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THE EXPECTATIONS TRAP HYPOTHESIS

Lawrence J. Christiano and Christopher Gust*

Abstract: We explore a hypothesis about the take-off in inflation that occurred in the early 1970s. According to the expectations trap hypothesis, the Fed was pushed into producing the high inflation out of a fear of violating the public's inflation expectations. We compare this hypothesis with the Phillips curve hypothesis, according to which the Fed produced the high inflation as an unfortunate by-product of a conscious decision to jump-start a weak economy. Which hypothesis is more plausible has important implications for what needs to be done to prevent other inflation flare-ups.

Keywords: 1970s inflation, Arthur Burns, monetary policy, Taylor rule.

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Introduction and summary

Many countries, including the U.S., experienced a costly, high inflation in the 1970s. This article reviews some research devoted to understanding why it happened and what can be done to prevent it from happening again.

We take it for granted that the high inflation was the result of high money growth produced by the U.S. Federal Reserve. But, to make sure that it does not happen again, it is not enough to know who did it. It is also necessary to know *why* the Fed did it. We hypothesize that the Fed was in effect pushed into producing the high inflation by a rise in the inflationary expectations of the public. In the language of Chari, Christiano, and Eichenbaum (1998), we say that when a central bank is pressured to produce inflation because of a rise in inflation expectations, the economy has fallen into an *expectations trap*. We call this hypothesis about inflation the expectations trap hypothesis.

We argue that the dynamics of inflation in the early 1970s are consistent with the expectations trap hypothesis. We describe two versions of this hypothesis. We also describe an alternative hypothesis, which we call the Phillips curve hypothesis. According to this hypothesis, inflation occurs when a central bank decides to increase money growth to stimulate the economy and is willing to accept the risk of high inflation that that entails. The expectations trap hypothesis and the Phillips curve hypothesis both maintain that high inflation is a consequence of high money growth. Where they differ is in the motives that they ascribe to the central bank.

Much of our analysis assessing the various hypotheses about inflation is based on an informal review of the historical record. We supplement this discussion by studying a version of the expectations trap hypothesis using a general equilibrium, dynamic macroeconomic model. There are two reasons that we do this. First, we want to demonstrate that the expectations trap hypothesis can be integrated into a coherent view of the overall macroeconomy.¹ Second, we want to document that that hypothesis has the potential to provide a quantitatively realistic account for the 1970s take-off in inflation.

The model we use is the limited participation model studied in Christiano and Gust (1999).² It requires a specification of monetary policy in the 1970s, and for this we use the policy rule

estimated by Clarida, Gali, and Gertler (1998). The account of the early 1970s that we produce using the model posits that a bad supply shock (designed to capture the various commodity shortages of the early 1970s) triggered a jump in expected inflation, which then became transformed into higher actual inflation because of the nature of monetary policy. We find that, consistent with the data, the model predicts stagflation. We view this result as supportive of the expectations trap hypothesis.

We compare our model with an alternative quantitative model of the 1970s inflation proposed by Clarida et al. That model can also explain the rise in inflation in the 1970s as reflecting a self-fulfilling increase in inflation expectations. It is a sticky price, rational expectations version of the IS–LM model.³ When we use that model to simulate the 1970s, we find that it is inconsistent with the observed stagflation of the time. It predicts that the rise in expected and actual inflation triggered by a bad supply shock is associated with a sustained *rise* in employment. We conclude that the limited participation model provides a better account of the high inflation of the 1970s than does the sticky price, IS–LM model with Clarida et al.’s representation of policy. This result is potentially of independent interest, since the latter model is currently in widespread use.

We begin with a description of the expectations trap hypothesis and what it implies for policy. Then, we review the 1960s and 1970s and provide an informal assessment of the expectations trap and Phillips curve hypotheses. We provide a quantitative evaluation of the expectations trap hypothesis using the limited participation model as a vehicle. We then provide an assessment of the Clarida et al. model.

What is an expectations trap?

We begin with an abstract definition of an expectations trap. We then describe two particular types of expectations traps. Finally, we ask, What is the ultimate cause of inflation under the expectations trap hypothesis?

The trap, defined

An expectations trap is a situation in which an increase in private agents’ expectations of inflation pressures the central bank into increasing actual inflation.⁴ There are different mechanisms by which this can happen. However, the basic idea is always the same. The scenario is initiated by a rise in the public’s inflation expectations. Exactly why their inflation

expectations rise doesn't really matter. What does matter is what happens next. On the basis of this rise in expectations, private agents take certain actions which then place the Fed in a dilemma: either respond with an accommodating monetary policy which then produces a rise in actual inflation or refuse to accommodate and risk a recession. A central bank that is responsive to concerns about the health of the economy could very well wind up choosing the path of accommodation, that is, falling into an expectations trap.

A cost-push trap and a working capital trap

We describe two versions of the expectations trap hypothesis, which differ according to the precise mechanism by which higher inflation expectations pressure the Fed into supplying more inflation. One mechanism, presented in Chari, Christiano, and Eichenbaum (1998), is similar to the conventional *cost-push* theory of inflation. We call it a cost-push expectations trap. Here is how it works. Higher inflation expectations lead people to demand, and receive, higher wage settlements. Firms are happy to pay the increased wages because, expecting a rise in the general price level, they think they can pass along the higher wage costs in the form of higher prices. This puts the Fed in the dilemma mentioned above. The Fed can produce the inflation everyone expects by raising money growth. Or, if it does not, it will put the economy through a recession. Under some circumstances, the Fed will not be willing to tolerate the recession and will feel compelled to produce inflation. In this case, the Fed ends up validating the original rise in inflation expectations. We call this hypothesis about inflation, the cost-push version of the expectations trap hypothesis.⁵

We shall see that this version of the expectations trap hypothesis encounters some difficulties explaining the high inflation of the 1970s. We now describe another version of this hypothesis, which does not have these problems.

The limited participation model of money, which is analyzed below, highlights a different mechanism by which an expectations trap can occur. We call this a *working capital* expectations trap. It relies on the assumption that firms must borrow funds in advance (acquire working capital) in order to finance some or all of the inputs needed to carry on production. Under these circumstances a high nominal interest rate has a negative impact on economic activity because it raises the cost of working capital. To see how this mechanism works, suppose, again, that there is a jump in inflation expectations. Private agents, correctly perceiving that the central bank is afraid of the negative output effects of high interest rates, anticipate that the higher future

inflation will be associated with low real interest rates. This leads them to cut back on saving, putting upward pressure on interest rates in the market for loanable funds. This places the central bank in a dilemma. If it keeps the money supply unchanged, then the higher expected inflation will not occur. However, the reduced saving would result in high interest rates. By drying up the supply of working capital, this would significantly slow the economy. A central bank that is concerned about the health of the private economy may prefer a second option: prevent a substantial rise in interest rates by injecting money into the economy. This has the effect of validating the initial jump in inflation expectations. Choosing this second option is another way to fall into an expectations trap. We call this hypothesis about inflation the working capital version of the expectations trap hypothesis.

Ultimate cause of inflation

Where, under the expectations trap hypothesis, does the ultimate responsibility for inflation lie? To answer this requires identifying the *cause* of the rise in inflation expectations. According to the expectations trap hypothesis, the cause lies with monetary institutions themselves. If, for example, the nature of those institutions is such that people cannot imagine a set of circumstances in which the central bank would accommodate a rise in inflation, then there is little reason for inflation expectations to suddenly jump. Expectations traps just couldn't happen.

To see this, imagine there is an oil shortage. Certainly, one might reasonably expect this to lead to a rise in the price level. Because of various lags, this rise might actually take place over a period of time, maybe even a year or two. But, there is nothing in conventional economic reasoning that would connect an oil shortage to the sustained, decade-long rise in prices that we call inflation. Anyone who inferred from a 10 percent jump in the price level in one year that prices would continue jumping like this and be 100 percent higher in ten years, would be viewed as a crank. Such a person would seem as foolish as the person who, seeing the temperature outside drop one degree from one day to the next, forecasts a drop in the temperature by 100 degrees over the next 100 days.

Now consider an economy whose monetary institutions are known to assign a high priority to output and employment. In addition, suppose that that economy's central bank has no way of credibly committing itself in advance to keeping money growth low. In a society like this, the idea that inflation could take off seems quite plausible. In such a society, even seemingly

irrelevant events could spark a rise in inflation expectations. For example, a person who revised upward their inflation forecast in the wake of an oil shock would now not necessarily seem like a crank. There are a number of ways they could back up their forecast with sensible economic reasoning. Such a person could use either of the two expectations trap arguments described above.

So, the expectations trap hypothesis lays responsibility for inflation with monetary institutions. To reduce the possibility of expectations traps, the institutions must be designed so that the central bank's commitment to fighting inflation is not in doubt. Under these circumstances, people participating in wage negotiations who profess to believe inflation is about to take off will be met with disbelief rather than a higher wage settlement.

How exactly monetary institutions should be designed to reduce the likelihood of an expectations trap is controversial. But, there is one point on which there appears to be agreement. The central banker at the very least should make a show of not being too concerned about the health of the economy. An example of this can be found in the reaction to a famous (or infamous) speech by the then vice-chairman of the Federal Reserve, Alan Blinder, at a conference in Jackson Hole, Wyoming, in 1994. In that speech, Blinder acknowledged that it is feasible for a central bank to influence unemployment and output. This generated an uproar. Many who objected probably did not do so because they thought what Blinder said was wrong. Instead, they simply thought it unwise that a central banker should let on that he thinks about such things.⁶ Why shouldn't he let on? One possibility—the one emphasized in the expectations trap hypothesis—is that the greater the apparent concern by the central bank for the real economy, the greater is the risk of falling into an expectations trap.

Background events

We provide a brief review of the basic economic events leading up to the high inflation of the 1970s. We argue that the data appear consistent with the hypothesis that the U.S. became ensnared in an expectations trap by the late 1960s and early 1970s. We then compare the expectations trap hypothesis about inflation with another hypothesis. According to that hypothesis, the Fed consciously produced the high inflation as a necessary, though unfortunate, byproduct of its aggressive attempts to stimulate the economy. We call this the *Phillips curve*

hypothesis, because it involves the Fed's attempts to exploit the Phillips curve. Finally, we look at the data to identify the economic consequences of the take-off in inflation in the early 1970s.

Events leading up to the 1970s: Setting the trap

An important part of the story of the inflation of the 1970s begins with the recession of the early 1960s. That recession helped bring the administration of John F. Kennedy into power. Kennedy brought with him the best and the brightest Keynesian minds of the time. The chairman of the Council of Economic Advisers (CEA) was the very distinguished Keynesian economist, Walter Heller. Members of the CEA included another distinguished Keynesian economist, the future Nobel laureate, James Tobin. Government policy was animated by the Keynesian conviction that if the economy was performing below its potential, then it was the responsibility of the government to use the fiscal and monetary policies at its command to restore it to strength. Figure 1 displays the federal funds rate and the growth rate of the monetary base, using annual data. Also exhibited are the years designated by the National Bureau of Economic Research to be periods of business cycle contraction (shaded area) and expansion (non-shaded area).⁷ The figure shows that the growth rate in the monetary base began to pick up in the early 1960s. The CEA also set to work to craft an expansionary fiscal policy, and one of the products of those efforts was the tax reduction legislation of 1964. Confidence in the feasibility and desirability of Keynesian stabilization policy soared with the long expansion of the 1960s.

Figure 2 shows that inflation started to pick up with a few years' delay, in 1965.⁸ As these observations suggest, that initial rise in inflation is probably not an example of an expectations trap. It is probably best understood in terms of the Phillips curve hypothesis: It was the consequence of expansionary monetary policy, deliberately undertaken to stimulate a weak economy. It is the dynamics of inflation after the initial uptick in the 1960s that appears to take on the character of an expectations trap.

Figures 1 and 2 show that inflation proceeded to hit three peaks, one in the early 1970s, one in early 1975, and the final one in late 1980. The initial pickup in inflation in the 1960s was noted with alarm by policymakers, who responded with a very sharp rise in the federal funds rate in 1969. This policy tightening is often credited with producing the 1970 recession. Policymakers expressed dismay that the inflation rate continued to be high, even as the economy

began to slide into recession (see figure 1). Arthur Burns, the chairman of the Federal Reserve at this time, said in a speech at Pepperdine College, Los Angeles, in December 7, 1970:

The rules of economics are not working in quite the way they used to. Despite extensive unemployment in our country, wage rate increases have not moderated. Despite much idle industrial capacity, commodity prices continue to rise rapidly. (Burns, 1978, p. 118)

The policy establishment became convinced that the underlying driving force of inflation was inflation expectations and that these expectations were all but impervious to recession. In a statement before the Joint Economic Committee of the U.S. Congress in 1971, Burns explained the role of inflation expectations as follows:

Consumer prices have been rising steadily since 1965—much of the time at an accelerating rate. Continued substantial increases are now widely anticipated over the months and years ahead. ... [I]n this environment, workers naturally seek wage increases sufficiently large ... to get some protection against future price advances. ... [T]houghtful employers ... reckon, as they now generally do, that cost increases probably can be passed on to buyers grown accustomed to inflation. (Burns, 1978, p. 126)

Policymakers understood that, in principle, inflation could be stopped with a sufficiently restrictive monetary policy, but they were concerned that the short-run costs, in terms of lost output, would be intolerable. In an appearance before the House of Representatives, Committee on Banking and Currency, July 30, 1974, Burns said:

One may therefore argue that relatively high rates of monetary expansion have been a permissive factor in the accelerated pace of inflation. I have no quarrel with this view. But an effort to use harsh policies of monetary restraint to offset the exceptionally powerful inflationary forces of recent years would have caused serious financial disorder and economic dislocation. That would not have been a sensible course for monetary policy. (Burns, 1978)

In remarks before the Seventeenth Annual Monetary Conference of the American Bankers Association, Hot Springs, Virginia, May 18, 1970, Burns elaborated on his views about the costs of relying on money growth alone (without, say, wage and price controls) to reduce inflation. He

thought the costs were so large that the strategy was fundamentally infeasible on political grounds. In his words,

There are several reasons why excessive reliance on monetary restraint is unsound. First, severely restrictive monetary policies distort the structure of production. General monetary controls, despite their seeming impartiality, have highly uneven effects on different sectors of the economy. On the one hand, monetary restraint has relatively slight impact on consumer spending or on the investments of large businesses. On the other hand, the homebuilding industry, state and local construction, real estate firms, and other small businesses are likely to be seriously handicapped in their operations. When restrictive monetary policies are pursued vigorously over a prolonged period, these sectors may be so adversely affected that the consequences become socially and economically intolerable, and political pressures mount to ease up on the monetary brakes. ...

An effort to offset, through monetary and fiscal restraints, all of the upward push that rising costs are now exerting on prices would be most unwise. Such an effort would restrict aggregate demand so severely as to increase greatly the risks of a very serious business recession. If that happened, the outcries of an enraged citizenry would probably soon force the government to move rapidly and aggressively toward fiscal and monetary ease, and our hopes for getting the inflationary problem under control would then be shattered. (Burns, 1978)⁹

Policymakers were so pessimistic about the prospects of getting inflation under control by restrictive monetary policy, that in August 1971 they turned to wage and price controls.

What happened after this may seem to be an embarrassment to the expectations trap hypothesis, particularly the cost-push version: Money growth continued to be high.¹⁰ According to the cost-push expectations trap hypothesis, high money growth is the Fed's response to inflationary wage and price contracts, which are themselves driven by inflation expectations. But, inflationary wage and price contracts became illegal during the wage and price control period, which lasted until 1973. So, this hypothesis seems to predict that money growth would have been low during the wage-price controls, not high.¹¹

The key to reconciling the expectations trap with this high money growth lies in interest rates. Policymakers were convinced that wage–price controls would not be politically feasible if interest rates were allowed to drift up. They thought that if this happened, the controls would be viewed as a cover for redistributing income from people earning wages and salaries to the (typically wealthy) people who earn interest. They feared that if this happened, then political support for the controls would evaporate, and inflation would take off again. So, policy was directed toward keeping the nominal interest rate about where it was before the severe monetary tightening of 1969 (see figure 3). It is interesting that it required such strong money growth to keep the interest rate at this level. A possible explanation is that this reflects the type of portfolio decisions emphasized in the working capital expectations trap hypothesis described earlier. That hypothesis predicts that, in the absence of high money growth, household portfolio decisions motivated by concerns about future inflation would drive up the rate of interest.

These considerations suggest to us that although the high money growth during wage–price controls may well be an embarrassment to the expectations trap hypothesis, it isn't necessarily so.

Policymakers started dismantling wage–price controls in 1973. They were once again surprised by the strength with which inflation took off. They had anticipated some inflationary pressure, and they raised rates sharply in this period (see figure 3). But, they were surprised at just how strong the rise in inflation was.¹² The increase in rates was greater than one measure of the rise in expected inflation (see figure 3). And, it just barely kept up with actual inflation (figure 4).¹³ Policymakers' resolve began to fade when output and investment started to show weakness in the middle of 1973 and hours worked began to soften in late 1973. They had indicated repeatedly that they were unwilling to countenance a severe recession in the fight against inflation. Their concerns about the recessionary costs of fighting inflation seemed credible since they appeared to have been confirmed by the experience of the 1970 recession. Moreover, the 1960s and 1970s were times when governments were expected to do good things for their citizens, and hurting a subset of them for the sake of curing a social problem seemed unfair and wrong.¹⁴ In an address before the joint meeting of the American Economic Association and the American Finance Association, on December 29, 1972, Burns expressed the general sense of the time:

Let me note, however, that there is no way to turn back the clock and restore the environment of a bygone era. We can no longer cope with inflation by letting recessions run their course; or by accepting a higher average level of unemployment. ...There are those who believe that the time is at hand to ... rely entirely on monetary and fiscal restraint to restore a stable price level. This prescription has great intellectual appeal; unfortunately, it is impractical. ... If monetary and fiscal policies became sufficiently restrictive to deal with the situation by choking off growth in aggregate demand, the cost in terms of rising unemployment, lost output, and shattered confidence would be enormous. (Burns, 1978)

So, toward late 1974, policymakers reversed course and adopted a loose monetary policy, driving interest rates down sharply, to turn the economy around. Note from figures 4 and 5 that real interest rates were negative or close to zero. Of course, as the economy entered the deep 1975 recession, inflation came down substantially anyway. But, the turnaround in monetary policy then had the implication that inflation would take off again as soon as the economy entered the expansion.¹⁵ Only later, in 1978 and 1979, did the Fed turn “tough” and consciously adopt a tight monetary policy until inflation came down (see how much higher the federal funds rate went in the early 1980s, and note how it stayed up—with the exception of a brief period of weakness in mid-1980—until after the inflation rate began to fall).

We interpret these observations as being consistent with the view that by the late 1960s and early 1970s, the U.S. economy had fallen into an expectations trap. Through their words and actions, policymakers sent two clear messages to the population:

- It is technically feasible for policymakers to stop inflation.
- The costs of doing so were greater than policymakers could accept.

Under these circumstances, it was perhaps reasonable for people to expect higher inflation. When wage–price controls began to be dismantled in 1973, it would have been reasonable for the public to think that there was now nothing left standing in the way of high inflation. Inflation expectations were even stronger than before. One indication of this is that actual inflation took much longer to begin falling during the 1974 recession than it did in the 1970 recession (see figure 3). Ironically, while policymakers expressed frustration with the public for the seeming intransigence of their inflation expectations, the true cause of that intransigence may have been

the nature of the monetary policy institutions themselves. This is the implication of the expectations trap hypothesis.

Phillips curve hypothesis

We now briefly consider the Phillips curve hypothesis about the take-off in inflation that occurred in the early 1970s. Like the expectations trap hypothesis, this hypothesis is also fundamentally monetarist in that it interprets the rise in inflation as reflecting an increase in money growth. It differs from the expectations trap hypothesis by highlighting a different set of motives on the part of the Fed. Policymakers believed the CEA estimates that output was below potential in 1971. Under the Phillips curve hypothesis, the Fed responded to this by adopting an aggressively expansionary monetary policy for the same sort of reasons that they appear to have done so in the early 1960s, to restore output and employment.

To see that the economy was below at least one measure of potential in 1991, consider the results in figures 6 and 7. Figure 6 displays quarterly data on (log) real gross domestic product (GDP) in the U.S. for the period 1966:Q1 to 1973:Q4. In addition, we report two estimates of potential GDP based on the Hodrick and Prescott (1997) filter.¹⁶ One is computed using data covering the period, 1948:Q1–1998:Q1. A possible problem with this is that by using currently available data we may overstate the estimate of potential GDP available to policymakers in the early 1970s. They would not have been aware of the slowdown in trend (that is, potential) GDP that started around that time (Orphanides, 1999). This motivates our second estimate of potential output, which is based only on data for the period 1948:Q1–1973:Q4. Note from figure 6 that the qualitative difference between the two estimates of potential is as expected. However, quantitatively, the difference in levels is quite small. The implied estimates of the output gap appear in figure 7.¹⁷ Note that the two sets of estimates virtually coincide through 1970, and then diverge a little after that. Each estimate implies that the gap in 1971 averaged around 2 percent.¹⁸

The 2 percent gap was substantial by historical standards (figure 7). Still, the notion that policymakers actively solicited higher inflation as a way to fight a weak economy conflicts sharply with the words of the chief monetary policymaker, Burns. Burns was very clear about his distaste for exploiting the Phillips curve for the sake of short-term gains. He certainly accepted the notion that policy could achieve higher output by increasing inflation. After all, his

fears about the consequences of fighting inflation with reduced money growth were fundamentally based on a belief in a short-term Phillips curve. His view, which corresponded to the one espoused by Milton Friedman (1968), was that attempts to exploit the Phillips curve for short-term gains would only produce more trouble in the long run.¹⁹ As he put it in testimony before Wright Patman's House Committee on Banking and Currency, July 30, 1974:

We have also come to recognize that public policies that create excess aggregate demand, and thereby drive up wage rates and prices, will not result in any lasting reduction in unemployment. On the contrary, such policies—if long continued—lead ultimately to galloping inflation, to loss of confidence in the future, and to economic stagnation. (Burns, 1978, p. 170)

It is hard to doubt the sincerity of these words. To Burns, an important lesson of the inflation of the 1970s was that price increases produced by temporary forces could lead to an intractable inflation problem later on. It would have taken an extraordinary amount of duplicity to, on the one hand, complain about the serious economic damage caused by past policy mistakes in not counteracting temporary forces, and on the other hand contribute to them himself.²⁰

Springing the trap

To evaluate our models, we require a simple characterization of what happened when the economy fell into the expectations trap in the early 1970s. For this, consider figures 8–10, which display the logarithm of real GDP, total hours worked in nonagricultural business, and business fixed investment, respectively. In addition, we display linear trends, computed using the data from the beginning of the sample to 1970:Q1, and extrapolated through the end of the sample. These lines draw attention to the trend change that occurred in these variables in the early 1970s. In addition, in each case we also fit a quadratic trend to the entire sample of data.

Consider the GDP data in figure 8 first. In this case, we have also included a linear trend fit to the data for the 1970s and extrapolated to the end of the sample. What is clear, by comparing the raw data with the two linear trends, is that the growth slowdown that started in the early 1970s became even more severe in the 1980s and the early 1990s. We infer from the fact that the slowdown persisted—even accelerated—in this period, that the inflation and other transient shocks that occurred in the early 1970s must have had little to do with it. Now consider hours worked in figure 9. Note how they take off beginning in the early 1970s, and how the growth

rate seems to just increase continuously throughout the following decades. Again, we infer from the fact that the growth rate continued to rise after the inflation stopped that the inflation and other temporary factors in the early 1970s were not a factor in this development. Finally, note that investment shows very little trend change in the 1970s (see figure 10). After a pause during the 1974–75 recession, investment returns to its former growth path. Investment does display weakness in the late 1980s and the 1990 recession. But after that, it grows again, returning to the pre-1970s trend line by 1997.

These trend changes in hours worked and output complicate our attempts to assess alternative explanations of the inflation of the 1970s. Ideally, we would like to remove the effect on the data reflecting the factors underlying the persistent change in trend, and study the remainder. We have not found a clean way to do this. The approach we take removes a quadratic trend from each variable and assumes that the result reflects the effects of the inflation and bad supply shocks of the early 1970s. The results are displayed in figures 11–13. In the 1974–75 recession hours worked fell to around 6 percent below trend, investment was down 11 percent, and output was down 3 percent. At the same time, inflation rose from 4 percent in 1972 to 10 percent by the end of the recession. The federal funds rate went from around 4 percent in 1972 to a peak of around 12 percent near the end of the recession. The episode is a classic stagflation, with inflation going up and the economy, down.

Models

We now report on a quantitative evaluation of the expectations trap hypothesis. For this, we need a mathematical representation of the way the central bank conducts monetary policy and of the way the private economy is put together. We describe two models of the private economy: the limited participation model of Christiano and Gust (1999) and the sticky price, IS–LM model of Clarida et al.²¹

Monetary policy rules

There is widespread agreement that the right way to model the Fed’s monetary policy is along the lines proposed by Taylor (1993, 1999a). He posits that the Fed pursues an interest rate target, which varies with the state of the economy. A version of this policy rule was estimated using data from the 1970s by Clarida et al. They estimated that the Fed’s monetary policy causes the actual federal funds rate, R_t , to evolve as follows:

$$1) R_t = rR_t + (1-r)R_t^*$$

In words, R_t is a weighted average of the current target value, R_t^* , and of its value in the previous period. By setting $\rho = 0$, the Fed would achieve its target, $R_t = R_t^*$ in each period. It might instead prefer $0 < \rho < 1$ if R_t^* exhibits more volatility than it wishes to see in the actual funds rate. The target interest rate is determined according to the following expression:

$$2) R_t^* = \text{constant} + \alpha E_t \log(P_{t+1}) + \gamma y_t, \quad P_{t+1} = \frac{P_{t+1}}{P_t},$$

where P_t is the price level, E_t is the date t conditional expectation, and y_t is the percent deviation between actual output and trend output. The estimated values of ρ , α , and γ are 0.75, 0.8, and 0.44, respectively. We use these parameter values in our analysis.²²

The idea is that a tough central banker who is committed to low inflation would adopt a rule with a large value of α . A central banker that is less able to commit to low inflation would have a low value of α . Clarida et al.'s estimate for the 1970s is relatively low. The value they estimate using data after 1979 is higher, and this is a period when monetary policy is thought to have been characterized by greater commitment to low inflation. To see how much tougher monetary policy became in 1979, consider figures 4, 5, and 14. Figures 4 and 5 show that the real rate was noticeably higher in this period. Figure 14 exhibits the difference between what the federal funds rate actually was and what it was predicted to be based on equation 1. Up until 1979, these differences were on average close to zero. After 1979, the average shifts up noticeably (see the horizontal line). This indicates that the actual funds rate in that period was higher than what a policymaker following the pre-1979 rule would have allowed.

How well does this policy rule capture our observations about monetary policy in the 1970s? In one sense, it misses. We saw that there were times when the Fed was very tough, and other times when it was accommodating. We think of this policy rule as capturing the Fed's behavior on average. On average, it was accommodating.

Two models of the private economy

We now present a brief description of the models used in the analysis. The mathematical equations characterizing both models may be found in Christiano and Gust (1999).

Consider the limited participation model first. Recall that this model emphasizes a working capital channel in the firm sector: In order to produce output in a given period, firms must borrow funds from the financial intermediary. By increasing and decreasing its injections of liquidity, the central bank can create an abundance or scarcity of those funds. The resulting interest rate fluctuations then have a direct impact on production. A scarcity of funds in the financial intermediary drives up the interest rate and induces firms to cut back on borrowing. With fewer funds with which to hire factors of production, they cut back on production. Similarly, an abundance of funds leads to a fall in the interest rate and an expansion of output.

The mechanism whereby a rise in expected inflation may lead to a rise in actual inflation in this model was sketched earlier, but we summarize it again here for convenience. When there is an increase in expected inflation (that is, $E_t \log(\pi_{t+1})$ rises) and $\alpha < 1$, this translates into a decrease in the real interest rate, $R_t - E_t \log(\pi_{t+1})$. This leads households to reduce their deposits with the financial intermediary, and has the effect of creating a scarcity of the funds available for lending to firms. Upward pressure develops on the rate of interest. In pursuing its policy of not letting the interest rate rise too much, the monetary authority must inject some liquidity into the banking system. This injection then produces a rise in prices, thus validating the original rise in inflation expectations. Since the monetary authority does permit some rise in the nominal rate of interest (that is, $\alpha > 0$), this has the effect of depressing output, employment, consumption, and investment. Thus, the limited participation model predicts that a self-fulfilling inflation outburst is associated with stagflation.

The pure logic of the model permits an inflation outburst to be triggered for no reason at all or in response to some other shock. In our modeling exercise, we treat the jump in expectations as occurring in response to a transitory, bad supply shock. Here, we have in mind the commodity supply shocks, including the oil shock, of the early 1970s.

Now consider the Clarida et al. model. In that model, a fall in the real rate of interest stimulates the interest-sensitive components of demand. The expansion of demand raises output and employment through a standard sticky price mechanism. In particular, firms are modeled as setting their prices in advance and then accommodating whatever demand materializes at the posted price. As output increases, the utilization of the economy's resources, particularly labor,

increases. This produces a rise in costs and these are then gradually (as the sticky price mechanism allows) passed into higher prices by firms. In this way an increase in the expected inflation rate gives rise to an increase in actual inflation, as long as $\alpha < 1$.

A feature of Clarida et al.'s model is that it does not have investment or money. The absence of investment reflects the assumption that only labor is used to produce output. Money could presumably be incorporated by adding a money demand equation and then backing out the money stock using output and the interest rate. Clarida et al. do not do this and neither do we.

Evidently, the Clarida et al. model implies that a self-fulfilling outburst of inflation is associated with a rise in employment and output. If there were no other shocks in the model, then it is clear that the Clarida et al. model would have a problem, since it would be inconsistent with the phenomenon of stagflation observed in the 1970s. However, we treat the Clarida et al. model in the same way as the limited participation model. In particular, we model the jump in inflation expectations as occurring in response to a bad supply shock. So, in principle, it might be compatible with the low output observed in the 1970s because of the bad supply shock.

Interpreting the Taylor rule in the two models

The various hypotheses about inflation that we discuss in this article focus on the *motives* of policymakers. The Taylor rule summarizes their *decisions*, and is silent on what motives produced these decisions. Still, in assessing the limited participation and Clarida et al. models, it is useful to speculate on what sort of motives might produce a Taylor rule with $\alpha < 1$ in these models.

In the limited participation model, we interpret $\alpha < 1$ as reflecting the working capital expectations trap considerations discussed above. That is, in this model a rise in inflation expectations confronts the Fed with a dilemma because it places the goals of low inflation and stable output in direct conflict. An interpretation of $\alpha < 1$ is that this reflects the Fed's relatively greater concern for the output goal, as in the working capital expectations trap scenario.

By contrast, in the Clarida et al. model a rise in expected inflation does not put the low inflation, stable output goals in conflict. By simply saying *no* to high money growth and inflation, the Fed in the Clarida et al. model prevents output and inflation from simultaneously going above trend. So, $\alpha < 1$ in the Clarida et al. model does not appear to reflect the type of central bank dilemmas that are at the heart of the expectations trap scenarios described above.

Perhaps the only interpretation of $\alpha < 1$ in the Clarida et al. model is that it reflects a mistake on the part of policymakers. Under this interpretation, policymakers were not aware that with $\alpha < 1$, a self-fulfilling inflation outburst is possible. That is, policymakers simply did not know that they could have gotten out of the high inflation by raising the rate of interest sharply. Our reading of the policymaking record of this period makes us deeply skeptical of this idea.²³

Evaluating the models

Neither of our models captures the events at the level of detail described earlier, nor would we want them to. The question is whether we have a model that captures the broad outlines of the take-off in inflation in the 1970s.

We construct a simulation of the 1970s using the two models described in the previous section. We specify that the fundamental exogenous shock in this period is a shift down in the production function by 1 percent.²⁴ That is, for each level of the inputs, output falls by 1 percent. Inflation expectations in the wake of this shock are not pinned down. They are exogenous variables, like the technology shock.²⁵ We picked the expectations subject to two constraints. First, we required that the limited participation model display a long-lasting, substantial response of inflation to the shock. Second, we required that the price in the period of the production function shock be the same between the two models.

Consider the limited participation model first.²⁶ Figure 15 exhibits the response of the variables in that model to a bad technology shock. The shock occurs in period 2. Not surprisingly, in view of our earlier discussion, the shock drives output and employment down and inflation up. The monetary authority reacts immediately to the increase in inflation expectations by reducing the money supply to push up the rate of interest (recall, the coefficient on expected inflation in the Taylor rule is positive).

Notice the variable, Q , in the model. That is the part of households' financial wealth that they hold in the form of transactions balances. When inflation expectations go up and $\alpha < 1$, then households increase Q and correspondingly reduce the part of their financial wealth that they deposit with financial intermediaries. The increased value of Q in period 3 reflects households' higher inflation expectations. They understand that the monetary authority's policy rule implies that the nominal rate of interest will go up, but that it will go up by less than the increase in inflation expectations (that is, $0 < \alpha < 1$). That is, they expect the real rate to go

down. This leads them to increase the funds allocated to the goods market by raising Q_3 , that is, to drain funds from the financial intermediary. To guarantee that the rate of interest only rises by a small amount (α is small), the monetary authority must inject funds into the financial intermediary to make up for the loss of funds due to the rise in Q_3 . The rise in the interest rate that occurs with all this produces a fall in output and employment. The stagflation persists for a long time. Money growth, inflation, and the nominal interest rate remain high for years. Output, employment, consumption, and investment are down for years. Investment is low, despite the low real rate of interest, because inflation acts like a tax on investment in this model.²⁷ Note that the effects are quite large. Output and employment remain 2 percent below trend for a long time, and money growth, inflation, and interest rates are more than 6 percentage points above their steady state. The fall in investment is over 6 percent. Inflation rises from 4 percent to about 10 percent and the interest rate rises from about 7.2 percent to 10 percent. These results are tentative, however, since the size of the supply shock, 1 percent, was not based on a careful analysis of the data. Nor was the response of inflation expectations chosen carefully. Still, the results build confidence that the working capital expectations trap hypothesis can deliver quantitatively large effects.

What is the reason for these persistent and large effects following a technology shock? Fundamentally, it is bad monetary policy. With a less accommodating monetary policy, it would not be an equilibrium for inflation expectations to jump so much, and so the nominal interest rate would not rise so much. With a smaller interest rate rise, the negative output and employment response to a bad technology shock would be reduced. Figure 16 exhibits what happens in our benchmark limited participation model when the policy rule estimated by Clarida et al. to have been followed in the post-Volcker period is used.²⁸ In this case, the equilibrium is (locally) unique.²⁹ Note that the fall in output and employment is smaller here. The rise in the interest rate is smaller too.

We think of a small value of α in the pre-Volcker policy rule as reflecting that the rule is the decision of a policymaker without an ability to commit to low inflation. If we interpret the inability to commit as reflecting that the policymaker has too soft a heart for economic agents, then there is plenty of irony here. The soft-hearted policymaker in the end does greater damage to the economy than a hard-hearted one who can commit to low inflation.³⁰

Now consider the Clarida et al. model. Figure 15 exhibits the dynamic response of the variables in that model to a 1 percent drop in technology. Note from the figure that in the Clarida et al. model, employment and output rise in response to the shock. After four quarters, output is down, but the employment response remains up for several years. This dynamic response pattern reflects two things. First, in sticky price models the direct effect on output of a bad technology shock is at most very small, since output is demand determined. As a result, a bad technology shock actually has a positive effect on employment in these models (see Gali, 1999, and Basu, Fernald, and Kimball, 1999).³¹ Second, a self-fulfilling rise in inflation by itself produces a rise in output and employment in the Clarida et al. model, as the fall in the real rate of interest stimulates the interest sensitive components of aggregate demand.

The simulation results in effect present the combined effects of both a self-fulfilling rise in inflation and a bad technology shock. In view of the observations in the previous paragraph, it is not surprising that the response of employment is positive. Output is also high for several quarters, although it eventually goes negative as the effect of the bad technology shock swamps the effect of the increase in employment. The employment response in particular puts this model in sharp conflict with the observed stagflation of the 1970s.

We conclude that the limited participation model provides a reasonable interpretation of the take-off in inflation in the 1970s as a working capital expectations trap. The effects in the model are large, and qualitatively of the right type: The model predicts a stagflation. The alternative model that we examine, the one proposed in Clarida et al., provides a less convincing explanation of the 1970s. The model predicts a boom. In addition, as discussed in the previous section, the model's explanation of why policymakers allowed the inflation rate to take off is not very compelling.

Conclusion

We have argued that the expectations trap hypothesis helps explain the high inflation in the early 1970s, particularly the take-off that began in 1973. We have argued against another hypothesis, the Phillips curve hypothesis. According to that, the high inflation was an unfortunate but necessary risk that the Fed was willing to take when it decided to jump start a weakened economy in the early 1970s. These hypotheses are in fact quite similar, and so it may

appear that we are splitting hairs in trying to differentiate between them. Is there anything at stake in the distinction?

We believe there is. Under the Phillips curve hypothesis, preventing a repeat of the high inflation of the 1970s is a relatively easy task: *just say no* to high money growth as a way to stimulate the economy. Under the expectations trap hypothesis, the problem of inflation is not solved so easily.

According to the expectations trap hypothesis, high inflation is the Fed's reaction to pressures originating in the private economy. The entire policymaking establishment, when confronted with these pressures, may truly not *want* to say no. To see this, imagine that bad supply shocks drove prices and unemployment up, and people responded by signing inflationary wage and price contracts. Certainly, the Fed would not be happy about following the path of accommodation and validating the expectations incorporated in the wage and price contracts. But, it may well choose to do so anyway. With the White House, the Congress, and the public at large bearing down on it like a great *tsunami*, the Fed may simply feel it has no choice.

So, the expectations trap hypothesis implies that it is not so easy to prevent a resurgence of a 1970s style inflation. According to that hypothesis, fundamental institutional change is needed to guarantee that people would never reasonably expect a take-off in inflation in the first place. What sort of institutional change might that be?

We have not attempted to answer this question. There is a large range of possibilities. One is that the necessary changes have *already* occurred. According to that, the simple memory of what happened in the inflation of the 1970s is enough to stay the hand of a policymaker tempted to validate the expectations incorporated in inflationary wage and price contracts. This is of course an attractive possibility, but there is reason to doubt it. When the expectations trap argument is worked out formally, it is assumed that the policymaker has unlimited memory, a clear understanding of the consequences of alternative actions, and excellent foresight (see Chari, Christiano, and Eichenbaum, 1998). The logic of expectations traps simply has nothing to do with ignorance. So, the notion that expectations traps became less likely when our eyes were opened by the experience of the 1970s does not seem compelling.

Another possibility is that changes in legislation are needed, changes that focus the legal mandate of the Fed exclusively on inflation. This would make it harder for a Congress and White House, panicked by high unemployment and inflation, to pressure the Fed into tossing inflation

objectives to the wind in favor of unemployment. Understanding this in advance, the public would be unlikely to raise inflation expectations in response to transient events, as it seems to have done in the early 1970s.

The expectations trap hypothesis does not say *what* change is needed to prevent a self-fulfilling take-off in inflation expectations. What it does say is that *if* the government finds a way to credibly commit to not validating high inflation expectations, then costly jumps in inflation expectations will not occur in the first place.

APPENDIX

Burns and Nixon

It has been argued that, as chairman of the Federal Reserve, Arthur Burns simply did what President Nixon told him to do. Burns initially joined the Nixon administration as a special advisor to President Nixon when the latter took office in 1968. The idea is that the boss–employee nature of that relationship continued when Nixon appointed Burns to be chairman of the Federal Reserve. This impression was reinforced by Stanford Rose in a famous article in *Fortune* magazine in 1974, which suggested that Nixon was able to interrupt the policymaking committee of the Fed with a one-hour telephone call and control the outcome of the meeting.

Nixon apparently did have *hopes* of influencing Burns when he appointed Burns chairman of the Federal Reserve. In his fascinating biography of Burns, Wells (1994, p. 42) quotes Nixon as having said to Burns: “You see to it: No recession.”

But, according to Wells (1994), the impression that Burns operated at the behest of Nixon is in fact completely untrue. Burns was a man with legendary self-confidence and a powerful, imposing personality. He had been an influential chairman of the Council of Economic Advisers under Eisenhower and left a stamp on that institution that is felt even today. During that time, according to Wells (p. 29), Burns’ relationship to Nixon was that of a “... senior partner: He was older than Nixon and enjoyed more influence with Eisenhower and his lieutenants than did the vice president. Burns thought of Nixon as a protege and treated him with what one friend described as ‘slight condescension.’ ... After Nixon became president, Burns had trouble adjusting to a subordinate position. ... He lectured Nixon on whatever issue was at hand, usually at great length and in considerable detail. Burns would also bluntly contradict the president or anyone else in the administration with whom he disagreed. ...” The diaries of H. R. Haldeman (1994), Nixon’s chief of staff, confirm this impression of a self-assured Burns who expected to get his way. For example, here are a couple of entries about Burns while he was in the Nixon White House: (p. 54) “... Huge Burns flap because he didn’t get in to see [the President]...;” (p. 59) “Big flap with Arthur Burns on AID. ...”

Wage and price controls were a major source of friction between Burns and Nixon: Burns concluded that they were necessary, and Nixon was opposed. For example, according to

Haldeman (1994, p. 310) Nixon told his cabinet on June 29, 1971, “Our decisions are that there will be no wage–price controls, no wage–price board.” According to Wells (pp. 70–77), the disagreement provoked ‘ugly’ confrontations between Burns and the White House, as Burns went public with his views. In the end, in mid-August, Nixon decided to impose wage–price controls after all. The episode shows that, as Wells (1994) puts it (p. 100), “The chairman was clearly no pliant tool of the chief executive but rather did whatever he thought was best.”

NOTES

¹Also, see Chari, Christiano, and Eichenbaum (1998).

²This model is a modified version of the model in Christiano, Eichenbaum, and Evans (1998).

³The model is derived from a dynamic general equilibrium model with maximizing agents and cleared markets. The possibility that such a model could, under the sort of policy estimated by Clarida et al. using data from the 1970s, have an equilibrium in which inflation expectations can be self-fulfilling was first discovered by Kerr and King (1996).

⁴In this article, we focus on expectations traps in which inflation is high. The opposite—an expectation trap in which inflation is low—is also a possibility.

⁵The cost-push expectations trap is very close to the hypothesis Blinder advances as an explanation of the takeoff of inflation in the early 1970s:

Inflation from special factors can “get into” the baseline rate if it causes an acceleration of wage growth. At this point policymakers face an agonizing choice—the so-called accommodation issue. To the extent that aggregate nominal demand is *not* expanded to accommodate the higher wages and prices, unemployment and slack capacity will result. There will be a recession. On the other hand, to the extent that aggregate demand *is* expanded (say, by raising the growth rate of money above previous targets), inflation from the special factor will get built into the baseline rate. (Blinder, 1982, p. 264)

⁶For one prominent commentator who takes this position, see Barro (1996, pp. 58–60).

⁷The data are taken from Citibase. The mnemonic for the federal funds rate is fyff, and the mnemonic for the monetary base is fmbase.

⁸Inflation is measured as the annual percent change in the Consumer Price Index with Citibase mnemonic, prnew (CPI-W: all items).

⁹In the same speech, Burns showed some foresight in warning about another danger associated with the strategy of relying on reduced money growth to stop inflation. He was concerned that the nature of the lags in monetary policy were such that the variance of inflation and money growth would go up in a “stop-and-go” process.

[The effects of monetary restraint on spending often occur with relatively long lags. ... Because the lags tend to be long, there are serious risks that a stabilization program emphasizing monetary restraint will have its major effects on spending at a point in time when excess demand has passed its peak. The consequence may then be an excessive slowdown of total spending and a need to move quickly and aggressively toward stimulative policies to prevent a recession. Such a stop-and-go process may well lead to a subsequent renewal of inflationary pressures of yet greater intensity. (Burns, 1978)

¹⁰Money growth in 1970–74 was 5.32 percent, 7.60 percent, 7.27 percent, 8.75 percent, and 7.99 percent, respectively. The number for period t is $100 \times \log(m(t)/m(t-1))$, where $m(t)$ denotes the monetary base, $t = 1970, 1971, 1972, 1973, \text{ and } 1974$.

¹¹We address the potential for the Phillips curve hypothesis to explain high money growth during the period of wage–price controls in the next subsection.

¹²To some extent, the rise in inflation was due to the oil shock in late 1973. However, about three-quarters of the price increases of that year occurred before the Yom Kippur war and the October oil embargo. The take-off in inflation in 1973 may, in part, have reflected the delayed response of prices to the high money growth that occurred during the period of wage–price controls. We attempted to estimate what fraction of the 1973 price rise reflected past money growth, but found that statistical uncertainty is too large to draw a definite conclusion.

¹³We calculated expected inflation for figure 4 based on a one-month-ahead forecast of monthly CPI inflation using five-month lags in monthly inflation, four-month lags in the federal funds rate, four-month lags in the monthly growth rate in M2, and four-month lags in the premium in the return to ten-year Treasury bonds over the federal funds rate. The rise in real rates reported

in figures 4 and 5 would have been somewhat larger if we had used the GDP deflator to measure inflation.

¹⁴With the experience of the Great Depression and the intellectual foundations provided by Keynes' General Theory, it was generally accepted that governments' responsibility was to preserve the health of the economy. This was put into law in the Employment Act of 1946, which created the Council of Economic Advisers:

There is hereby created in the Executive Office of the President a Council of Economic Advisers ... to formulate and recommend national economic policy to promote employment, production, and purchasing power under free competitive enterprise.

See DeLong (1995) for a discussion of the post-WWII intellectual climate regarding the proper role of government in the economy and the sharp contrast with the pre-WWII climate. As noted earlier, the feasibility of the notion that the government ought to stabilize the economy seemed to be confirmed with the apparent success of stabilization policy in the 1960s.

¹⁵This was precisely the stop-and-go process that Burns feared, as mentioned in note 9. For another discussion of the stop-and-go nature of inflation in this period, see Barsky and Kilian (2000).

¹⁶The trend implicit in the HP filter is a fairly standard way to estimate potential GDP. For example, the OECD (1999, p. 205) reports estimates of the output gap computed in this way. Taylor (1999b) also uses this method to compute the output gap. Finally, according to Orphanides and van Norden (1999, p. 1), "The difference between [actual output and potential output] is commonly referred to as the *business cycle or the output gap* (italics added)." For an analysis of the statistical properties of this way of computing the output gap, see Christiano and Fitzgerald (1999).

There are other output gap measures based on a different notion of trend. In these, the trend corresponds to the "nonaccelerating inflation" level of the variable: the level which, if it occurred, would produce a forecast of zero change in the rate of inflation in the near future. Gap concepts like this are fundamentally multivariate. To see how the HP filter can be adapted to correspond more closely to this alternative gap concept, see Laxton and Tetlow (1992) and St-Amant and Van Norden (1997). We assume that, for our purposes, it does not matter

significantly whether the output gap is measured based on the adjusted or unadjusted versions of the HP filter.

¹⁷The output gap is measured as $100 \times (\log GDP - \log GDP_{trend})$, where $\log GDP_{trend}$ is the trend in log GDP implied by the HP filter.

¹⁸The average gap for 1971 was -1.75 percent according to the full sample estimate and -1.99 percent according to the sample that stops in 1973:Q4.

¹⁹See Wells (1994), p. 72, for a further discussion of Burns' view about the Phillips curve.

²⁰It has been argued that even if Burns was not himself duplicitous, President Nixon was, and Burns acted at the behest of Nixon. To us, the record is inconsistent with this view. See the appendix.

²¹The limited participation model that we use is a modified version of the model in Christiano, Eichenbaum, and Evans (1998).

²²Clarida et al. (1998) use revised data to estimate the policy rule for the 1970s. Orphanides (1997) argues that constructing y_t using final revised data may give a very different view of y_t than policymakers in the 1970s actually had. As noted above, he argues that the productivity slowdown that is thought to have occurred beginning in the early 1970s was not recognized by policymakers until much later in that decade. As a result, according to Orphanides, real-time policymakers in the 1970s thought that output was further below potential than current estimates suggest. In private communication, Orphanides has informed us that when he uses real-time data on y_t and the other variables to redo the Clarida et al. estimation procedure, he finds that the point estimates for ρ , α , and β for the 1970s change. They move into the region where our models no longer imply that self-fulfilling inflation take-offs are possible. The standard errors on the point estimates are large, however, and a standard confidence interval does not exclude the Clarida et al. point estimates that we use.

²³Woodford (1998) develops an alternative interpretation of $\alpha < 1$ by building on the assumption that fiscal policy (something we abstract from in our analysis) was “non-Ricardian” during the 1970s. Using the fiscal theory of the price level, he argues that with fiscal policy

satisfying this condition, the Fed was forced to set $\alpha < 1$ to avoid an even more explosive inflation than the one that actually occurred. For a simplified explanation of this argument, see Christiano and Fitzgerald (2000). The fiscal theory of the price level offers another potential explanation of the take-off in inflation in the 1970s, one that is not based on self-fulfilling expectations and that assigns a central role to fiscal policy rather than monetary policy. While this interpretation is controversial, it deserves serious consideration. See Cochrane (1998) and Woodford (1998) for further discussion.

²⁴The production function is $Y_t = \exp(z_t) K_t^\theta L_t^{1-\theta}$, where Y_t denotes gross output, K_t denotes the stock of capital, and L_t denotes labor. The state of technology, z_t , evolves according to $z_t = \rho_z z_{t-1} + \varepsilon_{z,t}$, with $\rho_z = 0.95$. In the limited participation model, $\theta = 0.36$ and in Clarida et al., $\theta = 0$. The simulation involves setting $\varepsilon_{z,t} = -0.01$ for $t = 2$ and $\varepsilon_{z,t} = 0$ for all other t . With this value of ρ_z , the state of technology remains 0.7 percent below trend after ten periods and 0.4 percent below trend after 20 periods.

²⁵There is one important difference. Shocks to the production function can occur for any parameter values of the model. Shocks to expectations can only exist for certain parameter values.

²⁶For details of model parameterization, see Christiano and Gust (1999). The version of the limited participation model underlying the calculations in figure 15 is the one in which investment is a cash good, what Christiano and Gust (1999) call the “benchmark” model. They also consider the version of the model in which investment is a credit good. The simulation of the 1970s using the Clarida et al. estimated Taylor rule resembles the results in figure 15.

²⁷Feldstein (1997) has argued that high inflation hurts investment, though he emphasizes a mechanism that operates through the explicit tax system.

²⁸This uses a larger value of α .

²⁹The result that raising α above unity eliminates expectations traps (at least, locally) is somewhat model specific. In some models this does not work and the central bank would have to adopt a different policy to rule out expectations traps.

³⁰It deserves repetition that the policy rules have not been derived from well-specified optimization problems of policymakers and that our discussion represents an informal interpretation. For an explicit analysis based on policymaker optimization, see Chari, Christiano, and Eichenbaum (1998).

³¹The reasoning is simple. Let D denote demand and P and Y denote price and output. Then, $PY = D$. In a sticky price model, P cannot change so that if D does not change then Y cannot change either, even if there is a shock to technology. Of course, if the shock is such that it takes more people to produce a given level of output, then a fall in technology results in a rise in employment. This response of employment to a bad technology shock is not robust to all specifications of monetary policy. For example, if α is sufficiently large in the Clarida et al. model, then the rise in anticipated inflation produced by a bad technology shock leads the monetary authority to raise the interest rate a lot, driving down D . If the fall in D is sufficiently large, then a bad technology shock could actually lead to a fall in employment. Our results indicate that under the estimated monetary policy rule, employment rises after a bad technology shock in the Clarida et al. model.

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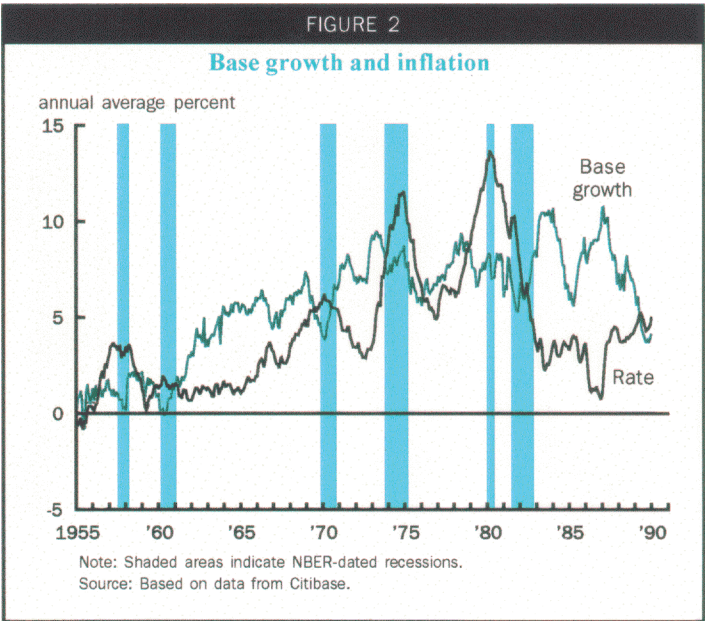
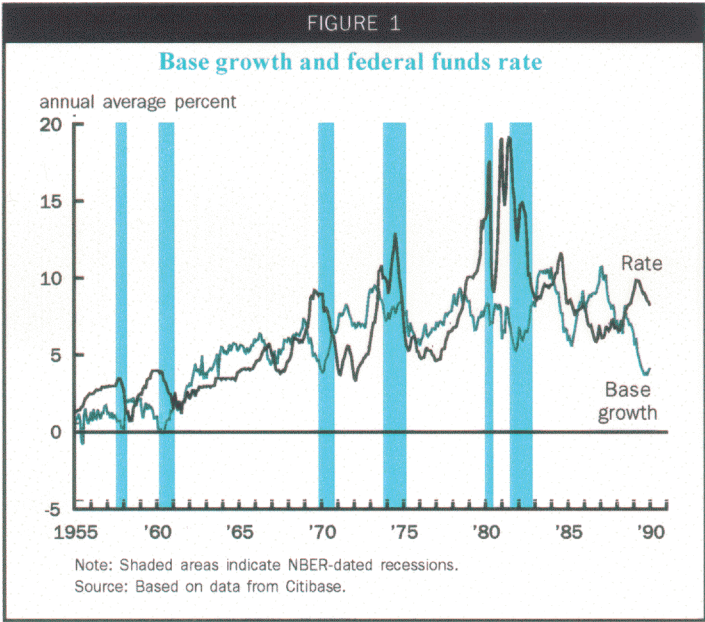
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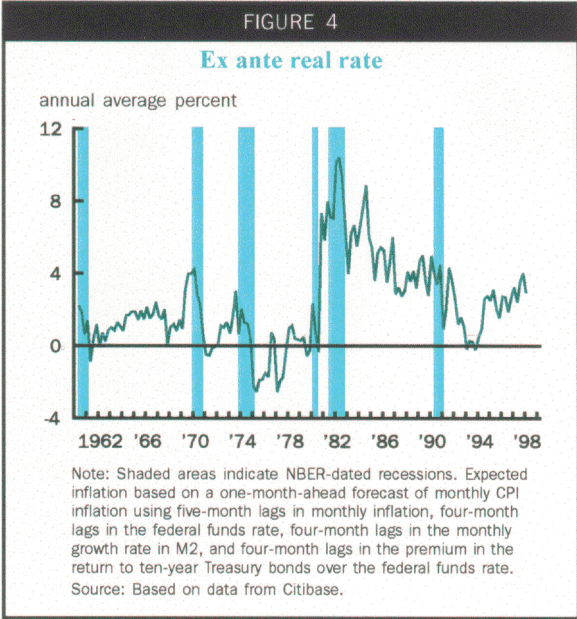
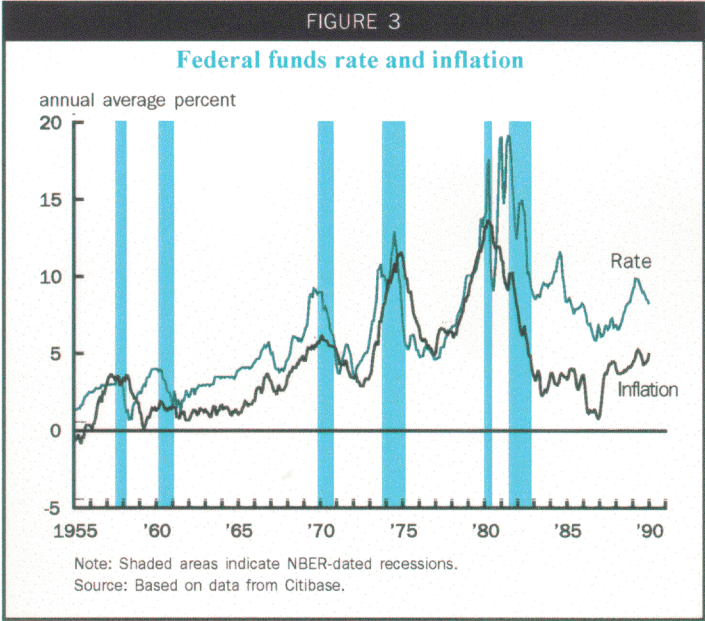
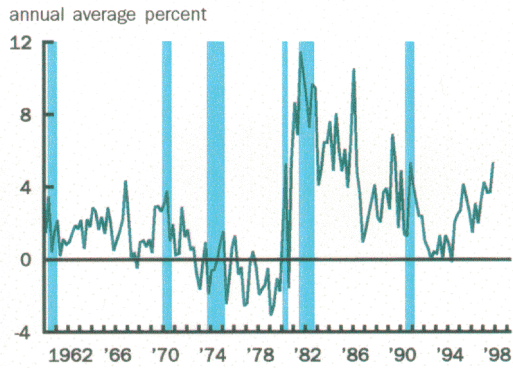


FIGURE 5

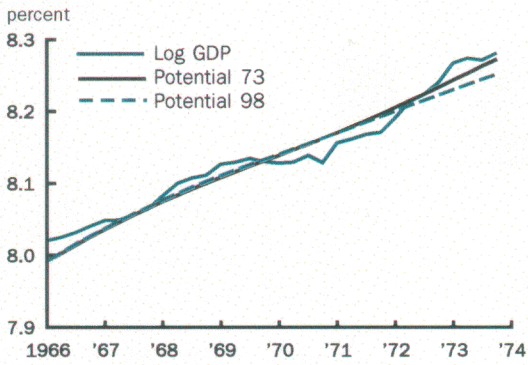
Ex post real rate



Note: Shaded areas indicate NBER-dated recessions.
Source: Based on data from Citibase.

FIGURE 6

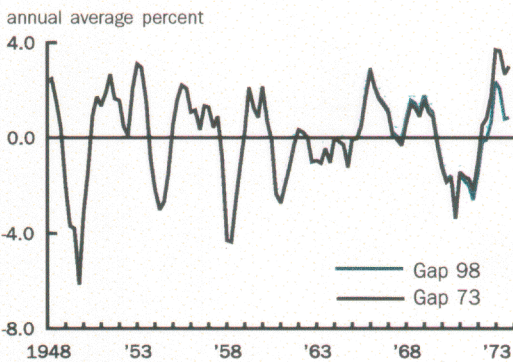
Real GDP and two measures of potential GDP



Source: Based on data from Citibase.

FIGURE 7

Two measures of GDP gap



Source: Based on data from Citibase.

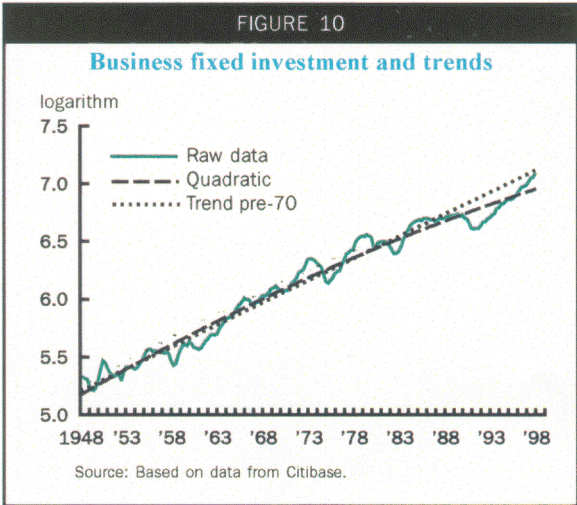
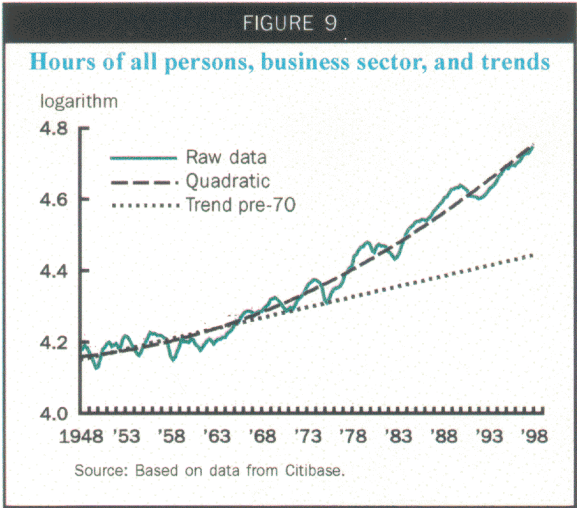
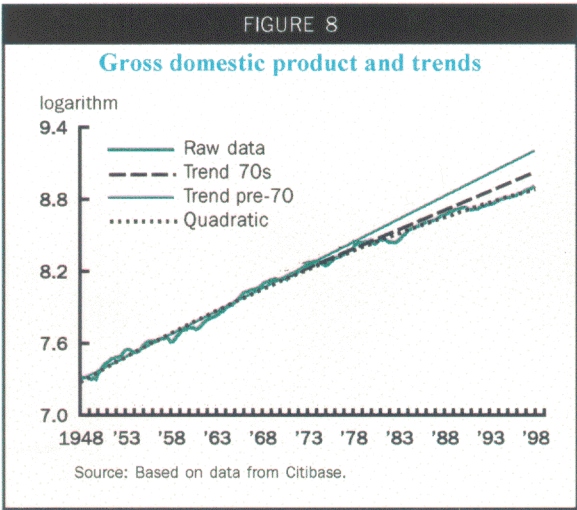
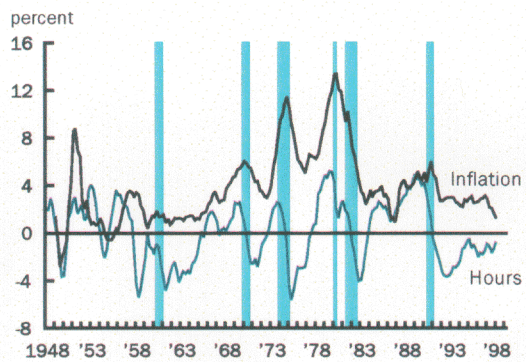


FIGURE 11

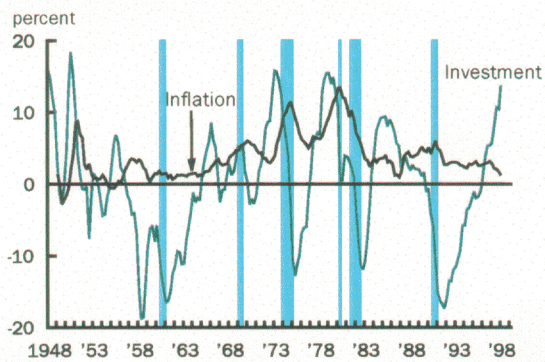
Detrended hours and inflation



Note: Shaded areas indicate NBER-dated recessions.
Source: Based on data from Citibase.

FIGURE 12

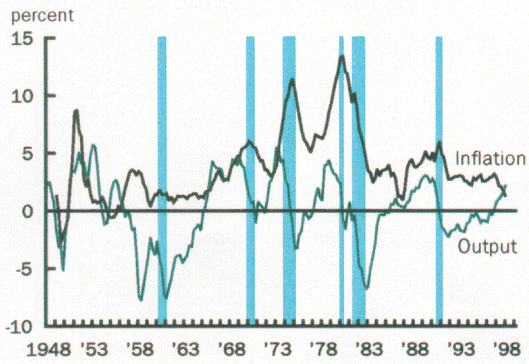
Detrended investment and inflation



Note: Shaded areas indicate NBER-dated recessions.
Source: Based on data from Citibase.

FIGURE 13

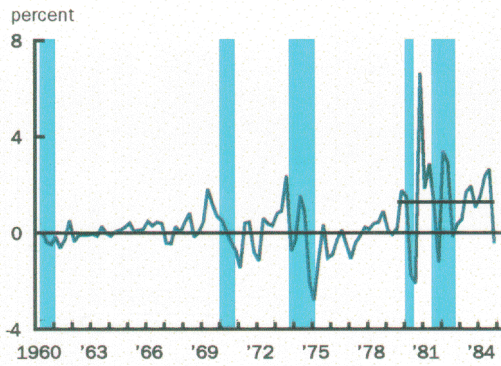
Detrended output and inflation



Note: Shaded areas indicate NBER-dated recessions.
Source: Based on data from Citibase.

FIGURE 14

Actual federal funds rate minus value predicted by 1970s rule

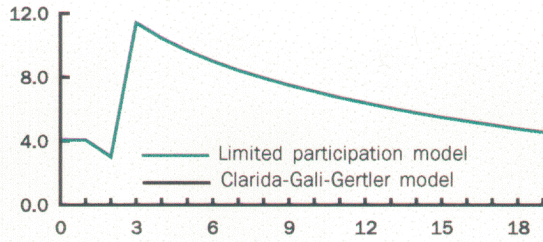


Note: Shaded areas indicate NBER-dated recessions.
Source: Based on data from Citibase.

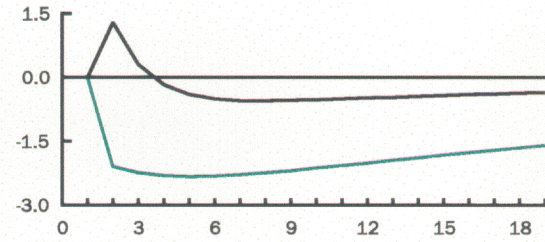
FIGURE 15

Response to technology shock in two different models

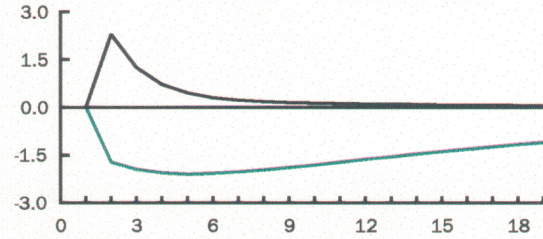
A. Money growth
annualized percentage rate



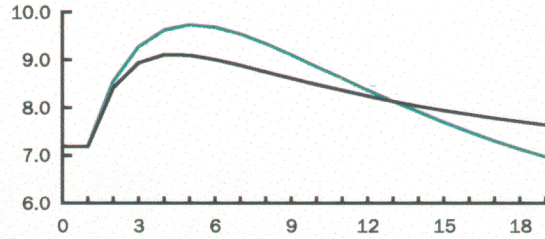
F. Output
percent deviation from steady state



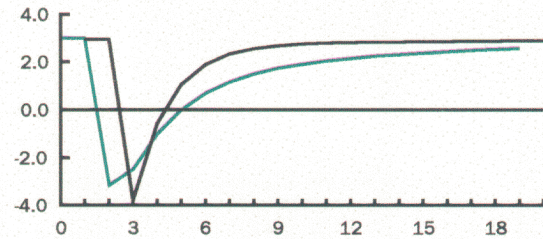
B. Employment
percent deviation from steady state



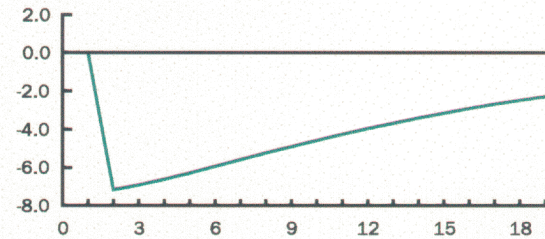
G. Nominal interest
annualized percentage rate



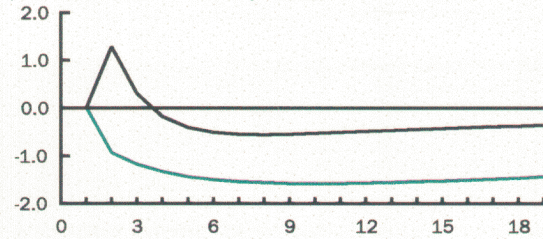
C. Real interest
annualized percentage rate



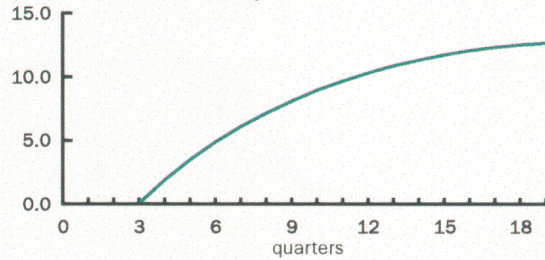
H. Investment
percent deviation from steady state



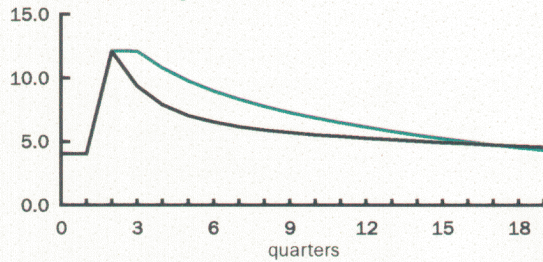
D. Consumption
percent deviation from steady state



I. Transactions balances (Q)
percent deviation from steady state



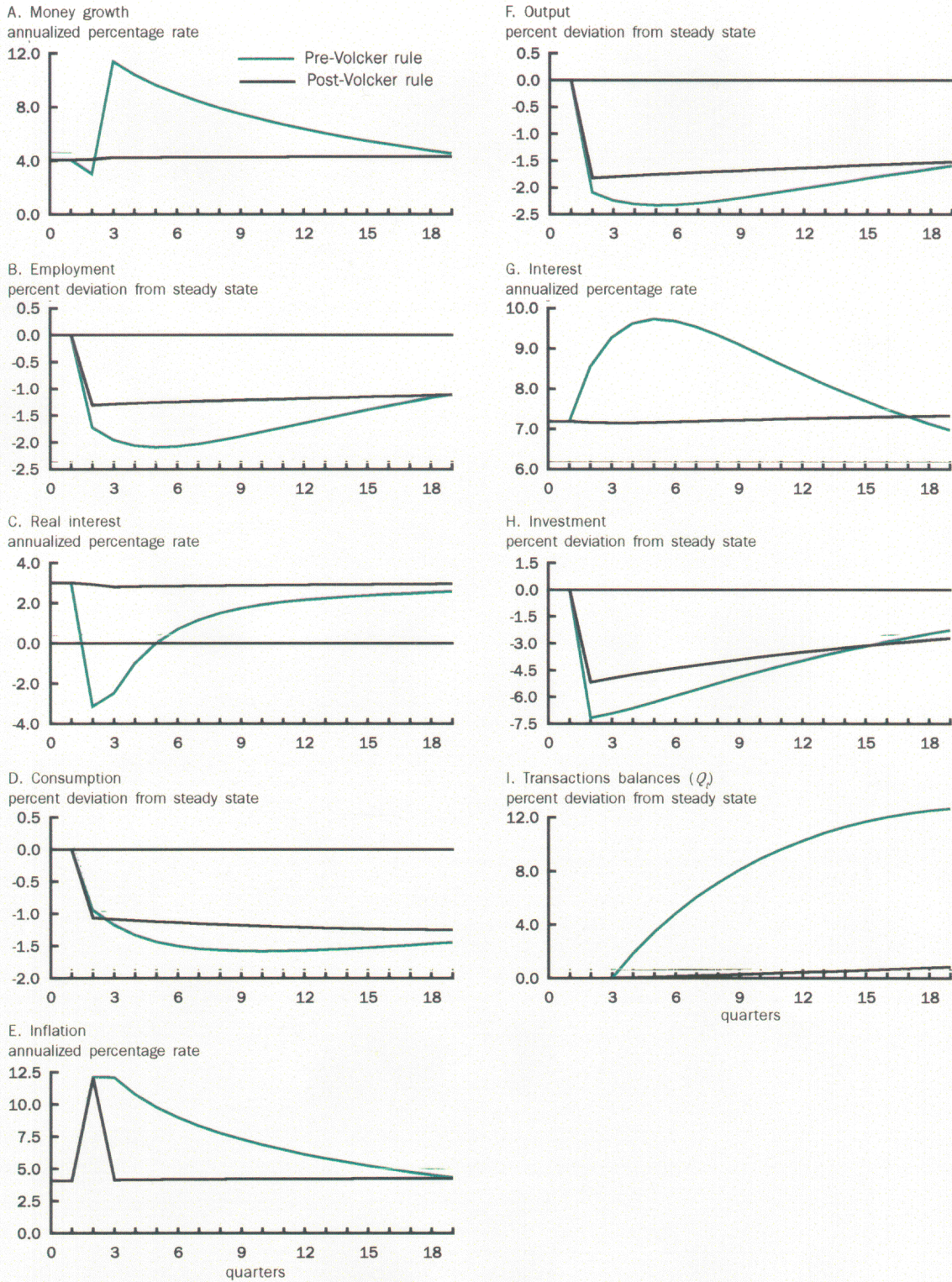
E. Inflation
annualized percentage rate



Note: Shock happens in quarter two.

FIGURE 16

Response to a negative technology shock under two different Taylor rules



Note: Shock happens in quarter two.