Evolving Market Perceptions of Federal Reserve Policy Objectives

By George A. Kahn and Lisa Taylor

The Federal Reserve Act states that the goals of monetary policy are "maximum employment, stable prices, and moderate long-term interest rates." Policymakers have interpreted the exact meaning of these goals differently over time depending on economic conditions and their understanding of the economy. For example, during the Volcker era when inflation was deemed excessive, policymakers placed a high priority on lowering inflation even at the expense of high and rising unemployment. During the Greenspan era, as further disinflation was achieved, policymakers emphasized "sustainable economic growth," with a view that such an outcome could be achieved only in an environment of low and stable inflation. Finally, in the aftermath of the financial crisis and soaring unemployment, the Federal Open Market Committee (FOMC) under Chairman Bernanke made explicit the nature of its "dual mandate." The Committee specified a longer-run numerical objective for inflation and provided estimates of the unemployment rate that in the long run would be consistent with maximum employment. In addition, the FOMC tied its expected path for the federal funds rate target to an unemployment rate threshold, provided inflation one to two years ahead remained below 2½ percent.

George A. Kahn is a vice president and economist with the Federal Reserve Bank of Kansas City. Lisa Taylor is a research associate at the bank. This article is on the bank's website at ***www.KansasCityFed.org.***

Have these evolving interpretations of Federal Reserve objectives influenced the way financial markets view monetary policy? In particular, have they affected market perceptions about how policymakers might respond to incoming news about economic conditions? This article examines these issues based on the idea that longer-term interest rates reflect the markets' view about the FOMC's setting of its target path for the federal funds rate. It shows that, despite apparent shifts in the way the FOMC has communicated about its objectives, the response of long-term interest rates to economic news has remained relatively stable over time. This finding suggests that market participants perceive little change in how the FOMC adjusts the federal funds rate in response to incoming information.

Section I describes the history of the Federal Reserve's legal mandate and the evolution of ideas about the importance of price stability and maximum employment as goals of policy during the Volcker, Greenspan, and Bernanke eras. Section II provides a theoretical framework for understanding how policymakers' views about the relative importance of the two legs of the dual mandate may depend on economic conditions. The section also provides a framework—the expectations theory of the term structure of interest rates, along with the efficient markets hypothesis—for measuring changes in private-sector perceptions of policy objectives. Section III quantifies changes over time in the response of longer-term interest rates to economic news about employment and inflation, taking these changes as an indication of changing market perceptions of Federal Reserve policy. The analysis is based on regressions of the daily change in longer-term interest rates on the unexpected component of various economic news announcements.

I. OBJECTIVES OF MONETARY POLICY

Congress mandated that the Federal Reserve "promote … maximum employment, stable prices, and moderate long-term interest rates" in the Federal Reserve Reform Act of 1977 (U.S. Congress, 1977). Since then, monetary policymakers have interpreted the practical meaning of this mandate in somewhat different ways, from an emphasis on price stability when inflation was at historically high levels in the late 1970s to a focus on employment when the unemployment rate soared in the Great Recession, ultimately reaching 10 percent.

The Federal Reserve's legislative mandate

At its inception in 1913, the Federal Reserve's main focus was to contain and eliminate the banking panics that were common to the time and to establish financial stability. Specifically, the Federal Reserve Act created the Federal Reserve System "to furnish an elastic currency" and "to establish a more effective supervision of banking in the United States," in addition to other purposes (U.S Congress, 1913).

While the Federal Reserve's responsibility for financial stability was spelled out at its inception, its macroeconomic mandate was not specified until many years later. The mandate has its roots in the Employment Act of 1946.[1] Although this legislation made no specific mention of the Federal Reserve, it directed the federal government "to promote maximum employment, production, and purchasing power" (U.S. Congress, 1946).

Another 31 years passed before Congress made explicit the Federal Reserve's macroeconomic mandate. The mandate was first introduced in House Resolution 133, which passed on March 24, 1975. Language from the resolution was later incorporated into the Federal Reserve Act with the passage on November 16, 1977, of the Federal Reserve Reform Act. With this amendment, Section 2A of the Federal Reserve Act formally mandated that:

> "The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates" (U.S. Congress, 1977).

These goals were reaffirmed in the Full Employment and Balanced Growth Act of 1978—also known as the Humphrey-Hawkins Act—which established the federal government's general responsibility to

> "promote full employment and production, increased real income, balanced growth, a balanced Federal budget, adequate productivity growth, proper attention to national priorities, achievement of an improved trade balance through increased exports and improvement in the international

> competitiveness of agriculture, business, and industry, and reasonable price stability" (U.S. Congress, 1978).

In addition, the Humphrey-Hawkins Act set numerical targets for both unemployment and inflation. Specifically, unemployment was to decline to 4 percent over the medium term and inflation, as measured by the consumer price index (CPI), was to be reduced to not more than 3 percent "provided that policies and programs for reducing the rate of inflation shall be designed so as not to impede achievement of the goals and timetables … for the reduction of unemployment" (U.S. Congress, 1978).[2] The Act specified that policies promoting these goals should "be based on the development of explicit economic goals and policies involving the President, the Congress, and the *Board of Governors of the Federal Reserve System*" (U.S. Congress, 1978, italics added).[3]

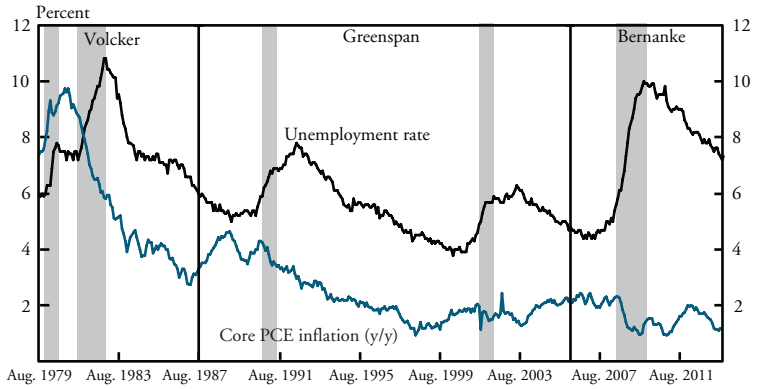
Today, the goals of maximum employment and stable prices are known as the "dual mandate." Moderate long-term interest rates—the third goal specified in the Federal Reserve Act—are viewed as a natural outcome of achieving the dual mandate for employment and inflation.

Evolving interpretations of the mandate

Interpretation of the dual mandate has varied over time depending on economic circumstances and policymakers' understanding of the economy. Although price stability was established as an explicit goal of policy in the mid-1970s, inflation rose sharply over the next several years. In response to high and volatile inflation, Chairman Volcker began in 1979 to emphasize price stability as a fundamental policy objective. Later, as inflation fell and stabilized, Chairman Greenspan turned to promoting "maximum sustainable economic growth" in the context of price stability. Then, with the onset of the financial crisis and Great Recession, Chairman Bernanke emphasized the duality of the mandate, making the unemployment rate a key indicator of the likely future path of policy.

The Volcker era. When Paul Volcker became chairman of the Federal Reserve on August 6, 1979, high and volatile inflation had plagued the economy for nearly a decade. Annual inflation, as measured by the core personal consumption expenditure (PCE) price index, was nearly 7.5 percent and rising, while the unemployment rate had declined to around 6 percent (Chart 1). Previously, the Federal Reserve had failed

Chart 1
HISTORICAL INFLATION AND UNEMPLOYMENT



Notes: Gray bars represent NBER-defined recessions. The vertical lines represent the beginning of the Greenspan and Bernanke chairmanships.

Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, Federal Reserve Board, and Haver Analytics.

to contain inflation, focusing greater attention on maintaining full employment. Volcker changed course from his predecessors, placed full responsibility for the long-term inflation rate in the hands of the Federal Reserve, and began the process of lowering and stabilizing inflation even at the cost of short-term employment losses.

Volcker's resolve to deal with inflation and inflationary expectations was translated into a dramatic shift in the operating procedures of monetary policy on October 6, 1979. This shift in policy implementation—from a focus on short-term interest rates as the instrument of policy to a focus on the quantity of reserves—is generally viewed as the turning point that ultimately led to more than a decade of disinflation beginning in early 1980.[4]

In his February 1980 testimony to Congress, Volcker justified his resolve to fight inflation, stating,

> "In the past, at critical junctures for economic stabilization policy, we have usually been more preoccupied with the possibility of near-term weakness in economic activity or other objectives than with the implications of our actions for future inflation … . As a consequence, fiscal and monetary policies alike too often have been prematurely or excessively stimulative or insufficiently restrictive. The result has been our now chronic inflationary problem … . The broad

> objective of policy must be to break that ominous pattern. That is why dealing with inflation has properly been elevated to a position of high national priority. Success will require that policy be consistently and persistently oriented to that end" (as cited in Lindsey, Orphanides, and Rasche).

Volcker viewed price stability in qualitative terms. He proposed that "A workable definition of reasonable 'price stability' would seem to me to be a situation in which expectations of generally rising (or falling) prices over a considerable period are not a pervasive influence on economic and financial behavior" (as cited in Lindsey and others).

With this qualitative definition in mind, Volcker advocated the view that long-run growth could not be achieved without first establishing price stability. In his testimony before the U.S. Senate Committee on Banking, Housing, and Urban Affairs in early 1981, Volcker stated, "… we will not be successful, in my opinion, in pursuing a full employment policy unless we take care of the inflation side of the equation while we are doing it … . I don't think that we have the choice in current circumstances … of buying full employment with a little more inflation" (as cited in Steelman).

During Volcker's time as chairman, the U.S. economy experienced two recessions, with the unemployment rate climbing above 10 percent after the 1981-82 recession (Chart 1). The core PCE inflation rate peaked at nearly 10 percent after the brief 1980 recession before turning downward. By the end of Volcker's second term as chairman, core inflation had fallen to roughly 3 percent—its lowest level in more than a decade—and the unemployment rate, after its initial rise, had returned to 6 percent, the same level it was when he began his first term.

The Greenspan era. Alan Greenspan inherited this moderate level of inflation and improving employment situation when he became chairman of the Federal Reserve on August 11, 1987. In the early years of his tenure, Greenspan continued to place primary emphasis on achieving the goal of stable prices. In defining price stability, Greenspan was reluctant to focus on any one particular measure or forecast of inflation given measurement and uncertainty concerns. Like Volcker, he viewed price stability "as an environment in which inflation is so low and stable over time that it does not materially enter into the decisions of households and firms" (2001b).[5]

He highlighted the importance of continuing Volcker's fight against inflation in his July 1988 congressional testimony, saying, "The strategy for monetary policy needs to be centered on making further progress toward, and ultimately reaching, stable prices. Price stability is a prerequisite for achieving the maximum economic expansion consistent with … high employment" (as cited in Thornton). Eventual achievement of price stability would allow Greenspan to concentrate more on fostering maximum sustainable economic growth later in his tenure.

After a brief uptick of inflation in the late 1980s and early 1990s, annual inflation as measured by the core PCE price index fell below 3 percent in 1992 and continued to fall for several years thereafter (Chart 1). During the recovery from the 1990-91 recession, however, employment growth was sluggish relative to the average postwar recovery. This slow improvement in labor market conditions marked the first "jobless" recovery. But a productivity rebound in the second half of the 1990s led to an acceleration of economic growth, and ultimately the unemployment rate fell below 4 percent in 2000. Even during these favorable economic times of low inflation and rapid growth, Greenspan and his colleagues on the FOMC maintained their resolve to attain price stability for the long run. They acted preemptively as necessary to avoid not only rising inflation but also to prevent unwelcome declines in inflation, a new and equally concerning possibility.

Greenspan acknowledged that the Federal Reserve's policy actions could sometimes be seen (unfairly) as favoring inflation containment over economic growth. In a 1997 speech, he pointed out that "The Federal Reserve, of late, has been criticized as being too focused on subduing nonexistent inflation and, in the process, being willing to suppress economic growth, retard job expansion, and inhibit real wage gains" (1997a). In response to such criticism, Greenspan reiterated, "Our objective has never been to contain inflation as an end in itself, but rather as a precondition for the highest possible long-run growth of output and income—the ultimate goal of macroeconomic policy" (1997b). Greenspan attributed the virtuous cycle of productivity and output growth that marked the late 1990s to the environment of low and stable inflation, stating in his semiannual testimony before Congress in July 1998, "The essential precondition for the emergence, and

persistence, of this virtuous cycle is arguably the decline in the rate of inflation to near price stability."

An interesting distinction in Greenspan's statement is his reference to "*near* price stability." Although by 1998 monthly readings on core inflation had reached annualized rates at or below 2 percent, policymakers still needed to ensure inflation would stay low and that inflation expectations remained well anchored at this low level before assuming price stability had been achieved. Greenspan voiced this sentiment in a 1999 speech, saying, "It is … up to us at the Federal Reserve to secure the favorable inflation developments of recent years and remain alert to the emergence of forces that could dissipate them." It was not until 2003 that Greenspan, other policymakers, and analysts acknowledged the attainment of price stability. Ben Bernanke, then a governor of the Federal Reserve Board, noted the accomplishment in a July 2003 speech, exclaiming, "not too long ago, something remarkable happened—the goal [of price stability] was achieved!"

Throughout his tenure as chairman, Greenspan continued to emphasize the view that stable inflation was a necessary condition for pursuing and achieving the second part of the Federal Reserve's mandate, which he commonly referred to as "maximum sustainable economic growth." For example, he told the Economic Club of New York, "a central bank's vigilance against inflation is more than a monetary policy cliché, it is, of course, the way we fulfill our ultimate mandate to promote maximum sustainable growth" (2001a). Even so, as inflation fell to, and remained at, a level consistent with long-run price stability, monetary policymakers were able to focus more on achieving maximum sustainable growth. After the 2001 recession, then-Vice Chairman Roger Ferguson said, "The fact that inflation appears to be under control currently and is likely to remain under control gives us a little more scope to look at the other side of the mandate—to foster maximum sustainable growth" (as cited in Thornton). The FOMC cut the federal funds rate target to unusually low levels, easing monetary policy to increase economic growth and employment, while inflation fluctuated around a 2-percent annual rate. When Greenspan stepped down as chairman, the unemployment rate had dropped to just under 5 percent.

The Bernanke era. On February 1, 2006, after Greenspan had served more than 18 years, Ben S. Bernanke became chairman of the

Federal Reserve. Like Volcker and Greenspan, Bernanke embraced the view that stable prices are necessary to achieve maximum employment and moderate long-term interest rates. Indeed, in his first testimony before Congress just two weeks after becoming chairman, Bernanke said, "achieving price stability is not only important in itself; it is also central to attaining the Federal Reserve's other mandated objectives of maximum sustainable employment and moderate long-term interest rates" (2006). Bernanke was also explicit in emphasizing the balanced nature of the Federal Reserve's mandate, saying "The Federal Reserve is legally accountable to the Congress for two objectives, maximum employment and price stability, on an equal footing. My colleagues and I strongly support the dual mandate and the equal weighting of objectives that it implies" (2007).

At the start of Bernanke's chairmanship, core inflation was near 2 percent and the unemployment rate was under 5 percent (Chart 1). But this favorable combination of inflation and unemployment was disrupted by the onset of the financial crisis and Great Recession in late 2007. During this pronounced economic downturn, the unemployment rate rose to 10 percent and core inflation dropped to around 1 percent, prompting concerns of possible deflation. To avoid falling short of both aspects of the dual mandate, the FOMC aggressively eased monetary policy by lowering the federal funds rate target from 5¼ percent in September 2007 to a range of zero to ¼ percent in December 2008.

After reaching this effective zero lower bound, the FOMC adopted several unconventional policies aimed at providing further accommodation. These unconventional policies included large-scale purchases of longer-term Treasury and agency mortgage-backed securities and the use of forward guidance to describe the likely future path of policy.

In addition, in January 2012, the Committee issued a "Statement on Longer-Run Goals and Monetary Policy Strategy" that for the first time established a numerical target for inflation for the Federal Reserve and provided estimates of the unemployment rate that would in the long run be consistent with maximum employment. The longer-run goal for inflation was set at 2 percent as measured by the annual change in the PCE price index and based on the view that longer-run inflation is primarily determined by monetary policy. In contrast, because

"maximum" employment is not directly observed, is largely determined by nonmonetary factors, and shifts over time, the Committee provided only an estimated range for the unemployment rate associated over the long run with maximum employment. In reaffirming the statement in January 2014, the Committee indicated its estimate of the longer-run normal rate of unemployment had a central tendency of 5.2 percent to 5.8 percent.[6]

Recognizing the goals of maximum employment and stable prices might at times conflict in the short run, the Committee also provided guidance in the statement about how it would approach any such conflict. The statement indicated that:

> "In setting monetary policy, the Committee seeks to mitigate deviations of inflation from its longer-run goal and deviations of employment from the Committee's assessments of its maximum level. These objectives are generally complementary. However, under circumstances in which the Committee judges that the objectives are not complementary, it follows a balanced approach in promoting them, taking into account the magnitude of the deviations and the potentially different time horizons over which employment and inflation are projected to return to levels judged consistent with its mandate" (Federal Open Market Committee, January 2012, 2013, and 2014).

After establishing explicit longer-run goals in 2012, the Committee began to more closely tie its policy actions—either qualitatively or quantitatively—to the longer-run objectives of monetary policy. For example, in September 2012 when the FOMC launched its "open-ended" asset purchase program, it indicated purchases would continue until the outlook for the labor market improved substantially in a context of price stability.[7] The FOMC also offered more explicit guidance about how the future path of its target for the federal funds rate was related to the longer-run objectives of policy. After initially indicating various time frames over which the federal funds rate was likely to remain at an exceptionally low level, the Committee in December 2012 provided forward guidance based on a conditional numerical threshold for unemployment. In particular, the statement said,

> "The Committee decided to keep the target range for the federal funds rate at 0 to ¼ percent and currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-½ percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2-percent longer-run goal, and longer-term inflation expectations continue to be well anchored" (Federal Open Market Committee, 2012).[8]

In addition to testing the Committee's commitment to the duality of its macroeconomic mandate, the financial crisis and Great Recession also prompted a renewed emphasis on financial stability and its role in promoting favorable macroeconomic performance. In a 2013 speech reviewing the first century of Federal Reserve history, Bernanke pointed out "Today, the Federal Reserve sees its responsibilities for the maintenance of financial stability as coequal with its responsibilities for the management of monetary policy … . In a sense, we have come full circle, back to the original goal of the Federal Reserve of preventing financial panics."

II. EVOLVING MARKET PERCEPTIONS—THEORY

To what extent are these shifting views about the relative importance of maximum employment and price stability in the Federal Reserve's mandate reflected in the behavior of financial markets? This article examines how financial markets have changed their outlook for the future path of the federal funds rate in response to economic news. A shift in the estimated response of financial markets to economic news is taken as evidence that markets believe the FOMC has adjusted its weighting of employment and price stability in its dual mandate. This section first discusses how and why policymakers might weigh the employment and inflation components of a dual mandate differently over time. It then describes a methodology for determining the extent to which the private sector has perceived changes over time in the nature of the dual mandate.

Monetary policy objectives under a dual mandate

The dual mandate can be expressed as a loss function that the central bank seeks to minimize. One example of such a loss function assumes the central bank sets its policy instruments each period to minimize deviations of inflation from a target rate and employment from its maximum sustainable level. One such specification takes a per-period quadratic form as follows:

$$Min[(1-\lambda_t)(\pi_t-\pi_t^*)^2+\ \lambda_t(y_t-y_t^*)^2],$$

where π_t is the inflation rate, π_t^* is the inflation target, y_t is the employment rate, and y_t^* is the employment rate associated with "maximum" employment, all at time *t*.

With a dual mandate, the central bank can be thought of as choosing the parameters π_t^* and λ_t over time.[9] The parameter π_t^* represents the central bank's implicit or explicit inflation target, and λ_t, which varies from zero to 1, represents the weight the central bank places on employment stabilization relative to the weight it places on inflation stabilization $(1-\lambda_t)$.[10] Given this loss function, shifting views about the goals of monetary policy can be thought of as changes in the values of π_t^* and λ_t. The inflation objective and the weighting of inflation stabilization relative to employment stabilization might evolve over time due to a variety of factors such as changes in Federal Reserve leadership, changes in economic conditions, or changes in how policymakers understand the economy. A decline in the value of π_t^* suggests a desire to achieve a lower target inflation rate. A decline in λ_t suggests a decline in the weight placed on employment relative to inflation in the dual mandate.

In practice, the central bank's loss function may be considerably more complex. Not only might the relative weights on employment and inflation evolve over time but so might the functional form of the loss function itself. For example, some analysts and policymakers have suggested that during the Greenspan era, the Federal Reserve followed an "opportunistic" approach to lowering inflation to its long-run goal. An opportunistic strategy is one in which monetary policy aims to hold inflation steady at, or close to, its current level until an unanticipated shock pulls inflation down. At that point, policymakers "opportunistically" accept the lower inflation rate as the new target for policy

and attempt to maintain the lower inflation rate until an unexpected shock again pulls inflation down.[11]

A per-period loss function that describes an opportunistic approach to disinflation might be given by the following:

$$Min[(1-\lambda_t)(\pi_t-\pi_t')^2+\lambda_t \mid y_t-y_t^* \mid],$$

where $|y_t-y_t^*|$ is the absolute deviation of the employment rate from its long-run maximum rate, λ_t is the weight policymakers place on the employment "gap" relative to inflation, and π_t' is an intermediate target for inflation. The intermediate target for inflation, in turn, depends on a weighted average of the inherited rate of inflation π^b and the long-run inflation target, π^*:

$$\pi_t' = (1-\alpha)\pi^* + \alpha\pi^b,$$

where α is between zero and 1.

Under the opportunistic loss function, the policymaker will try to move the inflation rate gradually and "opportunistically" toward the long-run objective. When inflation is above the long-run target, the opportunistic loss function would lead policymakers to reduce inflation toward the long-run target in gradual steps. As inflation moves down, the policymaker would adjust the intermediate target to reflect progress that had been made. Thus, the intermediate target eventually converges to the long-run inflation target. In addition, the absolute value of the employment gap in the opportunistic loss function (as opposed to a squared gap) would lead policymakers to place greater importance on the marginal loss from a small employment gap than the marginal loss from a small deviation of inflation from the intermediate target. Thus, for some range of deviations from the intermediate inflation target, employment stabilization would be the primary objective of the opportunistic policymaker. Large deviations of inflation from the intermediate target, however, would lead the policymaker to place greater emphasis on inflation stabilization.[12]

The quadratic and opportunistic loss functions are just two ways policymakers could choose to implement a dual mandate for price stability and maximum employment. Other loss functions could also be implemented depending on the central bank's mandate, economic circumstances, and policymaker preferences.[13] And, given a particular loss function, policymakers would need to establish values for key

parameters such as the relative importance of minimizing deviations of inflation from target versus deviations of employment from estimates of maximum employment. Conceivably policymakers' views on these issues could change over time.[14]

Private sector perceptions of monetary policy objectives

In theory, a loss function can make explicit policymakers' preferences about any short-run trade-off that may exist between achieving longer-run inflation objectives and pursuing maximum employment. In practice, identifying a particular form and parameterization of a loss function that describes policymakers' preferences would be difficult or impossible—especially when policy is made by a committee. On a diverse committee, views may differ, and they may evolve over time as economic circumstances change and as policymakers' understanding of the economy and monetary policy improves.

As a result, policymakers generally communicate how they view short-run trade-offs among policy objectives through qualitative statements. For example, as described in the previous section, the FOMC in its "Statement on Longer-Run Goals and Monetary Policy Strategy" states that it takes a "balanced approach" to addressing situations in which inflation and employment move away from their longer-run objectives in opposite directions (for example, if inflation moves higher than its longer-run objective at the same time employment moves below its maximum longer-run level). This balanced approach also takes into account the magnitude and expected persistence of the deviations of inflation and employment from mandate-consistent levels.

This article examines the objectives of Federal Reserve monetary policy through the lens of financial market participants. It relies on the expectations theory of the term structure of interest rates and the efficient markets hypothesis to examine how financial markets respond to news about the economy that could give rise to a change in Federal Reserve monetary policy. Changes in the response of financial markets to economic news, in turn, may indicate markets have changed their perceptions about how policymakers balance trade-offs between the longer-run goals of monetary policy.

Most central banks, including the Federal Reserve, conduct monetary policy by exerting control over the policy rate—a short-term

interest rate such as the overnight federal funds rate. This control over the policy rate gives the central bank considerable influence over short-term market interest rates. In addition, central banks seek to influence longer-term interest rates by influencing market expectations about the future stance of monetary policy. They do this by communicating information to the public about their long-run objectives, their outlook for economic activity and inflation and, to varying degrees, their assessment of the future course of the policy rate. Financial market participants, in turn, use this information to price financial assets such as Treasury securities.

One approach to pricing longer-term Treasury securities relies on the expectations theory of the term structure of interest rates. The expectations theory provides a model for understanding how the market's view of the policy path influences interest rates of different maturities.[15] In the expectations theory, the interest rate on any government security can be viewed as an average of today's policy rate and the policy rates that financial market participants expect to prevail over the life of the security, plus a term premium.[16] For example, today's one-year rate can be thought of as an average of today's policy rate and the sequence of policy rates investors expect over the next year, plus a term premium. Similarly, today's five-year rate can be thought of as an average of the policy rates expected over the next five years, plus a term premium.

Under the expectations theory, interest rates change when investors believe the future path of the policy rate will be changed. For example, suppose investors change their expectation for future policy from a constant path for the policy rate to a path in which the policy rate rises by 50 basis points in six months and remains there. Today's six-month rate would remain unchanged since the policy rate increase is not expected to take place for six months. In contrast, the six-month rate six months in the future would increase by the full 50 basis points. And, the current one-year rate would increase by 25 basis points, the average of the increase in the current six month rate (zero basis points) and the increase in the six-month rate expected six months from now (50 basis points).[17]

Information from financial markets can be used to estimate market participants' view of the policy path which, implicitly, reflects market participants' view of the objectives of policy. One approach is to examine how federal funds futures rates or long-term Treasury rates respond to

news about the economy. Under the efficient markets hypothesis, these rates build in all currently available information relevant to expected future economic conditions.[18] When new information about the economy becomes available, rates adjust. For example, when the Labor Department releases its monthly estimate of unemployment, rates typically rise if the reported unemployment rate is lower than expected. Similarly, when information about the CPI is released, rates typically rise if the reported inflation rate is higher than expected. These responses follow from the belief that an unexpected fall in the unemployment rate or rise in the inflation rate might lead the Federal Reserve to increase the current or future target for the federal funds rate. Such an expected tightening of monetary policy would lead to an increase in the federal funds futures rate and, through the expectations theory of the term structure, an increase in longer-term rates.[19]

The next section examines how the response of market rates to economic news has changed over time to infer changes in the markets' perception of the objectives of monetary policy. For example, an increase in the response of market rates to news about unemployment, combined with a decrease in the response of rates to news about inflation, is taken as an indication that financial markets perceive the Federal Reserve to be placing greater emphasis on the unemployment component of the dual mandate relative to the inflation component.

III. EVOLVING MARKET PERCEPTIONS—EVIDENCE

The analysis of how market rates have responded differently over time to economic news is based on ordinary least squares (OLS) regressions of daily changes in longer-term interest rates on the surprise component of regular releases of various economic indicators. Changes in the responses of longer-term interest rates to economic news are then related to economic conditions such as the level of unemployment and rate of inflation and to various policy regimes. Policy regimes include the chairmanships of Greenspan and Bernanke, the period before and after the FOMC lowered the federal funds rate to its effective lower bound, and the period in which some economists view the FOMC's policy actions as having been systematic and rule based versus the post-2000 period in which policy is claimed to have become more discretionary.[20]

Details of the empirical approach

A simple linear model is used to estimate the response of market rates to economic news:

$$\Delta rate_t = \alpha + \sum_{i=1}^{N} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where $\Delta rate_t$ represents the one-day change in the relevant interest rate, i indexes the economic indicators, $Surprise_{i,t}$ represents the unanticipated component of an economic news release for indicator i, and the γ coefficients control for day-of-the-week effects. Estimating the model requires information on changes in the relevant market rate and a measure of the surprise component of the economic data releases of interest.

The analysis focuses on the responses of the 10-year Treasury yield and the six-month federal funds futures rate to economic news. The 10-year rate—reflecting the expected path of short-term rates over a long horizon—moves sharply in response to new information, while the six-month federal funds futures rate provides a more direct indication of the market's expectations for monetary policy, albeit over a shorter horizon. The response of each rate is measured as the one-day change, in basis points, from market close on the day prior to the news release to market close on the day of the news release. Using a one-day window allows time for the market to absorb the news, with limited risk that other news will complicate interpretation of the market response.[21] Daily 10-year Treasury yields, reported by the Federal Reserve Board and collected through Haver Analytics, are available beginning in January 1962; daily six-month federal funds futures rates are available from Bloomberg L.P. on a continuous basis beginning January 1, 1994.

The unanticipated component of an economic news release is measured as the difference between the as-reported (real-time) value of the data in an economic news release and a measure of the market's expectation for the data. The real-time data come from Informa Global Markets, accessed through Haver Analytics. The market expectations data are based on weekly surveys first conducted by Money Market Services (MMS) and now published by Informa Global Markets.[22] About 40 market participants, including economists, commercial bankers,

brokers, consultants, fund managers, and academics, are contacted on Fridays and asked to report their forecasts for a range of economic indicators to be released the following week. The median response of survey participants is taken to be the anticipated component of an economic news release.[23] To make the unanticipated components of news releases comparable across various economic indicators in the analysis, each is divided by its standard deviation over the sample period.[24]

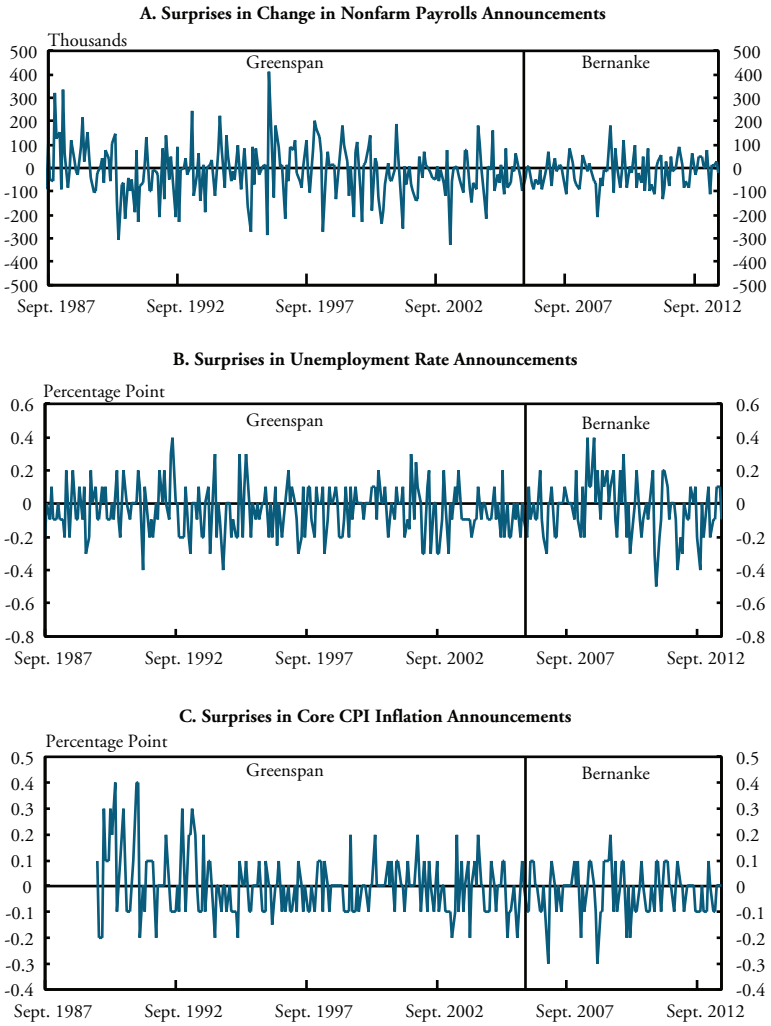
Chart 2 shows the unanticipated component of the announcements for three important economic indicators: the monthly change in nonfarm payrolls (Panel A), the unemployment rate (Panel B), and the monthly core CPI inflation rate (Panel C). The unanticipated components of these economic news releases have varied considerably since late 1987, but the variation was similar during the Greenspan and Bernanke chairmanships.

Thirteen of the surveyed economic indicators are used in this analysis: the monthly change in nonfarm payroll employment, the unemployment rate, the monthly core CPI inflation rate, the advance annualized quarterly real GDP growth rate, the monthly core producer price index (PPI) inflation rate, total industry capacity utilization, monthly growth in retail sales excluding motor vehicles, the consumer confidence index, the percent change in the leading indicators index, the ISM manufacturing index, new single-family home sales, monthly growth in advance new orders of durable goods, and weekly initial unemployment insurance claims. These indicators are the same as those analyzed in Swanson and Williams (2013) with the addition of advance orders of durable goods. Table A1 in the Appendix provides a set of summary statistics, including the mean, standard deviation, and maximum and minimum values, for the unanticipated component of each economic indicator included in the analysis.

Although the MMS survey has been conducted since 1980, many of the economic indicators were not included in the survey until many years later. The analysis focuses on data reported from August 11, 1987, (the start of Chairman Greenspan's tenure) through August 27, 2013. At the beginning of the sample, survey expectations were collected for just four of the 13 economic indicators analyzed; expectations for all 13 indicators were available beginning in July 1991. Given the availability of data on longer-term rates and market expectations, the response of

Chart 2

SURPRISES IN ECONOMIC NEWS ANNOUNCEMENTS



Note: Vertical line in each panel represents the beginning of the Bernanke chairmanship.

Sources: Informa Global Markets, Haver Analytics, and authors' calculations.

the 10-year Treasury yield is estimated over the period from August 11, 1987, to August 27, 2013, while the response of the six-month federal funds futures rate is estimated over the period from January 1, 1994, to August 27, 2013. Only the days on which one of the 13 economic indicators was released are included in the sample.[25]

Estimates from the baseline model for the 10-year Treasury yield and the six-month federal funds futures rate, based on ordinary least squares (OLS) regression, are reported in Table 1. Each coefficient β_i measures the market's response to a one-standard-deviation surprise in indicator *i*. For example, the coefficient on surprise changes in nonfarm payrolls in the 10-year Treasury yield regression is 4.1, meaning that when nonfarm payrolls increase by one standard deviation more than expected (roughly 103,000 jobs), the 10-year Treasury yield increases by 4.1 basis points.

Not all indicators have the same effect on market rates. Markets respond most strongly to surprises in monthly changes in nonfarm payrolls. The longer-term rates also exhibit a strong, statistically significant response to surprises in the ISM manufacturing index, monthly growth in retail sales excluding motor vehicles, and monthly core CPI inflation. Surprises in announcements of the unemployment rate, the consumer confidence index, capacity utilization, new home sales, and initial claims have a lesser but still generally significant effect on market rates. The two longer-term rates show mixed responses to surprises in monthly growth of durable goods orders and monthly core PPI inflation. Surprises in advance real GDP growth and the percent change in the leading indicators index have little to no effect on either interest rate.[26]

Going forward, the discussion will focus on those economic indicators most closely related to the dual mandate—nonfarm payroll employment, the unemployment rate, and core CPI inflation—while the analysis will still control for the 10 remaining economic indicators. Full results, including those for all 13 economic indicators, are reported in the Appendix.

Changes in market perceptions associated with economic conditions

One factor that could lead to changes in the relative importance policymakers attach to one leg of their dual mandate relative to the other might be the state of the economy. For example, when employment is

Table 1

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES

	(1) 10-Year Treasury Yield	(2) Six-Month Federal Funds Futures Rate
Change in nonfarm payrolls	4.1***	4.0***
	(0.52)	(0.45)
Unemployment rate	-0.8*	-1.3***
	(0.47)	(0.40)
Core CPI inflation	1.6***	1.2***
	(0.40)	(0.32)
Advance GDP	0.6	0.8*
	(0.72)	(0.44)
Core PPI inflation	1.1***	0.4
	(0.31)	(0.27)
Capacity utilization	0.9**	1.3***
	(0.45)	(0.50)
Retail sales excluding motor vehicles	1.9***	1.1***
	(0.38)	(0.30)
Consumer confidence	1.4***	0.8***
	(0.41)	(0.29)
Leading indicators index	0.4	0.0
	(0.36)	(0.25)
ISM manufacturing	3.0***	2.4***
	(0.38)	(0.54)
New home sales	1.0***	0.7***
	(0.32)	(0.28)
Durable goods orders	1.3***	0.5
	(0.42)	(0.32)
Initial unemployment claims	-1.2***	-0.7***
	(0.19)	(0.14)
Constant	0.3	2.2***
	(0.42)	(0.50)
R-square	0.10	0.12
RMSE	6.40	4.91
Observations	3,164	2,569

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The 10-year Treasury yield sample includes August 11, 1987, through August 27, 2013. The six-month federal funds futures rate sample includes January 1, 1994, through August 27, 2013. The regression model is given by:

$$\Delta\, rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators. Estimates of the day-of-week coefficients are not reported in the table.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

far below its long-run maximum level, policymakers might place greater emphasis on increasing employment and show a greater tolerance for allowing inflation to deviate from target. Similarly, an inflation rate far above target might lead policymakers to place greater emphasis on reducing inflation, perhaps at the expense of lower employment growth.

Chart 3 shows changes over time in the response of the 10-year Treasury yield (Panel A) and the six-month federal funds futures rate (Panel B) to a one-standard-deviation surprise in the announcement of the monthly change in nonfarm payrolls. Each observation, shown by points on the blue lines, is the coefficient on the payroll surprise variable in an OLS regression of the respective interest rate on a set of 13 economic news indicators over a five-year rolling window. As shown by gray lines in the top two panels, the response of interest rates to the surprise in the change in nonfarm payrolls is statistically significant throughout virtually all the estimation periods, with a positive surprise leading to an increase in interest rates.

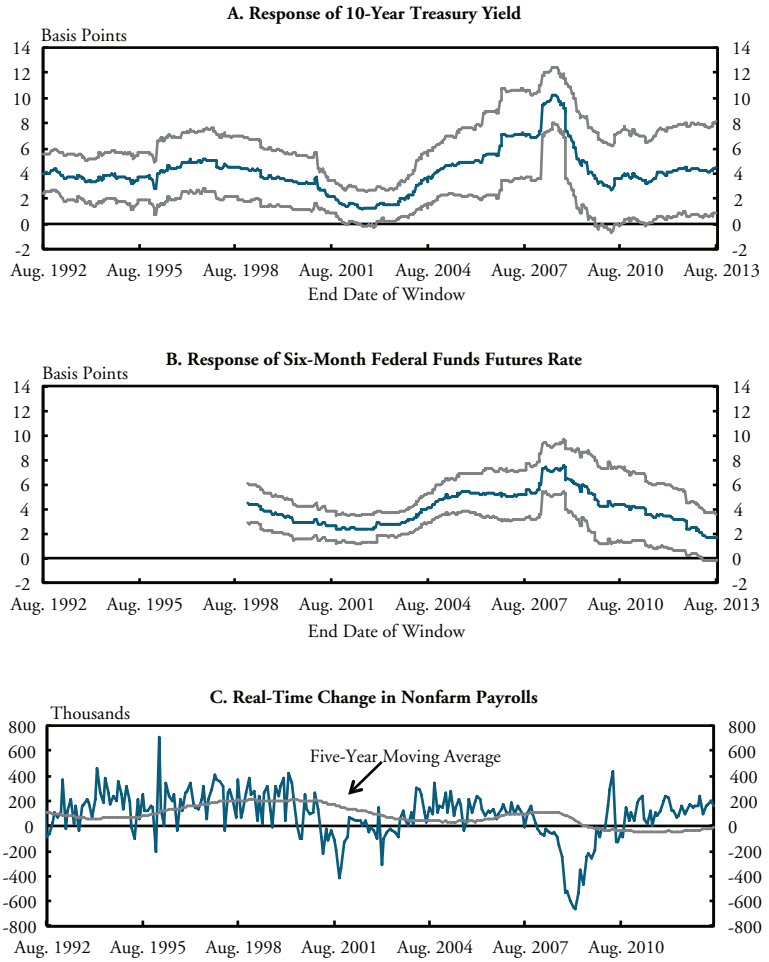
The bottom panel of the chart (Panel C) shows the corresponding changes in payroll employment, as measured in real time, along with their five-year moving average. Comparing the response of rates to jobs announcements in the top two panels with the absolute change in payroll employment over the same period suggests the interest rate response to payroll surprises is larger when nonfarm payroll growth is relatively high as in the late 1990s or relatively low as in 2008-09 during the Great Recession. This response suggests markets view the Federal Reserve as increasing its response to employment growth when employment growth is relatively strong or relatively weak.

In comparison to the response of market rates to payroll growth surprises, the response of rates to unemployment rate announcements is relatively muted. Chart 4 shows changes over time in the response of the 10-year Treasury yield (Panel A) and the six-month federal funds futures rate (Panel B) to a one-standard-deviation surprise in the announcement of the monthly unemployment rate.[27] Each observation, shown by points on the blue lines, is the coefficient on the unemployment surprise variable in an OLS regression of the respective interest rate on a set of economic news indicators over a five-year rolling window.

The top two panels show the response of interest rates to a surprise in the unemployment rate is relatively modest compared to that

Chart 3

ROLLING REGRESSION ESTIMATES OF MARKETS' RESPONSE TO SURPRISES IN THE CHANGE IN NONFARM PAYROLLS

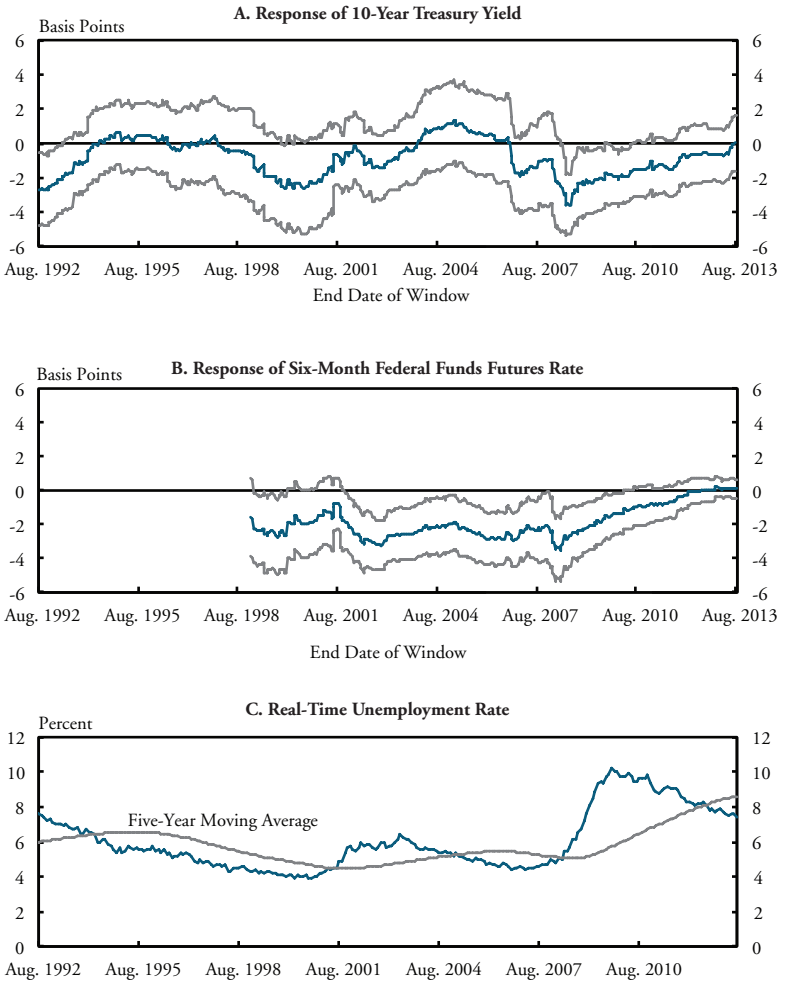


Notes: Panels A and B depict the response of the 10-year Treasury yield and the six-month federal funds futures rate, respectively, to a one-standard-deviation surprise in the change in nonfarm payrolls in a five-year rolling window regression. The gray lines denote the 95 percent confidence interval using robust standard errors.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Chart 4

ROLLING REGRESSION ESTIMATES OF MARKETS' RESPONSE TO UNEMPLOYMENT RATE SURPRISES



Notes: Panels A and B depict the response of the 10-year Treasury yield and the six-month federal funds futures rate, respectively, to a one-standard-deviation surprise in the unemployment rate in a five-year rolling window regression. The gray lines denote the 95 percent confidence interval using robust standard errors.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

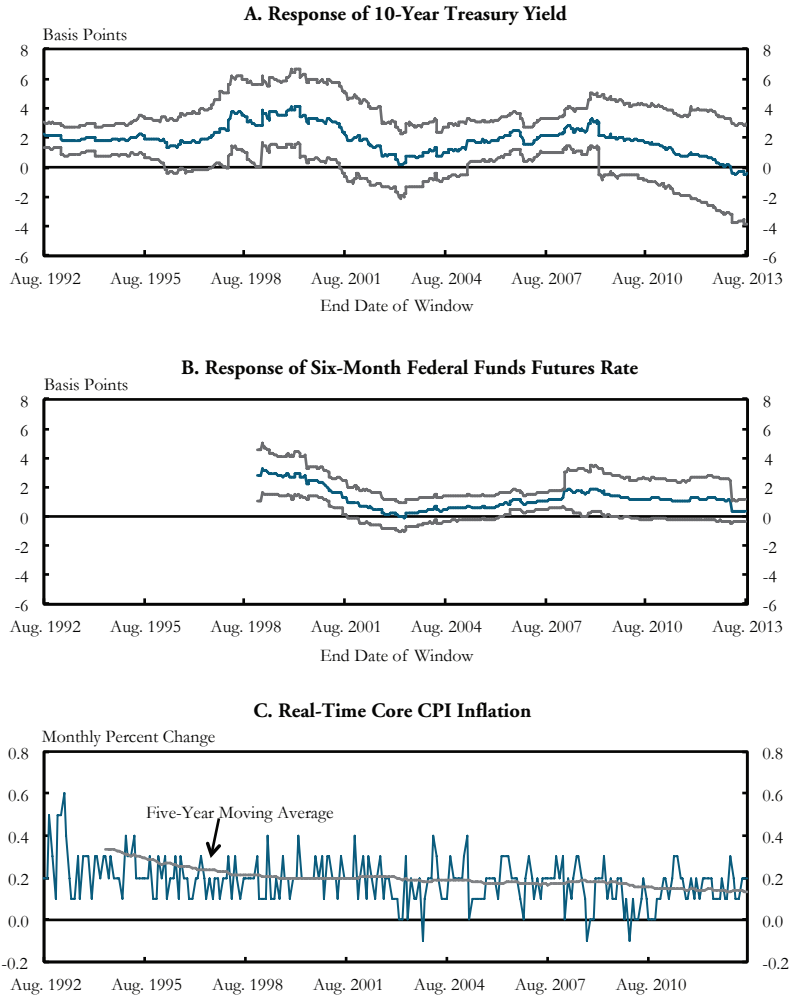
of a payroll employment surprise (note the scale difference in the top two panels of Charts 3 and 4). Moreover, the response of the 10-year Treasury rate is statistically insignificant across virtually all sample periods based on the 95 percent confidence intervals shown by the gray lines. In contrast, the response of the six-month federal funds futures rate—while muted relative to payroll employment surprises—is generally statistically significant and negative. This finding indicates that an unexpected increase in unemployment is associated with a decline in the six-month federal funds futures rate and that an unexpected decrease in unemployment is associated with an increase in the federal funds futures rate.

Comparing the interest rate responses due to unemployment rate surprises with the actual level of the unemployment rate (shown in Panel C) suggests a historically low unemployment rate is associated with relatively large—but generally statistically insignificant—interest rate responses. In contrast to the response to employment surprises, this result suggests that market participants may expect the FOMC to adjust its target path for the federal funds rate in response to an unemployment rate surprise more when labor market conditions are tight than when labor markets are slack. However, the average response of longer-term interest rates to payroll employment surprises clearly dominates the response to unemployment rate surprises.

Interest rate movements also seem to be modestly related to the level of inflation. Chart 5 shows changes over time in the response of the 10-year Treasury yield (Panel A) and the six-month federal funds futures rate (Panel B) to a one-standard-deviation surprise in the announcement of the monthly core CPI inflation rate. Each observation, shown by points on the blue lines, is the coefficient on the core CPI inflation surprise variable in an OLS regression of the respective interest rate on a set of economic news indicators over a five-year rolling window. For most sample periods, an inflation surprise is associated with a modest movement in interest rates in the same direction. Moreover, as shown in Panel C, during the mid- to late-1990s when the Federal Reserve was, according to some analysts, following an opportunistic disinflationary strategy, the response of interest rates to inflation surprises was somewhat stronger than in any other period. In addition, during the late-2000s, when inflation was near the FOMC's longer-run

Chart 5

ROLLING REGRESSION ESTIMATES OF MARKETS' RESPONSE TO CORE CPI INFLATION SURPRISES



Notes: Panels A and B depict the response of the 10-year Treasury yield and the six-month federal funds futures rate, respectively, to a one-standard-deviation surprise in core CPI inflation in a five-year rolling window regression. The gray lines denote the 95 percent confidence interval using robust standard errors.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

target of 2 percent, the response of interest rates to inflation surprises was also relatively strong.

A more formal statistical test confirms the visual impression from Charts 3 to 5 that the response of interest rates to economic news depends on economic conditions. Table 2 examines how the 10-year Treasury yield and the six-month federal funds futures rate respond to employment and unemployment announcements when the unemployment rate is relatively high (over 5¼ percent) versus when it is relatively low (5¼ percent or less). In addition, it examines how these rates respond to core CPI inflation announcements when inflation is relatively high (over 2½ percent at an annual rate) versus when it is low (2½ percent at an annual rate or below).

The table shows the coefficients on unexpected changes in the labor market variables depend on whether unemployment is relatively high or low, while the coefficients on unexpected inflation are similar whether inflation is high or low. Specifically, the response of longer-term rates to unexpected changes in nonfarm payrolls is generally larger when the unemployment rate is high.[28] In contrast, the response of longer-term rates to unemployment rate surprises is generally higher in absolute value when the unemployment rate is low. Of course, news about both of these indicators is released on the same day and time each month. When unemployment is above 5¼ percent, markets respond strongly to an unanticipated change in payroll employment and only modestly to an unexpected change in the unemployment rate. When unemployment is 5¼ percent or less, markets respond similarly to unanticipated changes in employment and unemployment.

The different responses stemming from economic conditions are generally statistically significant for the labor market indicators but not for inflation. The F-tests reported in Table 2 show that the response of both the 10-year yield and the six-month federal funds futures rate to payroll employment surprises is statistically different in periods of high unemployment than in periods of low unemployment. For unemployment surprises, only the response of the 10-year yield is significantly different. For inflation, the responses when inflation is greater than 2½ percent are not statistically different from the responses when inflation is less than or equal to 2½ percent.[29]

Table 2

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES UNDER VARYING ECONOMIC CONDITIONS

	(1) 10-Year Treasury Yield	(2) Six-Month Federal Funds Futures Rate
Change in nonfarm payrolls		
when unemployment rate is above 5.25 percent	4.7***	4.6***
	(0.67)	(0.60)
when unemployment rate is 5.25 percent or below	2.7***	3.2***
	(0.62)	(0.60)
Unemployment rate		
when above 5.25 percent	-0.3	-1.0**
	(0.58)	(0.47)
when 5.25 percent or below	-2.3***	-2.1***
	(0.66)	(0.68)
Core CPI inflation		
when above 2.5 percent annualized	1.7***	1.1**
	(0.51)	(0.49)
when 2.5 percent or less, annualized	1.4**	1.2***
	(0.66)	(0.41)
F-test of equality of change in nonfarm payrolls coefficients	*4.9***	*2.8**
p-value	*0.03*	*0.09*
F-test of equality of unemployment rate coefficients	*5.6***	*1.9*
p-value	*0.02*	*0.16*
F-test of equality of core CPI inflation coefficients	*0.2*	*0.0*
p-value	*0.67*	*0.87*
R-square	0.10	0.13
RMSE	6.40	4.90
Observations	3,164	2,569

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The 10-year Treasury yield sample includes August 11, 1987, through August 27, 2013. The six-month federal funds futures rate sample includes January 1, 1994, through August 27, 2013. The regression model is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{3} \beta_i^1 Surprise_{i,t}^1 + \sum_{i=1}^{3} \beta_i^2 Surprise_{i,t}^2 + \sum_{i=4}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators, $Surprise_{i,t}^1$ represents surprises when the unemployment rate is above 5.25 percent or when core CPI inflation is above 2.5 percent annualized, and $Surprise_{i,t}^2$ represents surprises when the unemployment rate is 5.25 percent or below or core CPI inflation is 2.5 percent or less, annualized. Rejecting $\beta_i^1 = \beta_i^2$ implies there is a statistically significant difference for varying economic conditions. Full results are given in Appendix Table A2.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Changes in market perceptions across policy regimes

Other possible reasons for a change in the financial market's response to economic news might include a change in Federal Reserve leadership, such as from Chairman Greenspan to Chairman Bernanke; a prolonged period in which the policy rate falls to, and is constrained by, its effective zero lower bound; or a movement away from a systematic, rule-based approach to policy to a more discretionary, ad hoc

regime. Such changes could be associated with changes in views about the relative importance of inflation and employment in the Federal Reserve's mandate, or perceived constraints on policymakers' ability to respond to economic news, or some combination of both.

Table 3 identifies the dates of possible regime shifts, along with the associated variability of economic news surprises. The Greenspan and Bernanke periods are defined by the respective terms of the chairmen, and the pre-zero lower bound period consists of Greenspan's entire term plus the part of Bernanke's term prior to the federal funds rate target falling to the range of zero to 25 basis points in December 2008.

The last sample split is based on the view that policy was "rule based" or systematically and predictably related to economic conditions from the beginning of the Greenspan era to the end of 2000, and then became discretionary and less predictable. This view has been advanced by Stanford University economist John Taylor who argues that in 2003 policy deviated from the rule-based approach that had contributed to a period of relative macroeconomic stability in the late-1980s and 1990s. He further argues the adoption of a more discretionary policy contributed to a subsequent deterioration in financial and macroeconomic stability.

Nikolsko-Rzhevskyy, Papell, and Prodan statistically test this hypothesis and find that policy was rule based from the first quarter of 1985 to the fourth quarter of 2000 and discretionary from the first quarter of 2001 to the fourth quarter of 2008. Based on this study, the analysis here dates the rule based period from the beginning of the Greenspan chairmanship to December 31, 2000, and the discretionary period from January 1, 2001, to December 15, 2008, when the federal funds rate reached its effective lower bound.

Table 3 shows the variability of economic news surprises across policy regimes. In particular, it shows the standard deviation of surprises in announcements about nonfarm payroll employment, the unemployment rate, and core CPI inflation. Across the various regimes, the Bernanke period and the zero lower bound period stand out with the lowest volatility in nonfarm payroll surprises and the highest volatility in unemployment rate surprises. Of course, these two periods overlap, with the zero lower bound period comprising most of the Bernanke period. The discretionary policy period—which has less overlap with

Table 3

STANDARD DEVIATION OF SURPRISES IN ECONOMIC NEWS ANNOUNCEMENTS

	(1) Change in Nonfarm Payrolls (Thousands)	(2) Unemployment Rate (Percentage Point)	(3) Core CPI Inflation (Percentage Point)
Entire sample (August 11, 1987 – August 27, 2013)	102.90	0.153	0.111
Greenspan period (August 11, 1987 – January 31, 2006)	115.13	0.145	0.118
Bernanke period (February 1, 2006 – August 27, 2013)	64.73	0.170	0.094
Pre-zero lower bound period (August 11, 1987 – December 15, 2008)	109.05	0.148	0.116
Zero lower bound period (December 16, 2008 – August 27, 2013)	68.41	0.175	0.088
"Rule-based" policy period (August 11, 1987 – December 31, 2000)	121.62	0.146	0.125
"Discretionary" policy period (January 1, 2001 – December 15, 2008)	82.36	0.152	0.101

Sources: Informa Global Markets, Haver Analytics, and authors' calculations.

either the Bernanke or zero lower bound periods—also has relatively low volatility in employment surprises. Similar to nonfarm payroll surprises, volatility in the core CPI inflation surprise is lowest in the Bernanke and zero lower bound periods.

Greenspan versus Bernanke. The Greenspan and Bernanke periods are similar in the way financial markets responded to economic news, suggesting private-sector perceptions of Federal Reserve policy objectives were similar in the two periods. The top panel of Table 4 shows separately for the Greenspan and Bernanke periods the response of the 10-year Treasury yield and six-month federal funds futures rate to unanticipated news about payroll employment, unemployment, and core CPI inflation. The coefficient on the change in nonfarm employment in the 10-year regression is higher in the Bernanke period than the Greenspan period, while the coefficient on core CPI inflation is lower. The coefficient on unemployment is similar and statistically insignificant in both periods.

The response of the six-month federal funds futures rate is more muted for all variables in the Bernanke period than in the Greenspan period. This diminished response of federal funds futures to economic news in the Bernanke period likely reflects the effect of the FOMC's

Table 4

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE GREENSPAN AND BERNANKE PERIODS

A. Estimating Over the Greenspan and Bernanke Periods

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Greenspan Period	(2) Bernanke Period	(3) Greenspan Period	(4) Bernanke Period
Change in nonfarm payrolls	4.0***	5.0***	4.1***	3.0***
	(0.55)	(1.52)	(0.49)	(1.05)
Unemployment rate	-0.8	-1.0	-2.0***	-0.5
	(0.61)	(0.69)	(0.65)	(0.37)
Core CPI inflation	1.9***	0.7	1.4***	1.0*
	(0.41)	(1.14)	(0.39)	(0.54)
R-square	0.12	0.09	0.16	0.07
RMSE	6.23	6.74	5.43	3.76
Observations	2,187	977	1,592	977

B. Testing for Statistical Differences

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Greenspan Period	(2) Bernanke Period Interaction Term	(3) Greenspan Period	(4) Bernanke Period Interaction Term
Change in nonfarm payrolls	4.0***	1.1	4.2***	-1.2
	(0.55)	(1.62)	(0.48)	(1.16)
Unemployment rate	-0.8	-0.1	-1.9***	1.4*
	(0.61)	(0.92)	(0.64)	(0.73)
Core CPI inflation	1.8***	-1.2	1.4***	-0.4
	(0.41)	(1.19)	(0.39)	(0.67)
R-square	0.10		0.14	
RME	6.40		4.89	
Observations	3,164		2,569	

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The Greenspan period includes August 11, 1987, through January 31, 2006, for the 10-year Treasury yield, and includes January 1, 1994, through January 31, 2006, for the six-month federal funds futures rate. The Bernanke period includes February 1, 2006, through August 27, 2013, for both market rates. The regression model in panel A is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. The regression model in panel B is given by:

$$\Delta rate_t = \alpha + \delta_0 Bernanke_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * Bernanke_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. Rejecting δ_i=0 implies there is a statistically significant difference between the two periods. Full results for the regressions shown in panels A and B are given in Appendix Tables A3 and A4, respectively.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

forward guidance that suggested the funds rate would likely remain at its effective lower bound for more than six months into the future.

Although the coefficients on news surprises differed to varying degrees across the Greenspan and Bernanke periods, the differences

were generally statistically insignificant. The bottom panel of Table 4 tests the hypothesis that the coefficients on news surprises are the same across the two periods. The test is based on a modified regression in which the surprise variable is interacted with a variable that equals 1 during the Bernanke period and zero otherwise. A statistically significant coefficient on this variable would lead to rejection of the hypothesis that the coefficient on the surprise variable was the same across the two regimes.

A key finding is that the difference in the response of the 10-year Treasury yield to surprises in the change in nonfarm payrolls from the Greenspan period to the Bernanke period is statistically insignificant. In fact, none of the coefficients on economic news surprises is statistically significantly different across the two periods except the coefficient on the unemployment rate surprise in the federal funds futures regression and, in that case, the difference is significant at only the 10 percent significance level. The conclusion is that the Greenspan and Bernanke periods are remarkably similar in the response of financial markets to economic news, suggesting market participants' perceptions of Federal Reserve objectives were likely stable over these two periods.[30]

Pre- versus post-zero lower bound. A similar exercise can be carried out for the periods before and after the federal funds rate reached its effective lower bound. Given the FOMC cannot lower the funds rate below zero, the response of market rates to weak economic news that would, in more normal times, lead to an easing of policy might in current circumstances be more muted. On the other hand, the FOMC's use of unconventional policies—in particular, its use of forward guidance—might still influence markets' expectations of the future path of the federal funds rate once economic conditions allowed for a liftoff from the zero lower bound. In general, evidence suggests long-term interest rates remained responsive to economic news even after the federal funds rate reached its effective lower bound.[31] This result is consistent with that of Swanson and Williams (2013) who conducted a similar study.

The top panel of Table 5 shows regression results for the pre- and post-zero lower bound periods. The coefficient on the change in nonfarm employment in the 10-year regression is actually higher in the zero lower bound period than in the earlier period. In contrast, the response of the 10-year rate to unemployment, which is statistically

Table 5

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE PRE-ZERO LOWER BOUND AND ZERO LOWER BOUND PERIODS

A. Estimating Over the Pre-Zero Lower Bound and Zero Lower Bound Periods

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Pre-Zero Lower Bound Period	(2) Zero Lower Bound Period	(3) Pre-Zero Lower Bound Period	(4) Zero Lower Bound Period
Change in nonfarm payrolls	3.9***	6.5***	4.2***	1.9*
	(0.55)	(1.32)	(0.49)	(1.02)
Unemployment rate	-1.1**	-0.2	-1.9***	0.3
	(0.55)	(0.94)	(0.54)	(0.30)
Core CPI inflation	2.0***	-1.9	1.4***	0.3
	(0.39)	(1.68)	(0.40)	(0.36)
R-square	0.11	0.11	0.14	0.15
RMSE	6.27	6.81	5.50	1.35
Observations	2,567	597	1,972	597

B. Testing for Statistical Differences

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Pre-Zero Lower Bound Period	(2) Zero Lower Bound Period Interaction Term	(3) Pre-Zero Lower Bound Period	(4) Zero Lower Bound Period Interaction Term
Change in nonfarm payrolls	3.8***	2.7*	4.2***	-2.3**
	(0.55)	(1.42)	(0.48)	(1.14)
Unemployment rate	-1.1**	1.0	-1.9***	2.1***
	(0.55)	(1.06)	(0.53)	(0.60)
Core CPI inflation	2.0***	-3.9**	1.4***	-1.2**
	(0.40)	(1.65)	(0.40)	(0.54)
R-square	0.11		0.14	
RMSE	6.37		4.88	
Observations	3,164		2,569	

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The pre-zero lower bound period includes August 11, 1987, through December 15, 2008, for the 10-year Treasury yield, and includes January 1, 1994, through December 15, 2008, for the six-month federal funds futures rate. The zero lower bound period includes December 16, 2008, through August 27, 2013, for both market rates. The regression model in panel A is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. The regression model in panel B is given by:

$$\Delta rate_t = \alpha + \delta_0 ZLB_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * ZLB_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. Rejecting $\delta_i=0$ implies there is a statistically significant difference between the two periods. Full results for the regressions shown in panels A and B are given in Appendix Tables A5 and A6, respectively.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

significant in the pre-zero lower bound period, is not statistically significant in the zero lower bound period. The response of the 10-year rate to inflation is positive and statistically significant in the pre-zero lower bound period but is insignificantly different from zero in the zero lower bound period, albeit with the "wrong" (negative) sign. Not surprisingly, the response of the six-month federal funds futures rate is more muted—and generally statistically insignificant—for all variables in the zero lower bound period. This diminished response again likely reflects the influence of the FOMC's forward guidance that suggested the funds rate would likely remain at its effective lower bound for more than six months into the future.

The bottom panel of Table 5 tests the hypothesis that the coefficients on news surprises are the same across the two periods. The results suggest the stronger response of the 10-year rate to the payroll employment report was statistically significant at the 10 percent level, perhaps indicating markets expected a stronger response of policy to employment surprises in the zero lower bound period. The difference in the response of the 10-year rate to inflation surprises in the zero lower bound period was also statistically significant, perhaps indicating markets expected a smaller response of policy to inflation surprises. Finally, the more muted response of the six-month federal funds futures rate to economic news in the zero lower bound period was statistically significant for both measures of labor market surprises and for the inflation surprise.

Rules versus discretion. The same approach can be used to examine the market's response to economic news in periods when policy was viewed as rule based versus when, according to some analysts, it was discretionary. A discretionary policy that was unpredictable might be associated with different responses of longer-term market rates to news about the economy. In such a policy regime, financial market participants would find it difficult to predict the policy response to an unanticipated change in economic conditions. As a result, markets might react cautiously to economic news. Alternatively, not knowing how policymakers respond to economic conditions might lead markets to overreact or react in the "wrong" direction.

Table 6 presents evidence that the market's reaction to economic news was similar in both the "rule based" and "discretionary" regimes. This result suggests markets perceived little fundamental change in the

Table 6

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN RULE-BASED AND DISCRETIONARY POLICY PERIODS

A. Estimating Over Rule-Based and Discretionary Policy Periods

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Rule-Based Policy Period	(2) Discretionary Policy Period	(3) Rule-Based Policy Period	(4) Discretionary Policy Period
Change in nonfarm payrolls	3.7***	4.5***	3.7***	5.2***
	(0.61)	(1.31)	(0.65)	(0.79)
Unemployment rate	-1.4*	-0.7	-1.7*	-2.3***
	(0.73)	(0.86)	(1.00)	(0.60)
Core CPI inflation	2.0***	2.3***	2.3***	1.1**
	(0.48)	(0.66)	(0.65)	(0.52)
R-square	0.13	0.12	0.15	0.16
RMSE	6.09	6.46	5.69	5.28
Observations	1,532	1,035	937	1,035

B. Testing for Statistical Differences

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Rule-Based Policy Period	(2) Discretionary Policy Period Interaction Term	(3) Rule-Based Policy Period	(4) Discretionary Policy Period Interaction Term
Change in nonfarm payrolls	3.7***	0.7	3.7***	1.5
	(0.60)	(1.44)	(0.65)	(1.02)
Unemployment rate	-1.3*	0.6	-1.7*	-0.6
	(0.73)	(1.11)	(0.98)	(1.13)
Core CPI inflation	2.0***	0.3	2.3***	-1.2
	(0.48)	(0.82)	(0.64)	(0.83)
R-square	0.12		0.15	
RMSE	6.25		5.49	
Observations	2,567		1,972	

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The rule-based policy period includes August 11, 1987, through December 31, 2000, for the 10-year Treasury yield, and includes January 1, 1994, through December 31, 2000, for the six-month federal funds futures rate. The discretionary policy period includes January 1, 2001, through December 15, 2008, for both market rates. The regression model in panel A is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. The regression model in panel B is given by:

$$\Delta rate_t = \alpha + \delta_0 Discretionary_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * Discretionary_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where *i* indexes the 13 economic indicators. Rejecting δ_i=0 implies there is a statistically significant difference between the two periods. Full results for the regressions shown in panels A and B are given in Appendix Tables A7 and A8, respectively.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

way policy was conducted over these two periods. The top panel of the table shows that in both the 10-year Treasury yield and the six-month federal funds futures rate regressions, the size of the coefficients on the economic news variables varied somewhat across the two periods. However, as shown in the bottom panel, the differences in the coefficients across the two periods were statistically insignificant. This evidence, though not definitive, is suggestive of no break in the perceived systematic response of monetary policy to economic conditions after 2000 as suggested by Nikolsko-Rzhevskyy and others.

IV. CONCLUSIONS

The Federal Reserve has a legislative mandate to promote maximum employment and stable prices. Over time, policymakers have interpreted this mandate in the context of economic conditions and their views about the relative importance of maximum employment and price stability. During the early Volcker years, in response to high and volatile inflation, policymakers emphasized the objective of achieving and maintaining price stability as a prerequisite for maximum employment. Later, during the Greenspan period, as further progress was made toward achieving the Federal Reserve's price stability mandate, policymakers focused on "maximum sustainable growth" as an objective of policy. Finally, in the aftermath of the financial crisis and Great Recession, policymakers in the Bernanke period reemphasized the duality of the mandate and the importance of achieving both price stability and maximum employment.

Despite varying interpretations of the mandate, market responses to news about the economy have remained remarkably stable over time, suggesting market participants perceive little change in the objectives of policy. The main driver of changing market responses appears to be changes in economic conditions. Periods of relatively high unemployment tend to be associated with a larger response of market interest rates to news about payroll employment. Periods of relatively low unemployment tend to be associated with similar responses of market rates to news about both employment and unemployment. In contrast, periods of high and low inflation appear not to lead to differing market interest rate responses.

The market's response to economic news has also been similar across potential changes in policy regime, suggesting relative stability in market perceptions of Federal Reserve objectives. For example, the responses of the 10-year Treasury yield and six-month federal funds futures rates to news surprises are similar across the terms of Greenspan and Bernanke as chairman. Surprisingly, the period since 2008 when the federal funds rate hit the zero lower bound has seen a somewhat *stronger* response of the 10-year rate to employment surprises, and a weaker response to inflation. The stronger employment response, however, may simply be explained by the high level of unemployment that has persisted over this period. Finally, no evidence is found that markets responded differently to economic news after 2000 when, according to some analysts, policy turned more discretionary.

APPENDIX

Table A1

SUMMARY STATISTICS OF ECONOMIC NEWS SURPRISES

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Change in nonfarm payrolls *Thousands, monthly*	312	-14.03	102.90	-328.0	408.0
Unemployment rate *Percent, monthly*	312	-0.04	0.153	-0.5	0.4
Core CPI inflation rate *Percent change, monthly*	289	0.00	0.111	-0.3	0.4
Advance real GDP growth rate *Annualized percent change, quarterly*	94	0.11	0.738	-1.4	1.7
Core PPI inflation rate *Percent change, monthly*	288	-0.03	0.247	-1.2	0.9
Total industry capacity utilization *Percent, monthly*	305	-0.01	0.358	-1.9	1.4
Retail sales excluding motor vehicles *Percent change, monthly*	289	-0.04	0.433	-1.8	1.4
Consumer confidence index *Index, monthly*	265	0.21	5.154	-13.0	13.3
Leading indicators index *Percent change, monthly*	312	0.01	0.211	-0.7	0.8
ISM manufacturing index *Index, monthly*	282	0.02	2.067	-6.1	7.4
New single-family home sales *Thousands (annualized rate), monthly*	303	4.91	58.49	-156.0	281.0
Advance new orders of durable goods *Percent change, monthly*	310	-0.06	2.767	-8.8	10.8
Initial unemployment claims *Thousands, weekly*	1,139	-0.13	19.11	-167.0	85.0

Note: Summary statistics are calculated over the period from August 11, 1987, to August 27, 2013.

Sources: Informa Global Markets, Haver Analytics, and authors' calculations.

Table A2

MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES UNDER VARYING ECONOMIC CONDITIONS

	(1) 10-Year Treasury Yield	(2) Six-Month Federal Funds Futures Rate
Change in nonfarm payrolls		
when unemployment rate is above 5.25 percent	4.7***	4.6***
	(0.67)	(0.60)
when unemployment rate is 5.25 percent or below	2.7***	3.2***
	(0.62)	(0.60)
Unemployment rate		
when above 5.25 percent	-0.3	-1.0**
	(0.58)	(0.47)
when 5.25 percent or below	-2.3***	-2.1***
	(0.66)	(0.68)
Core CPI inflation		
when above 2.5 percent annualized	1.7***	1.1**
	(0.51)	(0.49)
when 2.5 percent or less, annualized	1.4**	1.2***
	(0.66)	(0.41)
Advance GDP	0.6	0.8*
	(0.72)	(0.44)
Core PPI inflation	1.1***	0.4
	(0.31)	(0.27)
Capacity utilization	0.9**	1.3***
	(0.45)	(0.50)
Retail sales excluding motor vehicles	1.9***	1.1***
	(0.38)	(0.30)
Consumer confidence	1.4***	0.8***
	(0.41)	(0.29)
Leading indicators index	0.4	0.0
	(0.36)	(0.25)
ISM manufacturing	3.0***	2.4***
	(0.38)	(0.54)
New home sales	1.0***	0.7***
	(0.32)	(0.28)
Durable goods orders	1.3***	0.5
	(0.42)	(0.32)
Initial unemployment claims	-1.2***	-0.7***
	(0.19)	(0.14)
Tuesday	-0.7	-2.0***
	(0.49)	(0.55)
Wednesday	-0.6	-2.3***
	(0.51)	(0.54)
Thursday	-0.3	-2.4***
	(0.46)	(0.51)
Friday	-0.5	-2.3***
	(0.51)	(0.56)
Constant	0.3	2.2***
	(0.42)	(0.50)

Table A2 Continued

	(1) 10-Year Treasury Yield	(2) Six-Month Federal Funds Futures Rate
F-test of equality of change in nonfarm payrolls coefficients	*4.9***	*2.8**
p-value	*0.03*	*0.09*
F-test of equality of unemployment rate coefficients	*5.6***	*1.9*
p-value	*0.02*	*0.16*
F-test of equality of core CPI inflation coefficients	*0.2*	*0.0*
p-value	*0.67*	*0.87*
R-square	0.10	0.13
RMSE	6.40	4.90
Observations	3,164	2,569

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The 10-year Treasury yield sample includes August 11, 1987, through August 27, 2013. The six-month federal funds futures rate sample includes January 1, 1994, through August 27, 2013. The regression model is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{3} \beta_i^1 Surprise_{i,t}^1 + \sum_{i=1}^{3} \beta_i^2 Surprise_{i,t}^2 + \sum_{i=4}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators, $Surprise_{i,t}^1$ represents surprises when the unemployment rate is above 5.25 percent or when core CPI inflation is above 2.5 percent annualized, and $Surprise_{i,t}^2$ represents surprises when the unemployment rate is 5.25 percent or below or core CPI inflation is 2.5 percent or less, annualized. Rejecting $\beta_i^1 = \beta_i^2$ implies there is a statistically significant difference for varying economic conditions.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A3

ESTIMATING MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE GREENSPAN AND BERNANKE PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Greenspan Period	(2) Bernanke Period	(3) Greenspan Period	(4) Bernanke Period
Change in nonfarm payrolls	4.0***	5.0***	4.1***	3.0***
	(0.55)	(1.52)	(0.49)	(1.05)
Unemployment rate	-0.8	-1.0	-2.0***	-0.5
	(0.61)	(0.69)	(0.65)	(0.37)
Core CPI inflation	1.9***	0.7	1.4***	1.0*
	(0.41)	(1.14)	(0.39)	(0.54)
Advance GDP	0.8	-0.1	0.6	1.6*
	(0.81)	(1.42)	(0.50)	(0.89)
Core PPI inflation	0.9**	1.4***	0.5	0.3
	(0.37)	(0.55)	(0.35)	(0.39)
Capacity utilization	1.4***	0.3	1.6***	1.0
	(0.45)	(0.80)	(0.50)	(0.71)
Retail sales excluding motor vehicles	1.5***	2.2***	1.7***	0.6**
	(0.54)	(0.51)	(0.53)	(0.28)
Consumer confidence	1.9***	0.6	1.1**	0.4
	(0.47)	(0.75)	(0.46)	(0.26)
Leading indicators index	0.2	0.8	0.3	0.0
	(0.40)	(0.60)	(0.59)	(0.19)
ISM manufacturing	3.3***	2.4***	3.1***	1.0*
	(0.48)	(0.66)	(0.78)	(0.55)
New home sales	1.2***	0.5	0.6*	0.8*
	(0.36)	(0.77)	(0.34)	(0.45)
Durable goods orders	1.3***	1.2	0.4	0.5
	(0.49)	(0.74)	(0.42)	(0.39)
Initial unemployment claims	-1.0***	-1.8***	-0.7***	-0.6***
	(0.22)	(0.36)	(0.19)	(0.18)
Tuesday	-1.5***	1.1	-3.5***	0.0
	(0.56)	(0.92)	(0.80)	(0.60)
Wednesday	-1.9***	2.2**	-3.8***	-0.1
	(0.58)	(0.97)	(0.80)	(0.57)
Thursday	-1.2**	1.8**	-4.1***	0.0
	(0.54)	(0.84)	(0.76)	(0.54)
Friday	-1.3**	1.5*	-4.0***	0.1
	(0.60)	(0.90)	(0.83)	(0.57)
Constant	1.1**	-1.4*	3.9***	-0.2
	(0.49)	(0.76)	(0.73)	(0.51)

Table A3 Continued

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Greenspan Period	(2) Bernanke Period	(3) Greenspan Period	(4) Bernanke Period
R-square	0.12	0.09	0.16	0.07
RMSE	6.23	6.74	5.43	3.76
Observations	2,187	977	1,592	977

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The Greenspan period includes August 11, 1987, through January 31, 2006, for the 10-year Treasury yield, and includes January 1, 1994, through January 31, 2006, for the six-month federal funds futures rate. The Bernanke period includes February 1, 2006, through August 27, 2013, for both market rates. The regression model is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A4

TESTING FOR DIFFERENCES IN MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE GREENSPAN AND BERNANKE PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Greenspan Period	(2) Bernanke Period Interaction Term	(3) Greenspan Period	(4) Bernanke Period Interaction Term
Change in nonfarm payrolls	4.0***	1.1	4.2***	-1.2
	(0.55)	(1.62)	(0.48)	(1.16)
Unemployment rate	-0.8	-0.1	-1.9***	1.4*
	(0.61)	(0.92)	(0.64)	(0.73)
Core CPI inflation	1.8***	-1.2	1.4***	-0.4
	(0.41)	(1.19)	(0.39)	(0.67)
Advance GDP	0.8	-0.9	0.6	1.1
	(0.82)	(1.67)	(0.50)	(1.02)
Core PPI inflation	0.9**	0.5	0.5	-0.2
	(0.37)	(0.66)	(0.35)	(0.53)
Capacity utilization	1.4***	-1.0	1.6***	-0.6
	(0.45)	(0.94)	(0.49)	(0.92)
Retail sales excluding motor vehicles	1.6***	0.7	1.7***	-1.1*
	(0.54)	(0.74)	(0.53)	(0.60)
Consumer confidence	1.9***	-1.3	1.1**	-0.7
	(0.47)	(0.88)	(0.46)	(0.53)
Leading indicators index	0.2	0.5	0.2	-0.3
	(0.41)	(0.73)	(0.58)	(0.61)
ISM manufacturing	3.3***	-1.1	3.3***	-2.3**
	(0.47)	(0.80)	(0.78)	(0.93)
New home sales	1.2***	-0.7	0.6*	0.2
	(0.36)	(0.86)	(0.34)	(0.55)
Durable goods orders	1.3***	-0.2	0.4	0.1
	(0.50)	(0.90)	(0.43)	(0.59)
Initial unemployment claims	-1.0***	-0.9**	-0.7***	0.1
	(0.22)	(0.42)	(0.19)	(0.26)
Constant	0.1	0.3	2.3***	-0.5***
	(0.43)	(0.26)	(0.51)	(0.18)
Tuesday		-0.6		-2.0***
		(0.49)		(0.55)
Wednesday		-0.5		-2.3***
		(0.51)		(0.54)
Thursday		-0.2		-2.4***
		(0.47)		(0.51)
Friday		-0.3		-2.3***
		(0.51)		(0.56)

Table A4 Continued

	10-Year Treasury Yield	Six-Month Federal Funds Futures Rate
R-square	0.10	0.14
RMSE	6.40	4.89
Observations	3,164	2,569

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The Greenspan period includes August 11, 1987, through January 31, 2006, for the 10-year Treasury yield, and includes January 1, 1994, through January 31, 2006, for the six-month federal funds futures rate. The Bernanke period includes February 1, 2006, through August 27, 2013, for both market rates. The regression model is given by:

$$\Delta rate_t = \alpha + \delta_0 Bernanke_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * Bernanke_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators. Rejecting $\delta_i=0$ implies there is a statistically significant difference between the two periods.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A5

ESTIMATING MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE PRE-ZERO LOWER BOUND AND ZERO LOWER BOUND PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Pre-Zero Lower Bound Period	(2) Zero Lower Bound Period	(3) Pre-Zero Lower Bound Period	(4) Zero Lower Bound Period
Change in nonfarm payrolls	3.9***	6.5***	4.2***	1.9*
	(0.55)	(1.32)	(0.49)	(1.02)
Unemployment rate	-1.1**	-0.2	-1.9***	0.3
	(0.55)	(0.94)	(0.54)	(0.30)
Core CPI inflation	2.0***	-1.9	1.4***	0.3
	(0.39)	(1.68)	(0.40)	(0.36)
Advance GDP	0.8	0.1	0.8*	0.7
	(0.80)	(1.50)	(0.51)	(0.51)
Core PPI inflation	0.9***	2.4***	0.5	0.1
	(0.33)	(0.91)	(0.32)	(0.12)
Capacity utilization	1.7***	-1.7***	1.8**	0.2**
	(0.47)	(0.59)	(0.74)	(0.11)
Retail sales excluding motor vehicles	1.8***	2.0***	1.6***	0.1
	(0.46)	(0.65)	(0.43)	(0.16)
Consumer confidence	1.5***	1.0	1.1***	0.0
	(0.50)	(0.70)	(0.40)	(0.07)
Leading indicators index	-0.1	1.7***	0.1	-0.1
	(0.39)	(0.64)	(0.40)	(0.09)
ISM manufacturing	3.2***	2.2**	3.0***	0.6**
	(0.42)	(0.93)	(0.69)	(0.28)
New home sales	1.2***	-0.1	0.8**	0.5**
	(0.34)	(1.48)	(0.30)	(0.18)
Durable goods orders	1.3***	0.8	0.6	-0.1
	(0.46)	(0.89)	(0.39)	(0.09)
Initial unemployment claims	-1.2***	-1.5***	-0.9***	0.0
	(0.22)	(0.40)	(0.18)	(0.06)
Tuesday	-0.8	0.0	-2.5***	-0.7**
	(0.53)	(1.18)	(0.71)	(0.29)
Wednesday	-1.1**	1.3	-2.9***	-0.6**
	(0.53)	(1.33)	(0.71)	(0.24)
Thursday	-0.5	0.6	-3.0***	-0.7***
	(0.51)	(1.07)	(0.67)	(0.23)
Friday	-0.5	0.1	-2.9***	-0.3
	(0.55)	(1.15)	(0.73)	(0.30)
Constant	0.4	-0.5	2.7***	0.6***
	(0.46)	(0.99)	(0.65)	(0.23)

Table A5 Continued

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Pre-Zero Lower Bound Period	(2) Zero Lower Bound Period	(3) Pre-Zero Lower Bound Period	(4) Zero Lower Bound Period
R-square	0.11	0.11	0.14	0.15
RMSE	6.27	6.81	5.50	1.35
Observations	2,567	597	1,972	597

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The pre-zero lower bound period includes August 11, 1987, through December 15, 2008, for the 10-year Treasury yield, and includes January 1, 1994, through December 15, 2008, for the six-month federal funds futures rate. The zero lower bound period includes December 16, 2008, through August 27, 2013, for both market rates. The regression model is given by:

$$\Delta rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A6

TESTING FOR DIFFERENCES IN MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN THE PRE-ZERO LOWER BOUND AND ZERO LOWER BOUND PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Pre-Zero Lower Bound Period	(2) Zero Lower Bound Period Interaction Term	(3) Pre-Zero Lower Bound Period	(4) Zero Lower Bound Period Interaction Term
Change in nonfarm payrolls	3.8***	2.7*	4.2***	-2.3**
	(0.55)	(1.42)	(0.48)	(1.14)
Unemployment rate	-1.1**	1.0	-1.9***	2.1***
	(0.55)	(1.06)	(0.53)	(0.60)
Core CPI inflation	2.0***	-3.9**	1.4***	-1.2**
	(0.40)	(1.65)	(0.40)	(0.54)
Advance GDP	0.8	-0.9	0.8	-0.1
	(0.80)	(1.72)	(0.51)	(0.75)
Core PPI inflation	0.9***	1.5	0.5	-0.4
	(0.33)	(0.93)	(0.31)	(0.33)
Capacity utilization	1.7***	-3.4***	1.8**	-1.5*
	(0.47)	(0.74)	(0.74)	(0.76)
Retail sales excluding motor vehicles	1.8***	0.1	1.6***	-1.5***
	(0.46)	(0.78)	(0.43)	(0.46)
Consumer confidence	1.5***	-0.5	1.1***	-1.1***
	(0.50)	(0.86)	(0.40)	(0.40)
Leading indicators index	-0.1	1.7**	0.1	-0.2
	(0.40)	(0.75)	(0.39)	(0.42)
ISM manufacturing	3.2***	-1.2	3.0***	-2.5***
	(0.42)	(1.02)	(0.69)	(0.74)
New home sales	1.2***	-1.6	0.8**	-0.4
	(0.34)	(1.48)	(0.30)	(0.38)
Durable goods orders	1.4***	-0.6	0.6	-0.7*
	(0.46)	(1.06)	(0.39)	(0.41)
Initial unemployment claims	-1.2***	-0.4	-0.9***	0.8***
	(0.22)	(0.46)	(0.18)	(0.19)
Constant	0.2	0.2	2.2***	0.0
	(0.42)	(0.31)	(0.51)	(0.14)
Tuesday		-0.6		-2.0***
		(0.48)		(0.55)
Wednesday		-0.6		-2.3***
		(0.50)		(0.54)
Thursday		-0.2		-2.4***
		(0.46)		(0.52)
Friday		-0.4		-2.3***
		(0.50)		(0.56)

Table A6 Continued

	10-Year Treasury Yield	Six-Month Federal Funds Futures Rate
R-square	0.11	0.14
RMSE	6.37	4.88
Observations	3,164	2,569

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The pre-zero lower bound period includes August 11, 1987, through December 15, 2008, for the 10-year Treasury yield, and includes January 1, 1994, through December 15, 2008, for the six-month federal funds futures rate. The zero lower bound period includes December 16, 2008, through August 27, 2013, for both market rates. The regression model is given by:

$$\Delta\, rate_t = \alpha + \delta_0 ZLB_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * ZLB_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators. Rejecting δ_i=0 implies there is a statistically significant difference between the two periods.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A7

ESTIMATING MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN RULE-BASED AND DISCRETIONARY POLICY PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Rule-Based Policy Period	(2) Discretionary Policy Period	(3) Rule-Based Policy Period	(4) Discretionary Policy Period
Change in nonfarm payrolls	3.7***	4.5***	3.7***	5.2***
	(0.61)	(1.31)	(0.65)	(0.79)
Unemployment rate	-1.4*	-0.7	-1.7*	-2.3***
	(0.73)	(0.86)	(1.00)	(0.60)
Core CPI inflation	2.0***	2.3***	2.3***	1.1**
	(0.48)	(0.66)	(0.65)	(0.52)
Advance GDP	-0.3	3.2***	-0.1	2.1***
	(1.02)	(1.22)	(0.75)	(0.75)
Core PPI inflation	0.9*	0.9**	0.4	0.6
	(0.51)	(0.43)	(0.62)	(0.36)
Capacity utilization	1.7***	1.7**	2.4***	1.5
	(0.56)	(0.74)	(0.81)	(0.97)
Retail sales excluding motor vehicles	1.3**	2.3***	2.8***	1.2***
	(0.63)	(0.63)	(1.06)	(0.45)
Consumer confidence	2.7***	0.6	1.2**	1.1**
	(0.53)	(0.81)	(0.55)	(0.55)
Leading indicators index	0.3	-0.5	0.4	0.0
	(0.54)	(0.55)	(1.73)	(0.34)
ISM manufacturing	3.2***	3.2***	2.8**	3.1***
	(0.53)	(0.62)	(1.24)	(0.83)
New home sales	2.1***	0.5	1.4**	0.5
	(0.44)	(0.46)	(0.58)	(0.32)
Durable goods orders	1.6***	1.0	0.9**	0.4
	(0.41)	(0.95)	(0.42)	(0.57)
Initial unemployment claims	-0.5	-1.7***	-0.4	-1.1***
	(0.29)	(0.32)	(0.28)	(0.24)
Tuesday	-2.0***	0.5	-4.1***	-1.5*
	(0.72)	(0.78)	(1.23)	(0.84)
Wednesday	-2.4***	0.8	-4.8***	-1.5*
	(0.73)	(0.78)	(1.22)	(0.86)
Thursday	-1.7**	0.9	-5.0***	-1.6**
	(0.70)	(0.70)	(1.19)	(0.78)
Friday	-1.8**	1.3*	-4.8***	-1.6*
	(0.76)	(0.78)	(1.30)	(0.82)
Constant	1.4**	-0.6	4.7***	1.4*
	(0.65)	(0.62)	(1.16)	(0.73)

Table A7 Continued

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Rule-Based Policy Period	(2) Discretionary Policy Period	(3) Rule-Based Policy Period	(4) Discretionary Policy Period
R-square	0.13	0.12	0.15	0.16
RMSE	6.09	6.46	5.69	5.28
Obervations	1,532	1,035	937	1,035

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The rule-based policy period includes August 11, 1987, through December 31, 2000, for the 10-year Treasury yield, and includes January 1, 1994, through December 31, 2000, for the six-month federal funds futures rate. The discretionary policy period includes January 1, 2001, through December 15, 2008, for both market rates. The regression model is given by:

$$\Delta\, rate_t = \alpha + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

Table A8

TESTING FOR DIFFERENCES IN MARKETS' RESPONSES TO ECONOMIC NEWS SURPRISES IN RULE-BASED AND DISCRETIONARY POLICY PERIODS

	10-Year Treasury Yield		Six-Month Federal Funds Futures Rate	
	(1) Rule-Based Policy Period	(2) Discretionary Policy Period Interaction Term	(3) Rule-Based Policy Period	(4) Discretionary Policy Period Interaction Term
Change in nonfarm payrolls	3.7***	0.7	3.7***	1.5
	(0.60)	(1.44)	(0.65)	(1.02)
Unemployment rate	-1.3*	0.6	-1.7*	-0.6
	(0.73)	(1.11)	(0.98)	(1.13)
Core CPI inflation	2.0***	0.3	2.3***	-1.2
	(0.48)	(0.82)	(0.64)	(0.83)
Advance GDP	-0.4	3.5**	-0.1	2.2**
	(1.02)	(1.58)	(0.73)	(1.05)
Core PPI inflation	0.9*	0.0	0.4	0.1
	(0.51)	(0.66)	(0.61)	(0.71)
Capacity utilization	1.7***	0.1	2.4***	-0.9
	(0.56)	(0.96)	(0.79)	(1.29)
Retail sales excluding motor vehicles	1.3**	0.9	2.8***	-1.6
	(0.63)	(0.89)	(1.07)	(1.16)
Consumer confidence	2.7***	-2.1**	1.2**	-0.1
	(0.52)	(0.96)	(0.54)	(0.78)
Leading indicators index	0.3	-0.7	0.5	-0.5
	(0.54)	(0.77)	(1.74)	(1.77)
ISM manufacturing	3.3***	-0.2	2.9**	0.2
	(0.53)	(0.81)	(1.25)	(1.49)
New home sales	2.1***	-1.6**	1.5***	-1.1
	(0.44)	(0.63)	(0.56)	(0.65)
Durable goods orders	1.6***	-0.6	0.9**	-0.5
	(0.42)	(1.03)	(0.42)	(0.70)
Initial unemployment claims	-0.5	-1.2***	-0.4	-0.7*
	(0.29)	(0.43)	(0.28)	(0.37)
Constant	0.1	0.6**	2.9***	-0.4
	(0.48)	(0.26)	(0.68)	(0.25)
Tuesday		-0.8		-2.5***
		(0.53)		(0.71)
Wednesday		-1.0*		-2.9***
		(0.54)		(0.71)
Thursday		-0.4		-3.0***
		(0.51)		(0.67)
Friday		-0.4		-2.8***
		(0.55)		(0.73)

Table A8 Continued

	10-Year Treasury Yield	Six-Month Federal Funds Futures Rate
R-square	0.12	0.15
RMSE	6.25	5.49
Observations	2,567	1,972

* Significant at 10 percent level
** Significant at 5 percent level
*** Significant at 1 percent level

Notes: Robust standard errors are given in parentheses. The sample includes only dates on which a data release for an included economic indicator occurred. The rule-based policy period includes August 11, 1987, through December 31, 2000, for the 10-year Treasury yield, and includes January 1, 1994, through December 31, 2000, for the six-month federal funds futures rate. The discretionary policy period includes January 1, 2001, through December 15, 2008, for both market rates. The regression model is given by:

$$\Delta rate_t = \alpha + \delta_0 Discretionary_t + \sum_{i=1}^{13} \beta_i Surprise_{i,t} + \sum_{i=1}^{13} \delta_i Surprise_{i,t} * Discretionary_t + \gamma_1 Tuesday_t + \gamma_2 Wednesday_t + \gamma_3 Thursday_t + \gamma_4 Friday_t + \varepsilon_t,$$

where i indexes the 13 economic indicators. Rejecting δ_i=0 implies there is a statistically significant difference between the two periods.

Sources: Bloomberg, Federal Reserve Board, Informa Global Markets, Haver Analytics, and authors' calculations.

ENDNOTES

[1]See Judd and Rudebusch for a discussion of the evolution of the Federal Reserve's legal mandate and its interpretation.

[2]The Act further specified that, once the 3 percent inflation objective had been achieved, the president should set forth in the *Economic Report of the President* a goal of achieving by 1988 a zero percent rate of inflation, provided it not impede the goal for reducing unemployment.

[3]The Act also established the requirement that the Federal Reserve report semiannually to Congress on recent economic developments and on "objectives and plans of the Board of Governors and the Federal Open Market Committee with respect to the ranges for growth or diminution of the monetary and credit aggregates" (U.S. Congress, 1978). However, the reporting requirements of the Act expired on May 15, 2000, under the terms of the Federal Reports Elimination and Sunset Act passed by Congress in 1995. In December 2000, public law 106-569, Section 1003, replaced the reporting requirements from the Humphrey-Hawkins Act with a new requirement that the Federal Reserve chairman report semiannually before Congress on the "efforts, activities, objectives and plans of the Board and the Federal Open Market Committee with respect to the conduct of monetary policy" and on "economic developments and prospects for the future" (as cited in Lindsey). In addition, the Board was required to submit a written report concurrent with the chairman's testimony. Importantly, the requirement that the Board report target ranges for money and credit growth was eliminated. See Lindsey for additional information.

[4]Volcker introduced a nonborrowed reserves operating target, allowing short-term interest rates to rise sharply. In 1982, the FOMC returned to a focus on the overnight federal funds rate as the instrument of policy.

[5]See Kahn (1996) for a summary of views from the mid-1990s about how best to define price stability.

[6]The estimate was based on the FOMC's Summary of Economic Projections made in December 2013.

[7]At its December 2013 meeting, the Committee began to reduce its monthly asset purchases "In light of the cumulative progress toward maximum employment and the improvement in the outlook for labor market conditions" (Federal Open Market Committee, 2013).

[8] At its March 2014 meeting, with unemployment at 6.7 percent, the Committee adjusted its forward guidance away from an unemployment rate threshold and again toward qualitative guidance.

[9]In a more general setting in which the loss function is specified as the discounted sum of current and future quadratic losses, the discount factor could also be viewed as a choice parameter of the central bank.

[10]In some countries, the inflation target is set by the government.

[11]See Kahn (2012) for a description of the discussion at FOMC meetings during this period about opportunistic disinflation.

[12]This discussion of the opportunistic loss function is based on Aksoy, Orphanides, Small, Wieland, and Wilcox.

[13]Another possibility might be a loss function incorporating "lexicographic" preferences, in which the central bank focuses on one goal—say, price stability—as its primary objective and seeks to achieve a secondary objective—say, maximum employment—only after achieving the primary goal. The primary and secondary goals might shift over time depending on economic circumstances. See Driffill and Rotondi for a discussion of monetary policy with lexicographic preferences in which the primary goal is price stability and the secondary goal is output stability.

[14]Other factors such as changes in the underlying structure of the economy could lead to different policy responses to economic news, given an unchanged loss function. For example, if market participants have become more convinced of the Federal Reserve's commitment to long-run price stability, making long-term inflation expectations more stable, policymakers may have greater scope to respond to shocks to employment than otherwise. Alternatively, changes in the Federal Reserve's estimate of "maximum employment" could lead to different policy responses to economic news with no change in the Federal Reserve's weighting of its underlying policy objectives. For example, a decrease in the estimate of maximum employment might lead to a more muted response to an increase in unemployment than might otherwise be warranted. In addition, how policy is implemented, given a particular loss function, may depend on whether policymakers act systematically, according to a prescribed rule, or act period by period.

[15]This discussion draws on Kahn (2007).

[16]A term premium is the extra compensation required for an investor to purchase a long-term security rather than a series of short-term securities.

[17]This analysis assumes term premiums remain unchanged. See Sellon for an extended discussion of the relationship between the policy path and the term structure of interest rates.

[18]More formally, the efficient markets hypothesis says that asset prices reflect all current, publicly available information and respond quickly to new public information.

[19]The analysis assumes that the term premium remains fixed. In addition, the response of longer-term interest rates to unemployment surprises may reflect the market's perception that a decline in unemployment will lead to a future increase in inflation that, in turn, will lead the Federal Reserve to increase the path of the federal funds rate. In this case, the reaction of market rates to labor market surprises may be more about expectations of a preemptive response to rising inflationary expectations than a concern about labor market conditions per se. However, provided the relationship between current labor market conditions and future inflation

remains stable, *changes* over time in the response of longer-term interest rates to labor market surprises may still reflect changes in the relative weight of inflation and employment in the central bank's loss function, although disentangling these effects would be difficult. Alternatively, changes in the response of longer-term interest rates to economic news may reflect changes in the market's perception of the Federal Reserve's estimate of the full-employment unemployment rate. For example, an adverse unemployment surprise could lead markets to conclude that the Federal Reserve will revise up its estimate of the full-employment unemployment rate and therefore will become less accommodative.

[20]Data on the surprise component of economic releases are limited for the Volcker period. As a result, the analysis in the text focuses only on the Greenspan and Bernanke periods.

[21]Similarly, Swanson and Williams (2013); and Gürkaynak, Sack, and Swanson analyze the one-day change in various Treasury rates in response to economic news surprises. Other studies, including Andersen, Bollerslev, Diebold, and Vega (2003); Balduzzi, Elton, and Green; and Goldberg and Grisse, use high-frequency data to study market responses over a short time frame around economic news announcements.

[22]MMS merged with MCM, an Informa subsidiary, to become Informa Global Markets in 2003. The MMS survey data were obtained through Haver Analytics. Previous studies using the MMS forecasts include Andersen and others (2003); Balduzzi and others; and Gürkaynak and others. More recent studies by Swanson and Williams (2013), and Goldberg and Grisse supplement MMS forecasts with additional consensus forecasts such as those from Bloomberg L.P. and Action Economics.

[23]Previous studies, including Andersen and others (2003); Balduzzi and others; and Swanson and Williams (2013) have tested that MMS median forecasts exhibit desirable properties when used as a measure of market expectations. Similar tests were conducted for the median forecasts of the 13 economic indicators included in this analysis over the sample period from August 11, 1987, to August 27, 2013. These median forecasts were generally unbiased, contained relevant and up-to-date information, and resulted in better predictions of realized observations, as indicated by lower root mean square errors, than autoregressive models incorporating the optimal number of lags chosen by the Schwarz criterion.

[24]The standard deviation used to standardize the unanticipated components of various economic indicators was calculated from August 11, 1987, to August 27, 2013, for analysis using the 10-year Treasury yield and from January 1, 1994, to August 27, 2013, for analysis using the six-month federal funds futures rate. The conclusions drawn from the analysis of the six-month federal funds futures rate are generally robust to using the standard deviation from 1987 to 2013 to calculate the standardized surprises.

[25]Including all weekdays in the sample does not substantially alter the results.

[26]The results for the 10-year Treasury yield are largely consistent with those in Swanson and Williams (2013).

[27]Although the data are measured in "real time," the unemployment rate is not substantially revised.

[28]Results are similar when the response of the 10-year Treasury yield to employment surprises is estimated over three partitions of the real-time unemployment rate. The response is strongest when the unemployment rate is above 7 percent, weakest when the unemployment rate is below 5 percent, and "in between" when the unemployment rate ranges from 5 percent to 7 percent.

[29]Other economic conditions that could affect the response of longer-term interest rates to economic news were also considered. For example, the response of the 10-year Treasury yield to nonfarm payroll surprises was stronger when the surprise was to the upside than to the downside. The difference was statistically significant at the 1 percent level. In contrast, the response to inflation surprises was similar whether the surprise was to the upside or downside. Others have also examined variations in the response of market rates to economic news announcements over time and across various economic circumstances. Goldberg and Grisse find the effect of news varies with the level of policy rates and risk conditions. For example, the response of rates to good news is muted when risk is elevated. Goldberg and Grisse also survey previous research on the causes of time variation. They report that some studies—including Andersen and others (2003 and 2007); Ehrmann and Fratzsher; and Hautsch and Hess—find that positive surprises have smaller absolute effects than negative surprises (in contrast to the result reported above). Swanson and Williams (2013 and forthcoming) and Kiley examine the effects of hitting the zero lower bound. Andersen and others (2007) find the effect of news announcements is larger during economic contractions. Goldberg and Klein find that in Europe the introduction of the euro changed the market response to news announcements in a way that suggests the ECB had established inflation-fighting credibility. Consistent with the results reported here, Faust and others find little evidence of variation over time in the response of interest rates or exchange rates to unexpected news about a variety of real and nominal economic indicators.

[30]The Volcker period can also be compared with the other regimes, although the set of economic indicators for which market expectations are available is more limited. In particular, data on market expectations of changes in payroll employment and the core CPI inflation rate are not available. However, data on market expectations of headline CPI inflation and unemployment are available. In regressions of the change in the 10-year Treasury yield on the available set of indicators—including the unemployment rate, the CPI inflation rate, industrial production, the change in the index of leading indicators, and durable goods orders—the coefficients on the unanticipated change in each variable were similar across the Volcker and Greenspan periods. While the response of the 10-year Treasury yield to both an unemployment surprise and an inflation surprise was somewhat stronger

in the Volcker period than the Greenspan period, the difference was statistically insignificant.

[31]Similar results were obtained for the period after the introduction of forward guidance based on thresholds for unemployment. The response of the 10-year Treasury yield to nonfarm payroll surprises is actually stronger after the introduction of thresholds, while the response to core inflation surprises is roughly the same but statistically insignificant. Moreover, the differences in the response coefficients across the two periods are statistically insignificant.

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