the central bank's discretion might seem an obvious solution to the credibility problem. And, indeed, rules placing constraints on monetary growth have been proposed. Unfortunately, some of the features of such rules are themselves problematical.[10]

One proposed solution to the central bank credibility problem is for the central bank to adopt a strict constant growth rate rule. Under such a rule, the central bank would be required to keep the money supply growing at a constant rate every year. The central bank could never exercise discretion to vary this growth rate.

The principal appeal of the strict constant growth rate rule is that it does in fact solve the central bank credibility problem. Although the central bank still has an incentive to inflate when nominal wages are fixed, it can no longer act on that incentive. The central bank does not have the discretion to make policy changes. Because workers and firms know the central bank must adhere to the rule, they know that the central bank cannot generate surprise inflation. Thus, the credibility problem is solved.

The principal drawback of the strict constant growth rate rule is that it prevents a central bank from responding to various shocks that occasionally disrupt the economy. These shocks—either to the supply of goods and services (supply shocks) or to the amount of money that individuals wish to hold (money demand shocks)—lead firms to employ fewer workers, causing employment to decline below its natural level. An example of a supply shock is a drought. An example of a money demand shock is a financial crisis that increases the demand for liquid assets. (See box on page 11.) Such shocks impose a cost on an economy because they reduce employment, and adherence to a constant growth rate rule would not allow monetary policy to be eased to offset these costs. The results of a strict constant growth rate rule are summarized in row 1 of Table 1.[11]

An alternative to this strict constant growth rate rule is a more flexible rule that permits the central bank to respond to supply shocks but not to money demand shocks. Under such a rule, the central bank would be required to keep the money supply growing at a constant rate unless the economy experienced a supply shock. If a supply shock occurred, the central bank could accommodate it by increasing the rate of monetary growth. If a money demand shock occurred, in contrast, the central bank could not exercise such discretion.

Liberalizing the strict constant growth rate rule in this way does not reintroduce the credibility problem. Supply shocks such as droughts can be recognized by workers and firms. As a result, the central bank could never falsely claim that it had expanded the money supply to accommodate a supply shock when its real intention was to generate surprise inflation. It is assumed that the public can discriminate between actual and alleged supply shocks.[12] Hence, the credibility problem remains solved, and there are no costs incurred because of the inability to accommodate supply shocks. The costs of not accommodating money demand shocks remain, however. The results of this constant growth rate rule adjusted for supply shocks are summarized in row 2 of Table 1.

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[10] These rules are described by Matthew Canzoneri in "Monetary Policy Games and the Role of Private Information," *American Economic Review*, December 1985, pp. 1056-1070.

[11] These results extend to more complicated average targeting and feedback rules. See Anne Sibert, "Notes on Time-Inconsistency," unpublished notes, 1988.

[12] Supply shocks cannot always be easily identified. Productivity shocks, for example, are difficult to detect.

TABLE 1
Monetary growth rule solutions to the central bank credibility problem

Solution	Economy is shock free	Economy is subject to supply shocks	Economy is subject to both supply shocks and money demand shocks
	(1)	(2)	(3)
1. Strict constant growth rate rule	Problem solved Solution costless	Problem solved Solution costly	Problem solved Solution costly
2. Constant growth rate rule adjusted for supply shocks	Problem solved Solution costless	Problem solved Solution costless	Problem solved Solution costly
3. Constant growth rate rule adjusted for supply and money demand shocks	Problem solved Solution costless	Problem solved Solution costless	Problem remains

A third approach, of course, is to adopt a growth rate rule that permits the central bank to accommodate both supply shocks and money demand shocks. Under such a rule, the central bank would be forced to keep the money supply growing at a constant rate unless the economy experienced a supply shock or a money demand shock. The central bank would have the freedom to accommodate whatever shock occurred by altering the growth of money. The chief appeal of this rule is that it would eliminate the employment and output losses associated with not reacting to money demand shocks. The chief drawback of this rule is that the credibility problem reappears.

The credibility problem reappears because, unlike supply shocks, money demand shocks cannot typically be identified by the public.[13] An increase in the preference of individuals for more

liquid assets, for example, cannot easily be inferred except from empirical estimation of money demand functions. As a result, the central bank and the public must forecast money demand. Assuming that the central bank's forecast is not publicly available, the central bank will once again have an incentive to generate surprise inflation, claiming that it expanded the money supply on the mistaken belief that money demand had increased. And awareness on the part of workers and firms of this incentive may cause them to be skeptical of the central bank's claim that its empirical estimates indicate that the money demand function has shifted.

In effect, this constant growth rate rule adjusted for supply and money demand shocks is not really a rule at all. It is rather an arrangement that permits considerable discretion to the central bank. The central bank is free to change monetary growth in response to whatever real or imagined shock. There are no effective limitations on the central bank's actions. The results of such a rule are shown in row 3 of Table 1.

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[13] Canzoneri makes this point in "Monetary Policy Games . . . ."

Economic Shocks

An economy is typically subjected to a variety of random shocks. Two common shocks are supply shocks and money demand shocks. How monetary policy reacts to such shocks is the focus of much attention in the credibility literature.*

A supply shock, as the name would indicate, is some development that disrupts the supply of goods and services. Examples of supply shocks include an oil embargo, a crop failure, or a decline in labor productivity. When an economy experiences a supply shock, employment typically declines. How far it declines depends in part on how the central bank responds.

Figure 2 shows the labor market in the presence of a supply shock. Before the shock, workers and firms are assumed to be on their labor supply (S_1) and labor demand (D_1) curves, respectively, with the real wage at $(\frac{W}{P})_1$ and employment at its natural level, E_1^{nat}. Now a shock occurs—OPEC, for example, institutes an oil embargo that forces the price of oil much higher. As the price of oil rises, the demand for labor will fall because firms will want to scale back production. This decline in the demand for labor is represented in Figure 2 as a leftward shift in the labor demand curve, from D_1 to D_2.

What happens to employment? Employment falls to $\overline{\overline{E}}$, and workers are forced off their supply curve. Note that $\overline{\overline{E}}$ is below the new natural level of employment, E_2^{nat}. Employment will remain at $\overline{\overline{E}}$ until the real wage declines.

As new contracts are negotiated, the real wage will decline because workers will come to realize that nominal wage restraint is necessary if employment is to rise. However, the process could be long and hard. An alternative way to get employment at its new natural level is for the central bank to "accommodate" the supply shock. It does this by increasing the money supply, which in turn causes a rise in prices and a decline in

## FIGURE 2

The labor market in the presence of a supply shock
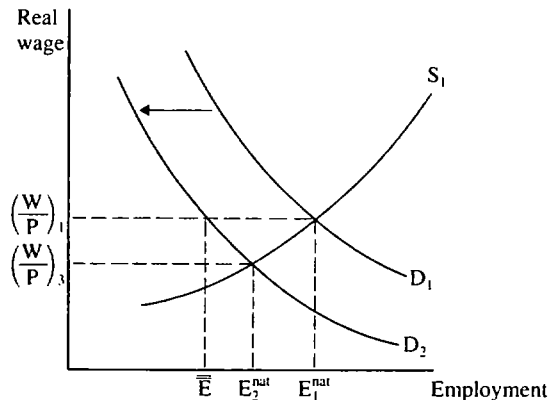
the real wage. The right amount of accommodation will lower the real wage to $(\frac{W}{P})_3$ and raise employment to E_2^{nat}.

A money demand shock is different. Such a shock occurs when—for reasons unrelated to changes in income or inflation—the public decides to hold more or less of its assets in the form of money.

Figure 3 shows the labor market in the presence of a money demand shock. Before the shock, workers and firms are assumed to be on their labor supply (S_1) and labor demand (D_1) curves, respectively, with the real wage at $(\frac{W}{P})_1$—and employment at its natural level, E_1^{nat}. Now a money demand shock occurs—households, for example, decide to sell some stocks and want to hold the proceeds in checking accounts. Because the supply of money has not changed, the amount of money now available to facilitate everyday transactions has declined. As a result, the price level falls and the real wage rises, to $(\frac{W}{P})_4$. At this higher real wage, firms want to hire fewer workers, so employment falls to $\widetilde{E}$ and workers

FIGURE 3
FIGURE 3
The labor market in the presence of a money demand shock
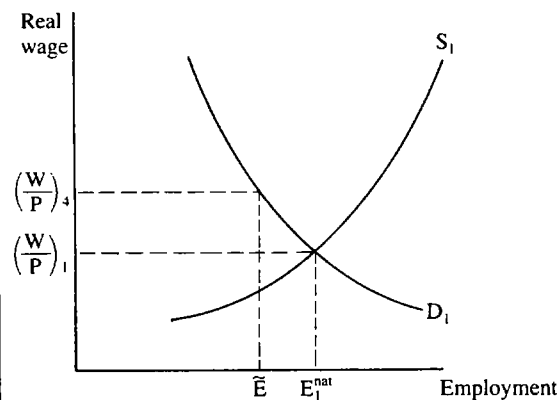
are again forced off their labor supply curve. Note that $\tilde{E}$ is below the natural level of employment, E_1^{nat}. Employment will remain at $\tilde{E}$ until the real wage declines.

As in the supply shock case, when an economy experiences a money demand shock, the central bank can take steps to ensure a speedy return to the natural level of employment. Specifically, it can increase the money supply, which causes a rise in prices and a decline in the real wage. The right amount of such accommodation will lower the real wage back to $(\frac{W}{P})_1$ and raise employment back to E_1^{nat}. Thus given some discretion, the central bank can offset disruptive shocks.

*The discussion here and in the text focuses on negative shocks; that is, shocks that potentially cause output and employment losses. Positive shocks, in contrast, potentially cause output and employment gains.

The main message of this discussion of monetary growth rules is summarized in column 3 of Table 1: In a realistic economic environment, one subject to both supply shocks and money demand shocks, either a credibility problem will remain or a solution will be costly.

Alternative solutions

Because of the problems inherent in monetary growth rules, alternative solutions to the central bank credibility problem have been proposed. These proposals do not limit the degree of central bank discretion but, rather, alter the environment in which the bank operates. Such proposals include wage indexation, a conservative central bank, and long-term relationships. A common feature of all is that they, too, are problematical.

Wage indexation

One possible solution to the credibility problem is to rely on wage indexation. Wage indexation ties nominal wages to the price level, so that nominal wages rise in line with the overall price level. Wage indexation typically takes the form of cost-of-living allowances (COLAs) in labor agreements.

Wage indexation can be either complete or partial. Complete indexation offers workers full protection against price increases: If prices rise 1 percent, nominal wages rise 1 percent, leaving the real wage unchanged. Partial indexation offers workers partial protection: If prices rise 1 percent, nominal wages rise less than 1 percent, causing some reduction in the real wage. As potential solutions to the central bank credibility problem, complete indexation and partial indexation possess different attributes.

Complete wage indexation would solve the credibility problem. A central bank would have no incentive to generate surprise inflation because expansionary monetary policy could not lower unemployment, even temporarily. Any increase in prices brought on by the central bank would be fully reflected in higher nominal wages. The

TABLE 2
Alternative solutions to the central bank credibility problem

Solution	Economy is shock free	Economy is subject to supply shocks	Economy is subject to both supply shocks and money demand shocks
	(1)	(2)	(3)
1. Complete wage indexation	Problem solved Solution costless	Problem solved Solution costly	Problem solved Solution costly
2. Partial wage indexation	Problem remains	Problem remains	Problem remains
3. Conservative central bank	Problem solved Solution costless	Problem solved Solution costly	Problem solved Solution costly
4. Long-term relationships	Problem solved Solution costless	Problem solved Solution costless	Problem solved Solution costly

real wage and the level of unemployment would remain unchanged. The central bank would thus have no incentive to pursue inflationary policies. Accordingly, the public would find a central bank's assurances of its commitment to price stability entirely credible.

Complete wage indexation would leave workers vulnerable to supply shocks, however. As noted in the previous section, a supply shock causes employment to fall below its natural level, and employment will remain below its natural level until the real wage is permitted to fall. With complete wage indexation, the real wage cannot fall. Thus, as noted in row 1 of Table 2, complete wage indexation would be costly because it would lead to higher unemployment by preventing real wages from adjusting to supply shocks.[14]

Partial wage indexation, in contrast, would allow greater flexibility of real wages but would not solve the credibility problem. Because the real wage would decline somewhat whenever prices rose, a central bank could temporarily raise employment by generating surprise inflation.

Recognizing the ability of the central bank to affect real wages and thus employment, the public would be skeptical about the central bank's commitment to price stability. This point is noted in row 2 of Table 2.

Conservative central bank

A second proposed solution to the credibility problem is that of a conservative central bank. A conservative central bank can be defined as one that dislikes inflation more than society does. Such a central bank will be less inclined to generate surprise inflation in an attempt to increase employment beyond its natural level. Thus, the credibility problem will be solved. However, this solution is not costless because this same central bank might also be less willing to accommodate supply shocks by increasing the rate of monetary growth. If so, employment and output would be lost.[15]

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[14] For further discussion, see Gray, "Wage Indexation . . . . "

[15] See Kenneth Rogoff, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, November 1985, pp. 1169-1189.

This discussion is moot, however, if inflation-averse central bankers cannot be appointed. The only way to ensure that they can be appointed is to have the central bank independent of the rest of government. That is, an institutional framework needs to be established that allows the central bank to operate free of political pressure. To some extent, such a framework is in place in the United States as well as other industrialized countries. The results of this conservative central bank solution are shown in row 3 of Table 2.

Long-term relationships

A final proposed solution to the credibility problem involves long-term relationships. The central bank credibility problem might be avoided or at least reduced if the relationship between a central bank and the private sector is a lasting one. Specifically, if the actions of the central bank affect the expectations of the private sector about the future, the central bank must weigh not only the direct costs and benefits of inflation but also the impact of such inflation on inflationary expectations. If current inflation leads to a sufficient worsening of inflationary expectations, the central bank may not have an incentive to inflate in the current period.[16]

Economists have developed formal models to capture the effect of central bank actions on inflation expectations. Suppose that the private sector has the following beliefs. If the central bank has never inflated more than the socially optimal amount, excess inflation is not expected. But if the central bank ever does generate surprise inflation, excess inflation will be expected for a certain amount of time in the future. Given these

beliefs, the central bank can increase employment in the short run. But the cost of doing so is higher inflation—with no accompanying employment gain—for some time in the future. If society and the central bank care enough about the future, these long-run costs may deter the central bank from generating surprise inflation.[17]

In a world free of money demand shocks, this deterrent effect of the public's inflation expectations would solve the credibility problem. Unfortunately, the world is not free of money demand shocks. Moreover, such shocks are not directly observable and, hence, must be forecasted by the central bank. As a result, when the private sector observes excess inflation, it does not know whether the central bank inadvertently inflated by incorrectly forecasting money demand or deliberately inflated in an attempt to increase employment.

But the credibility problem may still be solved, albeit at a cost. Suppose, for example, that as long as inflation remains below a certain trigger level the private sector will not expect inflation but that if inflation rises above this trigger level inflation will be expected for some time in the future. As in the previous scenario, if society and the central bank care enough about the future, the central bank may decide not to deliberately generate surprise inflation. However, because of unobserved money demand shocks, accidental inflation could arise. And if this accidental inflation exceeds the target level, the public will raise its inflation expectations. One would thus observe periods of costly excess inflation interspersed with

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[16] For further discussion, see William Fellner, *Towards a Reconstruction of Macroeconomics*, American Enterprise Institute, 1976, and William Fellner, "The Credibility Effect and Rational Expectations: Implications of the Gramlich Study," *Brookings Papers on Economic Activity*, 1:1979, pp. 167-178.

[17] This model is due to Robert J. Barro and David Gordon, "Rules, Discretion, and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, July 1983, pp. 101-121, and based on a game theory model developed by James W. Friedman, "A Noncooperative Equilibrium for Super-games," *Review of Economic Studies*, January 1971, pp. 1-12. Strictly speaking, in the Barro and Gordon model, the credibility problem is not fully solved but rather lessened.

periods of little or no inflation.[18] The characteristics of this long-term relationship are summarized in row 4 of Table 2.

This framework of a long-term relationship appears to provide some insight into developments in the United States in the 1970s and 1980s. Some economists would argue that the Federal Reserve pursued an overly expansionary monetary policy in the 1970s in an attempt to keep unemployment below its natural level. Others would argue that monetary policy was inadvertently expansionary because the Federal Reserve had imprecise information about supply shocks, money demand shocks, and changes in the natural level of unemployment.[19] For whatever reason, inflation and inflation expectations rose dramatically. By announcing a strict anti-inflation policy in 1979 —and then following through in the 1980s—the Federal Reserve has been able to reduce inflation and inflation expectations equally dramatically. The Federal Reserve in recent years has thus reestablished a good deal of credibility by recognizing that bringing inflation down can be worthwhile in the long run despite the short-run costs of doing so. Conducting monetary policy in a way that takes account of the long-term relationship between a central bank and the private sector may therefore be the best hope for maintaining the credibility of the central bank's commitment to price stability.[20]

Summary

Some economists believe that one important cause of higher inflation in the 1970s was central banks' attempt to keep unemployment at unrealistically low levels. If so, central banks' credibility in convincing the public of their commitment to price stability was tarnished. This article has explored the options available to central banks in maintaining their credibility.

The article has argued that, to the extent a credibility problem exists, solutions to the problem are themselves problematical. There are no costless ways to maintain the credibility of a central bank's commitment to price stability. Monetary growth rules remove too much discretion from a central bank operating in an environment in which financial innovation and deregulation create uncertainty about money demand and in which supply shocks can intermittently cause employment losses that perhaps should be offset by monetary policy. Nor are wage indexation and conservative central banks panaceas.

Perhaps the most promising approach is for the central bank to conduct policy in a way that takes account of the long-term nature of its relationship with the public. Even this approach has problems, however. Once inflation expectations have become imbedded in economic decisions as in the late 1970s, disinflation is likely to be accompanied by a temporary rise in unemployment until inflation expectations abate. Despite the proliferation of research analyzing the time-inconsistency and credibility problems, therefore, economists have not been able to discover a foolproof substitute for vigilance against inflation for maintaining central bank credibility.

[18] This model is due to Canzoneri, "Monetary Policy Games . . . ," and based on a model developed by Edward Green and Robert Porter in "Noncooperative Collusion Under Imperfect Price Information," Econometrica, January 1984, pp. 87-100.

[19] For further discussion of supply shocks, money demand shocks, and changes in the natural level of unemployment in the 1970s and 1980s, see Robert J. Gordon, Macroeconomics, 4th edition, Little, Brown and Company, 1987, pp. 295-301; Stanley Fischer, "Monetary Policy and Performance in the U.S., Japan, and Europe, 1973-86," NBER Working Paper No. 2475, December 1987, and Stuart E. Weiner, "The Natural Rate of Unemployment . . . ," respectively.

[20] Herb Taylor comes to a similar view in "Time Inconsistency: A Potential Problem for Policymakers," Business Review, Federal Reserve Bank of Philadelphia, March/April 1985, pp. 3-12.