

Inflation Dynamics

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The U.S. economy today is limping along. Some believe recession is at hand; others, and I include myself in this group, believe the economy will skirt recession. The difference in view may not be very large, as an economy growing at a barely positive rate will look and feel about the same as one with output falling slightly.

In recent speeches I have discussed a number of issues relating to the economic outlook, including especially problems in the mortgage market and the process by which the economy will in time restore greater stability to financial markets. Today I will discuss inflation. Federal Reserve policy is always and unavoidably a balancing act between unemployment concerns and inflation concerns. There is no question that in popular debates today the risk of higher unemployment is the No. 1 concern, but my reading of economic history is that we generally live to regret a monetary policy focused exclusively on the No. 1 economic concern of the day.

Before proceeding, I want to emphasize that the views I express here are mine and do not necessarily reflect official positions of the Federal Reserve System. I thank my colleagues at the Federal Reserve Bank of St. Louis for their comments. Robert H. Rasche, senior vice president and director of research, provided special assistance. However, I retain full responsibility for errors.

TRENDS IN INFLATION

Forty to 50 years ago, the sources and dynamics of trends in inflation were hotly debated top-

ics among professional economists. On one side of the discussion were Milton Friedman and economists of “Chicago School” persuasion who argued that trend inflation was always and everywhere a monetary phenomenon. An alternative perspective was the “Phillips curve” view that the level of the unemployment rate was the principal determinant of the rate of inflation. From that perspective, policy actions reducing the unemployment rate were seen to provoke a permanent increase in the rate of inflation. A third view at the time, frequently incorporated into the Phillips curve perspective, was that institutional structures such as the market power of concentrated firms over prices or of labor unions over wages also contributed to upward trends in the general level of prices.

In the late 1960s, Milton Friedman and Edmond Phelps introduced the expectations-augmented Phillips curve and the concept of the natural rate of unemployment. Under this hypothesis, there is no permanent trade-off between unemployment and inflation. Any trade-off is at best transitory, and reductions in unemployment gained through increased inflation disappear as private agents adjust their expectations about future inflation to the new inflation environment. Once this adjustment of expectations has occurred, all that is left would be the new higher inflationary environment. In the early 1970s, this theory gained wide acceptance among academic economists, though its acceptance by policymakers was slower.

As this discussion on inflation processes was evolving, the oil price shocks of 1973-74 and 1979 occurred. Initially these shocks were

MONETARY POLICY AND INFLATION

viewed as contributing to inflation trends. Over time, though, economists came to believe that supply shocks that caused large changes in relative prices—even very persistent or permanent changes in relative prices—could have only transitory effects on the inflation rate unless accommodated by monetary policy.

As late as 1979, former Federal Reserve Chairman Arthur Burns attributed the ongoing rise of inflation to fundamental changes in social institutions and values. Burns argued that these changes produced

...a persistent inflationary bias that has emerged from the philosophic and political currents that have been transforming economic life in the United States and elsewhere since the 1930s. The essence of the unique inflation of our times and the reason central bankers have been ineffective in dealing with it can be understood only in terms of those currents of thought and the political environment they have created.¹

By the 1980s, the hypothesis that trend inflation was a monetary phenomenon had gained almost universal acceptance among economists and policymakers. Fed Chairman Paul Volcker applied monetary medicine to tame the inflation of the 1970s and by 1984 achieved a roughly stable rate of inflation in the neighborhood of 4 percent per year. The experience and pain of the Volcker disinflation plus the emerging theoretical consensus among economists led central bankers throughout the world to conclude that the primary responsibility of monetary policy is to maintain price stability. Even in the United States where legislation explicitly defines a “dual mandate” for the Federal Reserve System, the primacy of the price stability goal is acknowledged. For example, in his first speech after his swearing-in, Chairman Bernanke stated:

Although price stability is an end of monetary policy, it is also a means by which policy can achieve its other objectives. In the jargon, price

stability is both a goal and an intermediate target of policy. As I will discuss, when prices are stable, both economic growth and stability are likely to be enhanced, and long-term interest rates are likely to be moderate. Thus, even a policymaker who places relatively less weight on price stability as a goal in its own right should be careful to maintain price stability as a means of advancing other critical objectives.²

The mechanisms through which central banks pursue an inflation objective are varied. In the 1970s and 1980s, the monetarist perspective, following Milton Friedman, was that central banks must target low and stable monetary growth. If the central bank established such a policy regime, a low and stable trend rate of inflation was expected to follow. The controlled growth rate of the money stock would provide the nominal anchor for the economy.

In the latter part of the 19th century, most Western central banks subscribed to the gold standard. In this environment, prices tended to fluctuate around a constant level. Certainly there were changes in the price level from year to year, sometimes quite substantial, but such changes tended to be reversed. The average trend in inflation was close to zero. The gold standard provided a nominal anchor for these economies. If central banks adhered to the rules of the gold standard, gold flowed out of a country when its price level rose and into a country when its price level fell. When these gold flows were allowed to feed through to the stock of money, as was supposed to be the case under the gold standard, changes in domestic prices were reversed over time. Hence, the gold standard maintained price stability through automatic adjustments of the money stock. The money stock was not itself a policy tool, but the policy rule in place—the gold standard—generated the required adjustment of the money stock to restore price stability.

In the late 1980s, after the Volcker disinflation and in response to a widespread acceptance of

¹ A.F. Burns, “The Anguish of Central Banking,” Per Jacobsson Lecture, Belgrade Yugoslavia, September 30, 1979, p. 9.

² “The Benefits of Price Stability,” February 24, 2006. <www.federalreserve.gov/newsevents/speech/bernanke20060224a.htm>.

the theory of the expectations-augmented Phillips curve, central bankers acknowledged their responsibility to provide a nominal anchor for their economies. In the United States, Chairman Volcker and, following him, Chairman Greenspan defined price stability as an inflation rate sufficiently low that businesses and households did not take it into consideration in their day-to-day economic decisions. In January 1988, the then governor of the Bank of Canada, John Crow, delivered a public lecture in which he stated that “price stability was set out explicitly as the Bank’s prime objective and, realistically, the only thing that it could deliver with the tools at its disposal.”³ In 1990, the Reserve Bank of New Zealand became the first official inflation-targeting central bank when it negotiated an agreement with the government that specified a numeric inflation objective for monetary policy.

In the judgment of Governor Crow’s successor at the Bank of Canada, Governor Gordon Thiesson, the statement of his predecessor was inadequate as a policy objective because “price stability, although often referred to, was not, however, clearly defined.”⁴ Subsequently, in February 1991, the Bank of Canada and the Canadian minister of finance introduced explicit inflation reduction targets in the New Zealand style. In subsequent years, more and more central banks adopted such numeric inflation targets, including the Swedish Riksbank, the Bank of England and the European Central Bank. While the Federal Open Market Committee (FOMC)—the Federal Reserve’s main monetary policymaking body—has not adopted an explicit numeric inflation target, many individual FOMC participants have been quite forthright about their views on price stability or “comfort zones” for inflation. I am on record as favoring a target in terms of the personal consumption price index of 1.5 percent annual rate of increase plus or minus 0.5 percent.

CONTROLLING INFLATION

The issue today is less about the desirability of controlling inflation, or about the appropriate inflation target range, than about the specification of a monetary policy to achieve the agreed objectives of low inflation and a high level of employment. In 1993, Stanford economist John Taylor proposed a simple equation as an approximate description of the systematic policy of the Greenspan Fed to that date. The FOMC, then and now, conducts policy by setting a target for the overnight federal funds rate, which is the interest rate on one-day loans in the interbank market. From his study of the FOMC’s actual behavior, Taylor concluded that the committee had adjusted its target for the federal funds rate in response to three elements: 1) a target or desired rate of inflation; 2) deviations of the actual inflation rate from the target rate; and 3) deviations of real output (GDP) from a measure of trend or “potential” output. Taylor incorporated these considerations in a specific equation, now widely known as the “Taylor rule.” Subsequent analysis showed that a central bank that followed such a policy rule with a sufficiently aggressive response to deviations of actual inflation from the target level would provide a nominal anchor for the economy.

A critically important part of Taylor’s analysis was the distinction between the real and nominal rate of interest. The nominal rate of interest is observed directly in the market. At present, for example, the FOMC’s target for the federal funds rate is 3 percent and the actual rate in the market is close to this target. The real rate of interest is the nominal rate less the expected rate of inflation. When the rate of inflation exceeds the nominal rate of interest, a lender is actually subsidizing a borrower because a loan is repaid—principal and interest together—with dollars of lower purchasing power than those originally lent.

³ G.G. Thiesson, “Can a Bank Change? The Evolution of Monetary Policy at the Bank of Canada 1935-2000,” Bank of Canada, *The Thiesson Lectures*, p. 76. <www.bank-banque-canada.ca/en/pdf/thiessen-eng-book.pdf>.

⁴ Ibid.

Recall that the gold standard automatically checked inflation because a country experiencing inflation would lose gold, which would depress the money stock and tend to return the price level to its initial state. Under the Taylor rule, a similar mechanism would be at work, provided the coefficients in the equation defining the rule were appropriate. For the policy rule to produce the desired results, a central bank has to raise or lower its nominal interest rate target enough so that the real rate of interest rises or falls in response to inflation above or below the inflation target. For example, if the inflation rate were to rise by one percentage point, the FOMC would have to raise its target federal funds rate by one percentage point just to keep the real rate of interest unchanged. A typical Taylor rule specification would call for the FOMC to increase its target fed funds rate by 1.5 percentage points to ensure that the real rate of interest actually rises when inflation rises.

If the money-demand function were stable, a central bank that pursued such an interest rate policy would find that the growth rate of the money stock would fall when inflation rose above target. Similarly, under the Taylor rule money growth would tend to rise when inflation fell below the target. If a central bank is successful in maintaining a relatively low rate of inflation, the resulting average growth in the money stock will be relatively low and stable. Hence, a central bank following an appropriately specified Taylor rule with an invariant inflation target would induce the pattern of money growth that the monetarists argued was required for a nominal anchor in the economy. The Taylor rule reconciles somewhat different theoretical approaches of economists who emphasize the money stock in their analysis of monetary policy and those who emphasize interest rates in their analysis.

I have been emphasizing the inflation part of the Taylor rule, but it is important to put equal emphasis on the real GDP part. Some specifications of the Taylor rule substitute the unemployment rate for real GDP, but for present purposes the two are equivalent given that unemployment and the deviation of real GDP from potential

GDP are closely related. The Taylor rule calls for the central bank to reduce its interest rate target when GDP drops below potential, and the larger the gap between actual and potential GDP, the larger is the reduction in the target interest rate.

There is a substantial literature examining how to set the coefficients on the inflation and real GDP terms in the Taylor equation to achieve the best possible balance between the goals of low inflation and high employment. Researchers have also examined other issues, such as whether a policy based on forecasts of inflation and real GDP works better than one based on the most recent actual readings of these variables. The complexities are considerable, in part because first releases of data are subject to revision and forecasts are subject to substantial errors.

The FOMC's decisions are informed by the Taylor rule and the extensive research behind it. However, the committee does not follow the rule precisely, as it can bring other considerations to bear, such as knowledge of the state of the financial markets and a wide variety of other information. A great deal is known about inflation processes that cannot at this time be incorporated in a Taylor-type equation in a precise way. A basic understanding of inflation dynamics is important to understanding FOMC policy. It is to this subject that I now turn.

SHORT-RUN INFLATION DYNAMICS—DEVIATIONS FROM TREND INFLATION

A convenient framework for organizing a discussion of short-run inflation dynamics is the expectations-augmented Phillips curve that I mentioned previously. In a diagram with the rate of inflation on the vertical axis and the rate of unemployment on the horizontal axis, picture a line drawn so that a higher rate of unemployment is associated with a lower rate of inflation. This line reflects a short-run situation. In this framework, economists identify three sources of inflation dynamics. First, there are permanent, or semi-permanent, changes in the inflation rate

resulting from changes in expectations held by consumers and firms about future actual rates of inflation. In the textbook graph, a one-time change in the expected rate of inflation is reflected in a long-lasting *shift* up or down in the short-run relation between the inflation rate and the unemployment rate, or more generally the rate of utilization of resources. The relevant variable is the gap between the actual and natural rate of unemployment, or between the level of GDP and potential GDP. Second, there are transitory changes in the inflation rate that result from changes in the rate of resource utilization in the economy. A transitory change is represented by a movement *along* a short-run Phillips curve. Third, there are transitory changes in inflation as a result of temporary *shifts* up or down in the short-run Phillips curve because of “supply shocks” or more generally changes in relative prices. Typically, such changes are identified as shocks to food or energy prices, though they could result from changes in many other relative prices. Examples would include changes in nominal exchange rates that alter prices of imported goods relative to domestically produced goods or certain domestic tax changes. Measures of “core inflation,” which I will discuss in a few minutes, in principle are designed to filter out very short-run movements in inflation originating from some of these sources in order to give better insight into fundamental forces affecting the inflation rate.

The effects of supply shocks and resource utilization weigh on the minds of policymakers as witnessed by a comment in minutes of the December 2007 FOMC meeting:

Participants thought *that recent increases in energy prices likely would boost headline inflation temporarily*, but with futures prices pointing to a gradual decline in oil prices and *with pressures on resource utilization seen as likely to ease a bit, most participants continued to anticipate some moderation in core and*

*especially headline inflation over the next few years.*⁵ (Italics added)

Recent research at the Federal Reserve Bank of St. Louis suggests that such movements along a short-run Phillips curve or transitory shifts up and down in that curve only account for a relatively minor portion of the observed inflation in the United States since the mid 1950s. The dominant factor in U.S. inflation history over the past 50 years has been changes in inflation expectations, or semi-permanent shifts up and down in the short-run Phillips curve. When it comes to the forces behind U.S. inflation, expectations trump the gap.⁶ While some observers might be startled by this conclusion, reflection on the broad outline of our economic history should allay any apprehensions. In the 1960s and 1970s, successive business cycle peaks had both higher inflation and higher unemployment rates, explained by increases in inflation expectations. After the recession of 1990-91, both inflation and unemployment trended down for the remainder of the decade. In the textbook paradigm, such patterns can only be produced by shifts in the short-run Phillips curve generated by changes in inflation expectations. Indeed, direct evidence on inflation expectations suggests that expectations did trend gradually down over the 1990s.

The conclusion that expectations trump the gap in generating inflation is extremely important for monetary policy. It implies that low and stable inflation will only be observed when the private sector’s expectations of inflation are solidly entrenched at a low level.

MEASURING INFLATION EXPECTATIONS

If expectations about future inflation held by households and firms are a critical determinant of actual inflation, then how can policymakers

⁵ Federal Open Market Committee, “Minutes of the Meeting of December 11, 2007,” p. 5. <www.federalreserve.gov/monetarypolicy/files/fomcminutes20071211.pdf>.

⁶ J.M. Piger and R.H. Rasche, “Inflation: Do Expectations Trump the Gap?” Federal Reserve Bank of St. Louis Working Paper 2006-013B.

monitor such expectations? In the past 20 years, survey measures of expectations of inflation at longer horizons have become available. The best known of such measures is the survey of professional forecasters conducted by the Federal Reserve Bank of Philadelphia. This survey has been conducted quarterly since the fourth quarter of 1991 and focuses on expectations of 10-year average CPI inflation. The respondent sample is relatively small.⁷

A decade ago, the U.S. Treasury started issuing bonds that are indexed to the CPI. Over time, new issues of these securities became available on a regular calendar and market liquidity improved. It is now possible to observe the difference between the yields on conventional nominal Treasury bonds and indexed bonds of comparable maturity. The yield difference typically is referenced as “inflation compensation” since, in addition to measuring expectations in financial markets about future inflation, the rate spread between conventional and indexed bonds includes a premium to compensate for differences in liquidity between the two types of bonds and a premium to cover inflation risk.

As an aside, inflation compensation in the bond market seems to me to be a more reliable measure of inflation expectations than survey information, because investors have put money on their expectations and not just an answer on a survey form. The disadvantage of the bond market measure is that experience dates back only to 1997, when the U.S. Treasury first issued inflation-indexed bonds.

Long-term inflation expectations, as measured by the survey data, trended steadily down through the early 1990s and then stabilized. They have differed little from 2.5 percent since 1998. Inflation compensation in the bond market was less than 2 percent in early 2003 but then rose and, since early 2004, has been around 2.5

percent. The survey- and market-based measures are quite consistent.

From this evidence, we can conclude that the current situation is one of substantial stability of inflation expectations. This observation is extremely important, because of the evidence that, historically, changes in inflation expectations have been by far the largest driver of changes in the actual rate of inflation. Recent relatively small increases in inflation are apparently due to transitory factors and not to changes in inflation expectations. Of course, the FOMC must continue to pursue a monetary policy that is consistent with well-anchored inflation expectations.

CORE VERSUS HEADLINE INFLATION

I have emphasized the importance of distinguishing temporary from longer-lasting changes in the rate of inflation. The concept of “core” inflation is an effort to make the distinction more precise.

The origins of core measures of inflation are somewhat obscure. As early as 1957, the Bureau of Labor Statistics (BLS) published a special consumer price index excluding food.⁸ Presumably, the rationale for this price index was that, in the short-run, food prices are highly volatile and are affected by weather and agricultural production conditions that are independent of the fundamental forces driving the overall rate of inflation. In 1973-74 the U.S. economy experienced an oil price shock when OPEC imposed an embargo on oil shipments to the United States. Beginning in 1977, the BLS started publishing a special CPI price index excluding food and energy prices.⁹ Such indexes have become known as “core” price indexes.

Do core measures of inflation give a better measure of longer-run inflation trends? If the rel-

⁷ Recent surveys have about 50 respondents. At times in earlier years the sample was considerably smaller.

⁸ A special CPI price index for all items excluding food first appeared in the *Monthly Labor Review* of July 1957, Table D-3.

⁹ A special CPI price index for all items less food and energy first appeared in the April 1977 issue of the publication *CPI Detailed Report*.

ative prices of food and energy display high-frequency transitory components, then these measures likely provide useful insights. However, these prices may not always display such characteristics. Economists at the St. Louis Fed have noted that, since 2003, inflation as measured by the core personal consumption price index has been consistently lower than inflation measured by the headline, or total, personal consumption price index.¹⁰

It does not seem likely that core measures of inflation were intended to filter out the impact of sustained trends in relative prices from the measurement of overall inflation. Certainly the relative prices of computers and consumer electronics have been falling for many years, even without adjustments for quality changes. No one, to my knowledge, has proposed removing the prices of computers and consumer electronics to measure core inflation. The economic forces at work here are trends, not high-frequency transitory fluctuations. Could it be that there are now trends in place in the relative prices of food and energy? I am not prepared to dismiss this possibility. Rapid economic development in China and India has placed increased demand on the world capacity to produce both food and energy and therefore has surely contributed to the persistent gap between core and headline inflation numbers observed over the past five years. It is not unreasonable to forecast that increased demand for food and energy by emerging economies with large populations will continue for a considerable period. This possibility suggests the FOMC must exercise caution lest monetary policy inadvertently accommodate an increased inflation trend by focusing on the behavior of price indexes excluding food and energy.

Although the danger is real, it is also true that oil futures prices for contracts several years ahead do not suggest continuing increases in oil prices of the magnitude observed over the past five years. That was also true five years ago—the futures market turned out to be wrong. However,

my view is that policymakers should rely on the judgment of the markets unless we have solid evidence that the markets are wrong. My personal experience is that, although the markets obviously can be wrong, I have no confidence that my own judgment on something like oil prices will be systematically more accurate.

PERSISTENCE OF FLUCTUATIONS AROUND TREND INFLATION

How much persistence will we observe in departures from trend inflation? From my discussion above, one critical element in the answer to this question is how sensitive inflation expectations are to actual changes in inflation. Persistence of inflation expectations is not independent of market perceptions as to how the central bank is pursuing its inflation objective. If actual inflation deviates from expected inflation, and households and firms believe that the central bank will move aggressively to restore inflation to a well-understood inflation target, then there will be little reason for them to adjust their longer-run inflation expectations. Markets will then help the central bank to minimize the persistence of the inflation fluctuations. If, however, households and firms perceive that the central bank will not move aggressively against an unwelcome change in inflation, then they may adjust their longer-run inflation expectations and, in doing so, amplify and make more persistent the change in inflation. The inflation-fighting credibility of the central bank is a crucial factor, perhaps the most critical factor, in short-run inflation dynamics.

CONCLUDING COMMENT

I began my remarks by noting that we are likely to regret a monetary policy that concentrates on the No. 1 economic concern of the day to the exclusion of other concerns. I believe that the FOMC in recent years has pursued a policy

¹⁰ See J.B. Bullard and G. Pande, “Energy Prices: In the Mix or Swept under the Rug?” Federal Reserve Bank of St. Louis *National Economic Trends*, April 2007, p. 1. <www.research.stlouisfed.org/publications/net/20070401/cover.pdf>.

MONETARY POLICY AND INFLATION

that is broadly on a sound track. I am willing to quibble on details, and have, but not on fundamentals.

There are insistent demands by some that the FOMC do more. At the Committee's meeting next month, which I will not attend as I am retiring from the St. Louis Fed shortly after that meeting, further cuts in the target federal funds rate may or may not be appropriate. The data on which the FOMC will base its decision will not be fully available until the time of the meeting.

I must say that I am a bit troubled that I hear loud claims that the FOMC did not tighten policy enough, and soon enough, in 2004-05 to choke off the bubble in house prices and unwise lending in the subprime mortgage market, developments that are at the root of today's problems. I do not recall many loud and insistent voices for tighter policy at that time. Policymakers are not clairvoyant. I wish I had seen these unfortunate developments in the housing market in their early stages, but I didn't.

My general approach is to think about all the things that *might* happen, as best I can, and then try to determine what is *actually* happening. My analysis includes my understanding of lessons from history. With regard to inflation, we know that inflation is a more slowly moving process than is unemployment, but also more persistent and more difficult to turn around. The seeds of an inflation problem are sown several years in

advance, and it is not always easy to see the seeds as they sprout. In present circumstances, monetary policymakers will need to be careful to react to evidence on the state of the economy and likely outlook for employment. The issue is *likely* developments in the labor market and not merely possible developments. At the same time, policymakers will have to remain conscious of the lessons of history with regard to inflation. Here again, *likely* developments and not just possible developments must be the focus of attention.

Risk mitigation to counter costly possible developments is an important strategy, but taking out insurance against certain risks is not free. At any given time, policymakers could pursue a powerfully expansionary policy to all but eliminate the possibility of a significant recession in the year ahead, but doing so would come at the cost and even likelihood of an unacceptable increase in the rate of inflation. We know that inflation does not buy a permanent reduction in unemployment. Indeed, a substantial increase in the rate of inflation promises a larger recession later, as the country learned at such great cost in the 1970s.

Monetary policy is a balancing act. Decisions must be based on good economic theory and the most complete information possible. That, in my experience over the past 10 years, is exactly what the FOMC does.