



Opening Remarks: Empirical Questions in Modeling Inflation and Understanding the Implications for Policy

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Understanding Inflation and the Implications for Monetary Policy:
A Phillips Curve Retrospective*

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I am very pleased to open the second day of this conference focused on the 50th anniversary of the Phillips Curve.¹ This conference, although long in the planning, turns out to be very timely. The effects of significant increases in food and energy prices are still feeding through the economy, as are the impacts of appropriately aggressive monetary and fiscal policy responses to the recent financial turmoil and its spillover

effects. As a result of all these developments, consumers, commentators, and policymakers are intensely interested in the current outlook for inflation.

Food- and gas-price increases – so-called supply shocks – have heightened everyone's awareness that the *total* consumer price index (CPI) has increased 3.9 percent over the past year; clearly an undesirable outcome. As consumers, we all buy food and gas with high frequency, so sharp relative price movements for these goods get our immediate attention. Furthermore, if sustained, such increases in food and energy prices, which are not currently suggested by food and energy *futures* prices, would raise concern that these commodity price increases could become embedded in expectations – clearly an outcome to be avoided.

Despite these recent supply shocks, the central tendency of the forecasts of the Federal Reserve Presidents and Governors indicates that total personal consumption expenditures (PCE) inflation and core PCE inflation are expected to move downward, to around or below 2 percent over the next two years (Table 1). While many private forecasts do not yet extend out through 2010, many that do are broadly consistent with the central tendency reported after the April Federal Open Market Committee (FOMC) meeting.

These baseline forecasts indicate a general expectation among many analysts, forecasters, and policymakers that inflationary pressures will moderate. However, there remain significant disagreements over which factors are the most important determinants of future inflation. It is my hope that this conference will help facilitate – and indeed sharpen – the debate and provide some empirical support for our thinking on the inflation outlook and the implications for monetary policy.

Today in these opening remarks I simply want to highlight and briefly mention some of the key empirical questions that I expect will be addressed in greater depth in the conference presentations and discussions.

- The first empirical question involves the role that domestic excess capacity (for example, unemployed workers) plays in reducing inflation. Does sizable excess capacity in the economy significantly reduce future inflation? This question is at the heart of discussions of the Phillips Curve and its relevance for forecasting inflation.
- The second question involves the divergence between core inflation and total inflation. Many forecasters – including many central bankers – use the core inflation rate as an indicator of future total inflation trends. Is that use of core inflation prudent? How will these two measures, core inflation and total inflation, converge over time? A closely-related question centers on higher food and energy prices: how important is the “pass-through” of these price changes to the core and overall inflation rates?
- And the third question involves the impact of relative price changes on labor markets. Specifically, under what circumstances do inflationary pressures affect inflation expectations, and become embedded in wage and salary increases? In the current environment, we need to gauge the likelihood that inflationary pressures will cause further upward pressures on wages and salaries.

I. Excess Capacity and Inflation

A key element of the Phillips Curve framework is the assumption that significant excess capacity in the economy should exert downward pressure on inflation. While this key link in the Phillips framework provokes considerable skepticism in some quarters, it nonetheless serves as the underpinning of the inflation forecast for many private forecasters, much of Wall Street, and indeed many of the models utilized within the Federal Reserve System.²

This widespread use reflects the fact that forecasts of inflation *do* seem to improve when measures of excess capacity are incorporated.³ These models derive their success from the simple empirical observation that during recessionary periods, the inflation rate tends to fall (Figure 1). Over the past 50 years, the rate of total CPI inflation has tended to be lower after a recession than before; and the proxies for excess capacity capture this business cycle regularity. The intuition behind this empirical regularity is that, with widespread current and expected excess capacity, firms have greater difficulty increasing prices, workers' expectations of inflation decline, and they thus demand smaller wage increases. As a result, during a recession wage and price inflation slow, and the economy returns to full employment with a lower equilibrium inflation rate.

Despite the heavy reliance on a Phillips Curve empirical framework in many models, the extent and reliability of the *short-run* tradeoff between excess capacity and the inflation rate remain matters of much debate. In addition, how inflation expectations are set remains an issue that economists are only beginning to understand, and an area of

considerable disagreement. As both questions are very important for policy, I look forward to a thorough discussion of these issues over the next two days.

II. Issues around Core and Total Inflation Rates, and their Divergence

In the long run, in my view, it is total inflation – rather than core inflation, which excludes the volatile food and energy components – that should be the focus of monetary policy.⁴ However, total inflation is typically much more strongly influenced by temporary changes in relative prices than core inflation. This suggests a potential role for core inflation as an indicator of the subsequent trajectory of total inflation – so I want to spend a few minutes focusing on the impact of relative price changes on inflation, and on the relationship between core and total inflation measures.

As shown in Figure 2, *total* CPI has been more volatile than *core* CPI, as food and energy prices have been much less stable than many of the other components of inflation. Because the volatility in food and energy components is largely transitory, many focus on the core rate of inflation as a “medium-term” indicator of where inflation is trending.

In gauging the usefulness of core inflation as an indicator of inflation’s trend, one might perform the following simple exercise: see whether, when total inflation and core inflation show significant divergence, the core inflation rate *moves to the total* inflation rate over time, or the total inflation rate *moves to the core*?⁵

One would expect the core to move to the total if aggregate inflation expectations consistently reflect a large part of the volatile changes in food and energy prices that arise from periodic supply shocks. If, instead, such supply shocks are seen as producing a temporary change in relative prices – and as a result are not incorporated into inflationary

expectations – then one would expect total inflation to converge to the underlying rate of core inflation.

This is more than just an academic debate. Over the last four years, rising food and energy prices have caused total inflation to be significantly higher than core inflation. Figure 3 plots, over ten years, the gap between total inflation and core inflation against the *total* inflation rate two years ahead. The relationship between the two shows that, at least in this period, when total inflation is higher than core inflation, total inflation tends to move down to close the gap.⁶

Figure 4 plots the same gap between total inflation and core inflation against the *core* rate of inflation two years ahead. In this case there is no relationship, indicating that at least in this period core inflation does not rise following an increase in the spread between total and core inflation.^{7, 8}

Given that total inflation has been higher than core inflation for the last several years, will core inflation tend to rise to close the gap, or will the total inflation rate fall to close the gap? Work under way in the Boston Fed's research department, forthcoming in a discussion paper, would seem to indicate the latter; however, we urge participants at this conference to share their views and help improve understanding of this important topic.

Of course, closely related to the question of how core and total inflation converge is the issue of how large movements in food and energy prices might differentially affect core versus total inflation – the so-called “pass-through” of food and energy prices into inflation.⁹ The observation that, of late, total inflation tends to converge to core inflation would seem to imply that higher food and energy prices have a significant concurrent

impact on the total inflation rate, but have little contemporaneous effect on core inflation, and little or no lasting effect on either. Food and energy prices, this observation implies, are likely to have little impact on longer-run expectations of inflation.

However, some have raised concerns that the future behavior of inflation may look different than the past, perhaps because food and energy price increases will no longer be transitory, but will instead become an enduring feature of the economic landscape. Rising food and energy prices could become the norm if demand for these commodities outstrips supply on a continuous or prolonged basis.

It is important to note, however, that futures prices do not generally reflect an expectation that oil prices will continue rising at their recent rapid rate. In the past, higher oil prices have spurred conservation efforts and contributed to slower economic growth – both reducing energy demand. Higher oil prices also encouraged new technological improvements, and exploration and production from higher-cost sources – increasing supply. In other words, economists expect that the laws of supply and demand will ultimately limit price increases – even in the face of relatively rapid economic growth in emerging markets. That said, it seems to be taking quite a long time to date for long-run supply and demand influences to rein in oil price increases. You might say the short run is getting longer every day.

Another frequent explanation for recent oil prices increases is that dollar depreciation has boosted the demand for oil in strong-currency countries while discouraging oil output in the oil-producing countries. However, the strength of the statistical correlation between the exchange rate and oil prices is modest at best. As Figure 5 shows, while the price of oil is indeed correlated with the exchange rate, the

cumulative change in the exchange rate pales in comparison to the enormous run-up in oil prices – in other words, the exchange rate cannot explain more than a very small fraction of the change in the dollar price of oil.

Finally, even if oil prices do continue to rise much faster than U.S. core inflation for an extended period, the experience of the past 20 years (shown in Figure 6) indicates that there is a relatively low correlation between oil price movements and the underlying core rate of inflation.¹⁰ More comprehensive statistical work by researchers at the Boston Reserve Bank concludes that the impact of relative price shocks from oil – and other related supply shocks – has had a very minor impact on the underlying rate of inflation.¹¹ Of course, we know that not everyone here shares that view, and we look forward to hearing other perspectives on this issue over the course of the next two days.

III. The Impact on Labor Markets

A question related to substantial supply shocks is whether labor contracts will start to incorporate higher wage demands intended to offset rising price pressures. If workers believe that underlying inflation will be higher over time as a result of increases in food and energy prices, they may begin demanding higher wages and salaries to match their expectations of future inflation.

The determinants of worker expectations remain a relative unknown in economics. We know that a wide variety of factors can affect expectations, factors ranging from past rates of inflation to sophisticated forecasts of future inflation which end up being consistent with economists' models. The role that the Federal Reserve may

play in the formation of those expectations has been an issue of discussion and debate for economists since the late 1970s; it continues to be so.

In any event, workers' ability to demand higher wages and salaries is likely to depend on the competitiveness and structure of labor markets, as well as on broader economic conditions. Recent increases in U.S. wages and salaries have been quite modest and do not show evidence of "ratcheting up" related to recent supply shocks (see Figure 7).

Like the inflation rate, increases in wages and salaries have, historically, slowed during recessions. Since wages and salaries are an important component of overall costs, one can argue that the excess capacity that exists during recessions is an important element in dampening wage and salary demands – and as a result plays the role in the inflation framework that is embedded in the Phillips Curve.

Work done in the Research Department at the Boston Fed indicates that recent wage and salary growth has not reflected increased inflationary expectations or a significant reaction to recent supply shocks. Because these conclusions have important policy implications, we hope the conference will include a vigorous discussion of the evidence on this issue.

Concluding Observations

In short introductory remarks like these, it is impossible to do justice to the topic of understanding inflation dynamics and how they might impact monetary policy. That is exactly why we were eager to seize the opportunity presented by the Phillips Curve anniversary and organize a conference devoted to the topic. Fortunately, those who are

presenting and discussing papers have the opportunity to delve into the issues in much more depth than I have been able to, today.

As I believe this conference will show, the past 50 years have brought significant advances in our understanding of these issues. Building from the relatively primitive relationship embodied in the Phillips Curve, economic researchers are now in the process of developing a much more robust understanding of inflation dynamics.

And in my view, one area that provides particularly promising opportunities for further research is inflation expectations. Early Phillips-Curve models used simple rules of thumb to capture how inflation expectations are set. But increasingly, economists are starting to develop a more rigorous understanding of how inflation expectations are established. I anticipate that the burgeoning field of behavioral economics will greatly improve our understanding of how individuals set their expectations and how consumers, firms, and workers react to supply shocks and other macroeconomic issues. The Federal Reserve Bank of Boston's Research Center for Behavioral Economics and Decisionmaking¹² is devoting a good deal of attention to these issues.

Although many economists have done extensive work on inflation dynamics, I strongly suspect that this conference will highlight that there is still plenty of work to be done. And like all of you here, I look forward to hearing about some of the new research that is currently under way. My hope for this conference is that each of us will gain a number of insights that will allow us to better understand our interesting and at times challenging macroeconomic environment – and that will help those of us who are policymakers to better serve the public's interests. So I wish you a very engaging two days.

Notes

¹ Of course, the views I express today are my own, not necessarily those of my colleagues on the Board of Governors or the Federal Open Market Committee (the FOMC). These comments have benefited from extensive discussions with members of the Federal Reserve Bank of Boston's research department, in particular with economists Jeff Fuhrer, Geoffrey Tootell, Jane Little and Giovanni Olivei.

² See for example the following articles which discuss the robustness of the Phillips Curve. Fuhrer, Jeff C. "The Phillips Curve is Alive and Well" *New England Economic Review* (March/April 1995 – <http://www.bos.frb.org/economic/neer/neer1995/neer295c.htm>) and Barnes, Michelle L. and Giovanni Olivei, "Inside and Outside Bounds: Threshold Estimates of the Phillips Curve," *New England Economic Review* (2003 – <http://www.bos.frb.org/economic/neer/neer2003/neer03a.pdf>)

³ Of course, the models may differ in their measures of excess capacity. Some measure excess capacity as the difference between the unemployment rate and the estimated Non-Accelerating Inflation Rate of Unemployment (NAIRU). Others may use the "GDP gap" – the difference between the actual and potential output of goods and services in an economy. Others use a cost-based measure of excess capacity, typified by the "New Keynesian Phillips Curves" that rely on a measure of the inflation-adjusted marginal cost of output.

⁴ Of course, some observers disagree that we should target total, not core, inflation, arguing that a central bank should target things it can control (domestic prices) not those it cannot.

⁵ Jeff Fuhrer, and Geoff Tootell have done more extensive work examining the statistical relationship between core and total inflation, to be forthcoming.

⁶ Figure 3: $R^2 = 0.3961$; $y = -1.0143x + 0.7406$
(-4.5095) (2.2481) t-statistics in parenthesis

⁷ Figure 4: $R^2 = 0.0926$; $y = 0.1817x - 0.0039$
(1.7791) (-0.0261) t-statistics in parenthesis

⁸ Notably, if we plot these relationships for an earlier time period, 1970-1990, the results are very different. When total inflation diverged from core inflation, total inflation did not move down to close the gap.

⁹ Of course, food and energy prices are just a subset of the factors outside the gap or Phillips Curve framework that could periodically affect core inflation. Other factors that could shift the Phillips Curve from time to time include other commodity prices, import prices and the exchange rate.

¹⁰ The weakness in the relationship between changes in oil prices and the underlying inflation rate is highlighted by the fact that over a thirty-year period the correlation is low and positive whereas over a twenty- or ten-year period the correlation is low and negative.

¹¹ Olivei, Giovanni, “Exchange Rates and the Prices of Manufacturing Products Imported into the United States.” *New England Economic Review* (First Quarter 2002 – <http://www.bos.frb.org/economic/neer/neer2002/neer102a.htm>), and Tootell, Geoffrey, M.B. Globalization and U.S. Inflation.” *New England Economic Review* (1998 – <http://www.bos.frb.org/economic/neer/neer1998/neer498b.htm>)

¹² You can learn more about the Center’s work at <http://www.bos.frb.org/economic/bedm/index.htm>

Table 1

Forecasts of Inflation

Federal Reserve Governors and Reserve Bank Presidents ¹		Global Insight ²	
	Central Tendency	Forecast	
	2009	2010	2009
PCE	1.9-2.3	1.8-2.0	2.0
Core PCE	1.9-2.1	1.7-1.9	2.2

1 April FOMC Forecast; 2 May Forecast

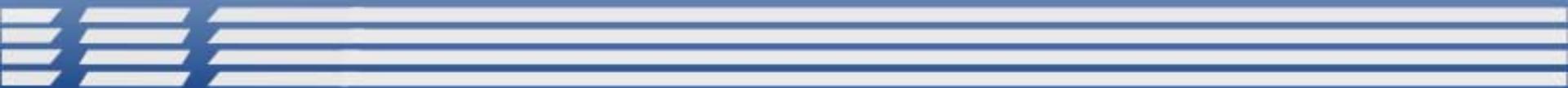
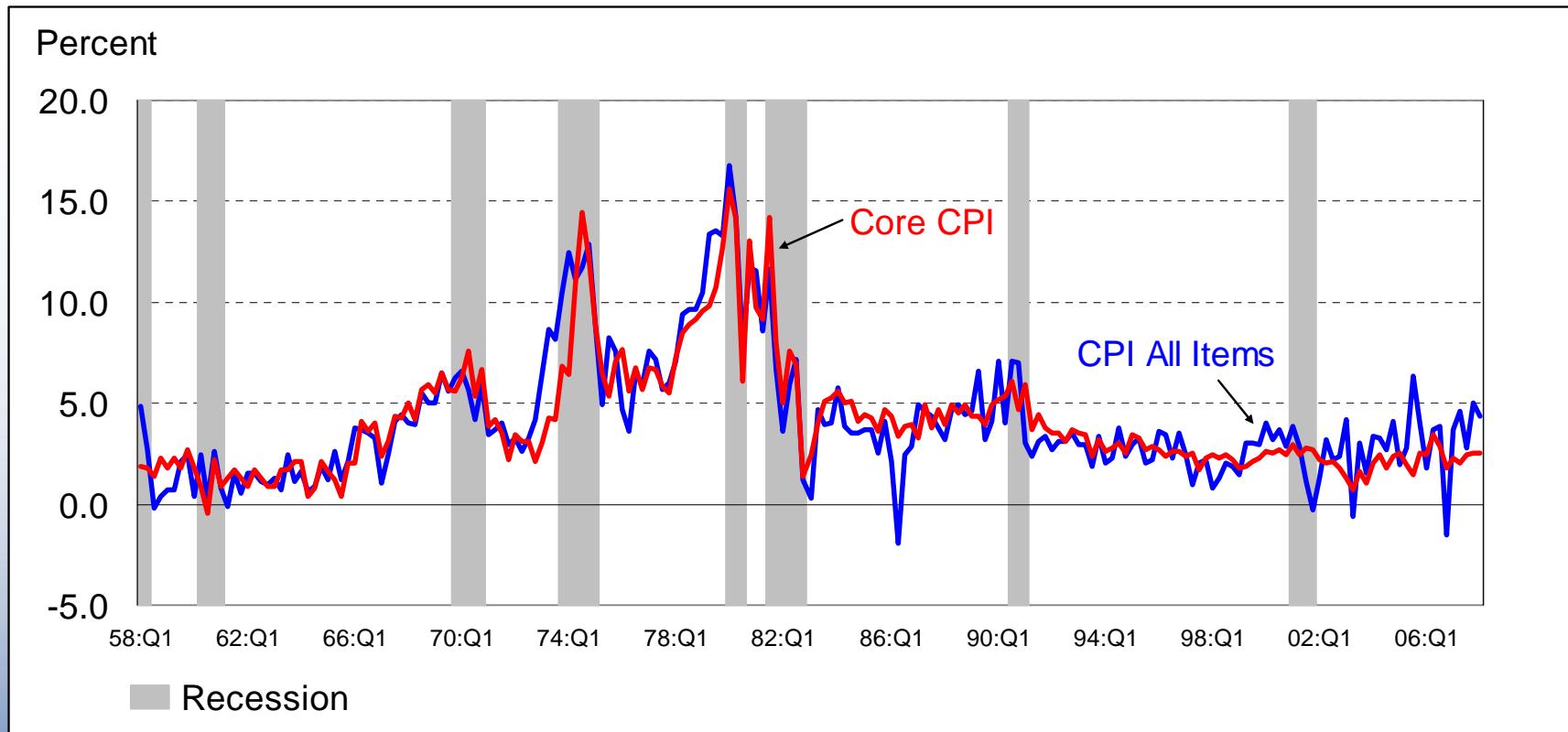


Figure 1

Inflation Rate: Total and Core CPI

Quarterly Percent Change, Annual Rate

1958:Q1 – 2008:Q1



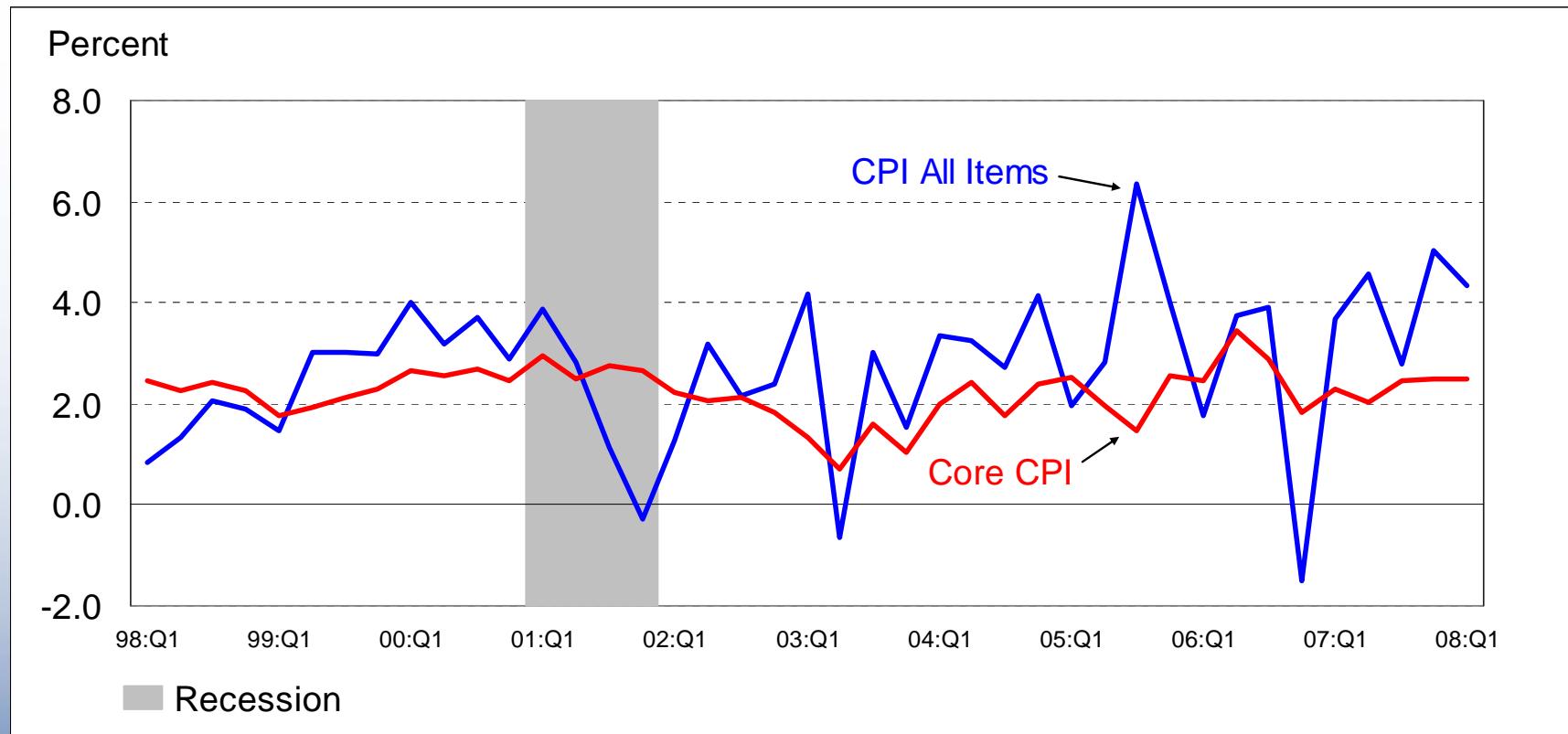
Source: BLS / Haver Analytics

Figure 2

Inflation Rate: Total and Core CPI

Quarterly Percent Change, Annual Rate

1998:Q1 – 2008:Q1

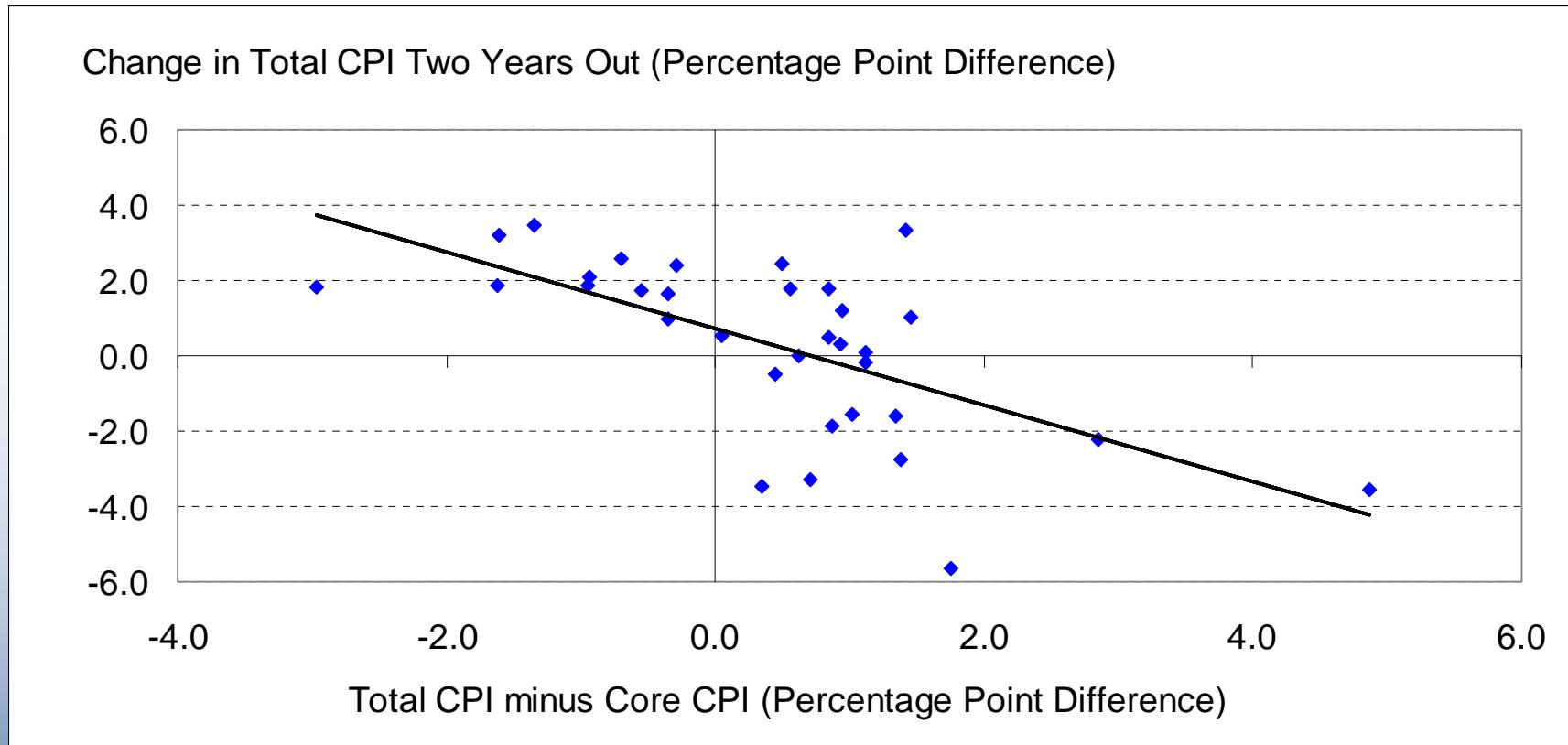


Source: BLS / Haver Analytics

Figure 3

Gap Between Total and Core Inflation vs Change in Total Inflation

1998:Q1 – 2008:Q1

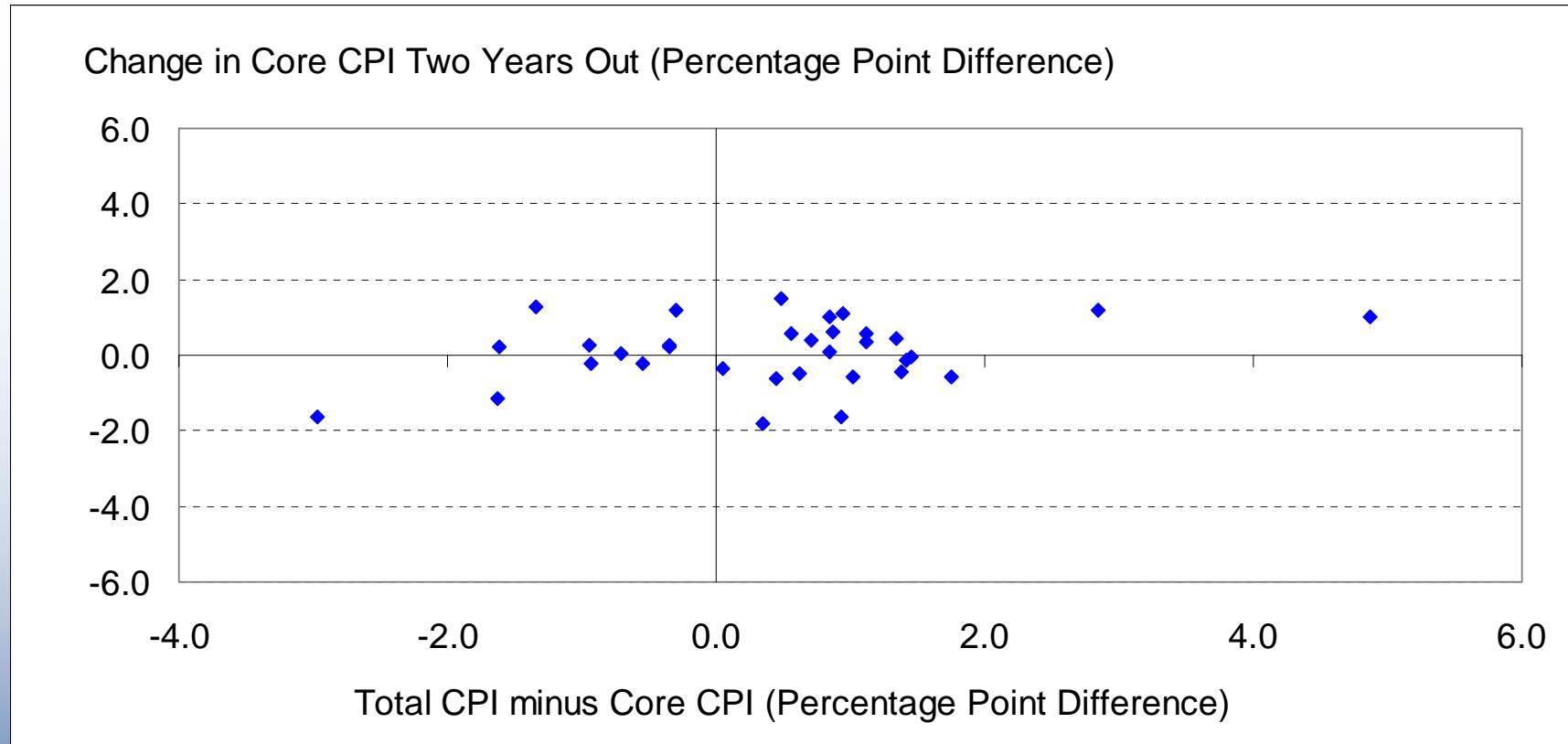


Source: BLS / Haver Analytics

Figure 4

Gap Between Total and Core Inflation vs Change in Core Inflation

1998:Q1 – 2008:Q1

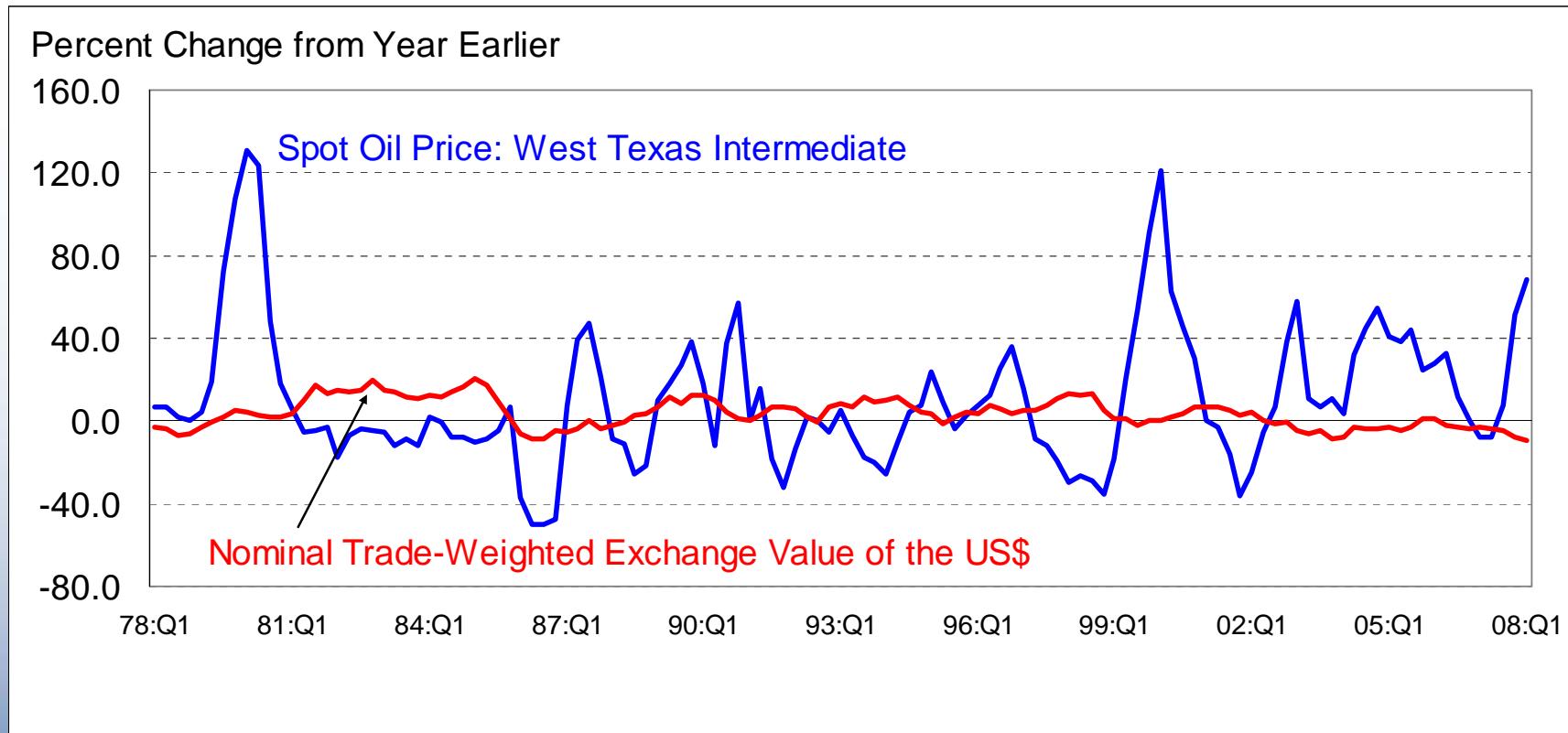


Source: BLS / Haver Analytics

Figure 5

Changes in Oil Prices and the Exchange Value of the U.S. Dollar

1978:Q1 – 2008:Q1

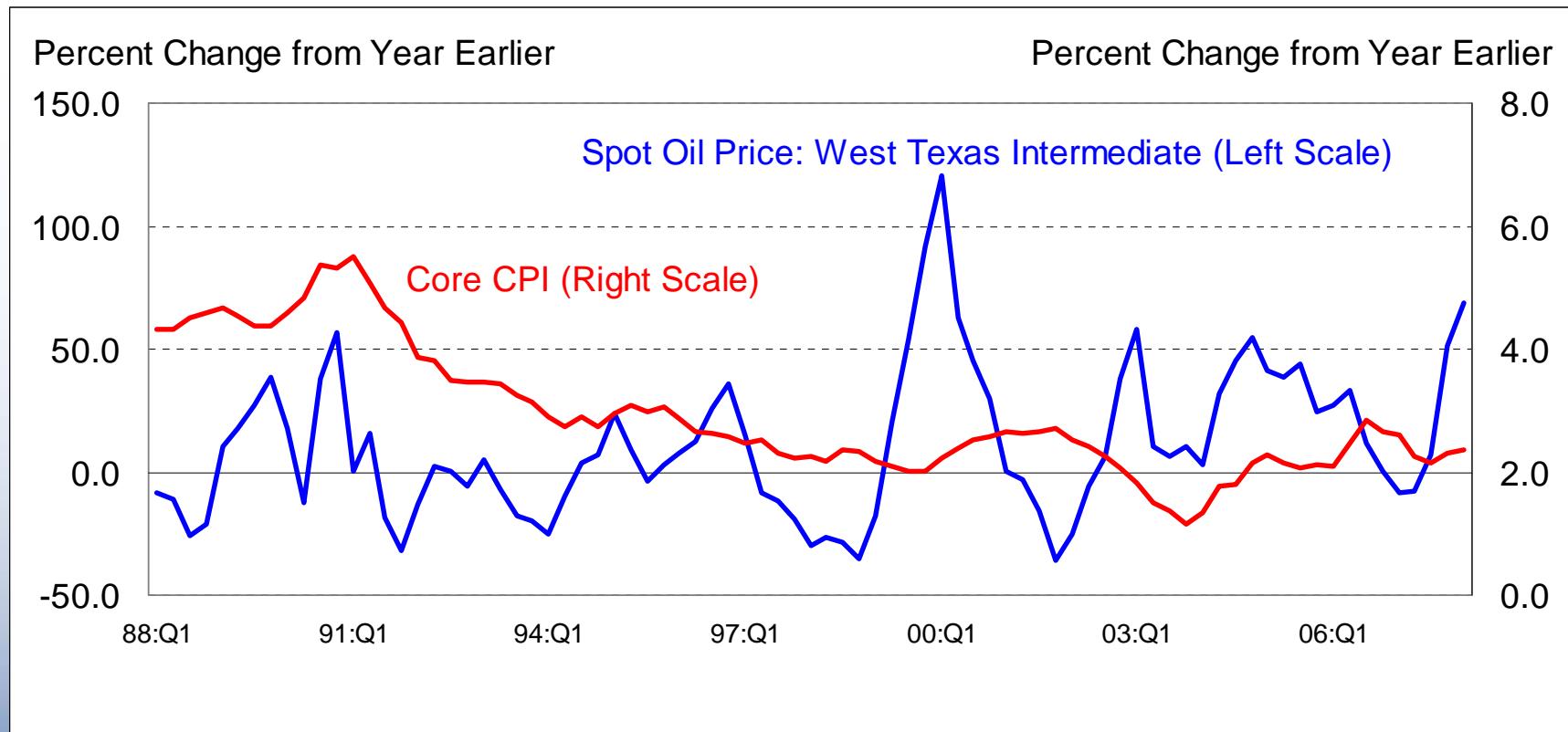


Source: Federal Reserve Board, Wall Street Journal / Haver Analytics

Figure 6

Changes in Core Inflation and Oil Prices

1988:Q1 – 2008:Q1



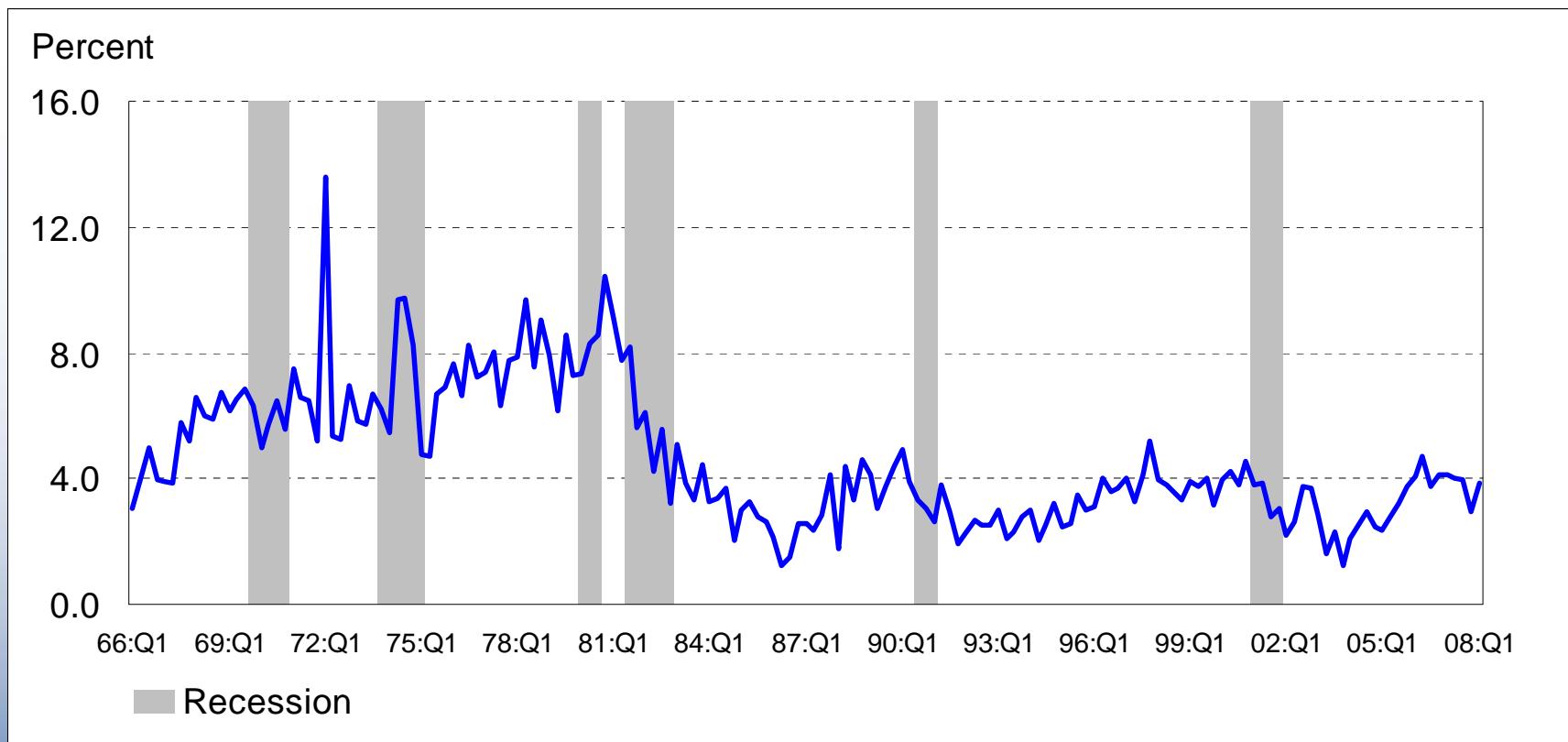
Source: Wall Street Journal, BLS / Haver Analytics

Figure 7

Average Hourly Earnings: Total Private Industries

Quarterly Percent Change, Annual Rate

1966:Q1 – 2008:Q1



Source: BLS / Haver Analytics