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SPEECH

Improving the Measurement of Inflation Expectations

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Good morning, it is a pleasure to be here today to talk with you about some of the ongoing research on the measurement of inflation expectations at the New York Fed. The views expressed are mine and do not necessarily reflect those of the Federal Reserve Bank of New York or the Federal Reserve System. That said, I want to acknowledge my colleagues in the Research Group who have pushed our research on inflation expectations forward.[2]

Expectations, and in particular inflation expectations, play a key role in the conduct of modern monetary policy. Expectations drive people's behavior, by influencing a wide range of economic decisions such as saving, investment, purchases of durable goods, wage negotiations, etc. These decisions in turn affect real economic activity and actual inflation.

Inflation expectations greatly influence the central bank's ability to achieve price stability and therefore represent an important link in the monetary transmission mechanism. It is crucial for a central bank to monitor inflation expectations, making sure that they remain well-anchored and consistent with policy objectives. Since the economy is constantly buffeted by unanticipated shocks, short-term inflation expectations should reflect the effects of these shocks. For example, if energy prices increase suddenly due to a supply disruption, short-term inflation expectations should move up. At the same time, forward inflation expectations—that is expectations of inflation after the end of the supply disruption—should not move. This stability of longer term inflation expectations in the face of movements in short-term inflation expectations is the hallmark of sound, effective and credible monetary policy.

In standard macroeconomic models it is trivial to measure inflation expectations: under the rational expectations assumption any economic agent in the model could produce the unique inflation expectation for any horizon. In the real world, central banks must rely on various indirect approaches to measure inflation expectations: market-based, surveys of professionals such as economists and market participants, and surveys of firms and households. All three types of measures have advantages and drawbacks. It is therefore important for a central bank to use a variety of measures that complement one another. Before turning to the focus of this talk—the measurement of household inflation expectations—I want to provide a quick summary of market-based, professional and business surveys.

The difference in yields between nominal and real government debt provides a natural measure of market inflation expectations for the price index used to protect the holders of real government debt from inflation. In the United States, that price index is the Consumer Price Index (CPI). Thus if the nominal 10 year yield is 3.5 percent and the real 10 year yield is 1 percent, one crude measure of average CPI inflation over the next 10 years would be 2.5 percent. Further, if the nominal five year yield is three percent and real five year yield is 0.2 percent, then a crude measure of average CPI inflation over the next five years would be 2.8 percent and a crude estimate of the five to 10 year forward average CPI inflation would be 2.2 percent.

I say crude because such calculations ignore any difference in liquidity between and within the two types of debt, any compensation investors require for the uncertainty of the real value of nominal coupons and a variety of other issues, such as the fact that TIPS are indexed to the CPI with a time varying lag.

There are numerous ways to take into account liquidity differences, risk compensation and the other factors. For example, Chart 1 shows estimates of the five to 10 year forward inflation compensation constructed by Barclays, the Board of Governors, the New York Fed Markets Group and inflation swaps. The differences are produced by differing assumptions on the liquidity of various securities and the use of an estimated yield curve to produce the Board estimates. No attempt is made to remove the compensation for inflation risk in these measures, thus these are estimates of compensation for expected and unexpected inflation. There are clearly different short-term fluctuations in the various estimates, but they all show a similar pattern—with the exception of the height of the financial crisis they have been contained within a range of just below 2.5 percent to just above 3 percent.

Yield curve model based estimates can provide a decomposition of the whole forward structure of inflation expectations. As shown in Chart 2 for the Board of Governors measure of inflation compensation, the recent decrease in market inflation compensation is centered on short-term inflation expectations with little to no movement in forward inflation expectations from 2013 onwards.

There are numerous surveys of economists and market participants that give additional information on inflation expectations. As

with the market-based measures, the surveys produce responses for a specific price index, usually the CPI and the CPI ex food and energy. The Survey of Professional Forecasters (SPF) also asks numerous questions about the deflator for Personal Consumption Expenditures, the price index for which the Federal Open Market Committee recently chose to adopt a two percent inflation objective over the longer-run as consistent with its statutory mandate. Compared to market-based measures, these measures have the advantages of not being affected by varying market liquidity and not requiring any adjustment for inflation risk compensation. Further, the SPF asks a number of questions about short-run inflation uncertainty.

These forecasts from professionals about core inflation and long-run average inflation provide additional insight into the stability of forward inflation expectations. Since many of the shocks that move around total inflation at high frequencies are removed from core inflation, forecasts of core in the short to medium term provide an additional check on the anchoring of inflation expectations. Recently, with the large increase in economic slack produced by the Great Recession, there was considerable debate on the relative strengths of slack to generate a decline in inflation versus the power of anchored inflation expectations to restrain this decline.

Chart 3 shows some detail on recent behavior of the forecasts for core Personal Consumption Expenditures (PCE) from the SPF and dispersion in long run CPI forecasts. The first panel shows the average of point forecasts since 2007 for the current year and year ahead core PCE inflation rate. As one would expect, the current year forecast is more variable and for the most part the year ahead forecast remains above the current year forecast after the financial crisis, consistent with the pull of anchored inflation expectations. Both set of forecasts are very close to the Federal Open Market Committee's (FOMC) 2 percent longer-run inflation objective. The second panel shows a measure of uncertainty for these forecasts. Here we can see that uncertainty increased as the financial crisis took hold. The third panel shows that disagreement across forecasters also increased with the financial crisis. Much of this disagreement appears to be related to differing views on the strength of standard Phillips curve dynamics versus other approaches to inflation dynamics. The final panel shows the disagreement in 10 year average CPI forecasts over the last 20 years. As you are aware, one of the great successes of the Federal Reserve in the 1980s and 1990s was a reduction in long-run inflation expectations. Indeed since 1998 the median forecast from this SPF question has stayed within a very narrow range. On the other hand, the amount of disagreement around this median has increased recently.

In a special question in the May 2012 SPF, professional forecasters were asked whether their longer term inflation forecasts differed in an economically meaningful way from the FOMC's 2 percent objective for PCE price deflator. Of the 31 responses to this question, 23 said there was no significant difference: the median longer-term inflation forecast of this group was 2 percent, and the range of responses was narrower than the overall distribution. Of the eight that said there was a significant difference, the median response was around 2.5 percent with a wider dispersion.

During the past decade many central banks have begun to explore ways to improve their measurement and understanding of the public's inflation expectations through surveys. At the New York Fed in November 2010 we hosted a conference where many different aspects of this research were discussed. In addition to initiating new surveys and gradually moving from traditionally qualitative to more quantitative questions and measures, research is being conducted to analyze the quality and information content of survey-based measures of inflation expectations.

A recent example of such innovation is the Business Inflation Expectations that the Atlanta Fed has been fielding in the Southeast on a regular basis since October 2011. While our focus in New York has been on consumers, there has long been a need for more information on the inflation expectations of firms. The Atlanta Fed survey focuses on business expectations of unit costs. Thus, unlike most other measures it doesn't immediately map into a measure of consumer price inflation. The Atlanta Fed also asks a number of questions about what firms expect the main drivers of changes in unit costs to be. In its most recent surveys, a special question on expectations of unit costs over the next five to ten years has been asked. Again the idea is to obtain information on the anchoring of inflation expectations but in this case at the intermediate level of unit costs. Chart 4 reports the distribution of these expectations: according to the Atlanta Fed panel of businesses, the most likely outcome for inflation in the near- and long-term is somewhere in the 1 percent to 3 percent range. But the risks seem to be imbalanced. In the near-term, businesses think there is potential for costs to moderate further. But over the longer-term, businesses indicate the risk to unit costs shifts to the upside.

In late 2006 at the New York Fed we initiated a major research project to examine a number of issues related to expectations: First, what is the best way to measure the public's inflation expectations in terms of inflation concepts and forecast horizon? Second, how do households form and update their expectations of future inflation: to what extent are they based on past inflation experiences and what information sources do they rely on? Third, do people act on their expectations and if so, how? My remarks today will mainly focus on the first set of issues but I will conclude with some preliminary research on the other two.

Despite the importance of inflation expectations for forecasting future inflation and economic activity and as a key link in the monetary transmission mechanism, surprisingly little is known to directly answer these questions. This was partly because back in 2006 when we started out, macroeconomists had enjoyed around twenty years of success with models where these questions were answered in a simple and unambiguous manner. As we have learnt painfully from the financial crisis and its aftermath the success of these models was much more due to luck than deep insight.

Our relative ignorance was also partly because economists do not receive detailed training in the design of survey questions. One

of the issues that sparked our initial interest was the wording of questions. We found most questions on inflation expectations did not directly ask about inflation but instead asked about prices. For example, the Thomson Reuters/University of Michigan Survey (the Michigan Survey from now on) asks about the change in "prices in general" or the Bank of England/GfK NOP Inflation Attitudes Survey asks about the expected "change in prices in shops generally". Not being experts in survey design we decided that we needed a wide collaboration to understand the implications of asking about prices in general and whether it was possible to ask directly about the rate of inflation.

We formed a cross disciplinary team among Federal Reserve research staff, academic economists, and psychologists at Carnegie Mellon University who specialize in behavioral decision making as well as risk perception and communication. The initial part of the project was structured in three stages. The first two stages—preliminary inquiries conducted through phone and Internet surveys—gauged how individuals interpreted the Michigan Survey questions and how they would respond to alternative questions about future inflation. The Internet survey also "piloted" questions on wage expectations and inflation uncertainty to expand the information currently elicited by the Michigan Survey. These preliminary inquiries guided the final formulation of the questions for the third stage—the actual implementation of an alternative experimental internet survey of inflation expectations using a sample panel of households drawn from previous respondents to the Michigan survey.

Reliable measurement requires that respondents agree with one another—and with economic modelers—on what the survey questions mean. For the questions asked in professional surveys there is little room for differing interpretations of the inflation concept since forecasts for a specific price index are requested. For questions asked of households, specific price indices are not used so respondents vary in their interpretation of the inflation concept. Thus, their responses may display disagreement not about expectations but the concept of inflation being used. Indeed, one feature that the Michigan Survey's question about "prices in general" shares with other surveys is a high dispersion of responses around the median. This evidence of disagreement is in part related to observable characteristics of respondents such as age, gender, education, and income. However, the differences in response across demographic groups far exceed the variations in inflation experienced by the groups.

When we probed survey respondents about their understanding of changes to "prices in general" (the Michigan Survey question), we found that a significant fraction believed we were inquiring about the prices they recently paid themselves—often prices that had increased or decreased markedly, such as those for food or gasoline. This tendency to think more about prominent price changes in one's own experience is particularly common among respondents with lower financial literacy. By contrast, when we asked about expectations for the "rate of inflation," respondents tended to think less about a few salient price changes specific to their own experience and more about price changes across a broader set of items or about changes in the cost of living—a result that aligns more with economists' definition of inflation as a sustained increase in the overall price level. Asking about the rate of inflation directly therefore produces answers more consistent with the concept of forward inflation expectations of interest to central banks.

Chart 5 plots the time series of median responses from our experimental survey to a "prices in general" question and a "rate of inflation" question. One can see that the median expectation for the rate of inflation question is less variable. Interestingly, the recent spikes in Michigan short term expectations in March of 2011 and 2012 (mirrored by our "prices in general" question) correspond to spikes in year-ahead inflation expectations for gasoline, as shown in Chart 6. Our preferred "rate of inflation" question is less sensitive to movements in prices or expectations for specific commodities that may be salient for consumers.

We also find that the dispersion of responses is significantly larger to the "prices in general" question. Further, in our initial investigations we had established evidence that many respondents would prefer to give a range rather than a point estimate and that most households were able to answer questions about their uncertainty over future inflation. We had also found our measure of individual forecast uncertainty to be positively correlated with the width of any range responses given to the standard point forecast questions. Thus, we added questions eliciting from our panel their subjective uncertainty about future inflation. I will show you an example of such a question in a minute.

As emphasized above, anchoring forward inflation expectations is crucial for monetary policy. In the Michigan survey, information on forward inflation expectations is generated by a question asking about "the change prices in general over the next five to 10 years". Chart 7 plots the time series for the 5-10 year Michigan expectations, together with their one year ahead series. Our initial exploratory work confirmed that many households were confused by this wording but that there was overwhelming evidence that long-term average expectations were being reported. Considering the rather elaborate structure of the Michigan questions shown in Chart 8, it also appears that small changes in the various challenges could lower the median response by a significant margin. Further, asking about the rate of inflation directly produced answers more consistent with the concept of forward inflation expectations of interest to central banks.

Rather than replicating the Michigan long-term inflation expectation question replacing "prices in general" with the "rate of inflation" we decided to work with a medium term explicit horizon and use only a probabilistic version of the question. So for example, in the most recent fielding of our survey the panel was asked: *In your view, what would you say is the percent chance that the following things may happen to the rate of inflation/deflation over the one-year period between May 2014 and May 2015*. Chart 9 gives you the question in full.

We have been fielding the forward inflation expectation question since spring 2008 and Chart 10 contains some time series information from the responses. We use established statistical techniques to estimate continuous probability distributions from each individual set of responses. We then find the median of the median of the individual distributions to represent the average forward expectation and the upper and lower quartiles of the individual medians to measure disagreement across respondents. For our measure of uncertainty we report the median of the individual inter-quartile ranges. Chart 11 compares median quartiles of the individual density forecasts at the short and medium term horizons.

As a complement to attempting to improve the measurement of household forward inflation expectations, we have also been investigating expectations about future house price appreciation, and about wage growth. House price expectations may be crucial in determining household behavior with regard to mortgage default or home buying. Chart 12 plots quartiles of responses for the expected change in average home prices one year ahead, separately by income group. Median expectations dropped significantly in fall 2010 and even more acutely in fall 2011, especially for low income households, but have since recovered for all income groups. With about a quarter of mortgage holders being under water during the past few years, an increase in the proportion of households expecting large declines in home prices was of some concern.

Because firms and workers may negotiate changes in wages to be in line with their expected rate of inflation, data on wage expectations are an additional information source for analyzing inflation dynamics and the interaction between wage and price determination. Furthermore, discrepancies between expected changes in wages and expected inflation may affect households' financial decisions. Despite the obvious importance of wage expectations, information on wage expectations is particularly scarce.

In formulating a question on wage expectations we needed to pose a hypothetical situation to gain information of direct relevance to inflation. It is easiest to illustrate this by giving you the format and exact wording of the question:

We first asked individuals who reported to be working for pay how many jobs they had. We then informed them that in some subsequent questions we would ask about their MAIN job, which we defined to be the job at which they usually work the most hours. We then ask: "Suppose that, 12 months from now, you actually are working in the exact same [MAIN] job at the same place you currently work, and working the exact same number of hours. Twelve months from now, do you expect your earnings on this job, before taxes and deductions, to have gone up, or gone down, or stayed where they are now?" For those who said gone up or gone down we then asked "By about what percent do you expect that your hourly earnings on this job, before taxes and other deductions, will have gone [UP/DOWN], 12 months from now, if you actually are working in the exact same job at the same place you currently work, and working the exact same number of hours?".

Chart 13 reports the quartiles of density medians across respondents, by income. Nominal wage growth expectations dropped significantly in fall 2008 at the height of the financial crisis, and have remained within a narrow band between 1 percent and 2 percent since then. Expected nominal wage growth tends to be slightly higher for high income households. Chart 14 depicts year ahead real wage growth expectations, by combining information from respondents' wage growth and rate of inflation expectations. Median real wage growth expectations have remained in negative territory since we started collecting this series, ranging roughly between zero and negative 2 percent growth. This sort of information can be very useful to analyze inflation dynamics as well as household financial decisions, insofar as they are affected by expected real income growth.

Knowing how consumers form expectations and revise them in response to new information is relevant for many aspects of monetary policy. As noted previously the large cross-sectional variation in inflation forecasts across survey respondents is inconsistent with the traditional rational expectations framework in which all agents are assumed to share the same information set and expectations. This has led to alternative models in which this heterogeneity is explained by a reliance of agents on different models for forecasting, the use of different information sets, and different capabilities for processing information. While in a full information rational expectations world there is no role for constant central bank communication, such a role becomes crucial in a world with learning.

Since in our survey we have utilized a panel design we have the ability to make progress in understanding how expectations are formed and revised over time. Initial analysis suggests that the differences in individual forecasts are persistent and probably related to different forecast models and reference information not just different experiences. We have also found that a respondent expressing higher than average uncertainty in the previous survey is more likely to change their point forecast in the current survey. Furthermore, we have performed a field experiment that indicates that respondents update their expectations in sensible ways after they are exposed to information that is relevant for inflation (such as past inflation or professional forecasters' predictions).

A better understanding of the factors affecting individual inflation expectations will also help evaluate and predict the impact and effectiveness of central bank policy decisions and communication strategy. Specifically, it will improve the central bank's capacity to evaluate the strength and weaknesses of various communication tools and strategies designed to keep inflation expectations well anchored. The ability to do so is especially important at times such as the current ones, in which central banks have been expanding their toolkits and conducting traditional as well as nontraditional monetary policy.

The third and final broad question that would benefit from additional research is whether and how people act on their

expectations. The theoretical link between inflation expectations and realized inflation and consumer decisions occurs through several channels. In addition to affecting future wages and prices through influencing the outcomes of nominal wage contract negotiations and through price-setting behavior of firms, there is the crucial link of real interest rates (nominal rates less expected inflation) with intertemporal consumption and investment decisions. In addition, households who fear high inflation are expected to reduce the amount of money they hold and keep more of their wealth in real assets such as land or gold which are considered better hedges against inflation. Inflation also raises the effective tax rate on income earned from investing and saving. As a result people may invest and save less. My colleagues at the New York Fed have performed a field experiment that shows that consumers indeed act in accordance to their inflation beliefs when asked to choose between financial investments whose payoffs are affected differently by realized inflation. This is a first step in establishing direct empirical evidence of the strength and nature of these theoretical links.

These are important questions, and a variety of approaches can be brought to bear to answer them. Surveys, field experiments and experiments in the lab can all be very useful to further our understanding of these issues, which lie at the heart of the mandate of any central bank. Of course many economists are perhaps appropriately skeptical about whether the results from many experiments can be generalized. While we believe that such experiments can have great value, there would still be tremendous value in linking information about expectations and how they are formed with the actual behavior of households.

Thank you for listening to me today, I would be happy to take some questions on our research on inflation expectations.

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[1] These remarks are an update of a talk I gave at the Forecasters Club of New York on March 30, 2011.

[2] Wilbert van der Klaauw, Giorgio Topa, Rob Rich, Olivier Armantier, Basit Zafar and Joe Tracy.

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