Inflation Expectations, the Phillips Curve, and Monetary Policy

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1. Introduction

Inflation expectations play a central role in models of the Phillips curve. Inflation expectations at long horizons may reflect the credibility of a monetary authority's commitment to price stability. These observations highlight the importance of inflation expectations for monetary policy. This note touches on three issues regarding inflation expectations:

- The evolving treatment of inflation expectations in empirical Phillips curve models;
- Three recent models of information imperfections and inflation expectations; and
- Potential policy implications of different models.

The discussion will highlight two points: Historical experience suggests an important role for some deviation from the most restricted form of rational expectations in inflation dynamics, but also shows that other aspects of sluggish price adjustment – such as nominal rigidities, are important; and the available indicators of inflation expectations show that imperfect information regarding central bank intentions has been one source of inertia in inflation expectations.

2. Inflation Expectations in the Phillips Curve

The Phillips curve has come a long way. The dominant paradigm at the conference on empirical work on price determination held at the Federal Reserve Board

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in 1970 (Eckstein, 1972) was adaptive expectations. Robert Lucas's contribution at the 1970 conference (Lucas (1972)) is stunningly familiar to a reader today in its approach and emphasis on rational expectations – the idea that agents form expectations optimally given their understanding of the economy and the information available to them.

The rational expectations revolution had two quite opposite effects on subsequent empirical research regarding inflation. One branch of the literature, exemplified by early contributions of John Taylor (1980) and Julio Rotemberg (1982), followed Lucas's suggestion closely and specified tightly parameterized models incorporating various types of nominal rigidities, which led to various restrictions on a system of equations that would allow econometric identification. Another branch responded to the broader criticism leveled by Chris Sims (1980) that the types of schemes traditionally used for identification in reduced-form Phillips curves and other empirical research were fatally flawed ("incredible") and looked for empirical techniques that imposed fewer restrictions on the data. Both lines of research bore significant fruit: Modern dynamic general equilibrium models, with a large number of frictions, fit U.S. macroeconomic data quite well (e.g., Smets and Wouters (2007)), Edge, Kiley, and Laforte (2008b)) and the set of stylized facts gleaned from analyses of vector autoregressions with minimal identifying restrictions has had a profound impact on the way such dynamic general equilibrium models are specified (e.g., Christiano, Eichenbaum, and Evans (2005)). However, it seems fair to say that the need for structural models when considering policy changes that represent significant departures from historically typical behavior implies that it will often be the case that tightly parameterized structural models will play an important role. This need is at some level troublesome: My perspective, as someone actively involved in specifying relative large and rich dynamic equilibrium models, is that the underlying assumptions used to achieve identification are clearly “incredible”. For example, while the model developed in Edge, Kiley and Laforte (2007a) has been useful for analyzing various questions and show signs of good forecast performance (Edge, Kiley and Laforte (2008a, 2008c)), it includes a large number of frictions that at least some economists may view skeptically (e.g., habit formation in consumption, adjustment costs in investment and nominal prices, etc.). But progress requires that economists make incredible assumptions sometimes; research strives to remove the need for such assumptions.

One area where such research on nominal price and wage rigidities is already being enriched, and may become more plausible, is in relaxing the assumption of perfect and homogeneous information sets underlying price setting that has been the primary assumption since Taylor (1980) and Rotemberg (1982). It is interesting to note that Robert Lucas emphasized expectations that were rational subject to an information constraint – in his model at the conference and related work (Lucas (1972, 1973)), agents in the economy only imperfectly perceived aggregate conditions.[2]

While research has found greater empirical support for the simple full-information rational-expectations model in recent data (e.g., Kiley (2007)), my reading of the evidence from aggregate inflation dynamics suggests that some type of information constraint is needed to explain inflation fluctuations in the United States of the past forty years. These stylized facts are well known:

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[2] A glance back at John Muth’s (1961) article on rational expectations reveals that his idea was more in line with the information-constrained version of rational expectations: “The hypothesis can be rephrased a little more precisely as follows: that expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for the same information set, about the prediction of the theory (or the "objective" probability distributions of outcomes)”. (Muth (1961), p. 316). In particular, Muth suggests that expectations are distributed around the mathematical expectation, implying some difference in signals available to different agents or errors in expectations.

- Inflation seems to respond sluggishly to (some) aggregate disturbances (e.g., Christiano, Eichenbaum, and Evans (2000))
- The costs of disinflation are sizable (e.g., Ball (1994))
- Inflation dynamics seem well characterized by a Phillips curve in which both leads and lags of inflation are important, especially for data including the 1970s and early 1980s (Fuhrer and Moore (1995), Kiley (2007)).

But these stylized facts provide little guidance regarding what types of information imperfections are important.

2. Models of Imperfect Information

Imperfections that have been the subject of some research include

- Learning about the structure of the economy (e.g., Orphanides and Williams (2005, 2007))
- Imperfect information regarding the goals (or credibility) of the central bank (e.g., Ball (1995), Bomfim et al (1997), Erceg and Levin (2003), Kiley (2008))
- Costs or constraints on information acquisition or processing (Caballero (1989?), Kiley (2000, 2007), Carroll (2003), Reis (2006a, 2006b), Sims (1998, 2003, 2006))

Interestingly, it is primarily the third example of information imperfections, emphasizing costs of information acquisition or processing, that gives rise to differences in information sets across agents as emphasized in Lucas (1972, 1973).

Each of these theories is capable of explaining costly disinflations and evidence on inflation dynamics. To date, research has not compared the ability of each model to fit the data relative to the other models. I will focus my attention on two of these models: imperfect information regarding the inflation objective of the monetary authority, and models of costly information acquisition.

The idea behind models emphasizing imperfect information regarding the inflation objective is simple: In an environment where the inflation objective of the monetary authority is not explicit or widely known, households and firms will need to infer where the monetary authority intends to bring inflation from its policy actions; as a result, agents make persistent mistakes regarding the inflation objective during a transition period after the objective has shifted. This idea seems plausible. For example, the Federal Reserve did not reveal an explicit objective for inflation in the period around 1980 when it began its effort to bring inflation down from undesirably high levels. And it can explain many of the stylized facts regarding inflation dynamics, including the costs of the Volcker disinflation (e.g., Erceg and Levin (2003)) and the slow evolution of survey measures of long-run inflation expectations (Kiley (2007)).

Models of costly information acquisition can also explain many of the stylized facts regarding inflation. Importantly, research in both the information processing tradition (e.g., Sims (1998, 2003, 2006)) and in the information cost/infrequent updating tradition (e.g., Reis (2006a, 2006b)) have emphasized that these models can explain the sluggishness of adjustment in much broader contexts – e.g., in addition to inflation, such models may help us explain better the patterns in consumption, investment, and other variables. The ability of such models to explain a range of facts is a great strength.

The work on rational inattention by Chris Sims is built upon an especially solid foundation: the communications literature has developed axiomatic descriptions of uncertainty and analyzed how constraints on information processing capacity affect choices regarding information flow. However, the payoff to economics has yet to be realized, as this area is very complex. The complexity of economic problems reflects their dynamic nature, the endogeneity of aggregate variables that can provide information, and the possibility of rich information "production functions".

Moreover, the information imperfections emphasized by Sims (2003, 2006) lie in the processing of information. An added area of complexity in economic problems involves the computation of optimal actions by firms and workers under uncertainty and with highly non-linear objective functions and constraints. While the computational tools to solve such problems are well understood by economists for many simple parametric examples, it is not obvious that the costs of such computations are trivial to the economic agents making decisions, and approaches that emphasize such costs, and their impact on the form of decisions made by workers and firms, may prove just as valuable to further understanding of wage and price behavior as the information-processing approach that has been the subject of research by Sims and others.[3]

Finally, I should also note that some recent research has suggested that a model in which inflation and other expectations reflect some type of information imperfection may be capable of explaining the data on prices without reference to nominal price rigidities. I think this is unlikely for (at least) three reasons. First, my own empirical work on the Phillips curve that compared some sticky price and sticky information models showed clear evidence supporting the sticky price specification (Kiley (2007)). Second, in my dissertation I considered a model with endogenous price and information rigidities and

[3] Gabaix and Laibson (2000) present an example of this type of research. Their analysis is sufficiently distant from the form of a dynamic price adjustment problem that development of this type of reasoning to the problem of inflation dynamics is a substantial challenge, with unclear payoff.

showed that sticky price and imperfect information models implied different affects of the trend inflation rate and the higher moments of inflation on the form of the Phillips curve; cross-country evidence clearly shows evidence of the link between mean inflation and the form of the Phillips curve, suggesting an important role for sticky prices (Kiley (2000). Finally, casual observation and microeconomic evidence supports a role for infrequent adjustment of nominal prices and wages in macroeconomic models (e.g., Nakamura and Steinsson (2006)). These considerations suggest that a model that combines a microeconomic foundation for nominal price rigidities with costs of information acquisition or processing will best account for the micro- and macro-economic aspects of price adjustment that have been documented. Woodford (2008) presents a step in this direction.

3. Inflation expectations and monetary policy

I would like to turn to some of the implications from the model emphasizing imperfect information regarding policymakers' inflation objective.

In the United States, we have a few sources of data regarding expectations of inflation at long horizons: surveys of household and professional forecasters and measures of inflation compensation implied by yields on nominal and inflation-indexed Treasury securities. Models emphasizing imperfect information regarding the inflation objective of policymakers imply that these data should show a link between monetary policy actions or the policy regime and these long-horizon inflation expectations, as inflation expectations at long horizons should reflect, to a significant extent, the expectations of households and firms regarding the inflation objective. The data show such links in several areas.

The top panel of figure 1 presents data on long-horizon inflation expectations from the Reuters/Michigan Survey of households and the Survey of Professional Forecasters.[4] Long-horizon expectations from the Michigan Survey or professional forecasters are sporadically available prior to the 1990s; both series are available continuously since the early 1990s. It is clear that long-horizon inflation expectations have fallen over the past 25 and 15 years; the recent data arguably provide evidence of some degree of anchoring.

Kiley (2008) shows that the survey measures of long-horizon inflation expectations in the United States behave very much as implied by models emphasizing uncertainty regarding the central bank's objective: Long-horizon inflation expectations respond to policy actions that are deemed as restrictive or expansionary, as judged by deviations from the Taylor rule, and the quantitative magnitude of such responses is consistent with plausible specifications and estimates of the costs of disinflation. This relationship can be expressed graphically. I define the perceived tightness of monetary policy as the gap between the nominal federal funds rate (r(t)) and the level predicted by the following Taylor rule involving consumer price inflation (p(t)) (as measured by the CPI), a perceived inflation target measured by long-run inflation expectations from the Reuters/Michigan Survey (p*(t)), and the output gap (y(t))[5]

$$r(t) = 2 + p(t) + 0.5*(p(t)-p^*(t)) + 0.5*y(t).$$

[4] This survey was formerly conducted by the American Statistical Association (ASA) and the National Bureau of Economic Research (NBER) and was known as the ASA/NBER survey. The Federal Reserve Bank of Philadelphia, in cooperation with the NBER, assumed responsibility for the survey in June 1990. With the exception of two observations, namely 1990-Q1 and 1991-Q2, the data from 1979 through 1991 are from the Blue Chip Survey. The two exceptions are from The Livingston Survey.

[5] From the Federal Reserve Board's FRB/US model.

The bottom panel of figure 1 plots the four-quarter change in the level of long-run expected inflation against this measure of perceived tightness of monetary policy lagged four quarters; there is a strong negative relationship.

Gurkaynak et al (2006) and Beechey et al (2007) examine differences in the properties of measures of inflation compensation and inflation expectations between the United States and other countries that have explicit inflation objectives. Their analyses demonstrate that both survey measures of inflation expectations and inflation compensation implied by government-issued securities appear more stable in countries with an explicit inflation objective. Interestingly, there is pretty clear evidence that the dispersion in long-run expected inflation is much smaller in some inflation targeting countries. Figure 2 compares the dispersion in long-run expected inflation among professional forecasters for the Euro area and the United States, following Beechey et al (2007); dispersion is much lower in the Euro area, which has an explicit long-run objective for inflation. This seems clearly consistent with a model emphasizing uncertainty regarding the long-run inflation objective as an important aspect of the link between monetary policy, expectations, and inflation or economic activity.

Finally, recent research has emphasized that inflation uncertainty is a significant factor determining term premia on nominal bonds (and hence the slope of the term structure, e.g. Wright (2007)). The link between the monetary policy regime and uncertainty about long-horizon inflation objectives suggests that the nature of such regimes can be expected to have significant effects on the term structure of interest rates. Figure 3 provides an example: The Bank of England was given operational independence on May 6, 1997. The slope the nominal yield curve flattened considerably that day; the slope of the real yields curve was little changed.

I interpret this set of results as suggesting that the setting of monetary policy and the nature of the policy regime are important determinants of inflation expectations and, potentially, macroeconomic performance more generally.

These concrete results provide an example of a type of analysis that cannot yet be supported by research in, for example, the rational-inattention vein. It may be that these stylized facts are very consistent with a model of rational inattention. Given the potentially wide-ranging implications of such models for macroeconomic dynamics that have been tentatively suggested in previous work, I view research in this direction as very promising. In the meantime, I also think that research emphasizing particular stories that may be applicable to policy considerations in the short-to-medium run, like that motivated by the model of imperfect information regarding the inflation objective, is likely to have a direct impact on policy discussions.

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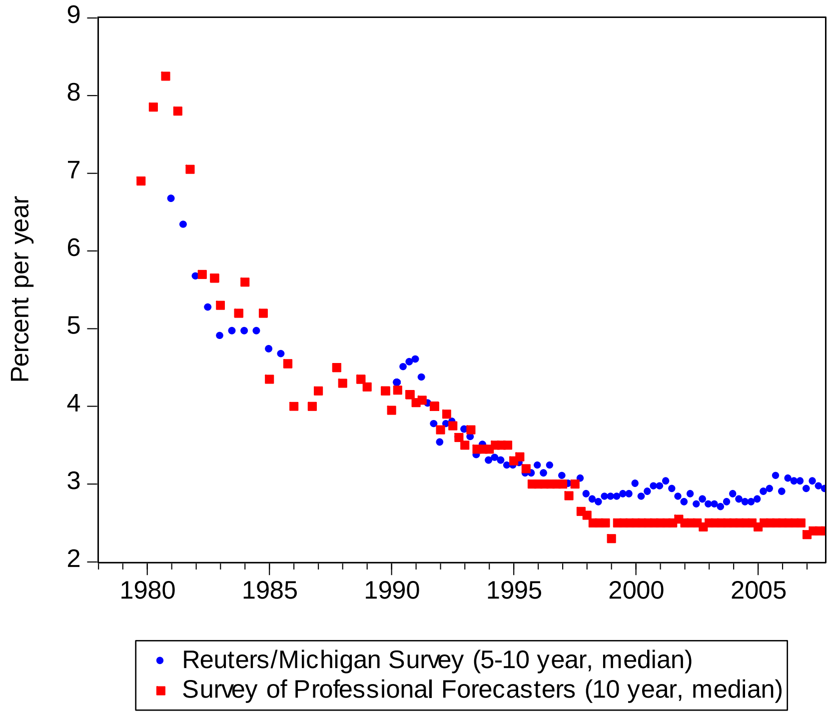
Figure 1
Panel A: Measures of Long-run Inflation Expectations



Panel B: Scatterplot of Change in Long-run Expectation Against Perceived Tightness of Monetary Policy

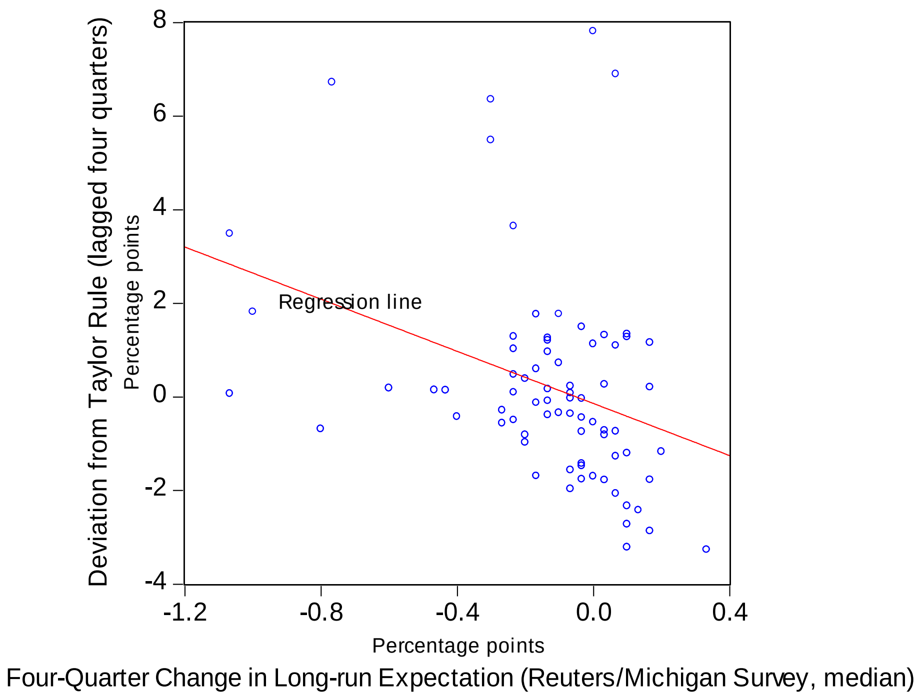


Figure 2
Cross-Sectional Dispersion in Long-Run Inflation Expectations

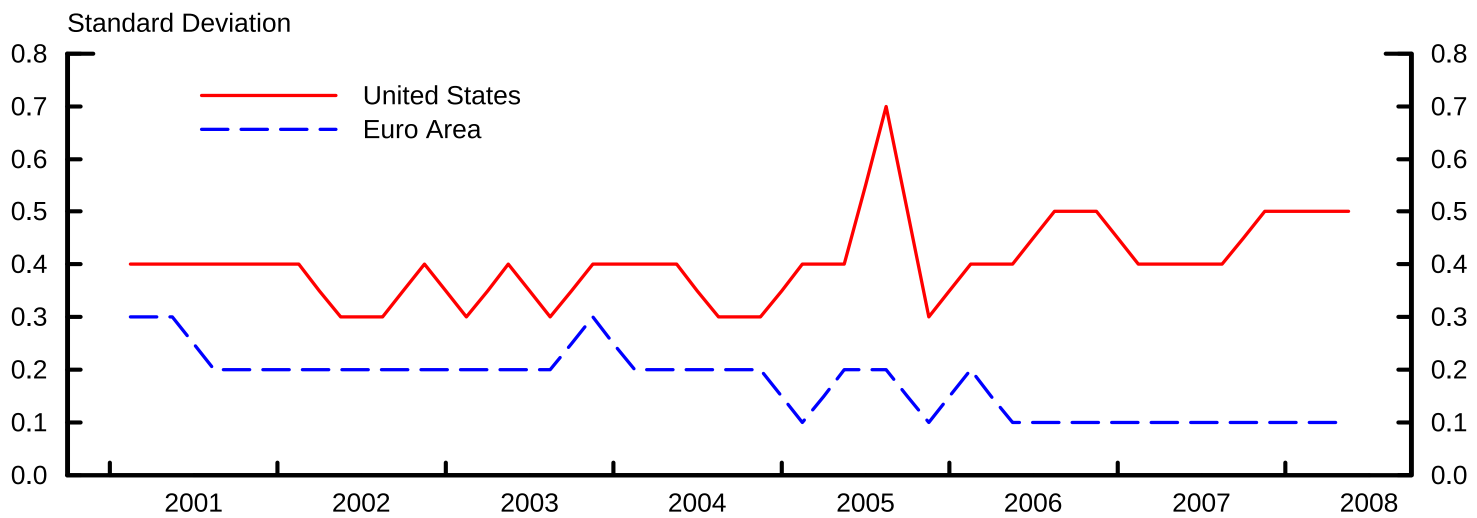


Figure 3
Nominal and Real Forward Curves in the United Kingdom Around Granting of Independence to the Bank of England