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**Monetary Policy and Uncertainty**

**Remarks by**

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Tonight I will talk about one of the themes of this conference: uncertainty and its influence on the monetary policy process. Policymakers always face an uncertain economic environment, and from time to time I think it is useful to review the nature of the uncertainties we face and the prescriptions for dealing with them. Both of these tend to evolve over time, and we may find some lessons--or at least subjects for further research--in recent experience. Of course, the views I express tonight are my own and do not necessarily reflect the opinions of my fellow members of the Federal Open Market Committee (FOMC).<sup>1</sup>

What are the basic sorts of uncertainty faced by central banks? In informal terms, we are uncertain about where the economy has been, where it is now, and where it is going. In gauging the past and current state of the economy, measurement difficulties are rife and so I will review some of the challenges that we face in that area. As for where the economy is headed, central banks confront many sources of uncertainty but tonight I will focus on one in particular, namely, our inadequate understanding of the public's expectations. Finally, I will conclude with a few observations on the ways that central bankers cope with risk in its various forms.<sup>2</sup>

### **Measurement Uncertainty**

An important source of our uncertainty about the recent past and the current state of the economy is that economic data typically come in with a considerable lag and are subject to substantial measurement errors and revision. Work by Athanasios Orphanides and other economists has helped to heighten economists' awareness of this issue by exploring the extent to which faulty estimates of potential output may have contributed to the monetary policy errors of the 1970s.<sup>3</sup> However, academic economists may still not

fully appreciate the degree to which measurement uncertainty bedevils policymaking. These difficulties are especially pronounced at times like the present, when resource utilization and the rate of economic growth are probably not far from their long-run potential, inflation trends may be shifting, and policy interest rates are close to their historical averages in real (that is, inflation adjusted) terms.

Consider our estimates of real economic activity. These estimates often change markedly with the receipt of just a few more days or weeks of data. For example, the Bureau of Economic Analysis released revised estimates in late July that showed persistently slower growth in real gross domestic product (GDP) in recent years. These more pessimistic data were then followed over the balance of the summer and into the fall by stronger-than-expected readings on current labor market conditions as well as by the announcement of upcoming benchmark revisions that will raise the level of payroll employment 1/2 percent. Taken together, these revisions have had important implications for our estimates of employment, productivity, labor costs, and related statistics.

Price data are subject to several measurement problems besides the well-known issues of quality changes and appropriate weights. For example, a significant portion of the personal consumption expenditures (PCE) price index is based on imputations of prices for important categories of household purchases, such as banking services, rather than on direct observations of market prices. This “nonmarket” component of the index is hard to replicate, tends to move in an erratic manner from month to month, and is subject to considerable revision--factors that reduce the usefulness of the overall index as a short-run indicator of price pressures.

Measures of labor compensation pose their own special problems. To begin, the available indicators often do not tell a consistent story. For example, the data in hand last week showed hourly compensation rising almost 7 percent over the past four quarters based on the national accounts measure, but only 3 percent as measured by the employment cost index. Beyond this, the compensation figures in the national accounts are subject to significant revision, as illustrated by the release of new data this week that suggests hourly compensation rose only 4-1/2 percent, not 7 percent, over the past year. Changes such as this make real-time estimates of unit labor costs and labor's share of total income much less useful in our analyses than studies based on revised data might suggest. Finally, the existing wage data are not well suited for measuring certain concepts important to modeling and policymaking, such as marginal labor costs. For example, hourly compensation in the national accounts includes stock options at their exercise value rather than at their value at the time of issuance.

Perhaps the most intractable problems surround the measurement of such key concepts as the equilibrium real interest rate, trend productivity, and potential output. We never observe these variables, which often figure prominently in our deliberations, but can only infer them from the behavior of other variables that are themselves subject to mismeasurement. As I just hinted, recent revisions to GDP and to labor input would seem to point to downward adjustments to estimates of trend productivity, but sorting out trend from cycle in the new data has been a challenge. These revisions may or may not also have implications for the level of the real federal funds rate consistent with longer-run macroeconomic stability. I will return later to the policy implications of this sort of measurement uncertainty.

## **Expectations Uncertainty**

Expectations--which are critical to the decisions of households and firms--are an area in which measurement problems are compounded by questions about the behavior of private agents and hence of the economy. We have only limited information on households' views of their income prospects or firms' beliefs about their future sales. For example, in the United States we have some survey information on household expectations for their financial situation and their labor market prospects. These expectations are undoubtedly important in households' estimates of their permanent income and hence in determining aggregate demand; indeed, econometric analysis suggests that these survey measures can help in predicting consumer spending. Nonetheless, our understanding of movements in household perceptions of permanent income is limited by a general paucity of data and associated research. Similar difficulties arise when considering firms' assessment of future demand. Although we have some information on expected conditions from various surveys and from the earnings guidance provided by publicly traded companies, these indications are mostly qualitative, the quality is mixed, and research has not clarified their link to aggregate economic prospects.

In the case of inflation expectations, we do have a larger number of indicators at our disposal. Yet here, too, the reliability and usefulness of the existing data are less than we might like. For example, survey measures of households are based on small samples. In addition, household expectations do not refer to any specific index and focus on time horizons that may not correspond to those relevant for wage bargaining or financial planning. Moreover, the wide dispersion of views across households strongly suggests

varying levels of sophistication in forming expectations, to a degree that raises questions about the link between measured expectations and behavior relative to common assumptions, at least for some households.

Measures of inflation compensation derived from nominal and indexed Treasury yields provide information that addresses some of the weaknesses in survey measures. For example, investors have strong incentives to ensure that inflation compensation reflects their beliefs about the prospects for a specific index, the consumer price index (CPI), over a fixed time horizon. Even here, however, we encounter important technical difficulties: These inflation compensation measures are “contaminated” both by an inflation risk premium and by differences in liquidity between the markets for nominal and indexed Treasury securities. More fundamentally, even a “rational” forecast of inflation from financial markets provides only part of the information needed to form monetary policy because it gives only a sense of *where* inflation is expected to go, not *why* it is going there. The latter question is often important for assessing the appropriate stance of policy.

Of course, asset prices are a category for which expectations are extremely important and for which data are available on a large scale. The term structure of interest rates, the spread between private and public yields on debt, equity prices, and the exchange value of the dollar--to name a few--are of first-order macroeconomic importance and are directly related to expectations. But we still face the challenge of distinguishing the quantitative role of, say, time-varying term and risk premiums on the one hand from that of expectations (including any speculative component) regarding underlying fundamentals on the other. As an example, consider house prices. Some

commentators have suggested that, over the past several years, households extrapolated previous gains in house prices in thinking about the likely return to real estate and, in doing so, created a speculative bubble that pushed home prices significantly above their “fundamental” level.<sup>4</sup> However, others have argued that the rapid rise in home prices was fully justified by strong income growth and low interest rates.<sup>5</sup> Distinguishing between these alternatives would be aided both by better measures of households’ expectations regarding the appreciation of their homes and by a better grasp of the determinants of those expectations. As I have noted elsewhere, our lack of understanding of the dynamics of asset price determination is a significant hurdle to giving them extra weight in setting monetary policy.<sup>6</sup>

Much of my discussion regarding expectations has so far focused on measurement issues, but the question of why economic conditions unfold as they do also raises a critically important question: How are expectations formed? The baseline assumption used in much research is that expectations are rational, in the sense that private agents use a fixed and known model of the economy to process all relevant information. This assumption is extremely useful because it is a benchmark that facilitates comparisons with other hypotheses about expectations formation, and it allows various questions to be considered without an extraneous focus on expectations. But this form of rational expectations seems to be of limited usefulness when the question at hand is the evolution of expectations and their effect on activity and inflation. For example, rational expectations models will often rule out the possibility that learning errors in households’ expectations of future labor market conditions can have an independent effect on

aggregate demand. And, these models usually simply assume that “irrational” movements in asset prices are not an important factor in the macroeconomic outlook.

Of course, research has led to some relaxation in the baseline assumption of rational expectations. One prominent example is the work in behavioral finance on how alternative assumptions regarding rationality can affect predictions for asset prices and saving behavior; another is the growing literature on the interaction of learning, inflation dynamics, and monetary policy. Nonetheless, this research has only begun to investigate how households and firms actually form their expectations, and the models we use for policy analysis, at most, only crudely embed the early lessons from this literature. As a result, uncertainty over how best to model expectations and hence how best to model the aggregate economy remains a central concern of policymakers.

To illustrate the effect of this sort of uncertainty on policy, consider the interaction of inflation dynamics and expectations--a subject of major study over the past thirty years. At one end of the spectrum of possible views is a policymaker who thinks that inflation expectations are rational and consistent with a New-Keynesian model of the economy, in which intrinsic sources of inflation persistence are not especially important. In this case, the policymaker might not be too worried that, say, a string of adverse supply shocks would create a severe conflict between the goals of price stability and of full employment. According to this worldview, if people expect the central bank to follow a price-stabilizing strategy, and the central bank ratifies that belief, then any undesired movement in inflation will be quite short lived. And restoring price stability in such a world will likely involve little cost in terms of real activity.



At the other end of the spectrum are policymakers who suspect that most firms and households form their expectations using something closer to simple rules of thumb based on recent history. Under this alternative worldview, a string of adverse supply shocks is dangerous because it has the potential to cause rising inflation to become embedded in expectations. Should this shift in expectations occur, the central bank would face a persistent inflation problem, one whose correction would likely require a prolonged period of tight monetary policy. In this less comfortable world, restoring price stability can involve a painful process of slow growth and elevated unemployment.

Of course, these considerations are more than a theoretical curiosity and help to explain the intense focus of central banks on inflation expectations. The marked rise in energy prices over the past few years led until recently to a rate of overall consumer price inflation notably above core inflation. However, the available measures of expectations--whether from surveys or financial markets--have shown longer-term expectations increasing very little, if at all, throughout this period, providing some assurance about the inflation outlook. However, this is an ex post assessment. As a policymaker, I would have been more confident in my ex ante judgment about the risk of expectations moving higher if we had had a better understanding of the determinants of expectations regarding prices and of the links between these expectations and the subsequent performance of inflation.

More generally, the uncertainty we face about the process of expectations formation makes interpretation of the underlying correlations in the data challenging. This is no surprise: The rational expectations revolution begun by Robert Lucas more than thirty years ago started from the premise that it is impossible to move from reduced-

form evidence to the underlying economic structure without understanding the evolution of expectations. Much of the macroeconomic literature over the past few years has focused on how alternative assumptions about expectations may explain the patterns of correlations in aggregate data. However, the empirical weaknesses of the rational expectations assumption have limited our progress in this area. The growing interest in research examining the evolution of expectations at the microeconomic level may provide better ways to discriminate between alternative hypotheses. In the meantime, policymakers must live with their uncertainty regarding how expectations are formed and how these expectations shape aggregate activity.

### **Coping with Uncertainty**

Given that uncertainty is pervasive, how should central banks deal with it? One obvious response has been to look for cost-effective ways to support both the development of more accurate and timely data and research to improve our understanding of the economy. Central banks also try to mitigate measurement problems by using data in a nuanced manner--for example, by looking at a multitude of alternative data series and by being cautious about the weight placed on short-run movements in various indicators. Realistically, however, such efforts can take policymakers only so far. Thus, risk is unavoidable, and central banks need to conduct policy in a manner that takes account of uncertainty in its various forms, as they strive to maximize public welfare. But what exactly does this mean?

The literature on this topic extends at least as far back as William Brainard's original paper on uncertainty and policy almost forty years ago.<sup>7</sup> Brainard's analysis showed that if policymakers are uncertain about how real activity and inflation will be

affected over time by monetary actions, they should be less aggressive in responding to changes in economic conditions than would be the case if they knew the true model of the economy. Subsequent research has largely supported Brainard's conclusions and highlighted a corollary to it: Monetary policy should not respond too strongly to any one economic indicator, as the relationship between that indicator and the goals of policy--price stability and full employment--often differs across alternative models in important ways. More generally, this literature suggests that central banks should be cautious about boldly acting on the predictions and policy prescriptions of any one model, especially given that policymakers usually are unsure about the nature and persistence of the shocks hitting the economy.

Central bankers around the world certainly seem receptive to taking a gradualist and cautious approach to policy under most circumstances, as indicated by (among other things) their apparent tendency to smooth interest rates. The behavior of the Federal Reserve during the second half of the 1990s illustrates this approach to policy. During this period, incoming data suggested that trend productivity might be accelerating. However, the evidence for this unexpected development was far from conclusive; moreover, the short-run implications for inflation and employment of a sustained pickup in productivity growth were ambiguous. Staff analysis at the time supported Brainard's conclusion that the appropriate response to heightened uncertainty about the economy's true productive potential would be to reduce the importance of the estimated output gap in setting policy.<sup>8</sup> Whatever the persuasiveness of this analysis, the FOMC did respond in a restrained manner to unusually robust real economic activity--as I believe was appropriate in light of the low and stable inflation that followed.

Of course, gradualism and model averaging may not be appropriate in all circumstances. For example, it may be necessary for monetary policy to respond to what might be called “tail events,” along the lines suggested by recent work on “robust control.” To simplify greatly, this approach often amounts to choosing policy settings to minimize the *maximum* possible loss across different models of the economy, in contrast to the standard Bayesian approach, which (loosely speaking) seeks to minimize the *average* loss across models. Much of the research on robust control has been a bit technical and esoteric. But the notion that policymakers may at times base policy settings on especially pernicious risks has an important ring of truth.

For example, in 2003 the FOMC noted that a continued fall in inflation would be unwelcome largely because such an eventuality might potentially lead to persistently weak real activity with interest rates stuck at zero. Partly in response, the FOMC reduced the federal funds rate to an unusually low level and kept it there for an extended period, in a manner that perhaps would not have occurred in the absence of concerns about the “worst case” effects of deflation. This type of risk management--in which the central bank takes out some insurance against a bad but improbable event--has been an aspect of policymaking for some time and does seem to respond to extreme risks in a way reminiscent of the literature on robust control.<sup>9</sup>

Policymakers also seem to have absorbed another lesson from the recent literature, namely, the desirability of reducing the public’s uncertainty about how the central bank will respond to changes in economic conditions. To this end, central banks now strive to conduct policy in a predictable (albeit flexible) manner that is consistent with their stated objectives. On occasion, however, the goal of predictability may

conflict with the concept of risk management, particularly when risk management requires taking steps to deal with an unusual or unprecedented risk. This conflict is probably unavoidable, and all that policymakers can do in such circumstances is to try to communicate as best they can the rationale behind their departure from standard practice.

Most central banks also strive to follow at least the spirit of Bayesian thinking by taking an eclectic approach to forecasting and to policy analysis. To see this, consider the range of material that the staff supplies to the FOMC. In the case of the economic projections contained in the briefing document we call the Greenbook, the staff consults a variety of indicators and models and then judgmentally pools this information to produce the baseline outlook. The staff then supplements this analysis with various alternative scenarios intended to illustrate the primary risks to the outlook. Although these scenarios are usually constructed using a single model (FRB/US), the simulations actually encompass a wider range of views about the nature of the economy. For example, the simulations routinely consider alternative characterizations of such key aspects of the economy as the expectations formation process, wealth effects, and the sensitivity of inflation to changes in resource utilization and monetary policy. Finally, the staff provides the FOMC with estimated confidence intervals for the forecast and produces studies addressing such questions as the optimal design of policy under different types of uncertainty. Of course, there is always room for improvement and the staff continues to refine and expand this type of analysis.

In addition, the structure of the FOMC, like that of a number of foreign monetary authorities, may also provide Bayesian-like benefits in attempting to deal with uncertainty. Many of the individuals who participate in policymaking at the Fed have

different views about the structure of the economy. These differences enter our discussions and, through the Committee's deliberations, affect the course of policy, although, I admit, how we weigh these competing views to arrive at a decision can appear to be murky. Certainly, the process is one that a good Bayesian might find hard to recognize. Nevertheless, studies suggest that the decisions reached by committees are usually superior to those produced by individuals.<sup>10</sup> In any event, I know that the heterogeneous viewpoints expressed by my fellow Committee members are intellectually stimulating and that they spur me to improve my own thinking about the economy and about the best course for monetary policy.

Thus policymakers and the public at large live in an uncertain world. For example, most of you are probably wondering when this speech will end. I thought about gradually drawing to a close at, say, a measured pace, but my risk-management instincts tell me just to stop. Thank you.

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<sup>1</sup> Michael Kiley and David Reifschneider, of the Board's staff, contributed to these remarks.

<sup>2</sup> In this speech, I use the words "risk" and "uncertainty" loosely. Although economists usually apply the former term to random events with known likelihood and the latter to possibilities whose probability is unknown, we often do not know enough in practice about actual probability distributions to make a sharp distinction between the two concepts.

<sup>3</sup> Athanasios Orphanides (2003), "The Quest for Prosperity without Inflation," *Journal of Monetary Economics*, vol. 50 (April), pp. 633-63.

<sup>4</sup> Joshua Gallin (2004), "The Long-Run Relationship Between House Price and Rents," Finance and Economics Discussion Series 2004-50 (Washington: Board of Governors of the Federal Reserve System, September).

<sup>5</sup> Jonathan McCarthy and Richard Peach (2004), "Are Home Prices the Next 'Bubble'?" Federal Reserve Bank of New York, *Economic Policy Review*, vol. 10 (December), pp. 1-17.

<sup>6</sup> Donald L. Kohn (2006), "Monetary Policy and Asset Prices," speech given at the European Central Bank Colloquium held in honor of Otmar Issing, March 16.

<sup>7</sup> William C. Brainard (1967), "Uncertainty and the Effectiveness of Policy," *American Economic Review*, vol. 57 (May), pp. 411-25.

<sup>8</sup> For an example of this type of analysis, refer to Athanasios Orphanides, Richard D. Porter, David Reifschneider, Robert Tetlow, and Frederico Finan (2000), "Errors in the Measurement of the Output Gap and the Design of Monetary Policy," *Journal of Economics and Business*, vol. 52 (January-April), pp. 117-41.

<sup>9</sup> A discussion of risk management by central bankers is in Alan Greenspan (2004), "Risk and Uncertainty in Monetary Policy," speech given at the Meetings of the American Economic Association, January 3.

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<sup>10</sup> Alan S. Blinder and John Morgan (2005), "Are Two Heads Better Than One? Monetary Policy by Committee," *Journal of Money, Credit, and Banking*, vol. 37 (October), pp.789-811.