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Inflation and Unemployment: A Layperson's Guide to the Phillips Curve

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What do you remember from the economics class you took in college? Even if you didn't take economics, what basic ideas do you think are important for understanding the way markets work? In either case, one thing you might come up with is that when the demand for a good rises—when more and more people want more and more of that good—its price will tend to increase. This basic piece of economic logic helps us understand the phenomena we observe in many specific markets—from the tendency of gasoline prices to rise as the summer sets in and people hit the road on their family vacations, to the tendency for last year's styles to fall in price as consumers turn to the new fashions.

This notion paints a picture of the price of a good moving together in the same direction with its quantity—when people are buying more, its price is rising. Of course supply matters, too, and thinking about variations in supply—goods becoming more or less plentiful or more or less costly to produce—complicates the picture. But in many cases such as the examples above, we might expect movements up and down in demand to happen more frequently than movements in supply. Certainly for goods produced by a stable industry in an environment of little technological change, we would expect that many movements in price and quantity are driven by movements in demand, which would cause price and quantity to move up and down together. Common sense

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suggests that this logic would carry over to how one thinks about not only the price of one good but also the prices of all goods. Should an average measure of all prices in the economy—the consumer price index, for example—be expected to move up when our total measures of goods produced and consumed rise? And should faster growth in these quantities—as measured, say, by gross domestic product—be accompanied by faster increases in prices? That is, should inflation move up and down with real economic growth?

The simple intuition behind this series of questions is seriously incomplete as a description of the behavior of prices and quantities at the macroeconomic level. But it does form the basis for an idea at the heart of much macroeconomic policy analysis for at least a half century. This idea is called the "Phillips curve," and it embodies a hypothesis about the relationship between inflation and real economic variables. It is usually stated not in terms of the positive relationship between inflation and growth but in terms of a negative relationship between inflation and unemployment. Since faster growth often means more intensive utilization of an economy's resources, faster growth will be expected to come with falling unemployment. Hence, faster inflation is associated with lower unemployment. In this form, the Phillips curve looks like the expression of a tradeoff between two bad economic outcomes—reducing inflation requires accepting higher unemployment.

The first important observation about this relationship is that the simple intuition described at the beginning of this essay is not immediately applicable at the level of the economy-wide price level. That intuition is built on the workings of supply and demand in setting the quantity and price of a specific good. The price of that specific good is best understood as a *relative* price—the price of that good compared to the prices of other goods. By contrast, inflation is the rate of change of the general level of all prices. Recognizing this distinction does not mean that rising demand for all goods—that is, rising aggregate demand—would not make all prices rise. Rather, the important implication of this distinction is that it focuses attention on what, besides people's underlying desire for more goods and services, might drive a general increase in all prices. The other key factor is the supply of money in the economy.

Economic decisions of producers and consumers are driven by relative prices: a rising price of bagels relative to doughnuts might prompt a baker to shift production away from doughnuts and toward bagels. If we could imagine a situation in which all prices of *all* outputs and inputs in the economy, including wages, rise at exactly the same rate, what effect on economic decisions would we expect? A reasonable answer is "none." Nothing will have become more expensive relative to other goods, and labor income will have risen as much as prices, leaving people no poorer or richer.

The thought experiment involving all prices and wages rising in equal proportions demonstrates the principle of *monetary neutrality*. The term refers

to the fact that the hypothetical increase in prices and wages could be expected to result from a corresponding increase in the supply of money. Monetary neutrality is a natural starting point for thinking about the relationship between inflation and real economic variables. If money is neutral, then an increase in the supply of money translates directly into inflation and has no necessary relationship with changes in real output, output growth, or unemployment. That is, when money is neutral, the simple supply-and-demand intuition about output growth and inflation does not apply to inflation associated with the growth of the money supply.

The logic of monetary neutrality is indisputable, but is it relevant? The logic arises from thinking about hypothetical "frictionless" economies in which all market participants at all times have all the information they need to price the goods they sell and to choose among the available goods, and in which sellers can easily change the price they charge. Against this hypothetical benchmark, actual economies are likely to appear imperfect to the naked eye. And under the microscope of econometric evidence, a positive correlation between inflation and real growth does tend to show up. The task of modern macroeconomics has been to understand these empirical relationships. What are the "frictions" that impede monetary neutrality? Since monetary policy is a key determinant of inflation, another important question is how the conduct of policy affects the observed relationships. And finally, what does our understanding of these relationships imply about the proper conduct of policy?

The Phillips curve, viewed as a way of capturing how money might not be neutral, has always been a central part of the way economists have thought about macroeconomics and monetary policy. It also forms the basis, perhaps implicitly, of popular understanding of the basic problem of economic policy; namely, we want the economy to grow and unemployment to be low, but if growth is too robust, inflation becomes a risk. Over time, many debates about economic policy have boiled down to alternative understandings of what the Phillips curve is and what it means. Even today, views that economists express on the effects of macroeconomic policy in general and monetary policy in particular often derive from what they think about the nature, the shape, and the stability of the Phillips curve.

This essay seeks to trace the evolution of our understanding of the Phillips curve, from before its inception to contemporary debates about economic policy. The history presented in the pages that follow is by no means exhaustive. Important parts of economists' understanding of this relationship that we neglect include discussions of how the observed Phillips curve's statistical relationship could emerge even under monetary neutrality.[1] We also neglect the literature on the possibility of real economic costs of inflation that arise

[1] King and Plosser (1984).

even when money is neutral.[2] Instead, we seek to provide the broad outlines of the intellectual development that has led to the role of the Phillips curve in modern macroeconomics, emphasizing the interplay of economic theory and empirical evidence.

After reviewing the history, we will turn to the current debate about the Phillips curve and how it translates into differing views about monetary policy. People commonly talk about a central bank seeking to engineer a slowing of the economy to bring about lower inflation. They think of the Phillips curve as describing how much slowing is required to achieve a given reduction in inflation. We believe that this reading of the Phillips curve as a lever that a policymaker might manipulate mechanically can be misleading. By itself, the Phillips curve is a statistical relationship that has arisen from the complex interaction of policy decisions and the actions of private participants in the economy. Importantly, choices made by policymakers play a large role in determining the nature of the statistical Phillips curve. Understanding *that* relationship—between policymaking and the Phillips curve—is a key ingredient to sound policy decisions. We return to this theme after our historical overview.

1. SOME HISTORY

The Phillips curve is named for New Zealand-born economist A.W. Phillips, who published a paper in 1958 showing an inverse relationship between (wage) inflation and unemployment in nearly 100 years of data from the United Kingdom.[3] Since this is the work from which the curve acquired its name, one might assume that the economics profession's prior consensus on the matter embodied the presumption that money is neutral. But this in fact is not the case. The idea of monetary neutrality has long coexisted with the notion that periods of rising money growth and inflation might be accompanied by increases in output and declines in unemployment. Robert Lucas (1996), in his Nobel lecture on the subject of monetary neutrality, finds both ideas expressed in the work of David Hume in 1752! Thomas Humphrey (1991) traces the notion of a Phillips curve tradeoff throughout the writings of the classical economists in the 18th and 19th centuries. Even Irving Fisher, whose statement of the quantity theory of money embodied a full articulation of the consequences of neutrality, recognized the possible real effects of money and inflation over the course of a business cycle.

In early writings, these two opposing ideas—that money is neutral and that it is associated with rising real growth—were typically reconciled by the distinction between periods of time ambiguously referred to as "short

[2] Cooley and Hansen (1989), for instance.

[3] Phillips (1958).

run" and "long run." The logic of monetary neutrality is essentially long-run logic. The type of thought experiment the classical writers had in mind was a one-time increase in the quantity of money circulating in an economy. Their logic implied that, ultimately, this would merely amount to a change in units of measurement. Given enough time for the extra money to spread itself throughout the economy, all prices would rise proportionately. So while the number of units of money needed to compensate a day's labor might be higher, the amount of food, shelter, and clothing that a day's pay could purchase would be exactly the same as before the increase in money and prices.

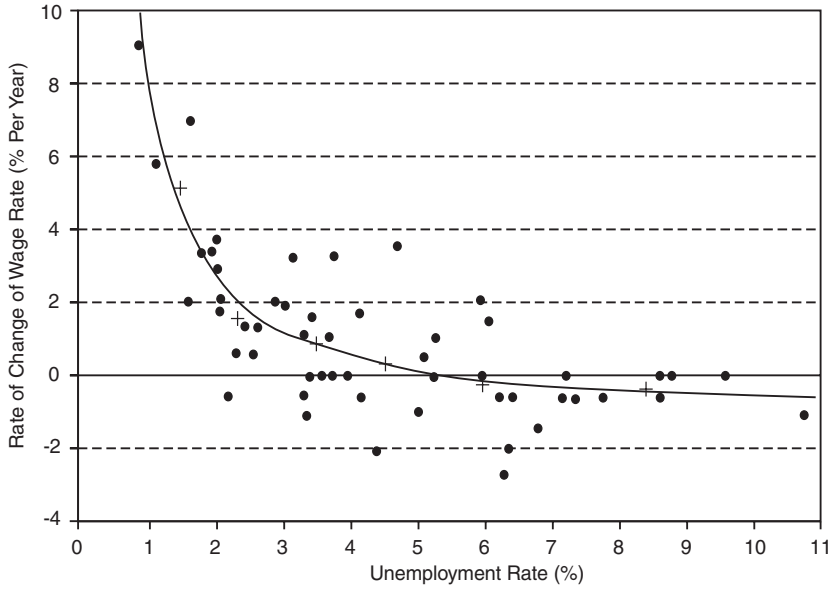
Against this logic stood the classical economists' observations of the world around them in which increases in money and prices appeared to bring increases in industrial and commercial activity. This empirical observation did not employ the kind of formal statistics as that used by modern economists but simply the practice of keen observation. They would typically explain the difference between their theory's predictions (neutrality) and their observations by appealing to what economists today would call "frictions" in the marketplace. Of particular importance in this instance are frictions that get in the way of price adjustment or make it hard for buyers and sellers of goods and services to know when the general level of all prices is rising. If a craftsman sees that he can sell his wares for an increased price but doesn't realize that all prices are rising proportionately, he might think that his goods are rising in value relative to other goods. He might then take action to increase his output so as to benefit from the perceived rise in the worth of his labors.

This example shows how frictions in price adjustment can break the logic of money neutrality. But such a departure is likely to be only temporary. You can't fool everybody forever, and eventually people learn about the general inflation caused by an increase in money. The real effects of inflation should then die out. It was in fact in the context of this distinction between long-run neutrality and the short-run tradeoff between inflation and real growth that John Maynard Keynes made his oft-quoted quip that "in the long run we are all dead." [4]

Phillips' work was among the first formal statistical analyses of the relationship between inflation and real economic activity. The data on the rate of wage increase and the rate of unemployment for Phillips' baseline period of 1861–1913 are reproduced in Figure 1. These data show a clear negative relationship—greater inflation tends to coincide with lower unemployment. To highlight that relationship, Phillips fit the curve in Figure 1 to the data. He then examined a number of episodes, both within the baseline period and in other periods up through 1957. The general tendency of a negative relationship persists throughout.

[4] Keynes (1923).

Figure 1 Inflation-Unemployment Relationship in the United Kingdom, 1861–1913



Source: Phillips (1958).

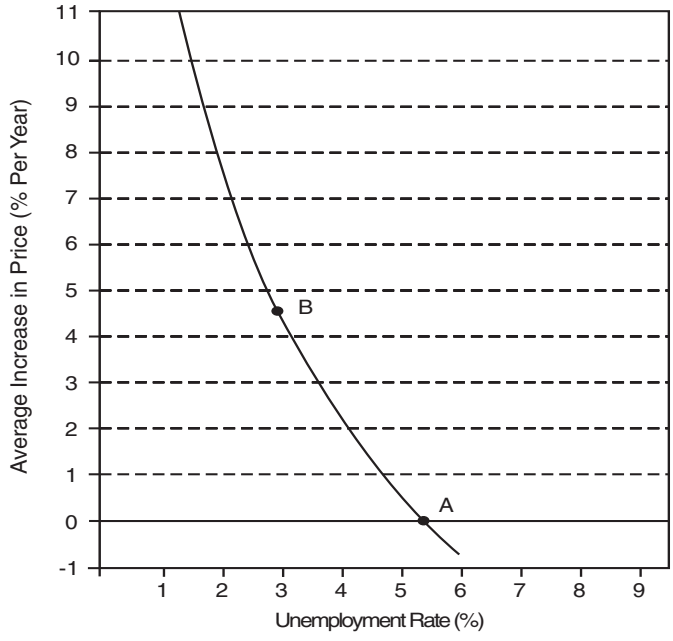
Crossing the Atlantic

A few years later, Paul Samuelson and Robert Solow, both eventual Nobel Prize winners, took a look at the U.S. data from the beginning of the 20th century through 1958.[5] A similar scatter-plot to that in Figure 1 was less definitive in showing the negative relationship between wage inflation and unemployment. The authors were able to recover a pattern similar to Phillips' by taking out the years of the World Wars and the Great Depression. They also translated their findings into a relationship between unemployment and *price* inflation. It is this relationship that economists now most commonly think of as the "Phillips curve."

Samuelson and Solow's Phillips curve is reproduced in Figure 2. They interpret this curve as showing the combinations of unemployment and inflation available to society. The implication is that policymakers must choose from the menu traced out by the curve. An inflation rate of zero, or *price stability*,

[5] Samuelson and Solow (1960).

Figure 2 Inflation-Unemployment Relationship in the United States around 1960



Source: Samuelson and Solow (1960).

appears to require an unemployment rate of about $5\frac{1}{2}$ percent. To achieve unemployment of about 3 percent, which the authors viewed as approximately full employment, the curve suggests that inflation would need to be close to 5 percent.

Samuelson and Solow did not propose that their estimated curve described a permanent relationship that would never change. Rather, they presented it as a description of the array of possibilities facing the economy in "the years just ahead."[6] While recognizing that the relationship might change beyond this near horizon, they remained largely agnostic on how and why it might change. As a final note, however, they suggest institutional reforms that *might* produce a more favorable tradeoff (shifting the curve in Figure 2 down and to the left). These involve measures to limit the ability of businesses and unions to exercise monopoly control over prices and wages, or even direct

[6] Ibid., p. 193.

wage and price controls. Their closing discussion suggests that they, like many economists at the time, viewed both inflation and the frictions that kept money and inflation from being neutral as at least partly structural—hard-wired into the institutions of modern, corporate capitalism. Indeed, they concluded their paper with speculation about institutional reforms that could move the Phillips curve down and to the left. This was an interpretation that was compatible with the idea of a more permanent tradeoff that derived from the structure of the economy and that could be exploited by policymakers seeking to engineer lasting changes in economic performance.

By the 1960s, then, the Phillips curve tradeoff had become an essential part of the Keynesian approach to macroeconomics that dominated the field in the decades following the Second World War. Guided by this relationship, economists argued that the government could use fiscal policy—government spending or tax cuts—to stimulate the economy toward full employment with a fair amount of certainty about what the cost would be in terms of increased inflation. Alternatively, such a stimulative effect could be achieved by monetary policy. In either case, policymaking would be a conceptually simple matter of cost-benefit analysis, although its implementation was by no means simple. And since the costs of a small amount of inflation to society were thought to be low, it seemed worthwhile to achieve a lower unemployment rate at the cost of tolerating only a little more inflation.

Turning the Focus to Expectations

This approach to economic policy implicitly either denied the long-run neutrality of money or thought it irrelevant. A distinct minority view within the profession, however, continued to emphasize limitations on the ability of rising inflation to bring down unemployment in a sustained way. The leading proponent of this view was Milton Friedman, whose Nobel Prize award would cite his Phillips curve work. In his presidential address to the American Economics Association, Friedman began his discussion of monetary policy by stipulating what monetary policy cannot do. Chief among these was that it could not "peg the rate of unemployment for more than very limited periods."[7] Attempts to use expansionary monetary policy to keep unemployment persistently below what he referred to as its "natural rate" would inevitably come at the cost of successively higher inflation. Key to his argument was the distinction between anticipated and unanticipated inflation. The short-run tradeoff between inflation and unemployment depended on the inflation expectations of the public. If people generally expected price stability (zero inflation), then monetary policy that brought about inflation of 3 percent would stimulate the

[7] Friedman (1968), p. 5.

economy, raising output growth and reducing unemployment. But suppose the economy had been experiencing higher inflation, of say 5 percent, for some time, and that people had come to expect that rate of increase to continue. Then, a policy that brought about 3 percent inflation would actually slow the economy, making unemployment tend to rise.

By emphasizing the public's inflation expectations, Friedman's analysis drew a link that was largely absent in earlier Phillips curve analyses. Specifically, his argument was that not only is monetary policy primarily responsible for determining the rate of inflation that will prevail, but it also ultimately determines the location of the entire Phillips curve. He argued that the economy would be at the natural rate of unemployment in the absence of unanticipated inflation. That is, the ability of a small increase in inflation to stimulate economic output and employment relied on the element of surprise. Both the inflation that people had come to expect and the ability to create a surprise were then consequences of monetary policy decisions.

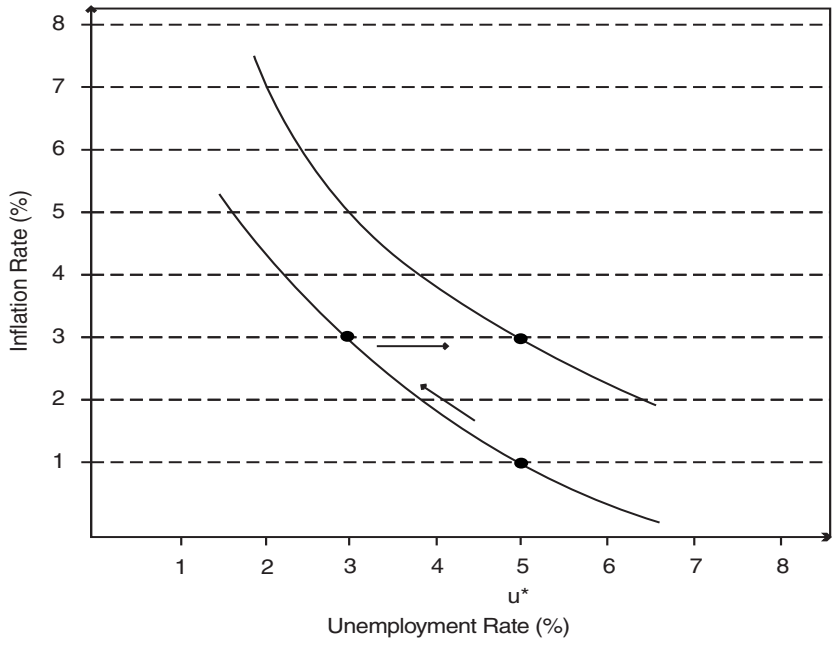
Friedman's argument involved the idea of a "natural rate" of unemployment. This natural rate was something that was determined by the structure of the economy, its rate of growth, and other real factors independent of monetary policy and the rate of inflation. While this natural rate might change over time, at any point in time, unemployment below the natural rate could only be achieved by policies that created inflation in excess of that anticipated by the public. But if inflation remained at the elevated level, people would come to expect higher inflation, and its stimulative effect would be lost. Unemployment would move back toward its natural rate. That is, the Phillips curve would shift up and to its right, as shown in Figure 3.

The figure shows a hypothetical example in which the natural rate of unemployment is 5 percent and people initially expect inflation of 1 percent. A surprise inflation of 3 percent drives unemployment down to 3 percent. But sustained inflation at the higher rate ultimately changes expectations, and the Phillips curve shifts back so that the natural rate of unemployment is achieved but now at 3 percent inflation. This analysis, which takes account of inflation expectations, is referred to as the *expectations-augmented Phillips curve*. An independent and contemporaneous development of this approach to the Phillips curve was given by Edmund Phelps, winner of the 2006 Nobel Prize in economics.[8] Phelps developed his version of the Phillips curve by working through the implications of frictions in the setting of wages and prices, which anticipated much of the work that followed.

The reasoning of Friedman and Phelps implied that attempts to exploit systematically the Phillips curve to bring about lower unemployment would succeed only temporarily at best. To have an effect on real activity, monetary

[8] Phelps (1967).

Figure 3 Expectations-Augmented Phillips Curve



Notes: When expected inflation is 1 percent, an unanticipated increase in inflation will initially bring unemployment down. But expectations will eventually adjust, bringing unemployment back to its natural rate (u^*) at the higher rate of inflation.

policy needed to bring about inflation in excess of people's expectations. But eventually, people would come to expect higher inflation, and the policy would lose its stimulative effect. This insight comes from an assumption that people base their expectations of inflation on their observation of past inflation. If, instead, people are more forward looking and understand what the policymaker is trying to do, they might adjust their expectations more quickly, causing the rise in inflation to lose much of even its temporary effect on real activity. In a sense, even the short-run relationship relied on people being fooled. One way people might be fooled is if they are simply unable to distinguish general inflation from a change in relative prices. This confusion, sometimes referred to as *money illusion*, could cause people to react to inflation as if it were a change in relative prices. For instance, workers, seeing their nominal wages rise but not recognizing that a general inflation is in process, might react as if their real income were rising. That is, they might increase their expenditures on goods and services.

Robert Lucas, another Nobel Laureate, demonstrated how behavior resembling money illusion could result even with firms and consumers who fully understood the difference between relative prices and the general price level.[9] In his analysis, confusion comes not from people's misunderstanding, but from their inability to observe all of the economy's prices at one time. His was the first formal analysis showing how a Phillips curve relationship could emerge in an economy with forward-looking decisionmakers. Like the work of Friedman and Phelps, Lucas' implications for policymakers were cautionary. The relationship between inflation and real activity in his analysis emerged most strongly when policy was conducted in an unpredictable fashion, that is, when policymaking was more a source of volatility than stability.

The Great Inflation

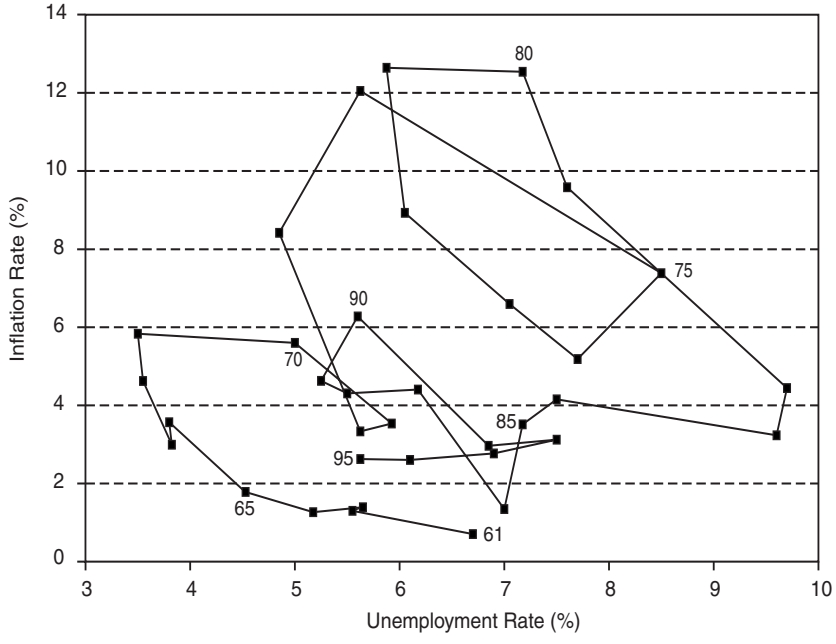
The expectations-augmented Phillips curve had the stark implication that any attempt to utilize the relationship between inflation and real activity to engineer persistently low unemployment at the cost of a little more inflation was doomed to failure. The experience of the 1970s is widely taken to be a confirmation of this hypothesis. The historical relationship identified by Phillips, Samuelson, and Solow, and other earlier writers appeared to break down entirely, as shown by the scatter-plot of the data for the 1970s in Figure 4. Throughout this decade, both inflation and unemployment tended to grow, leading to the emergence of the term "stagflation" in the popular lexicon.

One possible explanation for the experience of the 1970s is that the decade was simply a case of bad luck. The Phillips curve shifted about unpredictably as the economy was battered by various external shocks. The most notable of these shocks were the dramatic increases in energy prices in 1973 and again later in the decade. Such supply shocks worsened the available tradeoff, making higher unemployment necessary at any given level of inflation.

By contrast, viewing the decade through the lens of the expectations-augmented Phillips curve suggests that policy shared the blame for the disappointing results. Policymakers attempted to shield the real economy from the effects of aggregate shocks. Guided by the Phillips curve, this effort often implied a choice to tolerate higher inflation rather than allowing unemployment to rise. This type of policy choice follows from viewing the statistical relationship Phillips first found in the data as a menu of policy options, as suggested by Samuelson and Solow. But the arguments made by Friedman and Phelps imply that such a tradeoff is short lived at best. Unemployment would ultimately return to its natural rate at the higher rate of inflation. So, while the relative importance of luck and policy for the poor macroeconomic perfor-

[9] Lucas (1972).

Figure 4 Inflation-Unemployment Relationship in the United States, 1961–1995



Notes: Inflation rate is seasonally-adjusted CPI, Fourth Quarter.

Source: Bureau of Labor Statistics/Haver Analytics.

mance of the 1970s continues to be debated by economists, we find a powerful lesson in the history of that decade.[10] The macroeconomic performance of the 1970s is largely what the expectations-augmented Phillips curve predicts when policymakers try to exploit a tradeoff that they mistakenly believe to be stable.

The insights of Friedman, Phelps, and Lucas pointed to the complicated interaction between policymaking and statistical analysis. Relationships we observe in past data were influenced by past policy. When policy changes, people's behavior may change and so too may statistical relationships. Hence, the history of the 1970s can be read as an illustration of Lucas' critique of what was at the time the consensus approach to policy analysis.[11]

[10] Velde (2004) provides an excellent overview of this debate. A nontechnical description of the major arguments can be found in Sumo (2007).

[11] Lucas (1976).

Focusing attention on the role of expectations in the Phillips curve creates a challenge for policymakers seeking to use monetary policy to manage real economic activity. At any point in time, the current state of the economy and the private sector's expectations may imply a particular Phillips curve. Assuming that the Phillips curve describes a stable relationship, a policymaker might choose a preferred inflation-unemployment combination. That very choice, however, can alter expectations, causing the tradeoff to change. The policymaker's problem is, in effect, a game played against a public that is trying to anticipate policy. What's more, this game is repeated over and over, each time a policy choice must be made. This complicated interdependence of policy choices and private sector actions and expectations was studied by Finn Kydland and Edward C. Prescott.[12] In one of the papers for which they were awarded the 2005 Nobel Prize, they distinguish between rules and discretion as approaches to policymaking. By discretion, they mean period-by-period decisionmaking in which the policymaker takes a fresh look at the costs and benefits of alternative inflation levels at each moment. They contrast this with a setting in which the policymaker makes a one-time decision about the best rule to guide policy. They show that discretionary policy would result in higher inflation and no lower unemployment than the once-and-for-all choice of a policy rule.

Recent work by Thomas Sargent and various coauthors shows how discretionary policy, as studied by Kydland and Prescott, can lead to the type of inflation outcomes experienced in the 1970s.[13] This analysis assumes that the policymaker is uncertain of the position of the Phillips curve. In the face of this uncertainty, the policymaker estimates a Phillips curve from historical data. Seeking to exploit a short-run, expectations-augmented Phillips curve—that is, pursuing discretionary policy—the policymaker chooses among inflation-unemployment combinations described by the estimated Phillips curve. But the policy choices themselves cause people's beliefs about policy to change, which causes the response to policy choices to change. Consequently, when the policymaker uses new data to update the estimated Phillips curve, the curve will have shifted. This process of making policy while also trying to learn about the location of the Phillips curve can lead a policymaker to choices that result in persistently high inflation outcomes.

In addition to the joint rise in inflation and unemployment during the 1970s, other empirical evidence pointed to the importance of expectations. Sargent studied the experience of countries that had suffered from very high inflation.[14] In countries where monetary reforms brought about sudden and rapid *decelerations* in inflation, he found that the cost in terms of reduced

[12] Kydland and Prescott (1977).

[13] Sargent (1999), Cogley and Sargent (2005), and Sargent, Williams, and Zha (2006).

[14] Sargent (1986).

output or increased unemployment tended to be much lower than standard Phillips curve tradeoffs would suggest. One interpretation of these findings is that the disinflationary policies undertaken tended to be well-anticipated. Policymakers managed to credibly convince the public that they would pursue these policies. Falling inflation that did not come as a surprise did not have large real economic costs.

On a smaller scale in terms of peak inflation rates, another exercise in dramatic disinflation was conducted by the Federal Reserve under Chairman Paul Volcker.[15] As inflation rose to double-digit levels in the late 1970s, contemporaneous estimates of the cost in unemployment and lost output that would be necessary to bring inflation down substantially were quite large. A common range of estimates was that the 6 percentage-point reduction in inflation that was ultimately brought about would require output from 9 to 27 percent below capacity annually for up to four years.[16] Beginning in October 1979, the Fed took drastic steps, raising the federal funds rate as high as 19 percent in 1980. The result was a steep, but short recession. Overall, the costs of the Volcker disinflation appear to have been smaller than had been expected. A standard estimate, which appears in a popular economics textbook, is one in which the reduction in output during the Volcker disinflation amounted to less than a 4 percent annual shortfall relative to capacity.[17] This amount is a significant cost, but it is substantially less than many had predicted before the fact. Again, one possible reason could be that the Fed's course of action in this episode became well-anticipated once it commenced. While the public might not have known the extent of the actions the Fed would take, the direction of the change in policy may well have become widely understood. By the same token, and as argued by Goodfriend and King, remaining uncertainty about how far and how persistently the Fed would bring inflation down may have resulted in the costs of disinflation being greater than they might otherwise have been.

The experience of the 1970s, together with the insights of economists emphasizing expectations, ultimately brought the *credibility* of monetary policy to the forefront in thinking about the relationship between inflation and the real economy. Credibility refers to the extent to which the central bank can convince the public of its intention with regard to inflation. Kydland and Prescott showed that credibility does not come for free. There is always a short-run gain from allowing inflation to rise a little so as to stimulate the real economy. To establish credibility for a low rate of inflation, the central bank must convince the public that it will not pursue that short-run gain.

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[15] Goodfriend and King (2005).
[16] Ibid.
[17] Mankiw (2007).

The experience of the 1980s and 1990s can be read as an exercise in building credibility. In several episodes during that period, inflation expectations rose as doubts were raised about the Fed's ability to maintain its commitment to low inflation. These episodes, labeled *inflation scares* by Marvin Goodfriend, were marked by rapidly rising spreads between long-term and short-term interest rates.[18] Goodfriend identifies inflation scares in 1980, 1983, and 1987. These tended to come during or following episodes in which the Fed responded to real economic weakness with reductions (or delayed increases) in its federal funds rate target. In these instances, Fed policymakers reacted to signs of rising inflation expectations by raising interest rates. These systematic policy responses in the 1980s and 1990s were an important part of the process of building credibility for lower inflation.

2. THE "MODERN" PHILLIPS CURVE

The history of the Phillips curve shows that the empirical relationship shifts over time, and there is evidence that those movements are linked to the public's inflation expectations. But what does the history say about why this relationship exists? Why is it that there is a statistical relationship between inflation and real economic activity, even in the short run? The earliest writers and those that followed them recognized that the short-run tradeoff must arise from frictions that stand in the way of monetary neutrality. There are many possible sources of such frictions. They may arise from the limited nature of the information individuals have about the full array of prices for all products in the economy, as emphasized by Lucas. Frictions might also stem from the fact that not all people participate in all markets, so that different markets might be affected differently by changes in monetary policy. One simple type of friction is a limitation on the flexibility sellers have in adjusting the prices of the goods they sell. If there are no limitations all prices can adjust seamlessly whenever demand or cost conditions change, then a change in monetary policy will, again, affect different markets differently.

Deriving a Phillips Curve from Price-Setting Behavior

This price-setting friction has become a popular device for economists seeking to model the behavior of economies with a short-run Phillips curve. To see how such a friction leads to a Phillips curve, think about a business that is setting a price for its product and does not expect to get around to setting the price again for some time. Typically, the business will choose a price based on its own costs of production and the demand that it faces for its goods. But

[18] Goodfriend (1993).

because that business expects its price to be fixed for a while, its price choice will also depend on what it expects to happen to its costs and its demand between when it sets its price this time and when it sets its price the next time.

If the price-setting business thinks that inflation will be high in the interim between its price adjustments, then it will expect its relative price to fall. As average prices continue to rise, a good with a temporarily fixed price gets cheaper. The firm will naturally be interested in its average relative price during the period that its price remains fixed. The higher the inflation expected by the firm up until its next price adjustment, the higher the current price it will set. This reasoning, applied to all the economy's sellers of goods and services, leads directly to a close relationship between current inflation and expected future inflation.

This description of price-setting behavior implies that current inflation depends on the real costs of production and expected future inflation. The real costs of production for businesses will rise when the aggregate use of productive resources rises, for instance because rising demand for labor pushes up real wages.[19] The result is a Phillips curve relationship between inflation and a measure of real economic activity, such as output growth or unemployment. Current inflation rises with expected future inflation and falls as current unemployment rises relative to its "natural" rate (or as current output falls relative to the trend rate of output growth).

A Phillips Curve in a "Complete" Modern Model

The price-setting frictions that are part of many modern macroeconomic models are really not that different from arguments that economists have always made about reasons for the short-run nonneutrality of money. What distinguishes the modern approach is not just the more formal, mathematical derivation of a Phillips curve relationship, but more importantly, the incorporation of this relationship into a complete model of the macroeconomy. The word "complete" here has a very specific meaning, referring to what economists call "general equilibrium." The general equilibrium approach to studying economic activity recognizes the interdependence of disparate parts of the economy and emphasizes that all macroeconomic variables such as GDP, the level of prices, and unemployment are all determined by fundamental economic forces acting at the level of individual households and businesses. The completeness of a general equilibrium model also allows for an analysis of the effects of alternative approaches to macroeconomic policy, as well as an evaluation of the relative merits of alternative policies in terms of their effects on the economic well-being of the people in the economy.

[19] There are a number of technical assumptions needed to make this intuitive connection precisely correct.

The Phillips curve is only one part of a complete macroeconomic model—one equation in a system of equations. Another key component describes how real economic activity depends on real interest rates. Just as the Phillips curve is derived from a description of the price-setting decisions of businesses, this other relationship, which describes the demand side of the economy, is based on households' and business' decisions about consumption and investment. These decisions involve people's demand for resources now, as compared to their expected demand in the future. Their willingness to trade off between the present and the future depends on the price of that tradeoff—the real rate of interest.

One source of interdependence between different parts of the model—different equations—is in the real rate of interest. A real rate is a nominal rate—the interest rates we actually observe in financial markets—adjusted for expected inflation. Real rates are what really matter for households' and firms' decisions. So on the demand side of the economy, people's choices about consumption and investment depend on what they expect for inflation, which comes, in part, from the pricing behavior described by the Phillips curve. Another source of interdependence comes in the way the central bank influences nominal interest rates by setting the rate charged on overnight, interbank loans (the federal funds rate in the United States). A complete model also requires a description of how the central bank changes its nominal interest rate target in response to changing economic conditions (such as inflation, growth, or unemployment).

In a complete general equilibrium analysis of an economy's performance, all three parts—the Phillips curve, the demand side, and central bank behavior—work together to determine the evolution of economic variables. But many of the economic choices people make on a day-to-day basis depend not only on conditions today, but also on how conditions are expected to change in the future. Such expectations in modern macroeconomic models are commonly described through the assumption of *rational expectations*. This assumption simply means that the public—households and firms whose decisions drive real economic activity—fully understands how the economy evolves over time and how monetary policy shapes that evolution. It also means that people's decisions will depend on well-informed expectations not only of the evolution of future fundamental conditions, but of future policy as well. While discussions of a central bank's credibility typically assume that there are things related to policymaking about which the public is not fully certain, these discussions retain the presumption that people are forward looking in trying to understand policy and its impact on their decisions.

Implications and Uses of the Modern Approach

A Phillips curve that is derived as part of a model that includes price-setting frictions is often referred to as the *New Keynesian Phillips curve* (NKPC).[20] A complete general equilibrium model that incorporates this version of the Phillips curve has been referred to as the *New Neoclassical Synthesis model*.[21] These models, like any economic model, are parsimonious descriptions of reality. We do not take them as exact descriptions of how a modern economy functions. Rather, we look to them to capture the most important forces at work in determining macroeconomic outcomes. The key equations in new neoclassical or new Keynesian models all involve assumptions or approximations that simplify the analysis without altering the fundamental economic forces at work. Such simplifications allow the models to be a useful guide to our thinking about the economy and the effects of policy.

The modern Phillips curve is similar to the expectations-augmented Phillips curve in that inflation expectations are important to the relationship between current inflation and unemployment. But its derivation from forward-looking price-setting behavior shifts the emphasis to expectations of future inflation. It has implications similar to the long-run neutrality of money, because if inflation is constant over time, then current inflation is equal to expected inflation. Then, whatever that constant rate of inflation, unemployment must return to the rate implied by the underlying structure of the economy, that is, to a rate that might be considered the "natural" unemployment. Money is not truly neutral in these models, however. Rather, the pricing frictions underlying the models imply that there are real economic costs to inflation. Because sellers of goods adjust their prices at different times, inflation makes the relative prices of different goods vary, and this distorts sellers' and buyers' decisions. This distortion is greater, the greater the rate of inflation.

The expectational nature of the Phillips curve also means that policies that have a short-run effect on inflation will induce real movements in output or unemployment mainly if the short-run movement in inflation is not expected to persist. In this sense, the modern Phillips curve also embodies the importance of monetary policy credibility, since it is credibility that would allow expected inflation to remain stable, even as inflation fluctuated in the near term.

A more general way of emphasizing the importance of credibility is to say that the modern Phillips curve implies that the behavior of inflation will depend crucially on people's understanding of how the central bank is conducting monetary policy. What people think about the central bank's objectives and strategy will determine expectations of inflation, especially over the long run. Uncertainty about these aspects of policy will cause people to try to make

[20] Clarida, Galí, and Gertler (1999).

[21] Goodfriend and King (1997).

inferences about future policy from the actual policy they observe. Even if the central bank makes statements about its long-run objectives and strategy, people will still try to make inferences from the policy actions they see. But in this case, the inference that people will try to make is slightly simpler: people must determine if actual policy is consistent with the stated objectives.

Does this newest incarnation of the Phillips curve present a central bank with the opportunity to actively manage real economic activity through choosing more or less inflationary policies? The assumption that people are forward looking in forming expectations about future policy and inflation limits the scope for managing real growth or unemployment through Phillips curve tradeoffs. An attempt to manage such growth or unemployment persistently would translate into the public's expectations of inflation causing the Phillips curve to shift. This is another characteristic that the modern approach shares with the older expectations-augmented Phillips curve.

What this modern framework does allow is the analysis of alternative monetary policy rules—that is, how the central bank sets its nominal interest rate in response to such economic variables as inflation, relative to the central bank's target, and the unemployment rate or the rate of output growth relative to the central bank's understanding of trend growth.[22] A typical rule that roughly captures the actual behavior of most central banks would state, for instance, that the central bank raises the interest rate when inflation is higher than its target and lowers the interest rate when unemployment rises. Alternative rules might make different assumptions, for instance, about *how much* the central bank moves the interest rate in response to changes in the macroeconomic variables that it is concerned about. The complete model can then be used to evaluate how different rules perform in terms of the long-run levels of inflation and unemployment they produce, or more generally in terms of the economic well-being generated for people in the economy. A typical result is that rules that deliver lower and less variable inflation are better both because low and stable inflation is a good thing and because such rules can also deliver less variability in real economic activity. Further, lower inflation has the benefit of reducing the costs from distorted relative prices.

While low inflation is a preferred outcome, it is typically not possible, in models or in reality, to engineer a policy that delivers the same low target rate of inflation every month or quarter. The economy is hit by any number of shocks that can move both real output and inflation around from month to month—large energy price movements, for example. In the presence of such shocks, a good policy might be one that, while not hitting its inflation target each month, always tends to move back toward its target and never stray too far.

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[22] We use the term "monetary policy rule" in the very general sense of any systematic pattern of choice for the policy instrument—the funds rate—based on the state of the economy.

Complete models incorporating a modern Phillips curve also allow economists to formalize the notion of monetary policy credibility. Remember that credibility refers to what people believe about the way the central bank intends to conduct policy. If people are uncertain about what rule best describes the behavior of the central bank, then they will try to learn from what they see the central bank doing. This learning can make people's expectations about future policy evolve in a complicated way. In general, uncertainty about the central bank's policy, or doubts about its commitment to low inflation, can raise the cost (in terms of output or employment) of reducing inflation. That is, the short-run relationship between inflation and unemployment depends on the public's long-run expectations about monetary policy and inflation.

The modern approach embodies many features of the earlier thinking about the Phillips curve. The characterization of policy as a systematic pattern of behavior employed by the central bank, providing the framework within which people form systematic expectations about future policy, follows the work of Kydland and Prescott. And the focus on expectations itself, of course, originated with Friedman. Within this modern framework, however, some important debates remain unsettled. While our characterization of the framework has emphasized the forward-looking nature of people's expectations, some economists believe that deviations from this benchmark are important for understanding the dynamic behavior of inflation. We turn to this question in the next section.

We have described here an approach that has been adopted by many contemporary economists for applied central bank policy analysis. But we should note that this approach is not without its critics. Many economists view the price-setting frictions that are at the core of this approach as ad hoc and unpersuasive. This critique points to the value of a deeper theory of firms' price-setting behavior. Moreover, there are alternative frictions that can also rationalize monetary nonneutrality. Alternatives include frictions that limit the information available to decisionmakers or that limit some people's participation in some markets. So while the approach we've described does not represent the only possible modern model, it has become a popular workhorse in policy research.

3. HOW WELL DOES THE MODERN PHILLIPS CURVE FIT THE DATA?

The Phillips curve began as a relationship drawn to fit the data. Over time, it has evolved as economists' understanding of the forces driving those data has developed. The interplay between theory—the application of economic logic—and empirical facts has been an important part of this process of discovery. The recognition of the importance of expectations developed together with the evidence of the apparent instability of the short-run tradeoff. The

modern Phillips curve represents an attempt to study the behavior of both inflation and real variables using models that incorporate the lessons of Friedman, Phelps, and Lucas and that are rich enough to produce results that can be compared to real world data.

Attempts to fit the modern, or New Keynesian, Phillips curve to the data have come up against a challenging finding. The theory behind the short-run relationship implies that current inflation should depend on current real activity, as measured by unemployment or some other real variable, and expected future inflation. When estimating such an equation, economists have often found that an additional variable is necessary to explain the behavior of inflation over time. In particular, these studies find that past inflation is also important.[23]

Inflation Persistence

The finding that past inflation is important for the behavior of current and future inflation—that is, the finding of inflation *persistence*—implies that movements in inflation have persistent effects on future inflation, apart from any effects on unemployment or expected inflation. Such persistence, if it were an inherent part of the structure and dynamics of the economy, would create a challenge for policymakers to reduce inflation by reducing people's expectations. Remember that we stated earlier the possibility that if the central bank could convince the public that it was going to bring inflation down, then the desired reduction might be achieved with little cost in unemployment or output. Inherent inflation persistence would make such a strategy problematic. Inherent persistence makes the set of choices faced by the policymaker closer to that originally envisioned by Samuelson and Solow. The faster one tries to bring down inflation, the greater the real economic costs.

Inherent persistence in inflation might be thought to arise if not all price-setters in the economy were as forward looking as in the description given earlier. If, instead of basing their price decisions on their best forecast of future inflation behavior, some firms simply based current price choices on the past behavior of inflation, this backward-looking pricing would impart persistence to inflation. Jordi Galí and Mark Gertler, who took into account the possibility that the economy is populated by a combination of forward-looking and backward-looking participants, introduced a *hybrid* Phillips curve in which current inflation depends on both expected future inflation and past inflation.[24]

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[23] Fuhrer (1997).

[24] Galí and Gertler (1999).

An alternative explanation for inflation persistence is that it is a result primarily of the conduct of monetary policy. The evolution of people's inflation expectations depends on the evolution of the conduct of policy. If there are significant and persistent shifts in policy conduct, expectations will evolve as people learn about the changes. In this explanation, inflation persistence is not the result of backward-looking decisionmakers in the economy but is instead the result of the interaction of changing policy behavior and forward-looking private decisions by households and businesses.[25]

Another possibility is that inflation persistence is the result of the nature of the shocks hitting the economy. If these shocks are themselves persistent—that is, bad shocks tend to be followed by more bad shocks—then that persistence can lead to persistence in inflation. The way to assess the relative importance of alternative possible sources of persistence is to estimate the multiple equations that make up a more complete model of the economy. This approach, in contrast with the estimation of a single Phillips curve equation, allows for explicitly considering the roles of changing monetary policy, backward-looking pricing behavior, and shocks in generating inflation persistence. A typical finding is that the backward-looking terms in the hybrid Phillips curve appear considerably less important for explaining the dynamics of inflation than in single equation estimation.[26]

The scientific debate on the short-run relationship between inflation and real economic activity has not yet been fully resolved. On the central question of the importance of backward-looking behavior, common sense suggests that there are certainly people in the real-world economy who behave that way. Not everyone stays up-to-date enough on economic conditions to make sophisticated, forward-looking decisions. People who do not may well resort to rules of thumb that resemble the backward-looking behavior in some economic models. On the other hand, people's behavior is bound to be affected by what they believe to be the prevailing rate of inflation. Market participants have ample incentive and ability to anticipate the likely direction of change in the economy. So both backward- and forward-looking behavior are grounded in common sense. However the more important scientific questions involve the extent to which either type of behavior drives the dynamics of inflation and is therefore important for thinking about the consequences of alternative policy choices.

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[25] Dotsey (2002) and Sbordone (2006).

[26] Lubik and Schorfheide (2004).

The Importance of Inflation Persistence for Policymakers

Related to the question of whether forward- or backward-looking behavior drives inflation dynamics is the question of how stable people's inflation expectations are. The backward-looking characterization suggests a stickiness in beliefs, implying that it would be hard to induce people to change their expectations. If relatively high inflation expectations become ingrained, then it would be difficult to get people to expect a decline in inflation. This describes a situation in which disinflation could be very costly, since only persistent evidence of changes in actual inflation would move future expectations. Evidence discussed earlier from episodes of dramatic changes in the conduct of policy, however, suggests that people can be convinced that policy has changed. In a sense, the tradeoffs faced by a policymaker could depend on the extent to which people's expectations are subject to change. If people are uncertain and actively seeking to learn about the central bank's approach to policy, then expectations might move around in a way that departs from the very persistent, backward-looking characterization. But this movement in expectations would depend on the central bank's actions and statements about its conduct of policy.

The periods that Goodfriend (1993) described as inflation scares can be seen as periods when people's assessment of likely future policy was changing rather fluidly. Even very recently, we have seen episodes that could be described as "mini scares." For instance, in the wake of Hurricane Katrina in late 2005, markets' immediate response to rising energy prices suggested expectations of persistently rising inflation. Market participants, it seems, were uncertain as to how much of a run-up in general inflation the Fed would allow. Inflation expectations moved back down after a number of FOMC members made speeches emphasizing their focus on preserving low inflation. This episode illustrates both the potential for the Fed to influence inflation expectations and the extent to which market participants are at times uncertain as to how the Fed will respond to new developments.

4. MAKING POLICY

While the scientific dialogue continues, policymakers must make judgments based on their understanding of the state of the debate. At the Federal Reserve Bank of Richmond, policy opinions and recommendations have long been guided by a view that the short-term costs of reducing inflation depend on expectations. This view implies that central bank credibility—that is, the public's level of confidence about the central bank's future patterns of behavior—is an important aspect of policymaking. Central bank credibility makes it less costly to return inflation to a desirable level after it has been pushed up (or down) by energy prices or other shocks to the economy. This

view of policy is consistent with a view of the Phillips curve in which inflation persistence is primarily a consequence of the conduct of policy.

The evidence is perhaps not yet definitive. As outlined in our argument, however, we do find support for our view in the broad contours of the history of U.S. inflation over the last several decades. At a time when a consensus developed in the economics profession that the Phillips curve tradeoff could be exploited by policymakers, apparent attempts to do so led to or contributed to the decidedly unsatisfactory economic performance of the 1970s. And the improved performance that followed coincided with the solidification of the profession's understanding of the role of expectations. We also see the initial costs of bringing down inflation in the early 1980s as consistent with our emphasis on expectations and credibility. After the experience of the 1970s, credibility was low, and expectations responded slowly to the Fed's disinflationary policy actions. Still, the response of expectations was faster than might be implied by a backward-looking Phillips curve.

We also view policymaking on the basis of a forward-looking understanding of the Phillips curve as a prudent approach. A hybrid Phillips curve with a backward-looking component presents greater opportunities for exploiting the short-run tradeoff. In a sense, it assumes that the monetary policymaker has more influence over real economic activity than is assumed by the purely forward-looking specification. Basing policy on a backward-looking formulation would also risk underestimating the extent to which movements in inflation can generate shifts in inflation expectations, which could work against the policymaker's intentions. Again, the experience of past decades suggests the risks associated with policymaking under the assumption that policy can persistently influence real activity more than it really can. In our view, these risks point to the importance of a policy that makes expectational stability its centerpiece.

5. CONCLUSION

One key lesson from the history of the relationship between inflation and real activity is that any short-run tradeoff depends on people's expectations for inflation. Ultimately, monetary policy has its greatest impact on real activity when it deviates from people's expectations. But if a central bank tries to deviate from people's expectations repeatedly, so as to systematically increase real output growth, people's expectations will adjust.

There are also, we think, important lessons in the observation that overall economic performance, in terms of both real economic activity and inflation, was much improved beginning in the 1980s as compared to that in the preceding decade. While this improvement could have some external sources related to the kinds of shocks that affect the economy, it is also likely that improved conduct of monetary policy played a role. In particular, monetary

policy was able to persistently lower inflation by responding more to signs of rising inflation or inflation expectations than had been the case in the past. At the same time, the variability of inflation fell, while fluctuations in output and unemployment were also moderating.

We think the observed behavior of policy and economic performance is directly linked to the lessons from the history of the Phillips curve. Both point to the importance of the expectational consequences of monetary policy choices. An approach to policy that is able to stabilize expectations will be most able to maintain low and stable inflation with minimal effects on real activity. It is the credible maintenance of price stability that will in turn allow real economic performance to achieve its potential over the long run. This will not eliminate the business cycle since the economy will still be subject to shocks that quicken or slow growth. We believe the history of the Phillips curve shows that monetary policy's ability to add to economic variability by overreacting to shocks is greater than its ability to reduce real variability, once it has achieved credibility for low inflation.

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