Has the U.S. Economy Become Less Interest Rate Sensitive?

By Jonathan L. Willis and Guangye Cao

Over the past three decades, the U.S. economy seems to have become less responsive to monetary policy. Slow recoveries followed recessions in 1990-91, 2001, and 2007-09, a contrast to the much more rapid recoveries that followed pre-1990 recessions. These slow recoveries occurred despite sizeable monetary accommodation from the Federal Reserve, primarily through reductions in short-term interest rates.

This article investigates shifts in the economy's interest sensitivity by examining how total employment responds to changes in monetary policy. The Federal Open Market Committee (FOMC) has emphasized the important link between monetary policy and employment. For example, in September 2012, the FOMC announced its intention to provide additional monetary policy accommodation on an open-ended basis that would continue as long as "the outlook for the labor market does not improve substantially." While this implies a direct transmission channel between monetary policy and employment, the empirical analysis in this article suggests aggregate employment has become less responsive to monetary policy in recent decades.

The responsiveness of employment to monetary policy could have diminished for three reasons. First, the shift could be a result of changing behavior of monetary policy makers. Numerous researchers have

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characterized monetary policy in the past three decades as following an active (systematic) approach compared with the passive approach of the 1960s and 1970s (Clarida, Gali, and Gertler). Second, the shift could be due to innovations in financial markets and changes in governmental regulation of the banking industry. Monetary policy works by influencing market interest rates. Studies have suggested that developments in financial markets have weakened the relationship between interest rates and firm and consumer activities (Dynan, Elmerndorf, and Sichel). Third, the shift could be due to changes within and across industries. For example, changes in the relative sizes of industries may affect the overall interest sensitivity of the economy as interest-sensitive sectors, such as durable goods manufacturing and construction, have contracted, and less interest-sensitive sectors, such as the private service-providing sector, have expanded. Supply-side structural shifts occurring within individual industries over the past several decades, including changes in technology and capital intensity, may also affect interest sensitivity. And on the demand side, each industry's customers may now respond differently to changes in monetary policy.

This article finds that the key contributors to declining interest sensitivity are structural shifts within industries and a weaker transmission mechanism between short-term interest rates and the economy. In particular, two segments of the transmission channel appear to have operated with a longer lag since the mid-1980s: the transmission from shorter-term to longer-term rates and the transmission from longer-term rates to employment. Overall, the findings suggest the decline in the economy's interest sensitivity is not due to changes in the conduct of monetary policy but rather to structural changes in industries and financial markets.

Section I describes the interest rate channel of monetary transmission and the vector autoregression (VAR) model used to evaluate interest sensitivity. Section II assesses whether the declining interest sensitivity is specific to certain industries or more widespread. Section III uses the VAR and a structural model to examine the three possible sources of declining interest sensitivity.

I. The Declining Interest Rate Sensitivity of Employment

Monetary policy can affect the economy through several channels. The most frequently mentioned channel, or transmission mechanism, is the interest rate channel. In this channel, an increase in monetary accommodation such as a cut in the target federal funds rate leads to a decline in real interest rates if prices are slow to adjust.[1] Lower interest rates increase spending in interest-sensitive sectors. Next, the increase in interest-sensitive spending increases aggregate demand and ultimately output. Finally, to produce more output, firms increase employment.

While the interest rate channel is easy to describe, its recent effectiveness is hard to confirm. Monetary policy accommodation following the three most recent recessions did not produce the robust economic recoveries of the 1970s and 1980s. Furthermore, when the FOMC tightened monetary policy in 2004, the interest rate transmission channel appeared broken. In a speech in February 2005, the Federal Reserve's then-Chairman Alan Greenspan called the decline in long-term interest rates in the face of steady increases in the federal funds rate a "conundrum."

Evidence suggests the interest sensitivity of the U.S. economy has declined over the past 50 years. The challenge, however, is disentangling the interest rate channel of monetary policy from other factors affecting economic activity, such as changes in technology and the behavior of consumers and businesses. This section introduces a statistical model relating the federal funds rate to employment to identify shifts in the interest rate channel of monetary policy.

A statistical model of the interest rate channel of monetary policy

The statistical model consists of four economic variables. The first two—the federal funds rate and total nonfarm payroll employment—are included to capture the transmission of monetary policy to employment. The third variable is the Chicago Fed National Activity Index (CFNAI), which is included to capture movements in the economy associated with the business cycle. The fourth variable is the price index for personal consumption expenditures excluding food and energy, which captures movements in inflation. By including a nominal interest

rate and a price index, the model implicitly incorporates a real interest rate, a key element of the interest rate channel.

The framework for the analysis is a VAR with a sample period of January 1960 to December 2007. Data from the post-2007 period are excluded because the federal funds rate has been constrained at the zero lower bound during this period.[2] Following Christiano, Eichenbaum, and Evans, the VAR includes 12 lags of each variable.[3] The estimates are computed using ordinary least squares, and 90 percent confidence intervals are computed using Bayesian methods (Sims and Zha). A detailed description of the model is provided in Appendix A.

The interest rate channel of monetary policy is identified through an assumption on the timing by which the four variables interact with one another. Independent changes, or shocks, to the federal funds rate are assumed to have no effect on the other three variables in the first month in which they occur—instead, they affect the other variables with a lag. This assumption follows Milton Friedman's famous dictum that monetary policy operates on the economy with "long and variable lags."

Evidence of changes in the interest rate channel of monetary policy

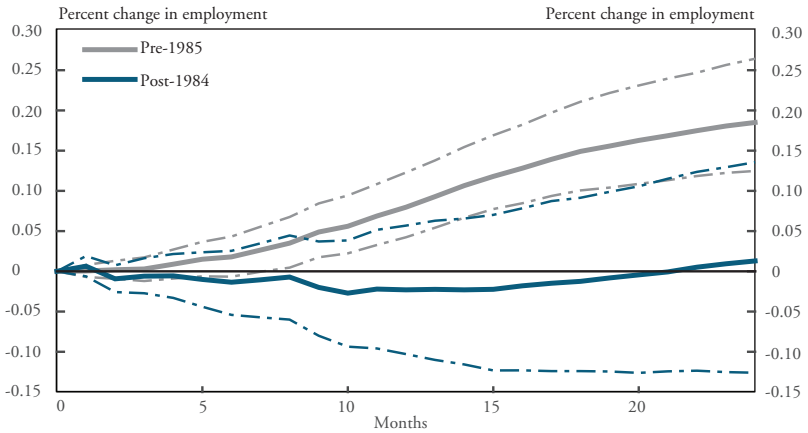
The statistical model shows the response of employment to a specific change in the federal funds rate over time. While the timing assumption precludes an employment response in the first month, the employment response in subsequent months captures the dynamic interactions among the model's four variables stemming from the initial shift in interest rates. All other possible shocks to the model are eliminated to focus solely on the interest rate channel of monetary policy.

To determine whether the interest rate channel of policy has diminished over time, the analysis is split into two subsamples. The first subsample is the pre-1985 period (from January 1960 to December 1984), and the second subsample is the post-1984 period (from January 1985 to December 2007).[4] The selection of these subsamples is similar to Boivin and Giannoni, who found the behavior of monetary policy makers changed in the early to mid-1980s.

The estimated responses of employment to changes in the federal funds rate indicate aggregate employment has become less interest-sensitive in recent decades (Chart 1). In the pre-1985 period, an unexpected 25 basis point cut in the federal funds rate led to a steady increase in employment, with a cumulative increase of approximately 0.2

Chart 1

Response of Aggregate Employment to a Cut in the Federal Funds Rate



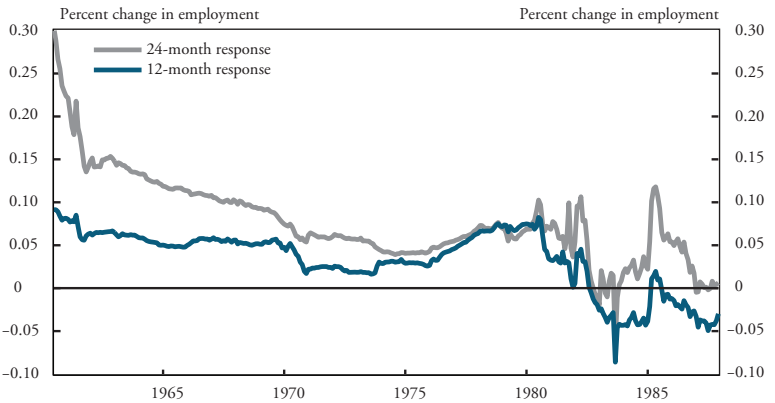
Note: The chart displays the estimated response of total nonfarm payroll employment to an unexpected 25 basis point cut in the federal funds rate. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. The post-1984 response is estimated using monthly data from January 1985 to December 2007. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

percent after two years. Based on the current size of nonfarm payrolls, this response would have added 255,000 jobs over a two-year period. In the post-1984 period, an identical cut in the federal funds rate had a statistically insignificant effect on employment. The estimates suggest the interest sensitivity of the economy decreased markedly from the pre-1985 to the post-1984 period.[5]

The estimated responses of employment, however, are sensitive to the choice of sample period. To illustrate this sensitivity, the VAR analysis is run repeatedly across 20-year segments of the data beginning with a start period of January 1960 and concluding with a start period of December 1987. Chart 2 shows the cumulative responses of employment at 12 months and 24 months following an unexpected 25 basis point cut in the federal funds rate. The 24-month response of employment is strong when the 20-year sample period starts before 1962. Both the 12- and 24-month responses weaken as the start date moves through the early 1970s. Once the start date moves past 1982, the 24-month response falls to a level near zero while the 12-month response becomes negative. When the start date reaches 1985, both employment responses increase briefly before subsequently declining.

Chart 2

Rolling-Window Response of Aggregate Employment to a Cut in the Federal Funds Rate



Note: The chart displays the estimated 12-month and 24-month responses of total nonfarm payroll employment to an unexpected 25 basis point cut in the federal funds rate. Each data point represents the estimated response using monthly data for a 20-year window. The response is plotted based on the start date of the 20-year window.
Source: Authors' calculations.

II. Shifts in the Interest Rate Sensitivity of Employment across U.S. Industries

Shifts in the interest sensitivity of employment could be due to a variety of factors. Changing behavior of policymakers, households, and firms could explain the observed shift. Similarly, structural changes resulting from new technologies, increased globalization, and financial regulations could alter the economy's responsiveness to monetary policy actions.

The analysis considers employment responses at the industry level to evaluate whether changes in overall interest sensitivity are due to shifts in a few industries or widespread. Some industries, such as durable goods manufacturing and construction, are more interest sensitive than others, such as health-care services and education. Accounting for differences in interest sensitivity across industries—and uncovering possible shifts in interest sensitivity over time for these industries—can provide useful insights into the overall change in the interest rate channel of monetary policy.

A statistical model of the industry-specific interest rate channel of monetary policy

To capture the industry-specific interest channel of monetary policy, the statistical model is expanded to include one additional variable: employment in an individual industry. The aggregate employment variable is adjusted to exclude employment in the given industry, and therefore represents employment in all other industries. The other three variables remain the same. In this expanded structure, the model estimates the relationship between the federal funds rate and employment in an individual industry. The timing assumption that monetary policy affects employment with a one-month lag remains the same.

The analysis incorporates a comprehensive set of industry-level employment variables. The initial stage of analysis examines four broad industry categories in the private sector. The first two categories encompass industries traditionally considered the most interest sensitive: durable goods manufacturing and construction. The third category encompasses nondurable goods manufacturing, and the fourth category represents employment in the private service-providing industries. The second stage of the analysis examines interest sensitivity within 18 different industries that make up the entire economy.

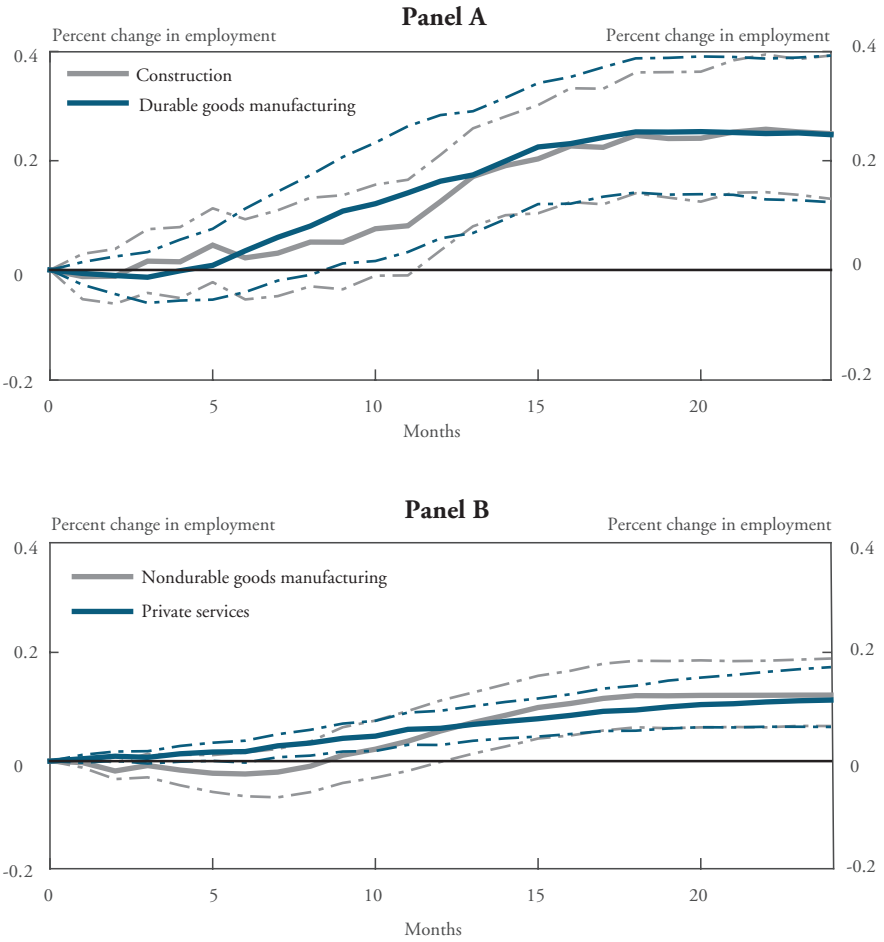
Changes in the interest rate channel of monetary policy across industries

Estimates of employment's interest sensitivity in the pre-1985 period closely match the traditional story of the interest rate channel of monetary policy. The largest employment response to an unexpected 25 basis point cut in the federal funds rate occurred in the durable goods manufacturing and construction categories (Chart 3, Panel A). Twenty-four months after the cut, the cumulative employment increase was 0.25 percent for construction and durable goods manufacturing, a greater response than that of aggregate employment.

The two other categories, nondurable goods manufacturing and private service-providing industries, exhibited less interest sensitivity than the overall economy in the pre-1985 period. The employment responses of these two categories were similar: a gradual increase in employment cumulating in an increase of 0.12 percent two years after the cut in the federal funds rate (Chart 3, Panel B). In broad terms, these estimates match the typical view of the interest rate channel that

Chart 3

Response of Industry-Specific Employment to a Cut in the Federal Funds Rate, Pre-1985



Note: The panels display the estimated responses of employment for specified industries to an unexpected 25 basis point cut in the federal funds rate. The responses are estimated using monthly data from January 1960 to December 1984. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

durable goods manufacturing and construction are the most interest-sensitive sectors and nondurable goods manufacturing and private service-providing industries are less interest sensitive, with the overall economy somewhere in between.

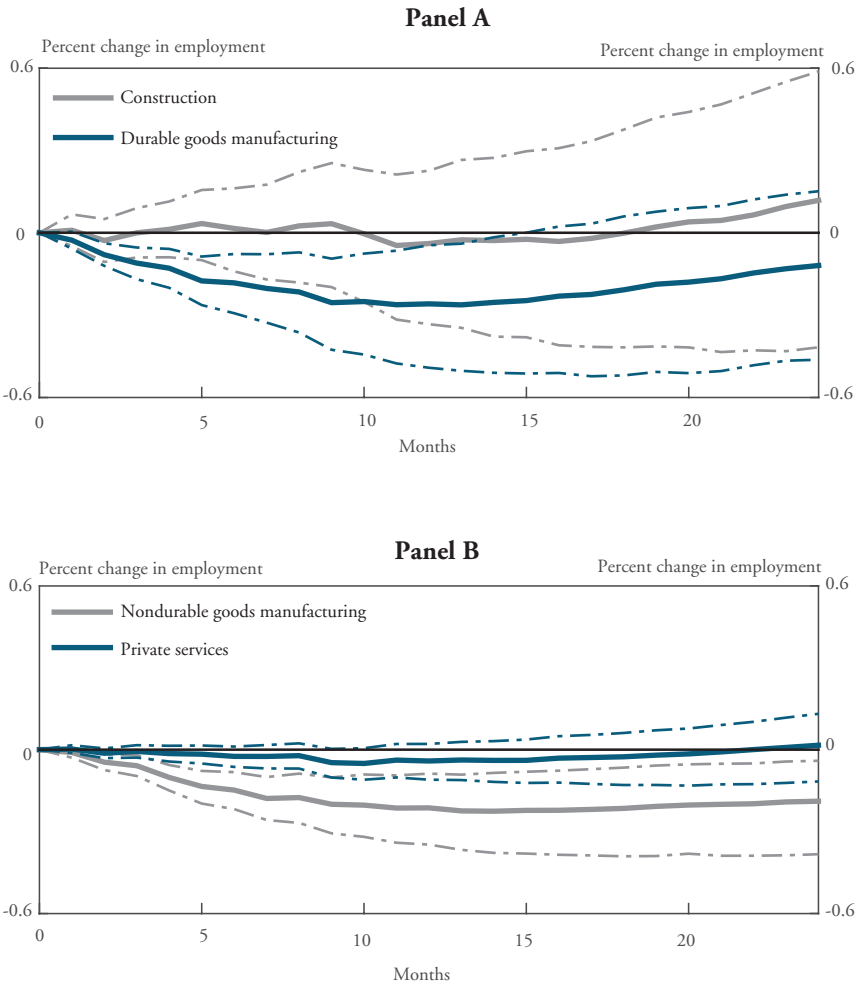
In the post-1984 period, interest sensitivity declined across all categories (Chart 4). Durable goods manufacturing experienced the largest downward shift in employment response, but the responses of nondurable goods manufacturing and private service-providing industries also decreased notably. In the nondurable goods manufacturing category, the cumulative employment response two years after the cut in the federal funds rate was a net decline of about 0.19 percent, as opposed to a 0.12 percent positive response in the pre-1985 period. In the construction category, the employment response in the post-1984 period was delayed much longer than in the pre-1985 period. The employment responses in all categories were statistically insignificant in the post-1984 period.

A similar decrease in the interest sensitivity of employment is found across a broad range of industries (Table 1). Industries with the greatest interest sensitivity in the pre-1985 period, such as construction and durable goods manufacturing, experienced the largest decreases in responsiveness over time. But many industries in the service sector, such as retail trade and trade, transportation, and utilities, experienced similar declines. The industry with the largest overall decline in interest sensitivity was information services, with a net decline of 0.5 percentage point 18 months after an unexpected 25 basis point cut in the federal funds rate in the post-1984 period compared with the pre-1985 period. The only industries with a modest increase in interest sensitivity were education and health, other services, and government, but the estimated employment responses for these industries were insignificant in the post-1984 period.

In summary, nearly all measures of employment's interest sensitivity at the aggregate and industry level declined in the post-1984 period. This evidence, however, does not identify the source of the change in the interest rate channel.

Chart 4

Response of Industry-Specific Employment to a Cut in the Federal Funds Rate, Post-1984



Notes: The panels display the estimated responses of employment for specified industries to an unexpected 25 basis point cut in the federal funds rate. The responses are estimated using monthly data from January 1985 to December 2007. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

Table 1

Response of Industry-Specific Employment to a Cut in the Federal Funds Rate

	Change in employment after 18 months		
Industry	Pre-1985 (percent)	Post-1984 (percent)	Change (percentage point)
Total nonfarm	0.15*	-0.01	-0.16
Goods producing	0.15*	-0.13*	-0.28
Mining and logging	-0.07	-0.11	-0.04
Construction	0.25*	0.00	-0.25
Manufacturing	0.19*	-0.19*	-0.38
Durable goods	0.25*	-0.21	-0.46
Nondurable goods	0.12*	-0.22*	-0.34
Private service-providing	0.09*	-0.03	-0.12
Trade, transportation, and utilities	0.13*	-0.03*	-0.16
Retail trade	0.15*	0.00	-0.16
Information services	0.05	-0.44	-0.50
Financial activities	0.09*	0.08*	-0.01
Professional and business services	0.06*	0.03	-0.03
Education and health services	0.04*	0.08*	0.04
Leisure and hospitality	0.13*	0.09*	-0.04
Other services	0.04*	0.07*	0.03
Government	0.04	0.06	0.01

*Significant at the 95 percent confidence level.
Notes: The table displays the estimated cumulative percentage change in employment 18 months after a 25 basis point cut in the federal funds rate. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. The post-1984 response is estimated using monthly data from January 1985 to December 2007.
Source: Authors' calculations.

III. Decomposing the Decline in Employment's Interest Rate Sensitivity

The decline in the interest rate sensitivity of employment may be a result of changes at different points in the interest rate channel of the monetary transmission mechanism (Figure 1). First, the response of monetary policy to current economic conditions such as inflation and employment may have changed over time. Second, changes in the financial sector may have altered the transmission of monetary policy changes to broader market interest rates and ultimately to the overall economy. And third, structural changes across the economy may have changed the way industries and the aggregate economy interact. These relationships are studied to analyze interactions between the federal funds rate and the 10-year Treasury yield, industry employment, and aggregate employment.

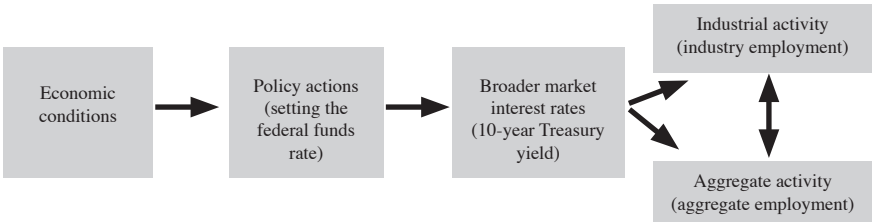
The contribution of monetary policy shifts to changes in interest sensitivity

While the Federal Reserve conducts monetary policy to "promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates," its methods have evolved, most notably in the late 1970s and early 1980s. On October 6, 1979, then-Chairman Paul Volcker led a change in the Fed's approach to begin targeting monetary aggregates—that is, the Fed began targeting the quantity of reserves rather than interest rates. By controlling the banking system's reserves, the Fed limited the supply of money to curb inflation. Although the Fed reverted to targeting the federal funds rate in 1982, the early 1980s marked the beginning of a new era in which monetary policy became more responsive to inflation.

Did the change in the conduct of monetary policy contribute to the estimated decline in the interest sensitivity of employment? To address this question, a counterfactual exercise is performed with an alternative model designed to capture the key features of the monetary transmission mechanism. An alternative model is needed because the VAR model used in the prior sections is not designed to analyze changes in the conduct of monetary policy over time.

Figure 1

Interest Rate Channel of the Monetary Transmission Mechanism



The alternative model consists of three equations specified at a quarterly frequency (Giordani). The first equation is the IS curve, characterizing the investment-savings relationship in which higher real interest rates dampen economic activity. The second equation is the Phillips curve, capturing the positive short-run relationship between inflation and employment. And the third equation is a monetary policy rule, characterizing the response of monetary policy to inflation and employment.[6]

IS curve: $emp_t^g = \beta_y emp_{t-1}^g - \beta_r (i_{t-1} - \pi_{t-1}) + \varepsilon_t^{AD}$

Phillips curve: $\pi_t = \pi_{t-1} + \alpha_y emp_{t-1}^g + \varepsilon_t^{CP}$

Policy rule: $i_t = \gamma_\pi \pi_t + \gamma_y emp_t^g + \varepsilon_t^{MP}$

The variable emp_t^g denotes the employment gap, measured as the difference between actual employment and the Congressional Budget Office's potential employment. The gap is expressed as a percentage of the overall labor force, where a negative employment gap indicates slack labor market conditions and a positive employment gap indicates tight labor market conditions. For the remaining variables, π_t represents core PCE inflation, and i_t represents the federal funds rate. The three shocks in this model are a shock to aggregate demand, ε_t^{AD}, a cost-push shock to inflation, ε_t^{CP}, and a monetary policy shock, ε_t^{MP}. The latter shock represents an unexpected change in the federal funds rate.

The model is estimated to examine whether a change in the conduct of monetary policy contributed to the declining interest sensitivity of employment. The data are separated into pre-1985 and post-1984 periods, and the parameters for each period are estimated using a generalized method of moments procedure. To test whether monetary policy

is the cause of decreased interest sensitivity in the later period, the estimated monetary policy rule parameters (γ_π, γ_y) of the pre-1985 period (1960:Q1 to 1984:Q4) are replaced with those from the post-1984 period (1985:Q1 to 2007:Q4). The reaction of the employment gap to an unexpected 25 basis point decrease in the federal funds rate is then examined. A full description of the model and estimates is provided in Appendix B.

The analysis suggests that a more proactive monetary policy in the post-1984 period did not contribute to the drop in interest sensitivity. Panel A of Chart 5 displays the actual pre-1985 response of the employment gap to the monetary policy shock and the counterfactual response produced using the alternative monetary policy estimated from the post-1984 period. The responses are qualitatively similar. The employment gap increases in the quarter following the shock and widens to approximately 1.2 basis points before gradually dissipating over the next three years. Panel B shows the results of the corresponding experiment in the post-1984 period—that is, imposing monetary policy's reaction from the early period onto the later period. The actual employment gap response post-1984 closely matches the counterfactual response, and both responses are much smaller than in the pre-1985 period.

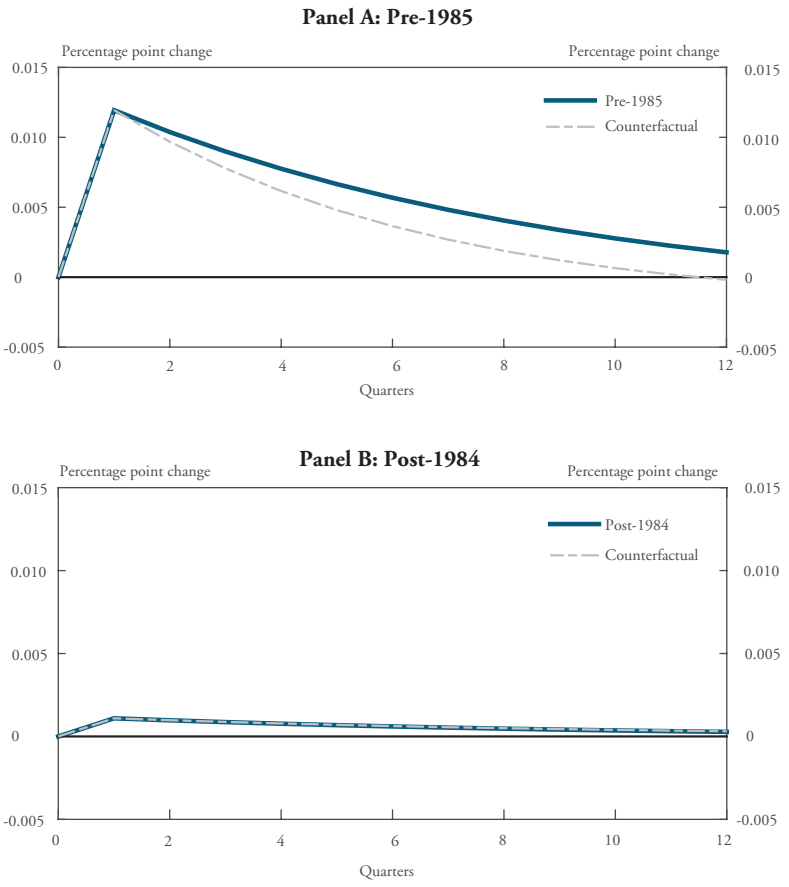
Two caveats should be attached to these results. First, this structural model of the economy incorporates only backward-looking agents and is relatively simple compared with models with a greater focus on expectations through forward-looking agents. Second, the literature is divided on the contribution of monetary policy shifts to observed declines in interest sensitivity. For example, Boivin, Kiley, and Mishkin find that changes in the conduct of monetary policy almost entirely account for the estimated declines in interest sensitivity. However, Primiceri finds that changes in the conduct of monetary policy "did not play an important role" in shifts in interest responsiveness over time.

The role of long-term interest rates in the interest rate transmission channel of monetary policy

While changes in the conduct of monetary policy do not appear to account for the observed change in interest sensitivity, changes in financial markets, as well as changes in lending and borrowing patterns of households and individuals, may alter the response of the economy to a given change in monetary policy.

Chart 5

Actual and Counterfactual Response of the Employment Gap to a Cut in the Federal Funds Rate



Notes: The panels display the estimated responses of the employment gap to an unexpected 25 basis point cut in the federal funds rate. The pre-1985 response is estimated using quarterly data from 1960:Q1 to 1984:Q4. The post-1984 response is estimated using quarterly data from 1985:Q1 to 2007:Q4. The solid line represents estimates from the baseline model and the dashed line represents estimates from a counterfactual exercise where monetary policy parameters from the other period are substituted.
Source: Authors' calculations.

Two possible shifts in the interest rate channel of monetary policy are examined. First, the transmission of monetary policy shocks from short-term interest rates (measured by the federal funds rate) to long-term interest rates (measured by the 10-year Treasury yield) may have changed. Second, the effect of a change in long-term interest rates on the economy, as measured by aggregate employment, may have changed.

The first exercise focuses on the transmission of monetary policy to long-term interest rates. In this transmission channel, the central bank's changes in short-term rates are transmitted through financial markets to broader market conditions, including long-term interest rates. This relationship, however, has not necessarily remained stable over time. For example, when the Federal Reserve began raising interest rates in 2004, long-term interest rates did not move up as expected.

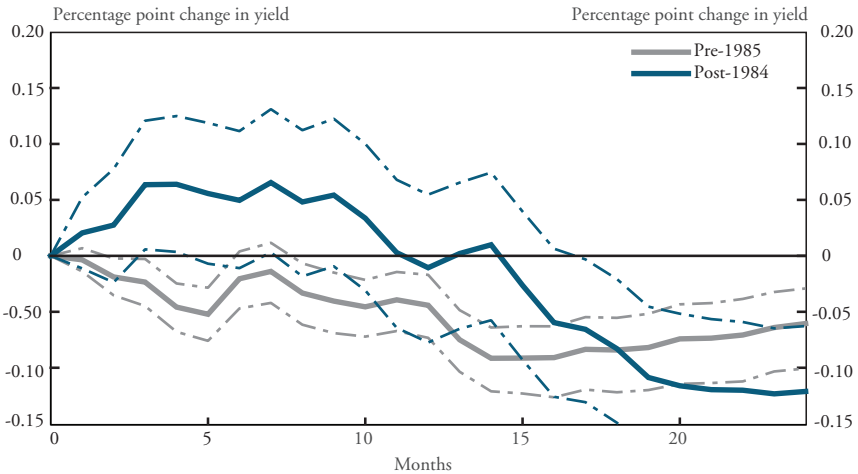
In line with the 2004 experience, the estimated transmission mechanism from unexpected changes in monetary policy to longer-term interest rates has shifted somewhat from the pre-1985 period to the post-1984 period. To examine policy's effect on broader interest rates, the VAR model from Section II incorporates the 10-year nominal Treasury yield as an additional variable and is estimated separately for the pre-1985 and post-1984 periods.[7] In response to an unexpected decline in the federal funds rate of 25 basis points in the pre-1985 period, the 10-year yield declines gradually over the first 15 months before the response begins to dissipate (Chart 6). In the post-1984 period, the 10-year yield initially rises in response to an unexpected decline in the federal funds rate. After 15 months, the response of the 10-year yield turns negative. The yield then moves down quickly over the next 5 months and drops below the response from the pre-1985 period after 19 months.

In comparison, the negative response of the 10-year yield to an unexpected decline in the federal funds rate is significant much earlier in the pre-1985 period than in the post-1984 period. This suggests that the transmission of monetary policy from short-term to longer-term interest rates occurs with a longer lag in the post-1984 period. This evidence is also in line with comments made by then-Chairman Greenspan in 2004 regarding the "conundrum" of longer-term yields not initially moving in the same direction as short-term rates.

The second exercise focuses on the transmission channel from long-term interest rates to aggregate employment. Long-term interest rates

Chart 6

Response of the 10-Year Treasury Yield to a Cut in the Federal Funds Rate



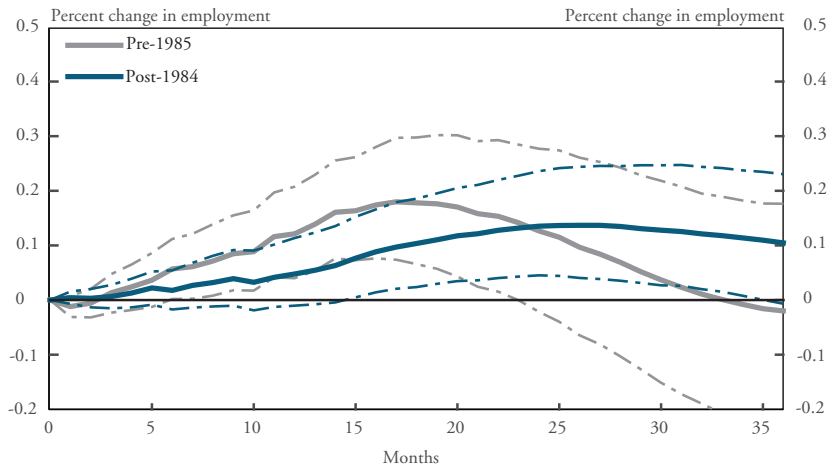
Notes: The chart displays the estimated response of the 10-year Treasury yield to an unexpected 25 basis point cut in the federal funds rate. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. The post-1984 response is estimated using monthly data from January 1985 to December 2007. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

are influenced by many factors, and this exercise investigates whether interest rate movements arising from factors other than monetary policy generated different aggregate employment responses across periods.

The estimated response of aggregate employment to unexpected movements in long-term interest rates is more protracted in the post-1984 period. The VAR model measures this relationship by estimating the response of aggregate employment to an unexpected 25 basis point decline in the 10-year Treasury yield. In this framework, the unexpected shifts in long-term interest rates are independent from monetary policy shocks, which are transmitted through the federal funds rate.[8] In the pre-1985 period, total nonfarm employment steadily increases in response to an unexpected shock to long-term interest rates, with a peak cumulative increase of 0.18 percent 18 months after the initial shocks (Chart 7). In the post-1984 period, employment responds with a longer lag. The response becomes significant after 15 months with a peak response of 0.14 percent after 27 months. These results suggest that aggregate employment continues to respond to unexpected changes in long-term interest rates unrelated to monetary policy, but with a longer lag.

Chart 7

Response of Aggregate Employment to a Cut in 10-Year Yield



Notes: The chart displays the estimated response of aggregate employment to an unexpected 25 basis point cut in the 10-year Treasury yield. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. The post-1984 response is estimated using monthly data from January 1985 to December 2007. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

The contribution of shifts within industries to changes in interest sensitivity

Structural shifts within industries could have also contributed to the estimated decline in interest sensitivity. Shifts in industry size, such as decreasing employment in the interest-sensitive durable goods manufacturing industry and increasing employment in the less-interest-sensitive private service-providing sector, could alter the response of aggregate employment to changes in interest rates. Changes within industries and by their customers could also alter the way particular industries interact with the broader economy and contribute to overall changes in aggregate employment.

One potential explanation for employment's declining interest sensitivity relates to shifts in the size of various industries. From 1960 to 2007, the share of total employment in the most interest-sensitive industry, durable goods manufacturing, declined from 17 percent to 6 percent. In contrast, the share of total employment in private service-providing industries, which were much less interest sensitive in the pre-1985 period, increased from 49 percent to 68 percent (Table 2, Columns 1 and 2). These shifts in industry size may contribute to changes in overall interest sensitivity.

Table 2

Response of Aggregate Employment to an Increase in Industry Employment

Industry	Employment share		Contemporaneous response			Response after 12 months		
	1960 (percent change)	2007 (percent change)	Pre-1985 (percent change)	Post-1984 (percent change)	Change (percentage point)	Pre-1985 (percent change)	Post-1984 (percent change)	Change (percentage point)
Goods producing	35.9	15.9	0.11*	0.14*	0.03	0.16*	0.76*	0.61
Mining and logging	1.4	0.5	0.01*	0.02	0.01	-0.01*	0.09	0.10
Construction	5.6	5.4	0.03*	0.06*	0.02	-0.01*	0.28*	0.29
Manufacturing	28.9	9.9	0.15*	0.06	-0.10	0.21*	0.49*	0.29
Durable goods	17.1	6.3	0.10*	0.01*	-0.09	0.11*	0.28*	0.17
Nondurable goods	11.8	3.6	0.28*	0.00	-0.28	0.42*	0.01	-0.42
Private service-providing	48.8	67.9	0.65*	0.41*	-0.24	1.12*	2.08*	0.96
Trade, transportation, and utilities	20.5	19.3	0.51*	0.21*	-0.29	0.12	1.15*	1.03
Retail trade	10.2	11.3	0.26*	0.11*	-0.15	0.34	0.67*	0.33
Information services	3.2	2.2	0.02*	0.02*	0.00	-0.06	0.03	0.08
Financial activities	4.6	6.0	0.51*	0.12	-0.39	0.39	0.60	0.21
Professional and business services	6.8	13.0	0.72*	0.00	-0.72	1.38*	0.01	-1.37
Education and health services	5.3	13.6	0.38*	0.01	-0.38	0.92*	0.32	-0.60
Leisure and hospitality	6.3	9.8	0.38*	0.04*	-0.33	0.59*	0.08	-0.51
Other services	2.1	4.0	0.43*	0.15*	-0.27	0.97*	0.37	-0.59
Government	15.3	16.2	-0.10*	0.01*	0.11	0.68*	-0.45*	-1.13

*Significant at the 95 percent confidence level.

Notes: Columns 3 and 4 display the estimated contemporaneous response of aggregate employment to a 1 percent increase in industry employment. Columns 6 and 7 display the response 12 months after the increase. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. The post-1984 response is estimated using monthly data from January 1985 to December 2007.
Source: Authors' calculations.

To examine spillover effects of individual industries on aggregate employment, the VAR model provides two measures of the effect of a change in employment in a particular industry on total employment. The first estimated relationship measures the direct, contemporaneous channel between industry employment and overall employment, filtering out the effects of monetary policy, aggregate prices, and business cycle fluctuations. In particular, the results show the estimated effect of a 1 percent increase in employment in a given industry on employment in all other industries in the initial month of the shift (Table 2, Columns 3-5). Based on these estimates, the immediate effect of an increase in industry employment on employment in all other industries has declined for expanding industries. For example, the effect of a 1 percent increase in employment in the private service-providing sector on all other industries declined from 0.65 percent in the pre-1985 period to 0.41 percent in the post-1984 period, a 0.24 percentage point drop in sensitivity.

Over a longer time horizon, however, the cumulative effect of shifts in industry employment on employment in all other industries suggests a more ambiguous relationship between the two. To measure the effect over a longer horizon, the VAR framework is used to estimate the cumulative change in employment in all other industries during the 12 months following a 1 percent increase in industry employment (Table 2, Columns 6-8). According to these estimates, the 12-month effect on employment in all other industries increased in the post-1984 period for most industries. However, expanding industries, mostly those in the service sector, witnessed the largest increase in their cumulative effect on total employment. The exceptions are education and health services, leisure and hospitality, and government: despite growing as a share of total employment, these industries had a smaller estimated effect on employment in all other industries in the post-1984 period.

Overall, these results suggest a notable shift over time in how employment changes in specific industries spill over into other industries. Compositional shifts in industry size seem to account for changes in only some industries, suggesting other factors may have altered the way industries interact. For example, the advanced use of integrated supply-chain management and lean manufacturing could account for changes in some industries. By reducing the need for inventories, which require

financing in many industries, these innovations may have contributed to an overall reduction in interest sensitivity. A second factor contributing to spillovers across industries may be technological. New technologies have encouraged outsourcing employment to other industries and shifts in occupations within industries associated with a decline in middle-skill jobs and increases in high- and low-skill jobs. Finally, in response to advancing technologies, some industries may have shifted their mix of capital and labor through capital deepening and increases in intangible capital (Corrado, Hulten, and Sichel). Such shifts could alter employment responses within and across industries over time.

IV. Conclusion

Although monetary policy is an important tool for promoting price and economic stability, its efficacy can change over time. This article investigates the interest rate channel of monetary policy and, more specifically, the response of employment to changes in the federal funds rate. Analytical results suggest the interest sensitivity of employment has declined in recent decades for nearly all industries and for the overall economy.

The article tests three possible explanations for the observed change in interest sensitivity. First, changes in the conduct of monetary policy do not appear to be responsible for the shift in interest sensitivity. Second, linkages between the short end and the long end of the yield curve along with linkages between financial markets and the overall economy have become protracted. Third, structural shifts have altered how employment changes at the industry level feed back to the aggregate economy.

Overall, the findings suggest that the decline in the interest sensitivity of the economy is not due to changes in the conduct of monetary policy, but rather to structural changes in industries and financial markets. Future research should investigate whether and how monetary policy should adapt in response to these changes.

Appendix A
Vector Autoregression (VAR) Model

A vector autoregression (VAR) model is used to estimate the response of employment to an unexpected monetary policy shock. The baseline VAR includes the following four variables: natural log of total nonfarm employment, the Chicago Fed National Activity Index (CFNAI), natural log of the price index for personal consumption expenditures excluding food and energy (core PCE), and the federal funds rate.

$$Y_t = \begin{pmatrix} \ln(\text{employment}_t) \\ \text{CFNAI}_t \\ \ln(\text{core PCE}_t) \\ \text{FFR}_t \end{pmatrix}$$

The data are analyzed at a monthly frequency, and the sample period is January 1960 to December 2007. Following Christiano, Eichenbaum, and Evans, 12 lags are used. The VAR is specified as:

$$Y_t = \alpha + B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_{12} Y_{t-12} + u_t.$$

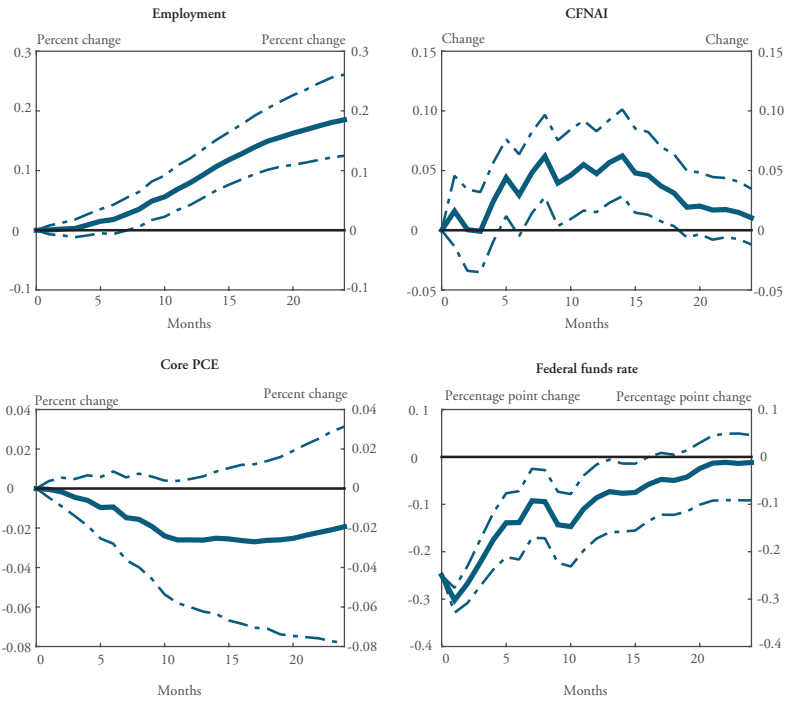
The order of the variables in Y_t reflects the identifying assumptions, in which each variable can only contemporaneously influence those ordered below itself. The federal funds rate is ordered last based on the assumption that monetary policy affects all other variables with a lag. The impulse responses are constructed using a Cholesky decomposition of the variance-covariance matrix of the residuals from OLS estimation.

Given that two of the variables, employment and the price index, are nonstationary, it is important to note that the OLS estimates are consistent, although test statistics may not be (Sims and others). Killian pointed out that in small samples, impulse response estimates may be biased and skewed, and confidence intervals may be inaccurate. Using the method described in Sims and Zha, 90 percent confidence intervals using Bayesian methods are computed to overcome the small sample problem. The prior assumes that coefficients are normally distributed and that the covariance matrix follows the Wishart distribution. For the posterior, coefficients follow normal distribution conditional on the covariance matrix being Wishart.

Charts A-1 and A-2 display the impulse responses of all four variables to an unexpected 25 basis point cut in the federal funds rate, respectively, in the pre-1985 and post-1984 periods. With the exception of core PCE, the variables respond more quickly to a monetary shock in the pre-1985 period than in the post-1984 period. The employment response is insignificant in the post-1984 period. For the expanded VAR, in which the 10-year Treasury yield and a commodity price index are added, the responses of employment, CFNAI, and the federal funds rate to a monetary policy shock are qualitatively similar. The inclusion of a commodity price index mitigates the negative, but insignificant, response of core prices to a monetary policy shock in the post-1984 period.

Chart A-1

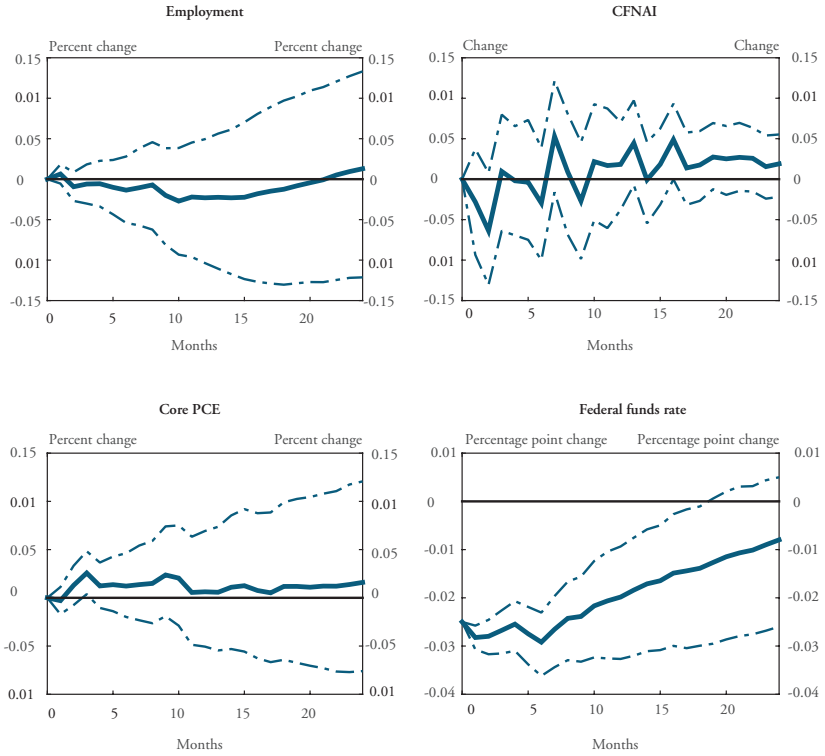
Response to a Cut in the Federal Funds Rate, Pre-1985



Notes: The chart displays the estimated responses to an unexpected 25 basis point cut in the federal funds rate. The pre-1985 response is estimated using monthly data from January 1960 to December 1984. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

Chart A-2

Response to a Cut in the Federal Funds Rate, Post-1984



Notes: The chart displays the estimated responses to an unexpected 25 basis point cut in the federal funds rate. The post-1984 response is estimated using monthly data from January 1985 to December 2007. Dotted lines represent 90 percent Bayesian confidence intervals.
Source: Authors' calculations.

Appendix B
Structural Model

A structural model by Svensson as described by Giordani is used to capture shifts in the conduct of monetary policy. The model consists of an IS equation, a Phillips curve, and a monetary policy rule obtained from the monetary authority's optimization problem. These equations describe the relationship between the employment gap ($empl^g$), inflation (π), and the federal funds rate (i). The employment gap is measured as the difference between actual employment and the Congressional Budget Office's potential employment. The gap is then expressed as a percentage of the total labor force. Inflation is measured by the quarterly percentage change (annualized) in the core PCE price index.

$$\text{IS curve: } emp_t^g = \beta_y empl_{t-1}^g - \beta_r (i_{t-1} - \pi_{t-1}) + \varepsilon_t^{AD}$$

$$\text{Phillips curve: } \pi_t = \pi_{t-1} + \alpha empl_{t-1}^g + \varepsilon_t^{CP}$$

$$\text{Monetary policy rule: } i_t = \gamma_\pi \pi_t + \gamma_y empl_t^g + \varepsilon_t^{MP}$$

All shocks are assumed to be independently and identically distributed (i.i.d). They represent aggregate demand (AD) shock, cost-push (CP) shock, and monetary policy (MP) shock. The VAR(1) representation of the model is:

$$\begin{bmatrix} empl_t^g \\ \pi_t \\ i_t \end{bmatrix} = \begin{bmatrix} \beta_y & \beta_r & -\beta_r \\ \alpha & 1 & 0 \\ \gamma_\pi \alpha + \beta_y \gamma_y & \gamma_\pi + \beta_r \gamma_y & -\beta_r \gamma_y \end{bmatrix} \begin{bmatrix} empl_{t-1}^g \\ \pi_{t-1} \\ i_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ \gamma_y & \gamma_\pi & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{AD} \\ \varepsilon_t^{CP} \\ \varepsilon_t^{MP} \end{bmatrix}.$$

The parameters are estimated using generalized method of moments (GMM). Lagged values of employment, inflation, and the federal funds rate are used as instruments along with a constant. An identity matrix is used as the weighting matrix in the estimation.

Separating the data into pre-1985 (1960:Q1-1984:Q4) and post-1984 (1985:Q1-2007:Q4) periods, the GMM estimates and standard errors, in parentheses, are shown in Table B-1.

This stylized model does not fit the data particularly well. Few parameters are statistically significant. However, γ_π is precisely estimated in both periods, indicating a significant shift in the responsiveness of monetary policy to inflation in the post-1984 period.

Table B-1

Coefficient Estimates of Structural Model

	Pre-1985	Post-1984
β_y	0.857 (0.259)	0.893 (0.660)
β_r	0.046 (0.047)	0.004 (0.089)
α	0.105 (0.209)	0.083 (0.403)
γ_y	-0.191 (0.299)	1.004 (0.823)
γ_π	1.554 (0.032)	2.312 (0.123)

The estimates in Table B-1 are used to construct the responses of the employment gap to an unexpected 25 basis point cut in the federal funds rate in Chart 5. For the pre-1985 period, the employment gap response is constructed using the pre-1985 estimates. For counterfactual responses the monetary policy rule coefficients from the post-1984 period are used in place of the pre-1985 coefficients. Similarly, for the post-1984 period, the employment gap response is constructed using the post-1984 estimates. For counterfactual responses in the post-1984 period, the monetary policy rule coefficients from the pre-1985 period are used in place of the post-1984 coefficients.

Appendix C
Replication of Christiano, Eichenbaum, and Evans

Many studies of monetary shocks focus on the responsiveness of real GDP to an unexpected change in the federal funds rate. To investigate whether the findings of a declining interest sensitivity of employment also apply to real GDP, this appendix replicates the VAR analysis of Christiano, Eichenbaum, and Evans for their sample period and also for the article's pre-1985 and post-1984 periods.

Following Christiano, Eichenbaum, and Evans, a VAR is specified with the following variables at a quarterly frequency: real GDP, the real GDP deflator, a commodity price index, the federal funds rate, total reserves, and the money stock (M1).

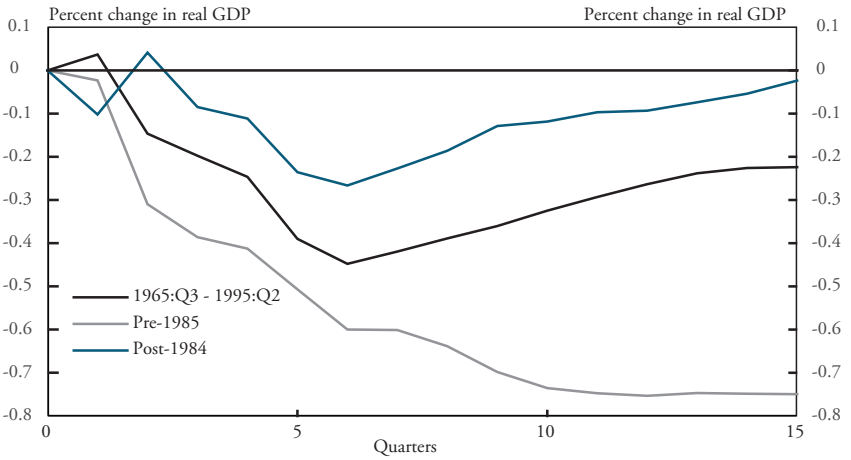
$$Y_t = \begin{pmatrix} \ln(\text{real GDP}_t) \\ \ln(\text{real GDP deflator}_t) \\ \ln(\text{commodity price index}_t) \\ \text{FFR}_t \\ \ln(\text{total reserves}_t) \\ \ln(\text{M1}_t) \end{pmatrix}$$

The data sources for several variables differ from the original analysis of Christiano, Eichenbaum, and Evans due to data availability limitations. The commodity price index is the commodity spot index from the Commodity Research Board. Total reserves of depository institutions and M1 are from the Federal Reserve Board. All six variables were collected from Haver Analytics.

The impulse responses are constructed from VAR estimates with four lags (quarterly) and a Cholesky decomposition of the residuals using the ordering of the variables listed above. To replicate the analysis of Christiano, Eichenbaum, and Evans, the impulse response of real GDP to a one standard deviation (70 basis points) increase in the federal funds rate is generated. Christiano, Eichenbaum, and Evans estimate the response of real GDP to a monetary shock using data from 1965:Q3 to 1995:Q2. The response shown in Chart C-1 for this sample period matches up very closely with Figure 2 in Christiano, Eichenbaum, and Evans.

Chart C-1

Response of Real GDP to an Increase in the Federal Funds Rate



Notes: The chart displays the estimated responses of real GDP to an unexpected 70 basis point increase in the federal funds rate. The 1965:Q3-1995:Q2 response replicates estimates from Christiano, Eichenbaum, and Evans. The pre-1985 response is estimated using quarterly data from 1960:Q1 to 1984:Q4. The post-1984 response is estimated using quarterly data from 1985:Q1 to 2007:Q4.
Source: Authors' calculations.

The shift in the responsiveness of real GDP to monetary shocks across the pre-1985 and post-1984 periods is qualitatively similar to the estimated shift in responsiveness of employment. The response of real GDP in the pre-1985 period (1960:Q1-1984:Q4) to an unexpected 70 basis point increase in the federal funds rate is larger and more persistent than the response estimated by Christiano, Eichenbaum, and Evans. And the response of real GDP in the post-1984 period (1985:Q1-2007:Q4) is smaller and less persistent than the response estimated by Christiano, Eichenbaum, and Evans.

Endnotes

[1]Other transmission channels are beyond the scope of this article but include the exchange rate channel, the credit channel, and other asset price effects (Mishkin).

[2]See Hakkio and Kahn for an analysis of monetary policy during periods when the federal funds rate is constrained by the zero lower bound.

[3]Christiano, Eichenbaum, and Evans examine the effect of monetary policy shocks on real GDP using data from 1965 to 1995. To examine whether real GDP has become less interest sensitive, their results are replicated using currently available data (see Appendix C). The results indicate that the responsiveness of real GDP to a monetary shock has diminished in the post-1984 period.

[4]While the data sample begins in January 1959, the VAR analysis starts in January 1960 due to the use of 12 lags.

[5]Boivin, Kiley, and Mishkin also find the responsiveness of employment has diminished in the post-1984 period using a factor-augmented VAR model. But contrary to this article's results, the diminished response of employment remains significant in the post-1984 period.

[6]This is an adaptive expectations model in which agents are backward-looking. See Milani for a discussion of additional models using rational expectations and learning behavior.

[7]A commodity price index is also included to control for the prize puzzle commonly found in these types of models. See Sims for additional description of the price puzzle. Adding a commodity price index does not quantitatively change any of the results described in Sections I and II. The source for the commodity price index is the commodity spot index from the Commodity Research Board.

[8]In this VAR specification, the 10-year Treasury yield is ordered immediately before the federal funds rate, which is ordered last. The impulse response to a Treasury yield shock is then constructed using a Cholesky decomposition of the variance-covariance matrix of the residuals from an ordinary least squares (OLS) estimation.

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