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Lessons for Central Bankers from a Phillips Curve Framework

Remarks by

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An economic model of inflation is an indispensable input to monetary policy deliberations. A model in the Phillips curve tradition remains at the core of how most academic researchers and policymakers--including this one--think about fluctuations in inflation; indeed, alternative frameworks seem to lack solid economic foundations and empirical support. But the modern Phillips curve differs substantially from versions in use several decades ago; policymakers and academics alike are now attuned to the importance of expectations, the possibility of structural change, and the uncertainty that surrounds our understanding of the dynamics of wage and price adjustment. Moreover, the link between inflation and resource utilization often emphasized in a Phillips curve framework accounts for only a modest part of inflation fluctuations. My comments today will focus on how the lessons from recent research on the Phillips curve are helping me think about the influence of fluctuations in the prices of commodities, such as oil, on the outlook for inflation and the appropriate policy responses to such developments.<sup>1</sup>

### **Policy Objectives and a Framework for Analyzing Inflation Fluctuations**

The Federal Reserve has been charged with the pursuit of price stability and maximum employment. Price stability is uniquely in the control of the central bank over long periods, and it is a prerequisite for the economy performing efficiently over time. The welfare costs of inflation result from many factors: the potential costs to households and firms that result from efforts to insure themselves against inflation or from confusion regarding real and nominal prices; distortions to the financial system related to inflation; imperfect indexation of the taxation, especially of capital income, and the related distortions to economic activity; and the costs associated with a slow adjustment of

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<sup>1</sup> Michael Kiley, of the Board's staff, contributed to these remarks. The views expressed are my own and not necessarily those of my colleagues on the Board of Governors or the Federal Open Market Committee.

nominal prices and wages. The costs of inflation imply that central banks should aim for low measured inflation. Moreover, many of the costs of inflation--such as those associated with misconceptions regarding inflation, efforts to insure against inflation, and distortions to the financial system--are associated with the rate of change in the entire set of prices of goods and services facing households or firms, suggesting that measured inflation should be gauged by the rate of change in a broad set of prices. Accordingly, the Federal Open Market Committee (FOMC) has been emphasizing that it gauges price stability over the long-term by the behavior of the overall personal consumption expenditures price index.

The economic framework that helps me think about fluctuations in inflation is based on the substantial body of research on models of price dynamics that has been developed over the past five decades. At its heart, the framework is based on the importance of sluggish adjustment in (some) nominal wages and prices to changing economic conditions. This sluggishness undoubtedly reflects a number of factors, which include the costs of adjusting some nominal prices and wages, imperfect information regarding shifts in economic conditions, and learning by firms and households about the structure of the economy, including the setting of monetary policy.

Regardless of its source, the presence of sluggish nominal adjustment brings to the fore three key elements driving wage and price dynamics: inflation expectations, supply shocks, and resource utilization. Because some prices and wages are adjusted only infrequently, both firms and households anticipate the future erosion of real prices and wages by incorporating the expectations they have for inflation into their current price settings and wage demands. As a result, inflation expectations play a critical role in

the formation of monetary policy. Moreover, the tendency of some prices to adjust very quickly to changing circumstances in conjunction with sluggish adjustment in other prices and wages implies that large, sharp price movements, such as a change in the price of oil, lead to relative price distortions throughout the economy; these distortions imply that relative price shocks have important implications for the functioning of the economy.<sup>2</sup> Finally, fluctuations in resource utilization, through their effects on the costs of production and on firms' desired markups over these costs, are a significant determinant of price and wage decisions. The link from resource utilization to inflation provides a major channel through which monetary policy settings influence inflation: Adjustments in the policy interest rate bring about changes in resource utilization, which then influence current and expected inflation.

### **Inflation Forecasting and Commodity Price Shocks**

The economic outlook is the prime focus of monetary policy. Because the stance of policy influences economic activity and inflation only with a lag, policymakers must adjust policy to minimize the costs from fluctuations in activity and inflation in the future. The Phillips curve framework is an important input into the forecast for inflation. I will focus specifically on how a shock to the price of oil affects the inflation outlook within this framework. This topic is especially salient of late--commodities prices in general, and perhaps most glaringly the price of oil, have risen sharply over the past year; indeed, oil prices have risen sharply for more than four years.

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<sup>2</sup> Relative price shocks act like supply shocks in the Phillips curve framework for two reasons. First, some prices are sluggish and others are flexible, and the Phillips curve framework focuses on the adjustment of sluggish prices. Second, prices are more likely to adjust to very large shocks, and the skewness on the distribution of relative price disturbances can fluctuate substantially, giving rise to shocks to the Phillips curve. Ball and Mankiw (1995) discuss these issues and argue that the second type of relative price shock is quantitatively very important.

Consider a sharp rise in the price of oil that primarily reflects a shift in the balance between demand and supply in the global market for oil.<sup>3</sup> In the first instance, higher oil prices lead to an increase in the overall level of consumer prices. When thinking about the outlook for future inflation, it is useful to distinguish between oil and other prices. The most significant factor determining oil prices is the current and prospective balance between demand and supply. The aggregate behavior of most other prices, consisting of a large set of nominal prices and wages that adjust slowly, is driven by the factors that enter the Phillips curve--inflation expectations, resource utilization, and supply shocks (in this case, a shock to the price of oil).

In a forecasting context, the Phillips curve framework motivates reduced-form regressions of the rate of inflation for consumer prices excluding food and energy against proxies for each key factor. Lagged values of inflation typically proxy for inflation expectations. The deviation of output from potential or of the unemployment rate from its sustainable rate serves as a proxy for resource utilization. And changes in relative prices for energy, food and imports are traditionally included as measures of supply shocks.<sup>4</sup> This type of regression is among the most useful tools for forecasting inflation. Nonetheless, its forecast record is far from spotless, and hence I consider the forecasts from such regressions as just one input that helps inform my outlook for inflation.

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<sup>3</sup> The rise in a broad range of commodity prices, as has occurred from time to time recently, would not affect the basic analysis which rests on the contrasting behavior of flexible and sluggishly adjusting prices. However, the simultaneous rise in many commodity prices might suggest that strong global aggregate demand is playing an important role, which would affect the appropriate setting for monetary policy. See the section below on Global Demand, Trending Commodity Prices and Monetary Policy.

<sup>4</sup> The amount of related literature is large. The article by Robert Gordon (1998) represents a good example and is relevant when considering the notion of supply shocks generally. Stock and Watson (1999) present a broad interpretation of the empirical Phillips curve in which a large number of macroeconomic indicators are used to forecast inflation.

The results of such exercises imply that, over recent history, a sharp jump in oil prices appears to have had only modest effects on the future rate of inflation. This result likely reflects two factors. First, commodities like oil represent only a small share of the overall costs of production, implying that the magnitude of the direct pass-through from changes in such prices to other prices should be modest, all else equal. Second, inflation expectations have been well anchored in recent years, contributing to a muted response of inflation to oil price shocks. But the anchoring of expectations cannot be taken as given; indeed, the type of empirical exercises I have outlined reveal a larger effect of the price of oil on inflation prior to the last two decades, a period in which inflation expectations were not as well anchored as they are today.<sup>5</sup>

Of course, oil prices have jumped repeatedly in recent years. The (relatively) continuous rise in energy prices since 2003 has been a surprise to me and to most others, as least as best as I can gauge by looking at prices that have been embedded in futures contracts over this period. These contracts currently suggest that the price of oil will flatten out in the period ahead.

Nonetheless, repeated increases in energy prices and their effect on overall inflation have contributed to a rise in the year-ahead inflation expectations of households, especially this year. Of greater concern is that some measures of longer-term inflation expectations appear to have edged up since last year. Any tendency for these longer-term inflation expectations to drift higher or even to fail to reverse over time would have troublesome implications for the outlook for inflation.

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<sup>5</sup> These factors are not the only two that have contributed to a lower effect of oil prices on inflation. For example, the energy intensity of the economy has fallen over time. Research like that in Hooker (2002) and subsequent work has discussed various possibilities in more detail. Blanchard and Gali (2007) suggest that the seemingly muted affect of changes in the price of oil and inflation in recent years has been the result of falling energy intensity, more flexible labor markets, better monetary policy, and good luck.

## **The Structural Phillips Curve, Commodity Price Shocks, and Monetary Policy**

The central role of inflation expectations implies that policymakers must look beyond this type of reduced-form exercise for guidance. After all, the lags of inflation in reduced-form regressions are a very imperfect proxy for inflation expectations. As emphasized in Robert Lucas's critique of reduced-form Phillips curves more than 30 years ago, *structural* models are needed to have confidence in the effect of any shock on the outlook for inflation and economic activity.<sup>6</sup>

The importance of structural relationships as inputs to the monetary policy process poses a challenge; for instance, there are many "structural" models of nominal price and wage adjustment, each of these models emphasizes different frictions or imperfections and therefore can have different policy implications, and empirical work has reached different conclusions regarding the merits of alternative models.<sup>7</sup> As a result, policymakers must look to lessons that are common across alternative specifications and base policy on our current understanding of the most likely important structural factors. Fortunately, I think that many of the models of nominal price and wage adjustment imply similar conclusions regarding the influence of commodity prices on the inflation outlook and the appropriate response of monetary policy.

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<sup>6</sup> See Lucas (1976). Robert Lucas had emphasized the importance of structural models of the Phillips curve well before his 1976 article; for example, see his contribution at the conference on wage and price dynamics held at the Federal Reserve in 1970 (Lucas, 1972). Michael Woodford (1994) presented an important critique of some research on commodity prices, inflation, and monetary policy in which the role of the Lucas critique was central: In particular, he re-emphasized that a tendency of commodity prices to forecast inflation may not be structural and could break down under alternative policy regimes--a tendency that seemed to be confirmed by Mark Hooker (2002) in his work documenting a break in the link between oil prices and inflation in recent decades.

<sup>7</sup> For example, Rudd and Whelan (2007) and Kiley (2007) review a number of models and empirical studies as well as conduct their own empirical analyses; these two studies reach quite different conclusions on the merits of alternative specifications.

I will again focus on a sharp jump in the price of oil, reflecting supply and demand in the market for oil. Because many nominal prices and wages are costly and slow to adjust, the efficient allocation of resources is impeded during a transition period in which relative price signals are distorted. For example, the prices of energy-intensive goods need to rise relative to those of less-energy-intensive goods, but this adjustment follows a gradual and asynchronous pattern. Similarly, the equilibrium real wage--the relative price of labor--will tend to be depressed by an oil price shock due to the accompanying adverse movements in the terms of trade and reduction in labor productivity, but the needed wage or price adjustments proceed gradually.<sup>8</sup> An efficient monetary policy should attempt to facilitate the needed economic adjustments so as to minimize distortions to economic efficiency on the path to achieving, over time, its dual objectives of price stability and maximum employment.<sup>9</sup>

In particular, an appropriate monetary policy following a jump in the price of oil will allow, on a temporary basis, both some increase in unemployment and some increase in price inflation. By pursuing actions that balance the deleterious effects of oil prices on both employment and inflation over the near term, policymakers are, in essence, attempting to find their preferred point on the activity/inflation variance-tradeoff curve introduced by John Taylor 30 years ago.<sup>10</sup> Such policy actions promote the efficient adjustment of relative prices: Since real wages need to fall and both prices and wages adjust slowly, the efficient adjustment of relative prices will tend to include a bit of

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<sup>8</sup> For example, see the article by Chao Wei (2003) illustrating the effects of a rise in oil prices in a dynamic equilibrium model.

<sup>9</sup> Erceg, Henderson, and Levin (2000) discuss the importance of relative price adjustments in the presence of sluggish nominal prices and wages in a general context; Mankiw and Reis (2003) present related results. Bodenstein, Erceg, and Guerrieri (2007) apply this reasoning to oil price shocks.

<sup>10</sup> See Taylor (1979).

additional price inflation and a bit of additional unemployment for a time, leading to increases in real wages that are temporarily below the trend established by productivity gains.

I should emphasize that the course of policy I have just described has taken inflation expectations as given. In practice, it is very important to ensure that policy actions anchor inflation expectations. This anchoring is critical: As demonstrated by historical experiences around the world and in the United States during the 1970s and 1980s, efforts to bring inflation and inflation expectations back to desirable levels after they have risen appreciably involve costly and undesirable changes in resource utilization.<sup>11</sup> As a result, the degree to which any deviations of inflation from long-run objectives are tolerated to allow the efficient relative price adjustments that I have described needs to be tempered so as to ensure that longer-term inflation expectations are not affected to a significant extent.

### **Global Demand, Trending Commodity Prices, and Monetary Policy**

My remarks so far have concentrated on the factors guiding the monetary policy response to a shock in the prices of commodities like oil that stems from a shifting balance of supply and demand in the specific market for these commodities. Some might think that this focus misses the point in the current context, for at least two reasons. First, it has been suggested that the run-up in the prices of a broad range of commodity prices reflects, in part, global excess demand rather than sector-specific forces. And second,

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<sup>11</sup> Ball (1994) presents estimates of the costs of disinflation for a variety of countries, including the United States. Kiley (2008) provides evidence on how survey measures of inflation expectations in the United States have responded to economic developments and presents a model that attempts to explain the patterns in the data. Orphanides and Williams (2005) present a model in which perpetual learning leads to fluctuations in inflation expectations at various horizons and provide examples of how alternative monetary policy settings can influence the course of inflation expectations, thereby illustrating the importance of the interaction between expectations formation and efficient monetary policy.

some have suggested that important commodity prices, like that of oil, may be on a more significant upward trend than is currently embedded in futures prices.

It seems highly likely that, over the period since 2003, the rise in commodity prices has reflected strong global economic growth as well as some sector-specific factors, such as geopolitical tensions and other disruptions to the supply of oil.<sup>12</sup> In this regard, I share the views expressed by Chairman Bernanke at this conference two days ago in which he discussed a range of factors that have likely influenced relative commodity prices.<sup>13</sup>

However, the fact that rising relative commodity prices have likely reflected many factors does not, by itself, change the analytical framework that I used to frame policy deliberations. As I highlighted at the beginning of my remarks, the most important drivers of inflation in the model of inflation dynamics I use are relative price shocks, inflation expectations, and the balance between aggregate demand and supply in the United States, as measured by some notion of resource utilization. If a shift in global demand affects both commodity prices and the demand for U.S. goods, the model I have in mind accounts for these influences on inflation through relative price shocks and resource utilization. For example, the rise in the price of oil this year has lowered consumption demand by pinching households' real incomes and likely damped the growth in labor productivity by trimming energy input; both of these factors have probably contributed to a lower equilibrium real wage, as I described earlier. If the impact on demand from these factors was accompanied by stronger global demand that

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<sup>12</sup> With regard to oil prices, Bodenstein, Erceg, and Guerrieri (2008) discuss the effects on the price of oil and the U.S. economy from shocks to various factors in a theoretical model; Kilian (2007) provides an empirical analysis. More generally, this area remains a fertile field for future research.

<sup>13</sup> See Bernanke (2008).

boosted demand for U.S. goods generally, the forecasts of inflation would need to take this into account. In any event, resource utilization has been slackening, judging from the rise in the unemployment rate and the slow pace of economic growth in the United States, on average, over the past six to nine months.

Some have suggested that the price of oil is on a more significant upward trend than currently appreciated.<sup>14</sup> Such an unanticipated shift in trend would not be embedded in the anticipated rate of change in slowly adjusting nominal prices and wages, implying that an adjustment period with distortions to relative prices would follow. Moreover, there would likely be upward pressure on overall inflation during this period, reflecting the slow response of the rate of change in some nominal prices to the new trend in the price of oil. This tendency for higher overall inflation could risk a rise in inflation expectations.

An appropriate monetary policy response would share many of the characteristics I discussed earlier. In particular, bringing overall inflation immediately back to the low rate consistent with price stability could be associated with a much higher rate of unemployment for a short time. It may be efficient to allow some adjustment period in which both overall inflation exceeds its desired low level and the unemployment rate is higher than its long-run sustainable level; as before, setting policy in a manner that balances the undesirable effects of a shock to the system on both inflation and

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<sup>14</sup>One might question whether significant price trends can reasonably be anticipated for a storable commodity like oil. The price of such a commodity should reflect expected demand and “anticipated” increases should be limited to approximately the cost of storage, including the nominal interest rate. Still, the following discussion would also apply to a shift in the trend in any important subset of consumer prices.

employment will tend to be more efficient than setting policy so as to deliver more extreme outcomes in either inflation or unemployment.<sup>15</sup>

However, two additional considerations are likely important when considering a shift in trend. First, developments in inflation expectations following a significant shift in the relative price trend of a commodity like oil should be monitored carefully, as our understanding of changes in long-run inflation expectations is limited and shifts in trends are infrequent, potentially implying a greater chance of confusion between relative price trends and overall inflation. Second, it is very important to remember that the costs of inflation in excess of the low rate of measured inflation consistent with price stability over any extended period are significant and reflect a broad range of factors. As I emphasized earlier, economic research into the many costs of inflation has suggested that these costs are associated with the rate of change in a broad set of prices. As a result, a trend in any individual relative price should not, in itself, lead to a change in the desirable rate of measured inflation over the long run.

### **Summary**

To reiterate, the Phillips curve framework is one important input to my outlook for inflation and provides a framework in which I can analyze the nature of efficient policy choices. In the case of a shock to the relative price of oil or other commodities, this framework suggests that policymakers should ensure that their actions balance the

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<sup>15</sup> An example of a change in the trend of other consumer prices could be seen in the relative prices of computers and other high-technology goods and services in the second half of the 1990s, which declined at an unexpectedly rapid rate as productivity accelerated. This shock placed downward pressure on inflation and raised both employment and the equilibrium real wage. In the presence of nominal price and wage rigidities, an efficient policy response would facilitate the rise in the real wage by allowing some downward drift in price inflation and upward drift in employment and wage inflation, which is, in fact, about the result observed over this period.

deleterious economic effects of such a shock in the short run on both unemployment and inflation.

Of course, the framework helps to define the short-run goals for policy, but it doesn't tell you what path for interest rates will accomplish these objectives. That's what we wrestle with at the FOMC and is perhaps a subject for a future Federal Reserve Bank of Boston conference.

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