Does the Federal Reserve respond to house prices? Implications for monetary policy*

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Abstract

This paper revisits Romer and Romer's (2004) narrative identification approach to monetary policy shocks by allowing the monetary authority to respond systematically to corporate credit spreads and real house price dynamics. The paper documents the systematic response of interest rates to these variables and shows that accounting for this systematic response solves the observed empirical puzzle in the literature where unanticipated increases in the interest rate, instead of contracting the economy, act as expansionary shocks during the Great Moderation period. The paper further investigates the Federal Open Market Committee (FOMC) transcripts using natural language processing tools to document the increased importance of house prices in the discussions of the FOMC members for the implementation of monetary policy.

Keywords: Monetary Policy, House Prices, Textual Analysis, Narrative Identification, External Instruments

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1 Introduction

The standard macroeconomic theory would suggest that an unexpected increase in interest rates should generate a contraction in real economic activity and reduce inflation, acting as typical demand shocks. This is the basis of the central bank's monetary policy. However, this evidence has been challenged recently (see Ramey, 2016 for a discussion, cite the HANDBOOK CHAPTER HERE) as in the post-1984 period, known as a Great Moderation period, it is difficult to empirically uncover theoretically consistent responses for economic variables to unexpected changes in interest rates.

Figure 1 reports impulse responses of the Federal funds rate, industrial production, the unemployment rate, and the aggregate price level to traditionally used, narratively identified monetary policy shocks as in Romer and Romer (2004) over the two different sample periods: 1969 to 1990 and 1991 to 2008[1]. The responses of the first sample period (in solid black lines and shaded areas) follow the classic effects of monetary policy shocks, which are consistent with conventional macroeconomic theory. A 100 basis point increase in the Federal Funds rate results in a recession - industrial production falls, unemployment increases, both recovering towards their steady-state levels after four years. Prices, as measured by CPI, decline after the initial increase (usually referred to as a price puzzle). The responses for the second subperiod, depicted in blue dotted lines, instead, show that increases in the federal funds rate raise industrial production and lower the unemployment rate. These results echo Barakchian and Crowe (2013) and Ramey (2016), who show that the traditional specifications imply that contractionary monetary policy has surprising expansionary effects in the sample from 1991 through 2008.

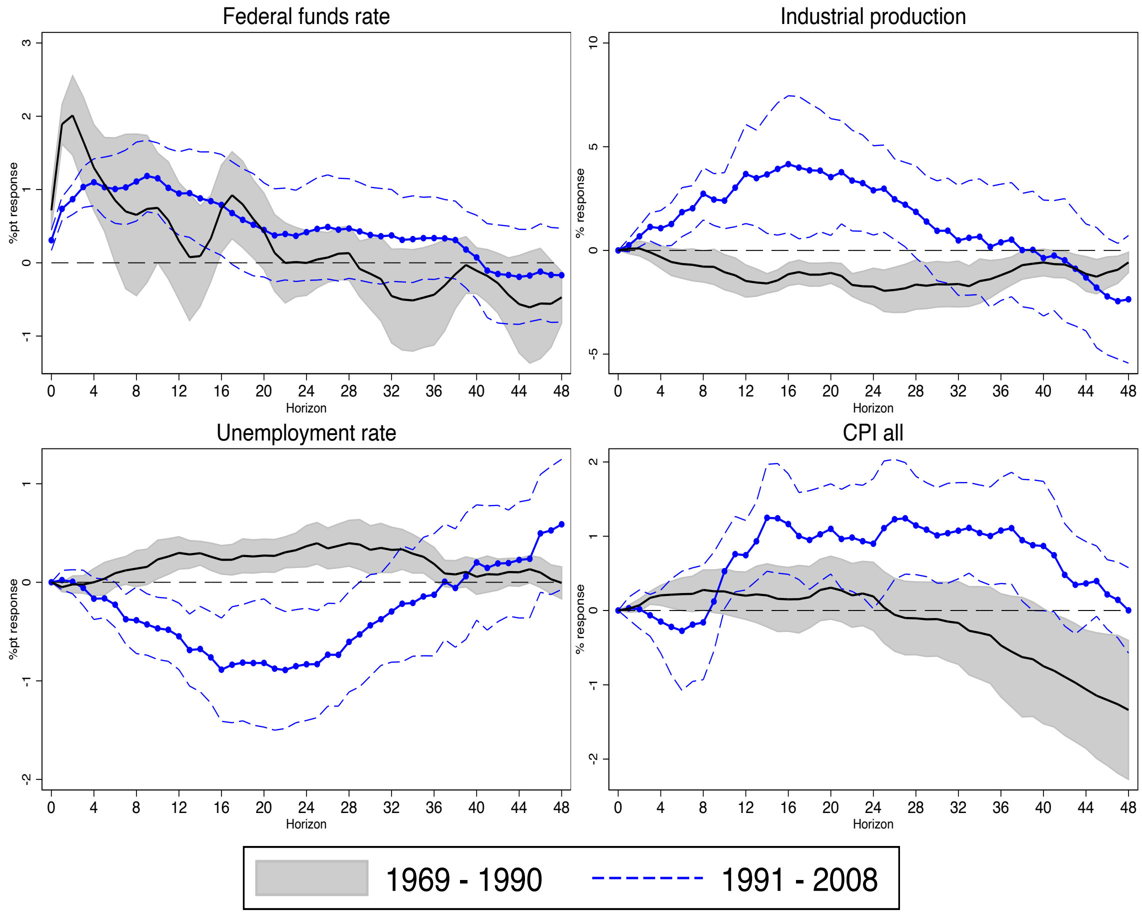
Overall, previous research on the transmission of monetary policy during the Great Moderation period has demonstrated that the estimated dynamic responses to policy innovations are sensitive to using different samples, estimation methodologies, and identification strategies. This paper contributes to the literature on the narrative identification of monetary policy by improving how we account for the systematic response of monetary policy and shows that controlling for house prices, in addition to credit spreads, recovers responses of macroeconomic variables that are consistent with the theory.

This paper contributes to two strands of the literature. First is the literature[2] on the identification of monetary policy shocks. It is more closely related to Gertler and Karadi (2015) and Caldara and Herbst (2019), which have paid close attention to the financial conditions, particularly focusing on the credit cost, as a critical component in the monetary authority's information set when setting the interest rate. There is also a relatively new and fairly scant literature that discusses

[1]The sample stops in 2008 to exclude the effective zero low bound period in the US.

[2]See Bernanke and Blinder (1992); Christiano, Eichenbaum, and Evans (1996); Leeper, Sims, and zha (1996); Leeper and Zha (2003); Romer and Romer (2004); and, more recently, Coibion (2012); Finocchiaro and von Heideken (2013); Arias, Caldara, and Ramirez (2015); Gertler and Karadi (2015); Ramey (2016); Aastveit et al. (2017); and Caldara and Herbst (2019)

Figure 1: Jordà local projection with R&R monetary policy shock



Note: The solid black line in each panel depicts the impulse response function of the specified variable (federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 100 basis point deviation of Romer and Romer (2004) monetary policy shock for 1969 - 1990 based on Jordà's local projection method (Jordà (2005)). The blue dotted line in each panel shows the response function of the specified variable to 100 basis point deviation from Romer and Romer (2004) monetary policy shock for 1991 - 2008. Shaded bands and blue dashed lines denote the associated 90% confidence intervals.

the relevance of housing prices for monetary policy. Finocchiaro and von Heideken (2013) estimate the house price coefficient in a monetary policy feedback rule and find evidence of a positive and significant response of interest rates to house prices in the US, specifically in the context of a DSGE model. A similar result emerges in Aastveit et al. (2017), who show that the Federal Reserve had responded systematically to house prices, but this response changed over time, using a VAR model with time-varying parameters and stochastic volatility. This paper, instead evaluates the role of house prices for the identification of monetary policy shocks, by revisiting Romer and Romer's (2004) narrative identification strategy.

My first contribution is in providing evidence of the relevance of house prices for monetary policy decisions by applying standard natural language processing (NLP) analysis. To show that house prices are on the radar of policy makers is a necessary, though not sufficient condition for arguing for the relevance of house prices for decision making. I use a direct measure of mentions of housing-related works that appear in FOMC discussions from 1991 M2 to 2008 M12. In this step, I define five groups of terms related to major macroeconomic variables that are relevant for monetary policy. These consist of "Inflation", "Output", "Labor", "Housing", and "Credit". I then derive the frequency of words expressed in each group to all five groups. This set-up allows to track the systematic reactions of monetary policy to the five components in each FOMC meeting over my sample period.

I find that the frequency of housing- and credit-related terms account for 11.23 percent and 15.62 percent respectively of total words identified to be important for monetary policy, on average, for the whole sample period, respectively. Interestingly, the word search suggest that terms associated with the housing market appeared frequently after 2000. Before 2000, the average frequency of words related to housing accounts for 8.85 percent. However, that increased by 5 percent point after 2000. Instead, the frequency of labor-related terms decreased after 2000s. Though this finding does not necessarily identify why the house prices are important for the policymakers, i.e., because they have been moving a lot or because the policymakers have a preference to stabilize them, it still provides suggestive evidence for the importance of house prices, above and beyond the regular variables traditionally considered to be important for monetary policy, in the FOMC discussions.

Does accounting for house price movements improve the identification of monetary policy shocks? To characterize this question, I revisit the narrative monetary policy shocks discussed in Romer and Romer (2004) by re-construct their monetary policy shocks (the baseline specification throughout this paper) with two changes to their identification framework. I expand the earlier model by adding both indicators of real house prices and credit spreads into their identification regression equation. The estimated residuals in the expanded model constitute the newly proposed narrative measures of the policy innovations at FOMC (regular) meeting frequency. These newly orthogonalized monetary policy shocks resolve various puzzle-type effects in output, inflation, or other variables discussed before in a local projections or structural VAR framework, now reconciling the effects of the monetary policy with traditional macroeconomic theory.

Notably, the estimated results show that the central bank reacts to changes in the Baa spread beyond the information contained in the Greenbook forecasts. Consistent with the evidence from the Caldara and Herbst (2019), FOMC meetings occurring in periods with elevated levels of corporate credit spreads are associated with cuts in the intended Federal funds rate. While the results on the response to credit spreads are in line with the previous literature, the new finding is that the response to real house price growth is also important. The empirical evidence in a different empirical context shows that the central bank had systematically and positively responded to real house price growth for the 1991-2008 period, consistent with Aastveit et al. (2017).

More importantly, accounting for the systematic reactions of policy to house prices has a significant role in understanding the transmission of monetary policy shocks, which is now in line with the standard macroeconomic theory, i.e. interest rate surprises generate recessions, which are accompanied with declines in prices. I further show that the results are robust to various estimation strategies by considering both local projections as well as hybrid-VAR-based responses. Regardless of using different estimation methods, the empirical findings support the importance of incorporating house prices to understand the transmission of monetary policy shocks to the macroeconomy during the Great-Moderation period.

The rest of the paper is structured as follows. Section 2 describes the NLP procedure utilized in the paper and the results on the frequency of topics in FOMC transcripts. Section 3 revisits the narrative identification of monetary policy shocks proposed by Romer and Romer (2004) and derive a new measure of the policy shocks by including two important systematic components into their estimation framework. Sections 4 and 5 examine narrative-based identification of the effects of monetary policy on macroeconomic variables in local projections and structural VAR framework. Section 6 discusses the implications of my results for monetary policy and lay out some ideas that hold promise for future research.

2 Discussion of FOMC Transcripts

Have house prices been important for the discussion to establish the monetary policy? To characterize this question, this section proposes a measure of central bank's preferences that associated with identifying the exogenous policy shocks and with determining whether or how those are taken into consideration by policy makers. I accomplish this by examining the FOMC's preferences directly by participants in the FOMC monetary policy meetings. In particular, I measure the presence of systematic responses of the Fed to house prices by applying the standard natural language processing (or textual) analysis from publicly available FOMC meeting transcripts. That is, rather than basing the measure on specific events or numerical data and having to investigate whether the FOMC is sufficiently concerned about them, I use a direct measure of mentions that actually appear in FOMC discussions.

Since these word counts are taken directly from FOMC meeting transcripts, they are particularly well suited for explaining the behavior of the FOMC. In general, examining such an indicator should highlight the degree of importance the FOMC accords to maximum employment, price and financial stability, hence those importance to the implementation of monetary policy. For instance, if FOMC members never discuss housing markets at these meetings, it would be difficult to argue that the stance of monetary policy has been affected by housing markets performance concerns. If the committee does discuss financial instability concerns, then it either cares about financial instability separately or believes that the forecast has not incorporated these concerns fully or accurately. The key aspect of my findings from the the textual analysis is that the FOMC considered housing (and credit) markets significantly in addition to the real macroeconomic variables which were typically expressed such as real GDP, inflation, and the unemployment rate (and those forecasts) when the central bank established its monetary policy, especially during the Great Moderation period.

My main textual data source is the public archive of FOMC transcripts, which are the most detailed records of FOMC meeting proceedings, that can be obtained directly from the Federal Reserve Board of Governors website with a five-year lag. Specifically, the FOMC Secretariat has produced the transcripts shortly after each meeting from an audio recording of the proceedings, lightly editing the speakers' original words to facilitate the reader's understanding. Meeting participants are given an opportunity within the subsequent several weeks to review the transcript for accuracy[3]. These include all regular FOMC meetings from 1976 to 2015, though I make use of February 1991 - December 2008 transcripts in this paper given other data constraints. To this end, my baseline sample is scheduled FOMC meeting days from February 1991 to December 2008, when the Federal funds rate hit the zero lower bound. I do not use days with unscheduled meetings. The main reason for this is pragmatic: the test for the presence of systematic response of monetary policy to financial conditions and house prices in the following section uses the projections from the Greenbooks for the Federal Reserve Board of Governors. The Greenbook is produced only before each scheduled meeting of the Federal Open Market Committee so that it is not available for each unscheduled meeting day[4]. Hence, my samples are a total of 144 transcripts since the FOMC meeting were occurred 8 times a year.

The textual analysis provides a narrative evidence for estimating the Feds' preferences since the approach relies on the assumption that the central bank' concerns are embedded in the words spoken by the policy makers at internal meetings. In that sense, I count the frequency of terms expressed by FOMC members, which can be related to the systematic components of monetary policy, including implicit inflation target, economic growth, financial and housing market performances. The advantage of this approach is that it could be used internally and externally to study the preferences of any central bank with transcripts, statements, or detailed summaries of their policy-making deliberations.

Initially, I convert all the transcripts in pdf format to text files and then apply several filters to remove words likely to be especially noisy. I proceed in three steps. Once a corpus, a collection of text documents, is created, I modify the documents, e.g., stemming stop-words and punctuation

[3]For the meetings before 1994, the transcripts were produced from the original, raw transcripts in the FOMC Secretariat's files. Though these records have been lightly edited by the Secretariat to facilitate the reader's understanding, the errors undoubtedly remain since the raw transcripts were not fully edited for accuracy at the time they were prepared because they were intended only as an aid to the Secretariat in preparing meeting minutes. While it has been criticized whether it is appropriate to use the transcripts before 1994, to my knowledge it is the best data available to the public and sufficient to capture the FOMC's preferences.

[4]A potentially important concern relates to the role of unscheduled meetings, where the FOMC takes urgent decisions in moments of particular economic distress. These unexpected meetings may in fact be the ones responsible for the information channel, which discussed in Miranda-Agrippino and Ricco (2021). They address this concern by repeating the estimation using market surprises registered around scheduled FOMC meetings only and found that results are robust. My sample has 52 unscheduled meetings out of 196 total events from February 1991 to December 2008.

removal. First, I drop punctuations except for inter-word dashes. Second, I remove extra white space and "stop-words", defined as common word that usually has no analytic meaning in terms of English. Third, I reduce word forms to stems, which makes any form of a term primitive. In some cases, I wish to preserve a concept that is only apparent as a collection of two or more words, such as economic growth, inflation expectation, and house prices; hence I combine them (or reduce them) to a meaningful acronym.

I begin my analysis by defining five different groups as a list of terms related to a specific economic variable. Table 1 provides a list of words I select for each group. The group "Inflation" is composed of terms that might be related to price stability, such as inflation expectation, deflation, and several price indexes. The words for the group "Output" are related to economic growth, such as output gap, potential output, GDP, industrial production, slack, utilization, recession, and economic activity. The list of words in the group "Labor" are as follows: unemployment, labor, hire, jobless, and natural rate, which terms are associated with the unemployment rates. In the group "Housing", I choose several terms that might be highly related to housing markets such as housing sector, house (home, housing) price, home-ownership, residential, mortgage, Fannie Mae, Freddie Mac, OFHEO (Office of Federal Housing Enterprise Oversight), foreclosure, and collateral. Lastly, the group "Credit" is composed of words that could be highly associated with credit market performances, e.g., credit spreads, treasuries, corporate bonds, yield curve, and forward rate. To classify the key economic terms, I follow the works by Peek et al. (2016) and Shapiro and Wilson (2019, 2021), their filtered subsets of transcript text for "Inflation", "Output", and "Labor". For the lists of transcript text to housing and credit, I use my own specification[5] after selecting and investigating some transcripts of the meeting.

Given a collection of text documents and categorization, I calculate the total number of words stated for each group of transcript text. An important issue is that, as seen in Figure 2, the total word count for transcripts in each FOMC meeting increased over the sample period. The average length of the transcripts has risen from under 11,000 words in 1991 to about 31,000 words in 2008. Accounting for that, I compute the frequency of words expressed in each group to all five groups[6] I defined. The associated results are shown in Table 2, which provides the average frequency of terms expressed for each group and total number of times these words are mentioned in the FOMC meeting transcripts across the three difference sample period. During the full sample period from 1991 to 2008, the average total number of words mentioned in each FOMC meeting indicates 19,431, on the other hand, the frequency of terms selected in all five groups accounts for 2.63% on average to the total number of words expressed. Under the five groups, in particular, the terms related to Output, Labor, Inflation, Housing, and Credits account for 20.18%, 19.45%, 33.52%, 11.23%, and

[5]The main point is to understand how the FOMC members described which topic and they were described them at each meeting. Based on this, the word classification was carried out for the last two groups. In that sense, subjectivity inevitably plays a role in the selection of which words to examine. The purpose of the selection, however, is to identify terms that are likely to be used for concern about the housing and credit markets.

[6]For instance, the frequency of terms associated with the group "Inflation" in a given FOMC meeting can be computed as, $\frac{\textit{\# of words expressed in the group Inflation}}{\textit{\# of words expressed in all five groups}} \times 100$

Table 1: List of Economic Terms in Each Group

Inflation	**Output**	**Labor**	**Housing**	**Credit**
			house	
inflation	output		home	
inflation expectation	output gap		house price	
inflationary	potential output	unemploy	home price	credit
inflationary expectation	gdp	unemployment	housing price	credit spreads
deflation	industrial production	nonemploy	housing related	treasuries
deflationary	slack	employ	housing sector	bond
disinflation	utilization	employment	homeownership	corporate bond
disinflationary	recession	natural rate	residential	yield curves
consumer prices	expansion	labor	mortgage	securities
producer prices	economic activity	hire	fannie mae	forward rate
cpi	economic growth	jobless	freddie mac	
pce	economic development		ofheo	
price stability	economic performance		foreclosure	
			collateral	
13	13	9	15	8

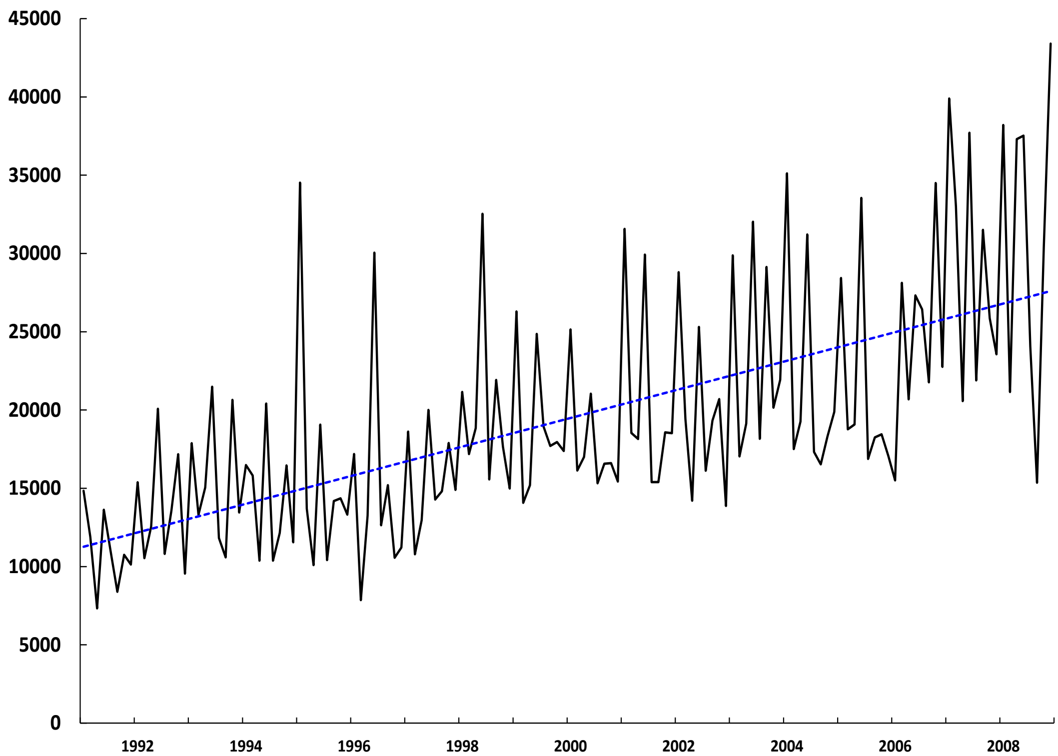
* For inflation, output and labor - Peek et al. (2016); Shapiro and Wilson (2021); Otherwise - own specification

15.62% on average, respectively.

The results of the word search imply three key aspects of the conventional wisdom on FOMC preferences. First, the results indicate that the frequency of terms associated with the group "Inflation" and "Output" have constituted about 33% and 20% on average, respectively, over the entire sample period and there is no noticeable change of those frequencies across the Pre- and Post-period. These findings are consistent with the fact that the Fed conduct monetary policy to promote stable growth in economic activities and prices (see Walsh (2017)), which is commonly known as the dual mandate. Second, the results shows that the frequency of terms related to "Credits" accounts for 15.5% on average over the full sample period, which can imply that the Fed had concerned the credit market performances steadily during the Great Moderation period from 1991 to 2008, which are compatible with the finding by Caldara and Herbst (2019). On the other hand, the third aspect of the results support the fact that the Fed had considered the housing market when they discuss the monetary policy and whether the extent had changed. For the Pre-period from 1991 to 1999, the average frequency of terms related to the group "Housing" accounts for 9%, which is about half less than those of the group "Output" or "Labor." However, the frequency increased to 14% on average during the Post-period, which is comparatively large amount with those of the other groups. Overall, a reading of the transcripts[7] clearly indicates

[7]For comparison purposes, I examine the frequency of terms for each group I defined to the total number of words expressed at each FOMC meeting over my sample period. In this case, each group's average frequency of words shows 0.5% for output and labor, 1% for inflation, and 0.3% for housing and credits from 1991 to 2008. The size of frequencies using a total number of words in each FOMC meeting are much less than those using the number of words in all five groups, but those moving across the periods are similar to each other. The associated results are

Figure 2: Total word count stated by the FOMC members at each meeting



Note: The solid black line shows the frequency of words expressed in transcripts at FOMC meeting over the sample period from 1991 through 2008. The dotted blue line represent the fitted line of linear estimation given sample.

that housing market concerns are discussed by FOMC members, with the mentions appearing most frequently during the Post-period.

Figure 3 provide a graphical description of how the frequency of the words for each group at each FOMC meeting moves for the period 1991 to 2008. The solid black line in Figure 3 represents the group "Output". The black dashed line indicates the group "Labor". The black dotted line shows the group "Inflation". The blue and red solid lines describe the frequency of terms related to housing and credit, respectively. The results form Table 2 and Figure 3 indicate two points. First, inflation-related words were consistently mentioned at each meeting at an average rate of 33% over the entire sample period. On the other hand, terms related to output, labor, housing, and credit showed different frequencies as the sample period varied. Specifically, the frequency of words

described in Table A.1 and Figure A.3 in Appendix.

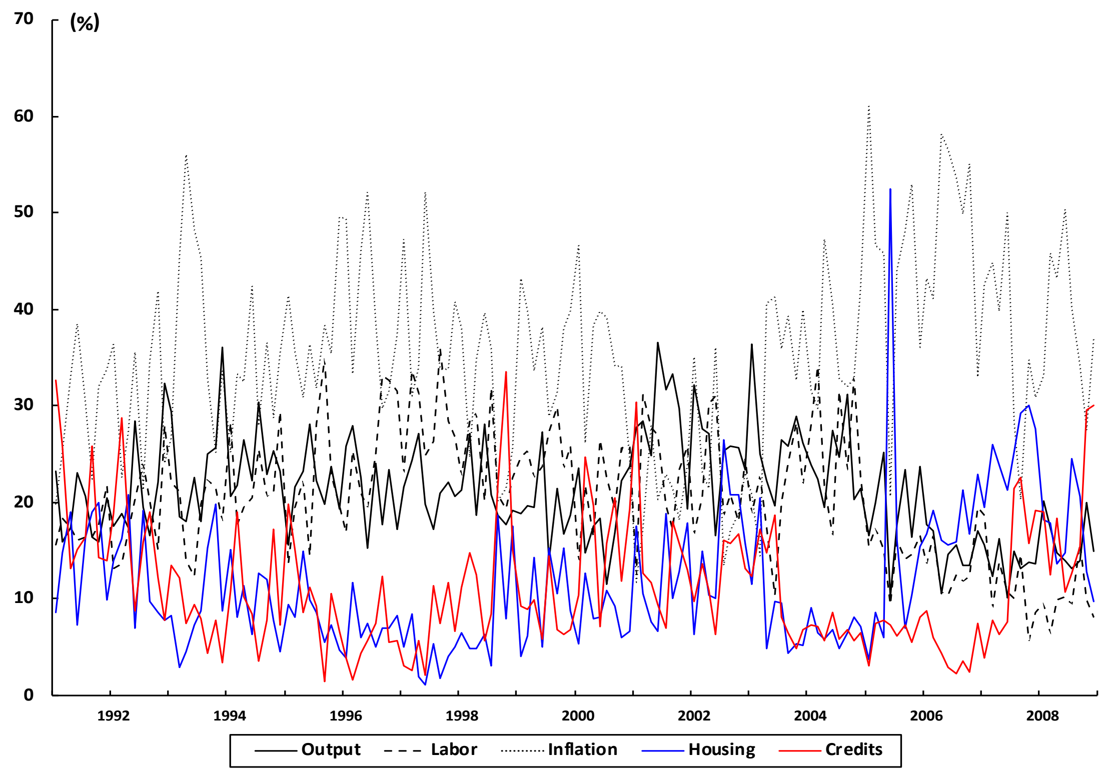
Table 2: Frequency of terms expressed by the group across the sample

Group (%)	Full sample: 91-08	Pre-period: 91-99	Post-period: 00-08
Output	20.18	20.51	19.85
	[5.226]	[4.397]	[5.954]
Labor	19.45	21.48	17.43
	[6.612]	[5.711]	[6.866]
Inflation	33.52	33.09	33.95
	[10.036]	[8.054]	[11.73]
Housing	11.23	8.85	13.61
	[7.001]	[4.676]	[8.083]
Credits	15.62	16.08	15.16
	[8.329]	[8.53]	[8.158]
All groups (#)	521	373	670
Total (#)	19431	15549	23314

related to output and labor maintained an average of about 20% until the early 2000s. Then, the number sharply decreased, showing a frequency of about 10% in 2008. In contrast, the frequency of words related to housing and credit changed significantly from the late 1990s. Before 1998, the frequency of words related to housing and credit accounted for around 10% on average, which is less than half of the frequency of other groups during the same period. However, from 1999, the frequency of words related to housing and credit gradually increased, reaching about 15% on average until the early 2000s, which is consistent with the findings from Peek et al. (2015), Walsh(2017), and Shapiro and Wilson (2019) who argue that the FOMC systematically responds to financial variables in this period. Further, the frequencies of both groups sharply rose from 2005 onward. Housing-related frequency exceeded an average of 20%, and Credit-related frequency accounted for about 18% on average. In particular, those frequencies were relatively high, considering that the frequencies of terms related to output and labor were less than 15% in this period. Overall, the housing sector and credit market performances were steadily and non-negligibly expressed by the FOMC members, along with concerns about full employment and price stabilization, which implies that those are the systematic components in the information set of the central bank. This result suggests that a simple dual-mandate-style reaction function that does not consider concerns about the financial market may not capture the actual behavior of monetary policymakers. In this sense, these findings are consistent with those obtained earlier by Aastveit et al. (2017) and Caldara and Herbst (2019).

There is, in fact, considerable external support for these results. Thornton(2011) documents that from 1991 until 2009 the FOMC's policy directive, announced to the public after each FOMC meeting, stated "*The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output*". In both periods, indeed, the

Figure 3: Frequency of word count for each group, FOMC transcripts, 1991 - 2008



Note: Each line represents the frequency (%) for the five groups of words mentioned in the transcripts of each FOMC meeting from February 1991 to December 2008.

volatility of the financial market changed significantly[8]. The late 1990s was a period when the stability of the US financial market deteriorated significantly due to the rise and burst of IT bubble and the financial turmoil around the globe. On the other hand, in 2007, excessive risk-taking by banks, combined with the bursting of the U.S. housing bubble, caused the values of securities tied to U.S. real estate to plummet and damaged financial institutions. In common, FOMC participants recognized the serious volatility of financial markets at meetings during these two periods, and discussed to find ways to stabilize them. Below is the excerpt from a transcript of the November 17, 1998 FOMC meeting, where FOMC participants explicitly expressed their concerns for stability in financial markets.

Excerpt from a transcript of the November 17, 1998 FOMC meeting:

[8] According to the Cboe Volatility Index (VIX), which is commonly known to measure the risk of financial markets, the period when the index exceeds 20 is in the late 1990s and after 2007.

> Because of the recent financial market volatility, we made a special effort to contact some market participants at the Chicago futures and options exchanges. Although our contacts believe they have successfully weathered the extraordinary volatility of late summer and early fall, many were apprehensive about the market's ability to withstand future shocks. One concern is that market depth may suffer in the months ahead. ... Banks face pressure to get exposure off their books and consequently they have cancelled lines of credit to some clearing members. ... Financial markets have improved from their earlier unstable condition, but they are not yet back to normal. We need to continue to facilitate a return to normalcy. Financial markets currently are like a sick person who feels better after taking antibiotics for a few days but still needs to stay on medication to avoid a relapse and to aid a return to good health. ... Although conditions in financial markets have settled down materially since mid-October, unusual strains remain. With the 75 basis point decline in the federal funds rate since September, financial conditions can reasonably be expected to be consistent with fostering sustained economic expansion while keeping inflationary pressures subdued.

As can be seen in ¡Table 2¿ and ¡Figure 3¿, the proportion of housing-related words has increased rapidly since 2005. Starting with the FOMC meeting in June 2005, the frequency of these meetings, accounting for more than 50%, has increased significantly. The FOMC participants at the June 2005 meeting frequently used terms related to housing unprecedently, considering that the share of words related to inflation was 61% (February 2005), which was the highest during the entire sample period. From then on, housing-related words were expressed frequently, with an average 20% share from 2005 to 2008. These results imply that the central bank had a considerable concern for the housing markets for their policy rule for establishing monetary policy. Interestingly, the changes in frequency for the housing group were highly related to aggregate house prices. Indeed, the growth rate in real house prices has increased significantly since the early 2000s and peaked in November 2005. Notably, participants in the FOMC meeting in June 2005 discussed this issue from various perspectives. Particularly, they tried to find out which models could best capture the macroeconomic implications of changes in house prices. The following is the excerpt from a transcript of June 30, 2005, in which some FOMC participants explicitly stated performance for the housing market.

> **The Transcript of June 30, 2005, FOMC Meeting:**
> *MR.GALLIN.* House prices, adjusted for general in ation, have risen at a rapid pace in recent years and did not even pause during the last recession. Indeed, the real rate of appreciation has increased, and the most recent readings have been at annual rates greater than 7 percent. By comparison, the average annual increase in real house prices during the past 30 years is only about 1.75 percent. ...
> *MR. LEHNERT.* The popular consensus appears to be that homebuyers, especially in hot housing markets, now make token down payments and can just scrape into their homes by resorting to interest-only mortgages; in this view, borrowers and lenders alike are vulnerable to any fall in house prices. In my prepared remarks I will address each of these issues.
> *MR. WILLIAMS.* I'll lay out a few scenarios that illustrate the potential macroeconomic

> fallout resulting from a significant decline in house prices, and I will examine policy responses that minimize it. ...
> *MS. YELLEN.* A second comment I wanted to make concerns the relationship of creative finance to the housing market. One view that I think is very prevalent is that the use of credit in the form of piggyback loans, interest-only mortgages, option ARMs [adjustable-rate mortgages], and so forth, involves financial innovations that are feeding a kind of unsustainable bubble. But an alternative perspective on that is that high house prices, in fact, are curtailing effective demand for housing at this point and that house appreciation probably is poised to slow. So the increasing use of creative financing could be a sign of the final gasps of house-price appreciation at the pace we've seen and an indication that a slowing is at hand.

Overall, the results in Section 2 indicates two aspects; first, by directly measuring the central bank's preference in transcripts of each FOMC meeting over the period 1991 through 2008 using textual analysis, I suggest that the Fed explicitly considered the housing market conditions for their decision-making, which can imply the presence of a crucial interdependence between monetary policy and house prices during the Great-Moderation period from 1991 to 2008. Second, in contrast with conventional wisdom, identification of the monetary policy shocks without accounting for the endogenous reactions induced by the housing market performances would have confounding effects of monetary policy on the real economy, especially for the Great Moderation period. Apparently, this narrative exercise is more obvious when compared to the numerical evidence. In the next section, to see whether monetary policy systematically responds to house prices (and credit spreads), I re-build the new measure of exogenous monetary policy shocks with two changes to Romer and Romer's (1989, 2004) estimation framework.

3 Policy Surprises

Previous section provides a narrative result using textual analysis to establish the presence of interdependences between monetary policy and changes in economic conditions, especially housing and credit market performances. In this section, I build on this result to re-examine the narrative identification of monetary policy shocks of Romer and Romer (2004). I first describe their identification strategy. I then propose a new measure of monetary policy shocks by including two components into their traditional framework. Specifically, I add a measure of the average Baa corporate credit spreads and 3-month moving average of monthly growth in the real house price index. According to the stylized fact I discussed in Section 2, both factors are systematically important, which can endogenously effect on monetary policy shocks especially for the Great Moderation period. In that sense, I finally develop monetary policy shocks as shift to the policy rate that are exogenous to changes in economic conditions (and their revisions), house prices and corporate credit spreads. Hence, by building on Romer and Romer (2004)'s identification, I propose a new measure of monetary policy shocks that take into account both the systematic components, house prices and credit spreads, in the function of central bank's policy making. At the end of this section, I provide several implications of these findings by comparing the narrative evidence using textual analysis, which I discussed in the previous section.

In general, narrative approaches involve constructing a series from historical documents to identify the reason and/or the quantities associated with a particular change in a variable. Romer and Romer (2004) proposed to identify monetary policy shocks by using the real-time "Tealbook (formerly Greenbook)" forecasts prepared by the Federal Reserve's economic staff in advance of each FOMC meeting. Greenbook forecasts have the appeal of being the actual figures and numbers discussed by the FOMC members at the meeting. Importantly, because the Greenbook forecasts are prepared prior to when the FOMC meets (usually 5 to 10 days prior), they can be considered exogenous with respect to the committee's dialogue.

Following Romer and Romer (2004), Coibion and Gorodnichenko (2011), and others, my baseline specification is constructed by regressing intended Federal funds rate change, Δff_m, decided at FOMC meeting date (m), on Greenbook forecasts to control for current economic conditions and the future economic outlook, especially on the level of, and the revisions to, the Federal Reserve's forecasts of real GDP growth, the unemployment gap, and inflation. These forecasts are typically published a week prior to each scheduled FOMC meeting and can be thought of as a proxy of the information set of the FOMC at the time of making the policy decision. For Δff_m, I update the series of intended federal funds changes to the end of 2008[9]. The following regression is the original form of equation introduced by Romer and Romer (2004);

$$\Delta ff_m = \alpha + \beta ffb_m + \sum_{i=-1}^{2} \left[\gamma_i \Delta\tilde{y}_{m,i}\right] + \sum_{i=-1}^{2} \left[\phi_i \tilde{\pi}_{m,i}\right] + \sum_{i=-1}^{2} \left[\lambda_i (\Delta\tilde{y}_{m,i} - \Delta\tilde{y}_{m-1,i})\right] + \sum_{i=-1}^{2} \left[\theta_i (\tilde{\pi}_{m,i} - \tilde{\pi}_{m-1,i})\right] + \rho\tilde{u}_{m,0} + u_m \tag{1}$$

where m is the monthly date of scheduled FOMC meeting, Δff_m is the change in target rate around FOMC meeting m, ffb_m is the level of intended funds rate before any policy decisions associated with meeting m; $\tilde{u}$, $\tilde{y}$, and $\tilde{\pi}$ refer to the Greenbook forecasts of the unemployment rate, the real output growth, and inflation, respectively (prior to the choice of the interest rate); and the i is the index in the summations refers to the horizon of the forecasts. The equation includes both the forecasts for the contemporaneous meeting and the revision in the forecast from the previous meeting because it is plausible that both the levels and the changes in the forecasts are important factors of Federal Reserve behavior. The estimated residuals $\hat{u}_m$ are interpreted as policy innovations at FOMC meeting frequency.

[9]While Greenbook forecast are available until the end of 2016 (as of the time of this writing), the interest rates approached the zero lower bound from 2009 onwards so that the regression including the sample period after 2009 might not appropriately capture the Federal Reserve's intended rates of policy target.

The second key contribution of this paper is in providing a new measure of monetary policy shocks based on the narrative approach by reconstructing the conventional Romer and Romer monetary policy shocks with two changes to their estimation framework. Next, I include in the regression an indicator of house prices and credit spreads, I then estimate the following equation at FOMC meeting frequency over my sample period from 1991 to 2008:

$$\begin{aligned}\Delta ff_m = \alpha + \beta ffb_m + \delta cs_m^{5D} + \psi \Delta h_m^{2M} + \sum_{i=-1}^{2} \Big[\gamma_i \Delta \tilde{y}_{m,i}\Big] \\ + \sum_{i=-1}^{2} \Big[\lambda_i (\Delta \tilde{y}_{m,i} - \Delta \tilde{y}_{m-1,i})\Big] + \sum_{i=-1}^{2} \Big[\phi_i \tilde{\pi}_{m,i}\Big] \\ + \sum_{i=-1}^{2} \Big[\theta_i (\tilde{\pi}_{m,i} - \tilde{\pi}_{m-1,i})\Big] + \rho \tilde{u}_{m,0} + \varepsilon_m \end{aligned} \tag{2}$$

Because Greenbook forecasts for credit spreads are available only starting in 1998, my instrument is instead cs_m^{5D}, the average Baa spread for the five days prior to the FOMC meeting[10]. I denote the associated regression coefficient by δ. Since forecasts for house prices are not provided in the Greenbook[11], my instrument is instead Δh_m^{2M}, the 3-month moving average of monthly growth in the real house price index for the 2 months prior to the FOMC meeting m. ψ is the regression coefficient associated with the house prices.

The house price index (HPI)[12] is published by the FHFA (Federal Housing Finance Agency). The HPI is a weighted repeat sales index, which measures average price changes in repeat sales in the value single-family homes or refinancings on the same properties and weights them. The HPI data are nominal so I deflate the data using headline CPI inflation at meeting m. It should be noted that house price data are generally released with a lag of 2-3 months. For example, the FHFA published the November 2020 HPI report on January 26, 2021, and the January 2021 data on March 30, 2021. Therefore, the monetary authorities have to make predictions based on information about house prices two to three months ago, no matter how early. This can be found in more detail by looking at the transcript of each FOMC meeting and the transcript forecast (as shown in Figure A.4 in Appendix). To reflect this, the 3-month moving average of house price growth[13] for the 2 months prior to the meeting are included in the equation. According to the equation (2), I build four different types of monthly[14] monetary policy shocks; (I) as conventional specification by Romer and Romer (2004), (II) as shifts to the policy rate that additional controls

[10]Results are robust to using the average Baa spread calculated from the first day of the month when the FOMC meeting takes place to the day prior to the meeting.

[11]While Greenbook forecasts for house prices had been used in several meeting, (e.g. the Greenbook forecast for house prices was shown in the graphically way based on the staff projection in the FOMC meeting on March 2006. See the Figure A.4 in Appendix), the numerical data are not yet available to the public.

[12]The price information is obtained from repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975.

[13]Results are robust to using the real house price changes for the 2 months, 3 months and 4 months prior to the meeting.

[14]Months without FOMC meetings are assigned a zero.

for the central bank's concern regarding credit costs, (III) as shifts to the policy rate that controls for the house prices, and (IV) as shifts to the policy rate that controls for both credit spreads and the house prices at the time of FOMC meeting. The results from four different versions of regression (2) are reported in Table 3.

The first column [1] of Table 3 tabulates the estimated coefficients and relative significance level of the projection of the changes in the intended funds rate over Greenbook forecasts and revisions to forecasts for output, in inflation and unemployment. The regression is run at monthly frequency on all surprises registered between 1991 and 2008. I do not include the zero-lower bound (ZLB) period because there is no time variation in the federal funds rate. The result suggests that output and inflation forecasts have significant and positive coefficients. Moreover, unemployment forecasts have a negative coefficient with a small standard error. In line with the results reported by Romer and Romer (2004); Coibion and Gorodnichenko (2011); and Cloyne and Hürtgen (2016), the estimation result implies that monetary policy tends to behave counter-cyclically and stabilizes movements in output and inflation. The R^2 of the regression is 0.51 , suggesting that although most of the changes in US monetary policy were taken in response to the evolution of forecasted output, unemployment and inflation, it does not guarantee that the unexplained variation is exogenous to the state of the economy.

The second column [2] of Table 3 tabulates the estimated coefficients for regression (2) that includes the average Baa spread for the five days prior[15] to the FOMC meeting over the same sample period. The estimated coefficients of the changes in the intended funds rate over Greenbook forecasts and revisions are similar to those in the fist column [1]. Notably, I find that the central bank reacts to changes in the Baa corporate credit spreads beyond the information contained in the Greenbook forecast of output, unemployment and inflation. δ has a point estimate of -0.16 with a small standard error; all else being equal, FOMC meetings occurring in periods with elevated levels of corporate credit spreads are associated with cuts in the intended federal funds rate. This evidence shows that, for the 1991–2008 period, the standard estimates of the Romer and Romer shocks are affected by the endogenous response of monetary policy to changes in credit spreads.

The third column [3] of table 3 reports the estimated coefficients for regression (2) that includes the 3-month moving average of monthly growth in the real house price index for the 2 months prior to the meeting. The estimated coefficients of the changes in the intended funds rate over Greenbook forecasts and revisions are similar to the results shown in column [1] and [2]. Further, the results show clear evidence that the U.S. monetary authority had systematically responded to changes in real house prices by weighting them with positive values for the Great Moderation period, which are in line with the findings by Aastveit et al. (2017), who shows that the Fed has on average responded to fluctuations in house prices and that this response has on average been quantitatively important. The coefficient ψ have a point estimate of 0.25 with a small standard error; all else

[15]The associate results are robust to using the average Baa spread calculated from the ten days prior to the meeting.

Table 3: Determinants of The Change in The Intended Federal Funds Rate

	[1]	[2]	[3]	[4]
Old Target	-0.0732***	-0.109***	-0.0917***	-0.116***
	[0.0213]	[0.0220]	[0.0226]	[0.0231]
Credit Spreads		-0.162***		-0.132***
		[0.0394]		[0.0368]
House Prices			0.250**	0.198*
			[0.111]	[0.110]
Forecasts				
Unemployment				
h = 0	-0.0760**	-0.101***	-0.0965***	-0.111***
	[0.0319]	[0.0294]	[0.0322]	[0.0305]
Output				
h = -1	0.0366**	0.0221	0.0411**	0.0285*
	[0.0156]	[0.0139]	[0.0161]	[0.0153]
h = 0	0.0735***	0.0603***	0.0685***	0.0604**
	[0.0219]	[0.0222]	[0.0240]	[0.0237]
h = 1	0.0216	0.00487	0.00927	-0.00302
	[0.0243]	[0.0250]	[0.0241]	[0.0250]
h = 2	0.0172	0.0146	0.00127	0.00132
	[0.0269]	[0.0265]	[0.0245]	[0.0246]
Inflation				
h = -1	0.0257	0.0194	0.0345	0.0286
	[0.0209]	[0.0204]	[0.0213]	[0.0209]
h = 0	0.0359	0.0427*	0.0539*	0.0539*
	[0.0273]	[0.0254]	[0.0284]	[0.0275]
h = 1	0.0688	0.0632	0.0870	0.0785
	[0.0693]	[0.0651]	[0.0684]	[0.0666]
h = 2	0.167**	0.126*	0.214***	0.168**
	[0.0738]	[0.0725]	[0.0809]	[0.0808]
Forecasts Revisions				
Output				
h = -1	-0.0256	-0.0141	-0.0220	-0.0133
	[0.0271]	[0.0250]	[0.0259]	[0.0249]
h = 0	0.0145	-0.00414	0.0184	0.00139
	[0.0321]	[0.0298]	[0.0329]	[0.0316]
h = 1	0.0563	0.0510	0.0688*	0.0640*
	[0.0366]	[0.0338]	[0.0367]	[0.0355]
h = 2	0.0411	0.0110	0.0312	0.00665
	[0.0610]	[0.0567]	[0.0556]	[0.0529]
Inflation				
h = -1	0.000661	0.00501	0.00636	0.0105
	[0.0944]	[0.0880]	[0.0953]	[0.0926]
h = 0	-0.0623	-0.0515	-0.0681	-0.0561
	[0.115]	[0.107]	[0.115]	[0.111]
h = 1	-0.0310	-0.0361	-0.0322	-0.0362
	[0.0545]	[0.0495]	[0.0440]	[0.0423]
h = 2	-0.0466	-0.0622*	-0.0619**	-0.0703**
	[0.0288]	[0.0315]	[0.0269]	[0.0274]
Observations	144	144	142	142
Adj. R-squared	0.515	0.566	0.561	0.593

Note: Projection of Δff_m , the series of changes in the intended funds rate around FOMC meetings constructed using the methodology in Romer and Romer (2004) on Greenbook Forecasts (revisions), corporate credit spreads, and house prices in the sample 1991:2008. Robust standard errors in brackets. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. Details on the specifications are reported in the text.

being equal, FOMC meetings occurring in the period with elevated levels of house price growth are associated with rising in the intended federal funds rate.

Lastly, the column [4] in table 3 reports the estimation result for equation (2) that contains both credit spreads and house prices. In line with the previous results reported in column [1] to [3], the estimated coefficients provide the evidence that monetary authority tends to endogenously response to the current economic condition and its outlooks (output, unemployment, and inflation forecasts (and those revisions). The estimated coefficient δ which is associated with credit spreads has a point estimate of -0.12 and the estimated coefficient ψ which is associated with house prices has a estimate of 0.2 with small standard errors[16], with an R^2 that is a bit higher. Overall, the results in Table 3 confirm that the conventional estimates of the Romer and Romer shocks are affected by the endogenous response of monetary policy to changes in credit spreads and house prices, simultaneously.

Further, the estimated residuals of the four specification in regression (2) shown in Table 3 constitute four different versions of narrative-based measure for monetary policy shocks. Here, I denote those as following: (I) "RR", the conventional Romer and Romer (2004) monetary policy shocks; (II) "RR+CS", adjusted monetary policy shocks which are constructed by controlling for the Baa corporate credit spreads in the regression; (III) "RR+HP", adjusted monetary policy shocks which are constructed by controlling for the 3-month moving average of real house price growth in the regression; (IV) "RR+CS+HP", fully-adjusted monetary policy shocks which are constructed by controlling for both credit spreads and house prices in the regression. Though the shocks are highly correlated (0.91 on average) each other, but they lead to dramatically different implications about monetary policy, as I show in the next section.

Taking stock of these numerical evidences, I empirically document two testable implications for the results of textual analysis using FOMC transcripts discussed in Section 2. In particular, I proceed in two steps. First, I construct a measure of distance to show the numerical differences caused by credit spreads from the residuals of the regression shown in Table 3 applying simple euclidean distance formula. I use the following specification:

$$D[RR,\ RR{+}CS] = \sqrt{([RR] - [RR{+}CS])^2} * 100 \tag{3}$$

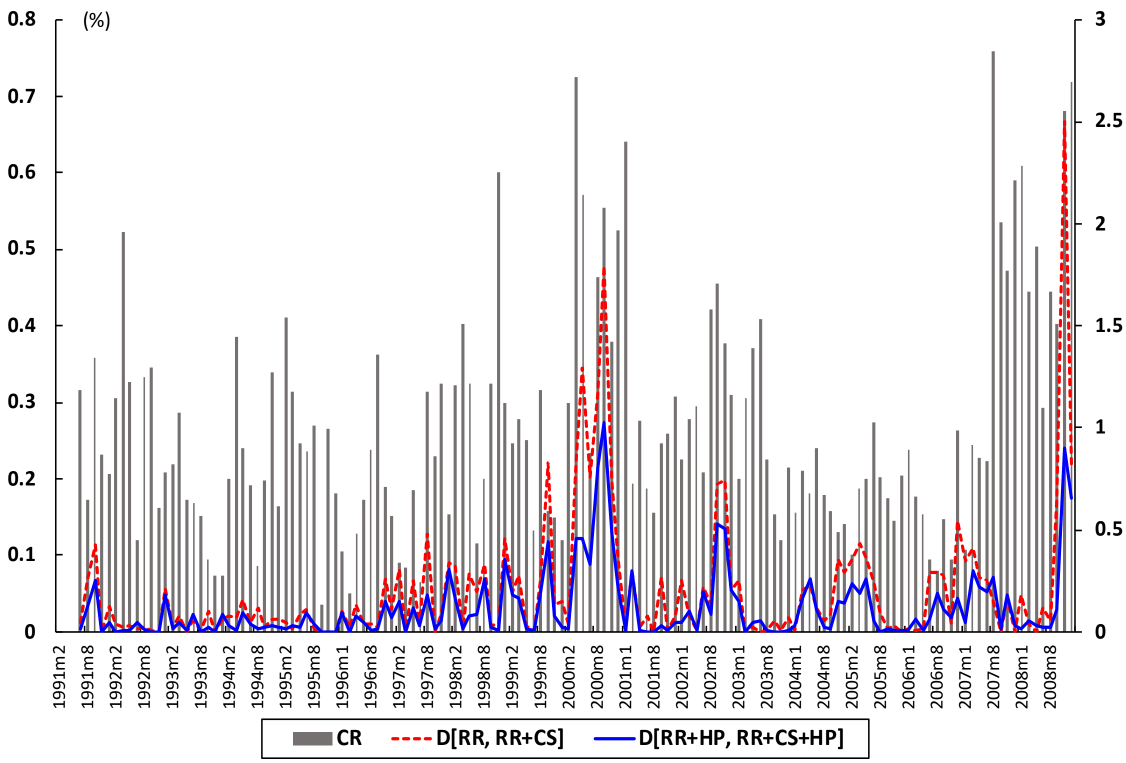
$$D[RR{+}HP,\ RR{+}CS{+}HP] = \sqrt{([RR{+}HP] - [RR{+}CS{+}HP])^2} * 100 \tag{4}$$

Both indicators, $D[RR,\ RR{+}CS]$ and $D[RR{+}HP,\ RR{+}CS{+}HP]$, imply that those values are positive if one should not consider credit spreads to identify the monetary policy shocks in terms of narrative approach. Further, both indicators are compatible with the results of textual analysis, which reflect the frequency of terms that is associated with credit market discussed in Section 2.

[16] Aastveit et al. (2017) finds that the estimated coefficient associated with real house price growth is significant and roughly equal to 0.1 using a structural VAR model with time-varying parameters model. They describe that such a response to house prices is estimated over most of their sample, 1975 Q2 to 2008 Q4 on a quarterly basis, with the important exception of the second part of the 1990s.

To make the comparison easier, the size of distances are rescaled by multiplying 100.

Figure 4: Implication for credit spreads: word search and distances



Note: Shaded bars (CR) denote the share (%) of word counts related to credit market performances to the total terms expressed in transcripts for each FOMC meeting from July 1991 to December 2008. The rates of share are plotted on the left axis. The re-scaled euclidean distances in residuals are plotted on the right axis; Red-Dashed line for "RR" and "RR+CS", Blue-Solid line for "RR+HP" and "RR+CS+HP"

Figure 4 reports the test for correlation with the frequency of word counts in the credit group (a set of list that contains terms related credit market performances) and the numerical distance that can be occurred if changes in corporate spreads are not taken into account when estimating the narrative-based monetary policy shocks. The shaded bars in Figure 4 depict the frequency (%) of word counts related to credit market performances to the total terms expressed in transcripts for each FOMC meeting over the sample period from July 1991 to December 2008. The black dashed line, *D[RR, RR+CS]*, refers to rescaled euclidean distances between the "RR" and "RR+CS" and the blue solid line, *D[RR+HP, RR+CS+HP]*, shows the rescaled distances between the "RR+HP" and "RR+CS+HP". Notably, I document that the values of both distance indicators are caused when it does not control for the systematic responses of monetary policy shocks to changes in corporate spreads. Two remarkable results can be found in Figure 4. First, the movements in each distance line are very similar to each other over the sample period, which implies that the differences can be due to credit spreads. Second, the two distance indicators and the word search results of textual analysis for the credit group in Section 2 have a higher relationship. Indeed, the correlation between CR and those distances depicted in Figure 4 is around 0.4 to 0.45. This can imply that the narrative evidence based on textual analysis using FOMC transcripts is consistent with the numerical results estimated through the re-constructed Romer and Romer (2004) estimation. Thus, both approaches provide empirical evidence that, for the Great Moderation period, the effects of monetary policy shocks depends on the presence of a systematic response of monetary policy to financial performances[17].

In a same manner, I build another measure of distance to further imply for the numerical differences caused by house prices from the estimated residuals of the regression shown in Table 3. Specifically:

$$D[RR,\ RR{+}HP] = \sqrt{([RR] - [RR{+}HP])^2} * 100 \tag{5}$$

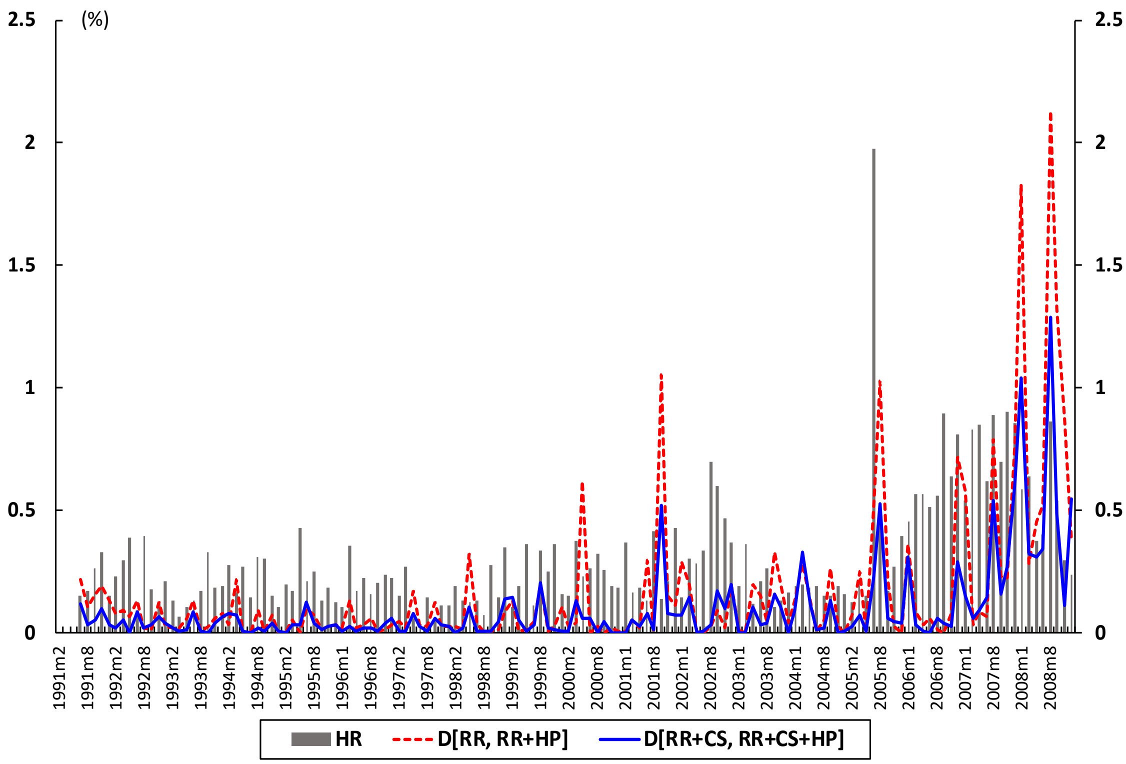
$$D[RR{+}CS,\ RR{+}CS{+}HP] = \sqrt{([RR{+}CS] - [RR{+}CS{+}HP])^2} * 100 \tag{6}$$

The equation (5) and (6) illustrate the distances of the Romer and Romder shocks which are originated by house prices for their shock construction. Similarly, both indicators are compatible with the results of textual analysis, which reflect the frequency of terms that is associated with housing market discussed in Section 2.

Figure 5 reports the test for correlation with the frequency of word counts in the housing group (a set of list that contains terms related housing market) and the numerical distance that can be created if changes in house prices are not taken into account when estimating the narrative-based monetary policy shocks. The shaded bars in Figure 5 depict the frequency (%) of word counts related to the housing market to the total terms expressed in transcripts for each FOMC meeting over the same sample period. The black dashed line, *D[RR, RR+HP]*, refers to rescaled euclidean distances between the “RR” and “RR+HP” and the blue solid line, *D[RR+CS, RR+CS+HP]*, shows the rescaled distances between the “RR+CS” and “RR+CS+HP”. I note that both distance indicators are positive values when one does not control for the endogenous reactions of monetary policy shocks to changes in house prices. In Figure 5, similarly, the trends in each distance line are comparable, implying that the disparities can be due to house prices. Moreover, the two distance indicators and the word search results of textual analysis for the housing group in Section 2 have a close relationship. Indeed, the correlation between HR and those distances illustrated in Figure 4 is around 0.42. Thus, the narrative evidence based on textual analysis and the subsequent numerical results provide clear evidence that the effects of monetary policy shocks depend on the presence of a systematic response of monetary policy to the housing market.

[17] There are several ways to measure distance indicators, such as using a square function or an absolute function of the difference between two distinct points. Nevertheless, the correlations are robust to using other methods.

Figure 5: Implication for house prices: word search and distances



Note: Shaded bars (CR+HR) denote the share (%) of word counts related to housing and financial markets to the total terms expressed in the transcripts for each FOMC meeting from July 1991 to December 2008. The rates of share are plotted on the left axis. The re-scaled euclidean distances in residuals are plotted on the right axis; Blue-Solid line for "RR" and "RR+CS+HP"

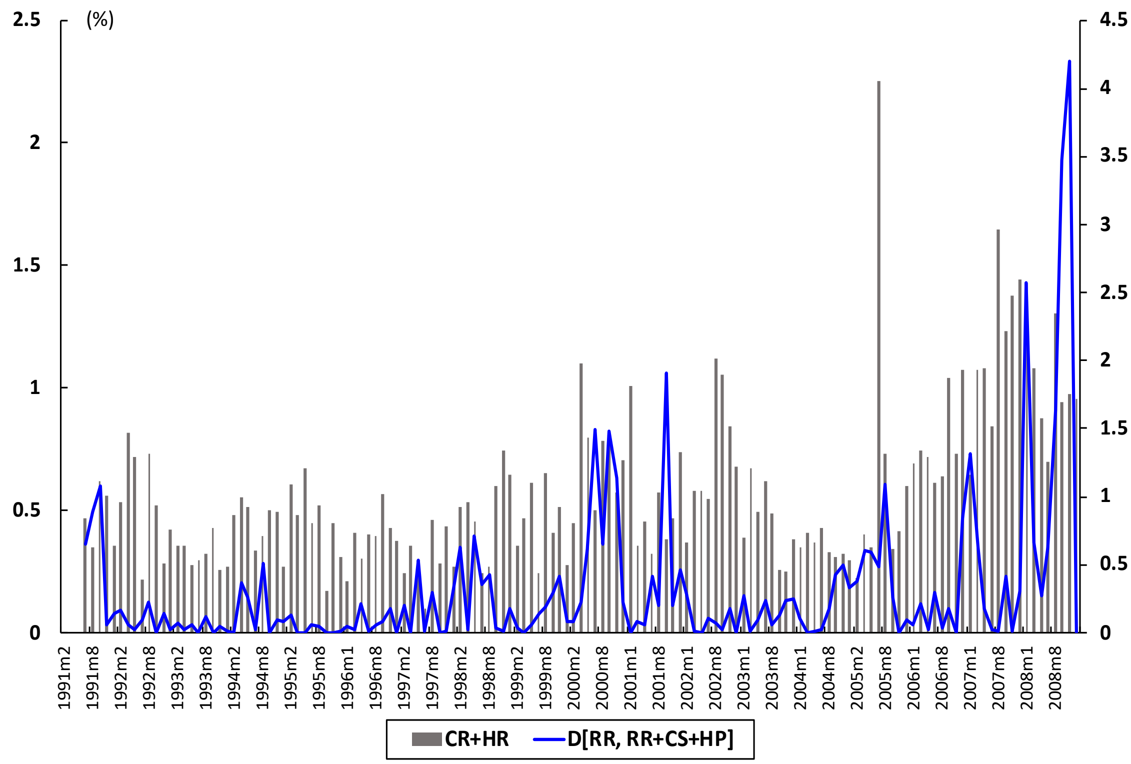
Lastly, I define a measure of distance to show the numerical differences caused by both house prices and credit spreads from the estimated residuals of the regression shown in Table 3, specifically the distance between the first and last column, applying the same formula. I use the following specification:

$$D[RR,\ RR{+}CS{+}HP] = \sqrt{([RR] - [RR{+}CS{+}HP])^2} * 100 \tag{7}$$

The equation (7) indicates the distances of the Romer and Romder shocks which are caused by both house prices and credit spreads for their shock identification. Again, the indicator is compatible with the word search, which reflect the frequency of terms that is associated with housing and credit markets discussed in Section 2.

In figure 6, I repeat the test for correlation with the frequency of word counts in the both

Figure 6: Implication for house prices and credit spreads: word search and distances



Note: Shaded bars (CR+HR) denote the frequency (%) of word counts related to both housing and credit markets to the total terms expressed in transcripts for each FOMC meeting from July 1991 to December 2008. The rates of frequency are plotted on the left axis. The re-scaled euclidean distances in residuals are plotted on the right axis; Blue-Solid line for "RR" and "RR+CS+HP"

(housing + credit) groups, a set of list that contains all terms related to housing and credit markets, and the distance that can be occurred if changes in house prices and corporate spreads are not taken into account. The shaded bars in Figure 6 depict the frequency (%) of word counts over the sample period from July 1991 to December 2008. The blue solid line, *D[RR, RR+CS+HP]*, shows the rescaled distances between the "RR" and "RR+CS+HP". The associated results are almost identical with those described in Figure 4 and Figure 5. Particularly, *D[RR, RR+CS+HP]* and the word search results "CR+HR" have a higher relationship and both follow the similar pattern. The correlation between these two indexes is around 0.39, which implies that the narrative evidence based on textual analysis is consistent with the numerical result estimated. Consequently, both approaches provide empirical evidence that the effects of monetary policy shocks rely on the presence of a systematic response of monetary policy to not only credit spreads but also house prices.

From a technical point of view, if one doesn't control for elements that can systematically affect monetary policy shocks, this identification strategy will create an endogenous component to the monetary policy shocks. In turn, the failure to account for these systematic reactions induces an attenuation in the response of all real variables to monetary policy shocks. In that sense, my view is that the evidence in Section 3 most strongly supports the fact that house prices and corporate credit spreads are critical components in the monetary authority's information set. What matters is that those conventional narrative-based monetary policy shocks are correlated with house prices and credit spreads, which has important implications for estimating monetary policy transmission to the real macroeconomic variables using these shocks. This is what I turn to next.

4 Econometric Methodology

In conventional wisdom, the study of dynamic causal inference of monetary policy can be divided into two steps. The first would be the step identifying exogenous (and unexpected) variation in monetary policy, which I closely discussed in Section 3. My results in Section 3 imply that traditional narrative-based monetary policy shocks are correlated with house prices and credit spreads. From this point of view, I propose a novel measure of monetary policy shocks that is controlled for house prices and corporate credit spreads by re-building the original Romer and Romer (2004) estimation framework, and compare the estimates to those obtained for conventional measure of the monetary policy shocks.

The second step delivers the impulse response functions estimated with given policy shocks from the first step. Hence, I now investigate to what extent the narrative identification of the effects of monetary policy shocks in structural VARs (SVARs) and local projections are affected by these correlation and my proposed correction. I begin, in Section 4.1, by laying out the basic local projections similar to those in Ramey (2016). In Section 4.2 I first document a standard SVARs and consider the alternative estimation method of Plagborg-Møller and Wolf (2021) that uses a recursive SVAR with the monetary policy shock ordered first, which is the model that is typically used to track the effects of policy shocks using external instruments.

4.1 Local Projections

Jord'a (2005) local projection is an approach to estimate the dynamic effects of a monetary policy shock. The idea is to directly regress future values of macroeconomic variables on the identified monetary policy shock, with controls for lags and other relevant macroeconomic variables. When the monetary policy shock is observed, I can perform the local projections regressions. Based on the four series of residuals from the regressions shown in Table 3, I estimate the specified macroeconomic variables directly to at horizon $t+h$ on the shock in period t, as constructing impulse responses. The advantage of this method is that impulse responses are not functions of the structural parameters of the standard Vector Autoregressive (VAR) model, and hence are less sensitive to model misspecification. Moreover, Ramey (2016) shows that the use of local projections, as opposed to VAR models, can have a major impact on the sign and size of impulse responses to a monetary policy shock. To investigate the results of this less restrictive specification, I estimate the following series of regressions: For each $h = 0, 1, ..., H$,

$$y_{j,t+h} = \alpha_h + \beta_{j,h} e_{i,t} + \psi_{j,h}(L) z_t + \varepsilon_{j,t+h} \tag{8}$$

where y_j is the variable of interest, z is a vector of (pre-treatment) control variables, $\psi_{j,h}(L)$ is a polynomial in the lag operator, and $e_{i,t}$ is the identified monetary shock which I discussed in the previous section, “RR”, “RR+CS”, “RR+HP”, and “RR+CS+HP”. The coefficient $\beta_{j,h}$ gives the response of y_j at time $t+h$ to the shocks at time t. Thus, one constructs the impulse responses as a sequence of the $\beta_{j,h}$s estimated in a series of single regressions for each horizon.

In this exercise, the vector of endogenous variables, y, consists of the real industrial production (IP), the unemployment rate, consumer price index (CPI), real durable/non-durable consumption indexes, real house price index[18], an average 10-Year Baa corporate credit spread, and the federal funds rate[19]. Variables enter the specification in log levels with the exception of interest rates and credit spreads. By keeping the composition of variables of interest fixed across the four specifications, I can assess the differences in the impulse response functions as an indication of the shocks constructed under different identification strategy. The estimation is run on a monthly basis for the sample period January 1991 through December 2008. The term $\psi(L)$ is a polynomial of order 6[20]. The vector of (pre-treatment) control variables, z, contains six lags of interest rates, log of industrial productions, the unemployment rates, log of prices, log of durable and non-durable consumptions, log of commodity prices, and 1-year treasury constant maturity rates. Most of the data can be obtained from Federal Reserve Bank of St Louis database (FRED) and Federal Housing Finance Agency (FHFA). As described in Silvia and Giovanni (2019), ε_{t+h} will be serially correlated, so the standard errors must incorporate a correction, such as Newey-West.

[18] I deflate the price information using consumer price index for all items in U.S. city average since the index is measured in nominal basis.

[19] My sample period does not include the zero lower bound.

[20] The estimation results are robust including contemporaneous value of control variables to preserve the recursiveness assumption.

4.2 Standard SVARs

Consider the following VAR, written in structural form:

$$A_0 y_t = \sum_{\ell=1}^{p} A_\ell y_{t-\ell} + c + e_t = A_+ x_t + e_t, \qquad for \quad 1 \leq t \leq T, \tag{9}$$

where y_t is a $n \times 1$ vector of endogenous variables, e_t is $n \times 1$ vector of structural shocks, A_ℓ is an $n \times n$ matrix of structural parameters for $0 \leq \ell \leq p$, c is a $n \times 1$ vector of intercepts, p is the lag length, T is the sample size, $x_t = [y_{t-1}^{'} \cdots y_{t-p}^{'} \ 1]^{'}$, and $A_+ = [A_1 \cdots A_p \ c]$. The reduced-form representation of this model is given by

$$y_t = \Phi x_t + u_t, \qquad u_t \ \sim N(0, \Sigma) \tag{10}$$

where the reduced-form parameters and the structural parameters are related through

$$\Sigma = (A_0^{'} A_0)^{-1} \qquad and \qquad \Phi = A_0^{-1} A_+ \tag{11}$$

As discussed in Leeper, Sims, and Zha (1996), specifying the monetary policy shock, denoted $e_{mp,t}$, is equivalent to specifying an equation that characterizes monetary policy behaviour. In what follows, I assume, without loss of generality, that $e_{mp,t}$ is the first shock in e_t. Consequently, the first equation of the SVAR is the monetary policy equation, for $1 \leq t \leq T$,

$$A_{0,1} y_t = A_{+,1} x_t + e_{mp,t} \tag{12}$$

where $A_{0,1}$ and $A_{+,1}$ denote the first row of A_0 and A_+, respectively. If we assume that the policy rate r_t is also ordered first in y_t, I can rewrite equation (12) as follows: For $1 \leq t \leq T$

$$r_t = \sum_{j=2}^{n} y_{j,t}^{'} \ \psi_{0,j} + \sum_{\ell}^{p} y_{t-\ell}^{'} \ \psi_\ell + \ \sigma_{mp} e_{mp,t} \tag{13}$$

where $\psi_{0,j} = -a_{0,1j}/a_{0,11}$, $\psi_\ell = a_{\ell,1\cdot}/a_{0,11}$, and $\sigma_{MP} = 1/a_{0,11}$ with $a_{\ell,ij}$ denoting ijth element of A_ℓ. The first two terms on the right-hand side of equation (13) describe the systematic component of monetary policy (in the central bank's information set), characterizing how the policy rate at time t responds to contemporaneous and lagged movements in the variables included in the model.

It is clear from equations (12) and (13) that the identification of the monetary policy shock $e_{mp,t}$ is equivalent to the identification of the systematic component of monetary policy. In turn, to characterize that we require knowledge of a subset of the structural parameters, $A_{0,1}$ and $A_{+,1}$. As is well known, without additional restrictions, it is not possible to discriminate between the many possible combinations of structural parameters ($A_{0,1}$, $A_{+,1}$) that yield the same reduced-form parameters (Σ, Φ), that is, the likelihood of the SVAR model (9) is at with respect to these combinations. If the VAR adequately captures the components in the information set of monetary authority, this method is optimal at all horizons. The majority of the literature, beginning with Sims (1980) and discussed in CEE(1999); Stock and Watson (2001), has used theoretical restrictions to achieve identification, that is, to inform the choice of $(A_{0,1}, A_{+,1})$, and most debates in the SVAR literature are about the "correct" choice of restrictions for any given application. In turn, if the VAR is misspecified, then the specification errors will be compounded at each horizon.

Plagborg-Møller and Wolf (2021) (here and forth, PMW) recommend a procedure for estimating impulse response functions using an external instrument, which they call the "internal instrument" approach. They suggest including the instrument in the VAR, ordering it first, and using a recursive (Cholesky) ordering to estimate its effects. Intuitively, this allows the other variables in the VAR to respond to the instrument on impact while the dynamics are asymptotically the same (in population and for infinite lag length) as a conventional VAR or LP-IV estimation. As discussed in section 3, the residuals of the four regressions shown in Table 3 constitute narrative-based measures of monetary policy shocks. Here I rebuild the estimates of PMW, which I call as Hybrid-SVARs, using my new series of shocks based on the narrative identification I discussed.

Typically, the Hybrid-SVARs specification substitutes the narrative (and cumulative) shocks for the Federal funds rate (ordered last) in a standard VARs model, as shown in Coibion (2012), Barakchian and Crowe(2013), and Ramey (2016). In my explorations, instead of substituting the narrative shocks for the Federal funds rate, I use the PMW version, a monthly VAR with a fixed composition of variables, to trace the effects of each identified monetary policy shock in the estimation system. This specification uses the recursive assumption; placing the narrative policy shock first, followed by the Federal funds rate, the log of real industrial production, the unemployment rates, the log of prices, and the log of commodity prices, thus assuming that the monetary shock can have an impact on the macroeconomic variables within the month but not vice versa.

5 The Dynamic Causal Inference of Monetary Policy

Section 5 applies my new measure to reassess previous empirical estimates of the effects of monetary policy on the macroeconomics. I begin my empirical reassessment of the transmission of monetary policy with the shocks that control the endogenous reactions of monetary innovations to house prices and credit costs. In Section 5.1, I estimate the local projections and in Section 5.2, I revisit Hybrid-SVARs to estimate impulse response functions of real economic variables equipped with the new measures of exogenous variation in the monetary policy shocks. In each section, the estimation is run on a monthly basis for the sample period January 1991 through December 2008 with three variants of the specification: the first that excludes both credit spreads and house prices from the standard Romer and Romer (2004) equation, the second where monetary shocks are estimated by imposing that the target rates endogenously react to changes in credit spreads, and the last model that includes both credit spreads and house prices in the identification of monetary policy shocks.

5.1 Results from Local Projection

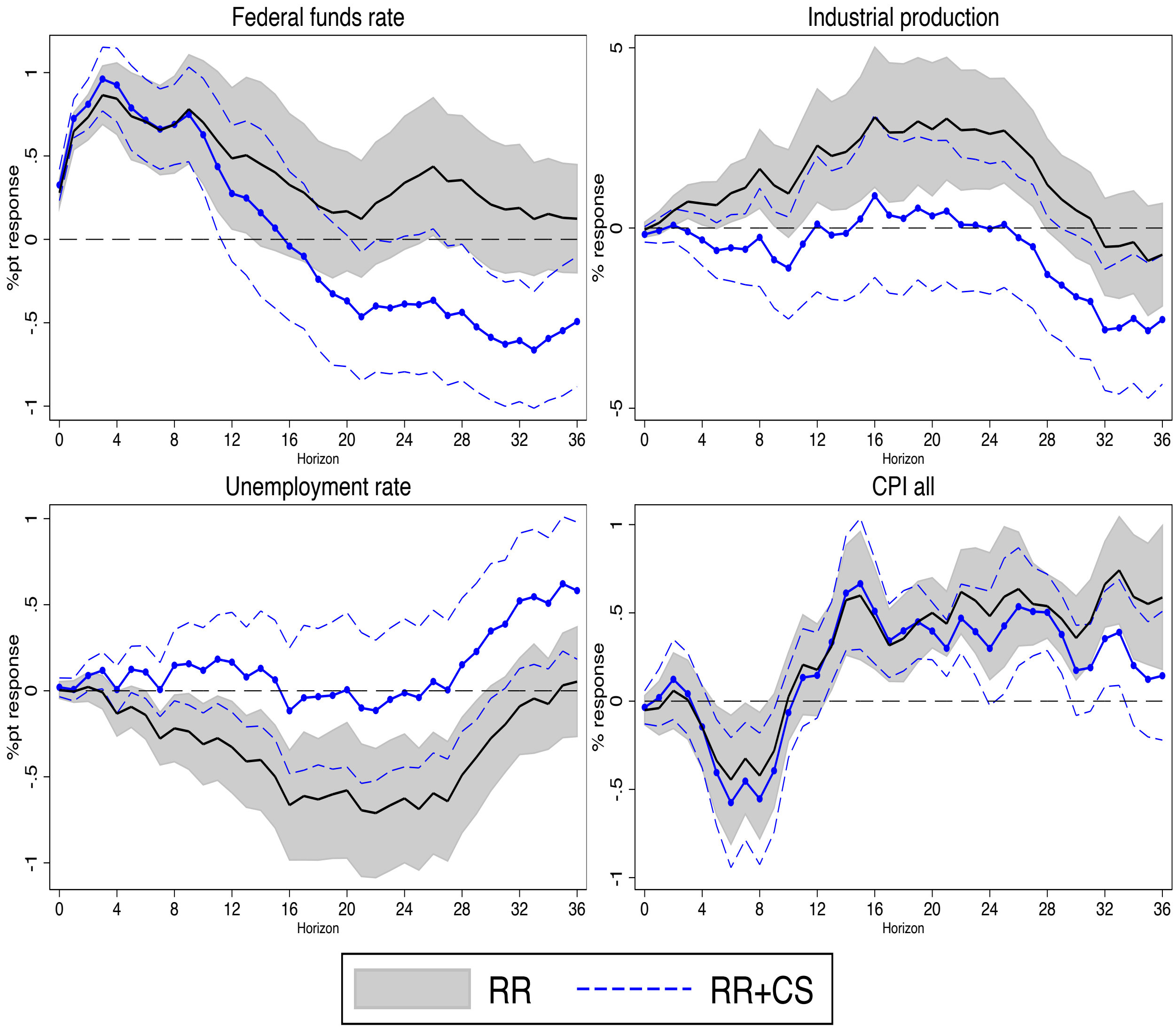
The estimation results are presented in Figures 7 through 9. Figure 7 reports impulse response functions to a monetary policy shock estimated using local projections that encompasses two different identification, "RR" and "RR+CS" over the sample Jan. 1991 through Dec. 2008. The solid black line in each panel depicts the impulse response function of the specified variable (Federal funds rate, real industrial production, the unemployment rate, and headline CPI) to an 1 percentage point changes in monetary policy shock identified in the original R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to an 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with Baa corporate credit spreads, using the "RR+CS" shocks as the policy variable. Shaded bands and blue dashed lines report the associated 68% confidence intervals around those point estimates.

For the baseline specification (solid black line), the near-term effect of the contractionary monetary policy shock causes the federal funds rate to increase about 0.25 percent. Then the rate slowly falls, returning to zero after approximately three years. The shock elicit expansionary effect on real industrial production, consumption, and unemployment, hence deliver real activity puzzles, which are not in line with standard theory of monetary policy[21]. Industrial production begins to rise in the next period and peaks 16 months later. The unemployment rate falls and reached the bottom around 24 months later. Both industrial production and the unemployment rate gradually back toward steady state after 32 months. The response of house prices and credit spreads are not consistent with the standard monetary theory, as well. The CPI is affected over the first year in the contractionary way, although they rise over a longer horizon on ward. Overall, the results from using baseline R&R shock as an instrument for monetary policy in Figure 7 echo Ramey (2016), who finds no evidence of contractionary effects of monetary policy during the Great Moderation period. Hence, the use of the conventional R&R instrument triggers real activity puzzles and price puzzle over a longer horizon, implying that conventional estimates of the effects of monetary policy on the macroeconomy using narrative identification are substantially biased due to the endogeneity of the monetary policy shocks.

One possible explanation for odd features of the impulse responses shown in Figure 7 is that miss-identification of the policy shock is distorting the estimated impulse responses. Caldara and Herbst (2019) argue that it is crucial to notice a systematic component of monetary policy is

[21] These results echo those of Barakchian and Crowe (2013) and Ramey (2016), who show that the leading specifications imply expansionary effects in the sample from 1988 through 2007; contractionary monetary policy shocks appear to be expansionary.

Figure 7: IRFs to monetary policy shocks: "RR" and "RR+CS"



Note: The solid black line in each panel depicts the impulse response of the specified variable (Federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with Baa corporate credit spreads, using the "RR+CS" shocks as the policy variable. Shaded bands and blue dashed lines denote the associated 68% confidence intervals. Sample: 1991:1 - 2008:12.

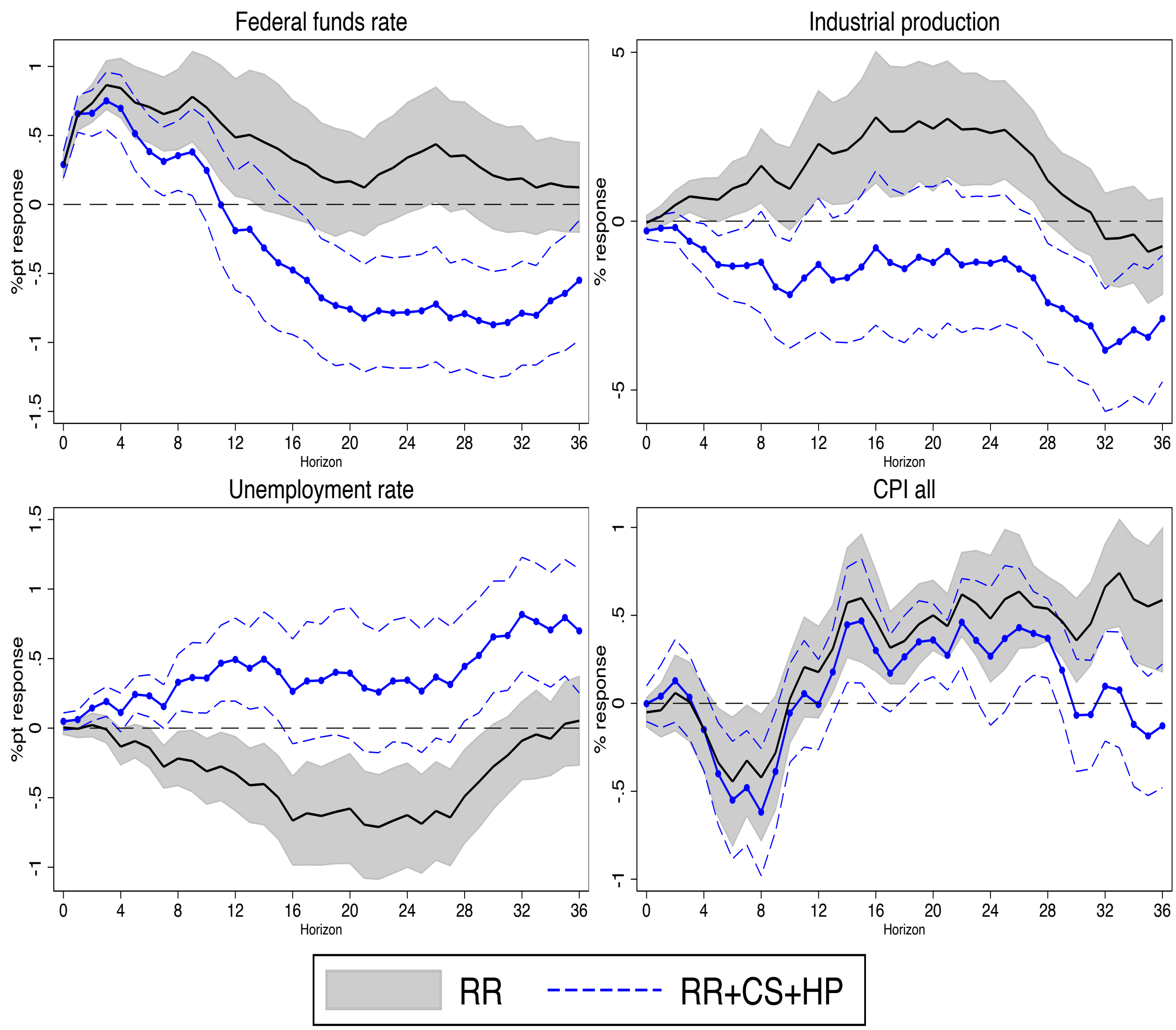
characterized by a direct reaction to changes in corporate credit spreads. They show monetary policy shocks identified using Bayesian proxy SVARs that include corporate spreads have large economic effects compared to shocks identified using conventional SVAR identification schemes. The second regression model employs the corporate credit spreads in the estimation framework to assess their findings. Indeed, the results imply that the propagation of monetary policy shocks to real economic variables depend on the presence of systematic response of monetary policy to credit spreads. In case of RR+CS shock (blue dotted line), the impact (near-term) responses of the Federal funds rate, industrial production, the unemployment rate, consumptions, and prices are nearly identical to those in the case of baseline specification. In contrast, the two identifications display different dynamics. The Federal funds rate rises quickly after the shock and turns negative after about one year and half, which implies that monetary policy becomes more accommodative relative to its initial level. This is intuitive if we think of economic data as being persistent, so that the Fed's response to that data leads to an upwardly biased estimate of interest rate persistence. This change in monetary policy stance also can be explained by inspecting the real and financial consequences of the shock.

Overall, the second model shows that the shocks constructed controlling for corporate credit spreads do not give rise to puzzles on real activity but induce no statistically significant changes in real economic variables under the 68% confidence interval. This can imply the hypothesis that a systematic component other than corporate credit spreads can explain the endogenous response of monetary policy rules. However, the key point to take away from Figure 7 is that using narrative policy shocks identified with credit spreads is crucial for understanding the direction of propagation of policy innovations during the Great-Moderation period.

I now turn to the main research questions of this paper: How much difference does controlling for the endogenous response of monetary policy shocks to house prices make for estimating the effects of monetary policy on the economy? Figure 8 provides an answer to this question. In particular, the associated results imply that the direction and size effects of monetary policy shocks on the real economy depend on the presence of a strong systematic response of monetary policy to real house prices and credit costs. Figure 8 reports impulse response functions to monetary policy shock by estimating local projections that encompass the two identification strategies, "RR" and "RR+CS+HP" over the sample form Jan. 1991 through Dec. 2008. The solid black lines report the baseline results, which are identical response functions of each variables I discussed in Figure 7. The blue dotted line in each panel in Figure 8 depicts the impulse response functions of the Federal funds rate, real industrial production, the unemployment rate and the aggregate price index to the identified monetary shocks with house prices and credit spreads, using the "RR+CS+HP" shocks as the policy variable.

The first key point to note in Figure 8 is that, in contrast with the results in Figure 7, the real activity puzzles become less pronounced with statistically significant estimates and long-lasting responses when using my improved measure of monetary policy shocks constructed by controlling for both house prices and credit spreads. Industrial production and consumptions fall on impact and those are significantly persistent over the sample period. The unemployment rate rises on impact, which are theoretically consistent results. Two years after the shock, output has fallen about 1 percent and the unemployment rate has increased about 0.5 percent. Interestingly, the real house prices drop significantly on impact and contract persistently. The results align with those

Figure 8: IRFs to monetary policy shocks: “RR” and “RR+CS+HP”



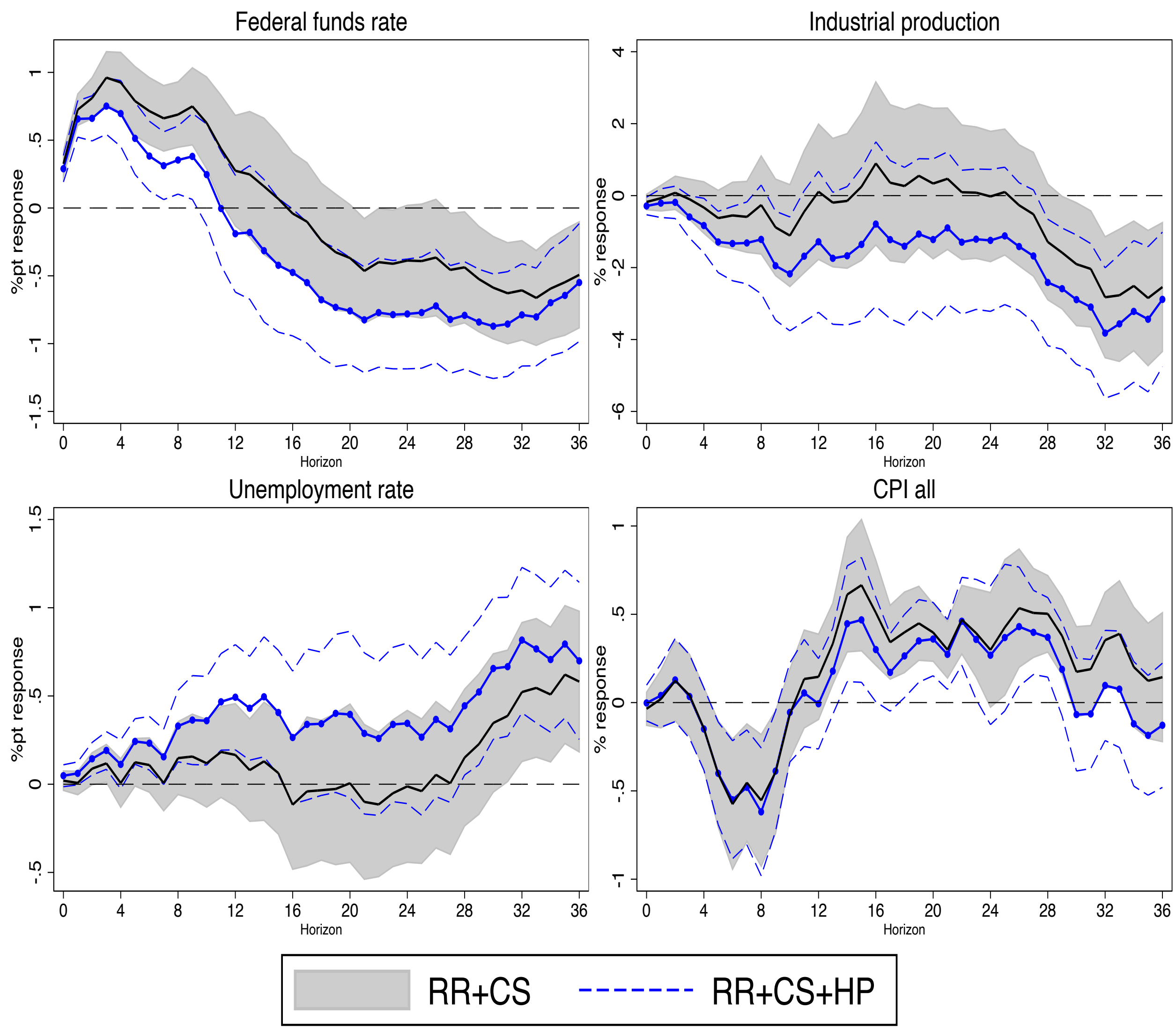
Note: The solid black line in each panel depicts the impulse response of the specified variable (Federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with both Baa corporate spreads and real house prices, using the “RR+CS+HP” shocks as the policy variable. Shaded bands and red dashed lines denote the associated 68% confidence intervals. Sample 1991:1 - 2008:12.

Iacoviello (2005); Del Negro and Otrok (2008) obtained earlier. In addition, the exercise supports the empirical finding that contractionary monetary policy shock causes a sudden tightening in financial conditions, with Baa credit spreads increase on impact significantly as discussed in Gertler and Karadi (2015), Peek, Rosengren, and Tootell (2016), Caldara and Herbst (2019).

The second key point to take away from Figure 8 is that the differences in the blue dotted lines in each Figure 7 and Figure 8 provides important implication which the attenuation occurs in the magnitude of monetary policy shocks to economic fluctuations when the shocks are not identified with real house prices. By embracing all the implications of the empirical results in Figures 7 and 8, and further to find out the potential role of house prices in the identification strategy of monetary policy shocks, finally I investigate impulse response functions to monetary policy shock by estimating local projections that encompass the two identification strategies, "RR+CS" and "RR+CS+HP" over the same sample period. The solid black line in each panel in Figure 9 illustrates the response functions of the Federal funds rate, real industrial production, the unemployment rate, and headline CPI to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation by controlling only Baa corporate spreads. On the other hand, the blue dotted line in each panel shows the response function of the variables to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with both Baa corporate spreads and real house prices, using the "RR+CS+HP" shocks as the policy variable. The results in Figure 9 provide a supporting evidence that controlling for endogenous reactions of monetary policy to changes in house prices has a significant role for understanding the transmission of policy innovations to macroeconomy. In Figure 9, the fully-adjusted monetary policy innovation shows a fall in output and a rise in the unemployment rates significantly within two months, which are 30 percent larger effects than those in the second model.

Overall, the empirical results presented in Section 5.1 can be stylized in two aspects. The key implication of the analysis presented in this section is that models that without embedding the systematic response of monetary policy to corporate credits spread or house prices identify a monetary policy shock that is contaminated by the endogenous response of monetary policy to the spreads and prices. As shown from the Figures 7 through 9, this section provide the quantitative evidences that shocks constructed without controlling for the systematic response of monetary policy to credit spreads and house prices have no discernible effect on real activity for the Great Moderation period by estimating local projections given external instruments. In addition, though the use of identified instrument accounting for the credit spreads or house prices only does not provide strong evidence, but the shocks identified by controlling both credit spreads and house prices simultaneously shows the response functions being more consistent with standard macroeconomic theory. Further, those give strong evidence that a contractionary monetary policy shock induces a contraction in output/consumptions, a rise in unemployment/credit spreads, and a reduction in (house) prices. The reasonable explanation to these finding is that both credit spreads and house prices are either conduit of changes in monetary policy to the real economy and important to quantifying the systematic response of monetary policy to economic and both financial and housing market, which are highly correlated to each other. Consequently, missing this interaction are likely to underestimate the effect of policy for business cycle analysis.

Figure 9: IRFs to monetary policy shocks: "RR+CS" and "RR+CS+HP"



The solid black line in each panel depicts the impulse response of the specified variable (Federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with Baa corporate spreads. The red dotted line in each panel depicts the impulse response of the specified variable to 1 percentage point changes in monetary policy shock identified in the R&R (2004) equation with both Baa corporate spreads and real house prices, using the "RR+CS+HP" shocks as the policy variable. Shaded bands and red dashed lines denote the associated 68% confidence intervals. Sample 1991:1 - 2008:12.

5.2 Results from Hybrid VAR

The empirical results by estimating local projections provide the strong evidence of the presence of a interdependence between monetary policy and two systematic components, credits spreads and house prices. In particular, the findings discussed in Section 5.1 are primarily based on the heterogeneous responses of the real macroeconomic variables to changes in narrative monetary policy shock across different identification strategies using the local projection method. To ensure that the empirical results are not dependent on changes in estimation methodologies, Section 5.2 examines estimated responses with a hybrid approach by integrating the newly measured monetary policy shocks into standard VARs with the same composition of variables of interest. As discussed in Section 4.2, the specification uses the recursive assumption, placing the narrative shocks first in the ordering, followed by the federal funds rate, output, unemployment, and the price index.

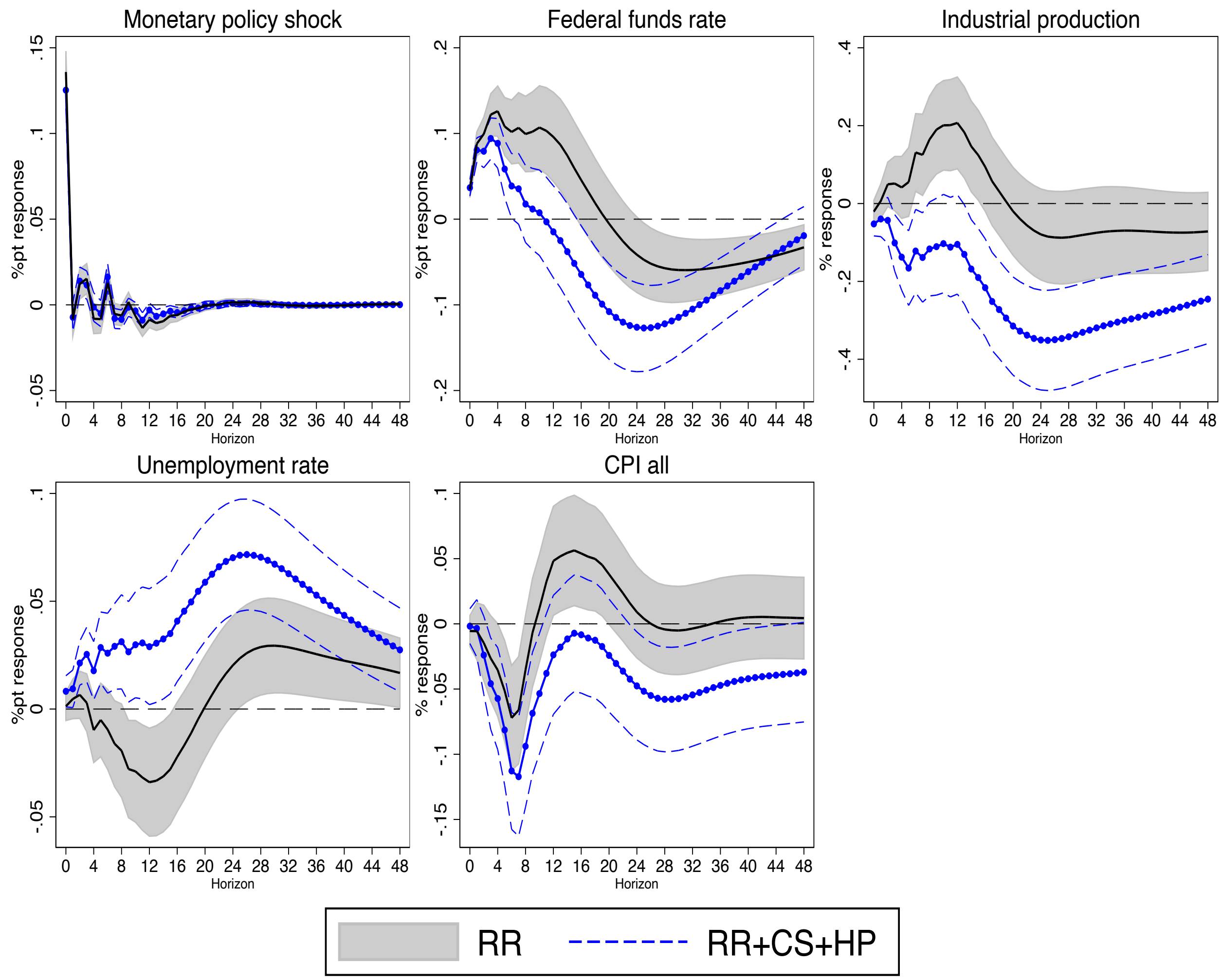
To show how monetary policy and real activity interact in Hybrid-VARs, I present empirical results from two models. I first estimate a five-equation Hybrid-VARs that consists of the policy shock projected from the baseline specification; the Federal funds rate; the log of manufacturing industrial production; the unemployment rate; and a measure of prices, the log of the consumer price index [22]. The second model is a five-equation Hybrid-VARs that consists of the same specifications as the first model except the policy innovation, the R&R narrative monetary policy shocks by controlling for the systematic responses of monetary policy to both credit spreads and house prices. The regression, which include a constant, are estimated on data from 1991 to 2008 using 6 lags.

The estimated results with Hybrid-VARs align with those in local projections. Figure 10 shows the dynamic impulse responses to monetary policy shocks using the Hybrid-VARs under the alternative identification strategies, "RR" and "RR+CS+HP". In each panel, the solid black line represents the impulse response of the variable of interests (policy shock, federal funds rate, real industrial production, the unemployment rate, and the headline consumer price index) to 100 basis point deviation of monetary policy shock identified by applying the standard R&R equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 100 basis point deviation of monetary policy shock identified from the R&R equation with the components of Baa corporate spreads and real house prices. The shaded areas and red dashed bands denote the associated 68% confidence intervals estimated over the sample period for 1991 to 2008. The baseline identification shows that contractionary monetary policy shock induces a similar puzzling on real variables in which industrial production rises and unemployment falls instantly. On the other hand, the new measure of policy shocks can account for much of the historical fluctuations at business cycle frequencies in production, employment, and inflation. The response of the real activities does not exhibit pronounced puzzles, which are theoretically consistent. Consequently, regardless of using different estimation methods, the empirical findings support the importance of incorporating house prices to understand the transmission of monetary policy shocks to the macroeconomy during the Great-Moderation period.

I then show the further implications of this finding by estimating a five-equation Hybrid-VARs that consists of the same specifications as the first model except the policy instruments, the RR shocks containing the systematic response of monetary policy to corporate credit spreads only. Fig-

[22] Coibion (2012) substitutes the cumulative sum of monetary policy shocks in place of the Federal funds rate, but the selection of endogenous variables is similar to Coibion (2012) and Ramey (2016).

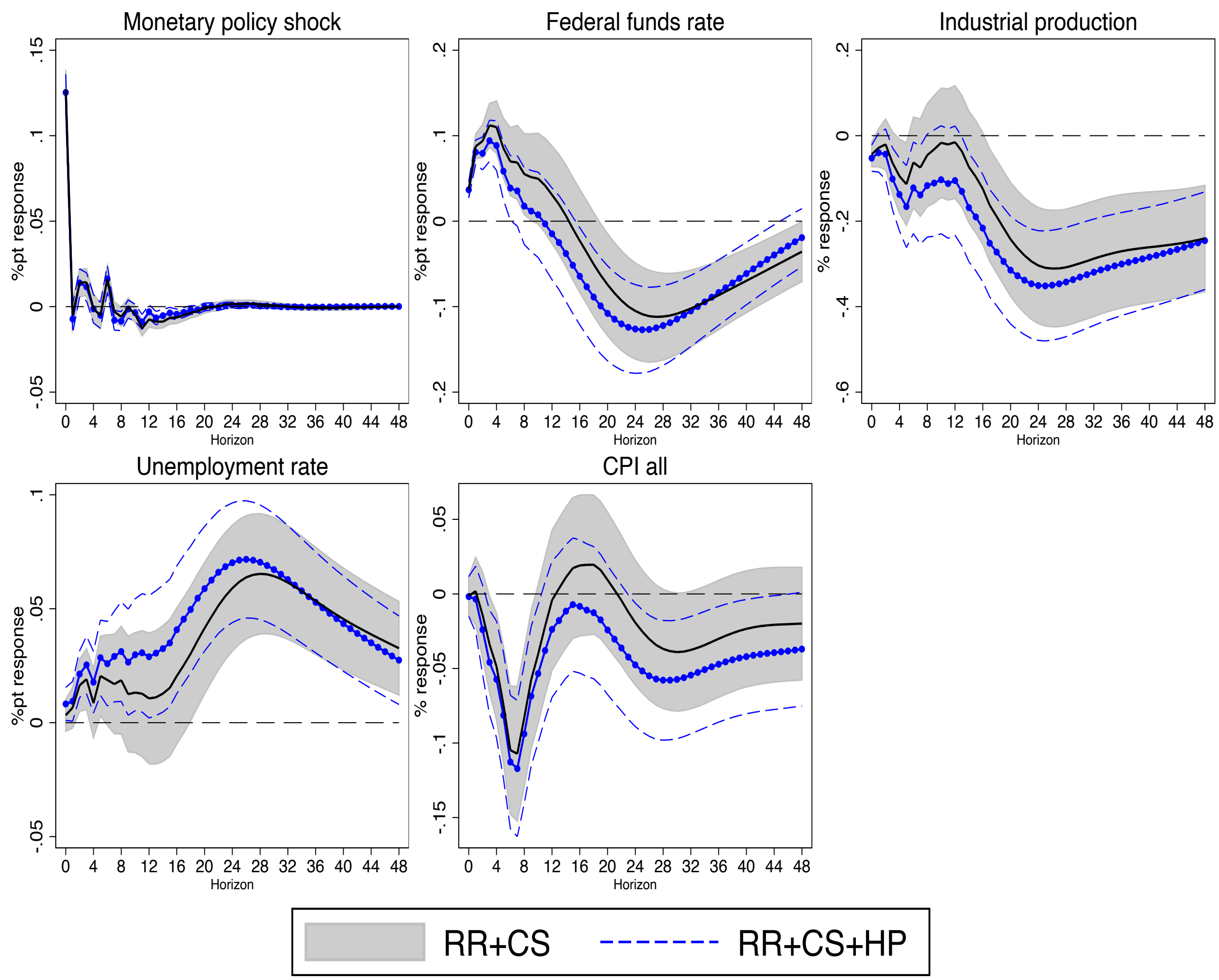
Figure 10: Hybrid-VARs - IRFs to monetary policy shocks: “RR” and “RR+CS+HP”



Note: The solid black line in each panel depicts the impulse response of the specified variable (Policy shock, federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 100 basis point deviation of monetary policy shock identified in the R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 100 basis point deviation of monetary policy shock identified in the R&R (2004) equation with both Baa corporate spreads and real house prices, using the “RR+CS+HP” shocks as the policy variable. Shaded bands and red dashed lines denote the associated 68% bootstrap confidence intervals for the system estimated over the sample period, 1991:1 - 2008:12.

ure 11 shows the impulse response functions of the variable of interests to monetary policy shocks using the Hybrid-VARs under the alternative identification strategies, “RR+CS” and “RR+CS+HP”. In each panel, the solid black line represents the impulse response to 100 basis point deviation of monetary policy shock identified by incorporating credit spreads in the R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 100 basis point deviation of monetary policy shock identified from the R&R equation with the components of Baa corporate spreads and real house prices. The shaded areas and blue dashed bands denote

Figure 11: Alternative approach (Hybrid-VARs): Dynamic impulse responses to monetary policy shocks under the different identification, “RR+CS” and “RR+CS+HP”



Note: The solid black line in each panel depicts the impulse response of the specified variable (Policy shock, federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 100 basis point deviation of monetary policy shock identified using corporate spreads in the R&R (2004) equation. The blue dotted line in each panel depicts the impulse response of the specified variable to 100 basis point deviation of monetary policy shock identified in the R&R (2004) equation with both Baa corporate spreads and real house prices, using the “RR+CS+HP” shocks as the policy variable. Shaded bands and blue dashed lines denote the associated 68% bootstrap confidence intervals for the system estimated over the sample period, 1991:1 - 2008:12.

the associated 90% bootstrap confidence intervals for the system estimated over the sample period for 1991 to 2008.

Overall, the estimated real effects of monetary policy shocks using Hybrid-VARs align with the local projection results. The baseline identification shows that contractionary monetary policy shock induces a similar puzzling on real variables in which industrial production rises and unemployment falls instantly. The response of the price level is not significantly different from zero to the policy innovation. On the other hand, the new measure of policy shocks can account for much of the historical fluctuations at business cycle frequencies in production, employment, and inflation. The response of the real activities does not exhibit pronounced puzzles, which are theoretically consistent. Consequently, regardless of using different estimation methods, the empirical findings support the importance of incorporating house prices to understand the transmission of monetary policy shocks to the macroeconomy during the Great-Moderation period.

6 Conclusion

What is the role of monetary policy? The discussion on the effects of monetary policy appears to be still controversial with a substantial degree of uncertainty despite the numerous theoretical and methodological advances as well as being one of the central questions in macroeconomics. Specifically, not only the magnitude and the significance but also the sign of the responses of economic variables such as output and prices rely on the given identification strategy, the details of the model specification, and the sample period. This paper helps rationalize the puzzling and the inconsistent results by introducing house prices and credit spreads in the identification strategy in terms of the narrative approach.

Conventional estimates of the effects of monetary policy on the macroeconomy using narrative identification are substantially biased, due to the endogeneity of the monetary policy shocks. In particular, the direction and size effects of monetary policy shocks on the real economy depend on the presence of a strong systematic response of monetary policy to real house prices and credit costs.

I find that monetary policy affects and endogenously reacts to house prices at least for the Great Moderation period. Compared with conventional estimates, which often ignore the endogenous response of monetary policy to house prices, monetary policy shocks have a more prominent role in business cycle fluctuations. The empirical evidence shows that following a monetary tightening, production, unemployment, prices contract; lending and house prices cool down, which is in line with the standard theory of monetary policy. These effects are both sizable and persistent, suggesting that monetary policy is meaningful for both economic stabilization and financial stability. These findings are robust to a number of severe tests. It is important to stress that the dynamic responses of the real activities follow the standard theory of monetary policy with the inclusion of house prices as well as credit spreads in the estimation system. The results imply that both are crucial conduits of changes in monetary policy to the real economy and factors in quantifying the systematic response of monetary policy.

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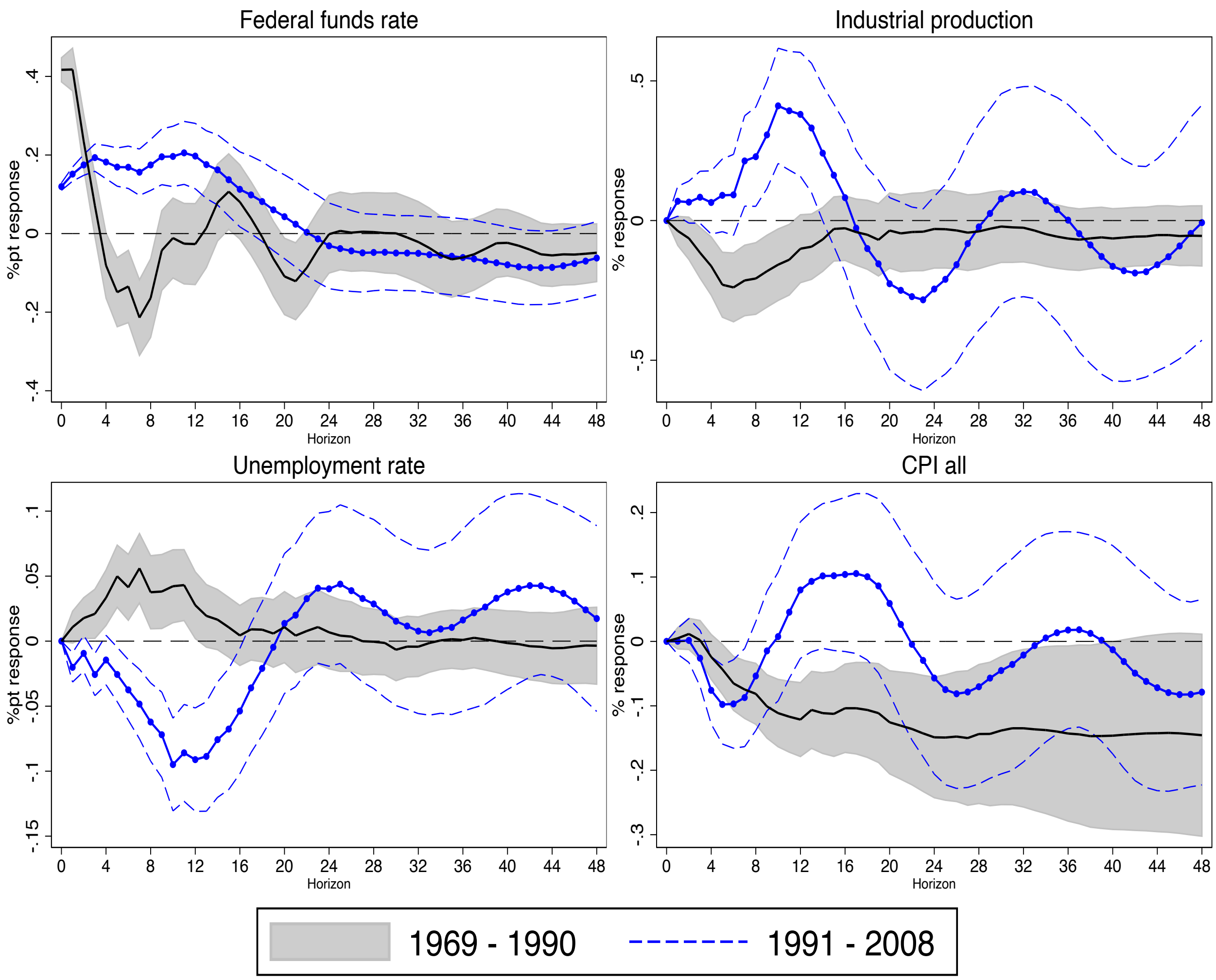
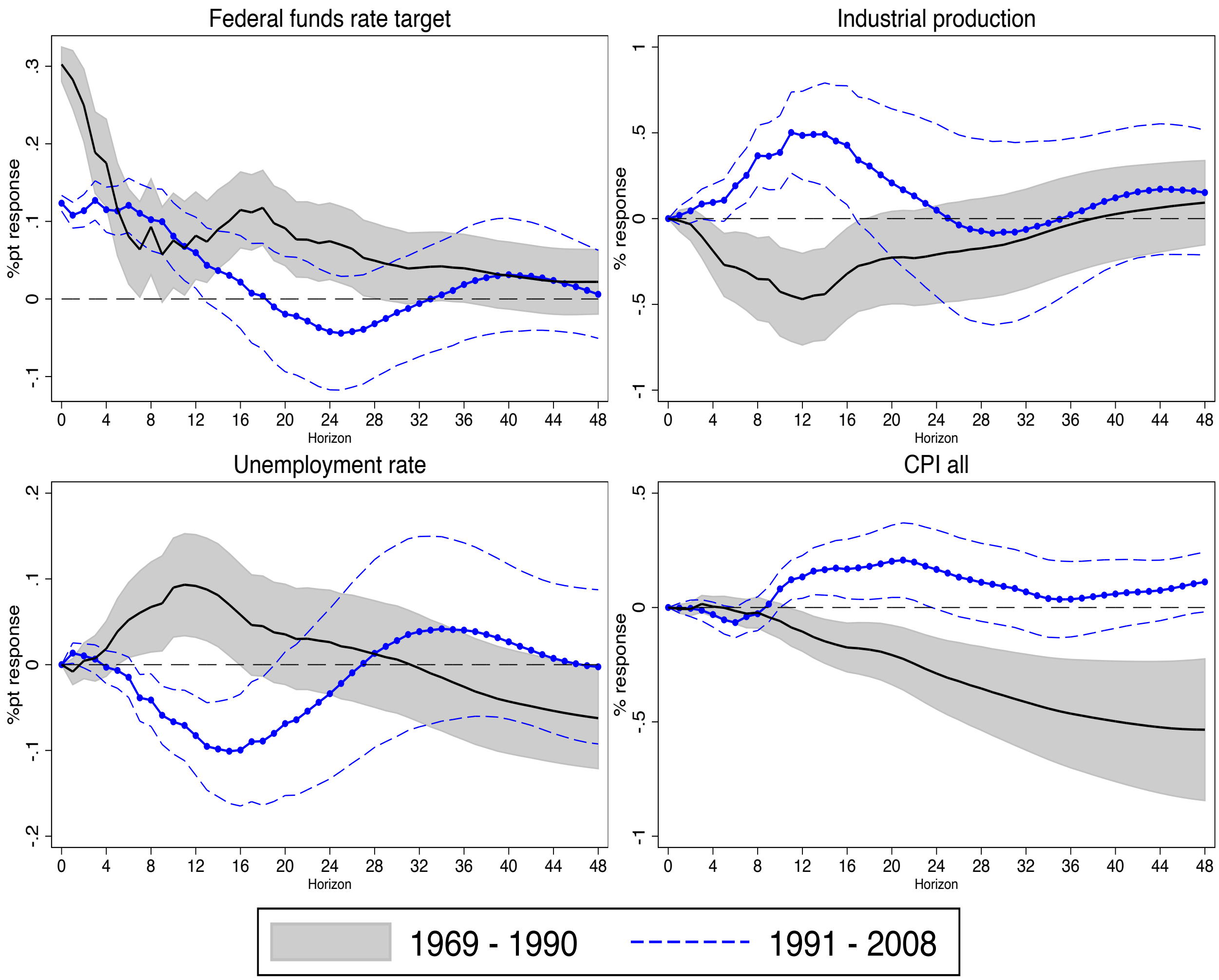
A Appendix: Supplementary tables and figures

Figure A.1: Christiano et al. (1999): SVARs identification



Note: The solid black line in each panel depicts the impulse response function of the specified variable (federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 100 basis point changes in standard deviation of monetary policy shock for 1969 - 1990. The blue dotted line in each panel shows the response function of the specified variable to 100 basis point changes in standard deviation of monetary policy shock for 1991 - 2008. Shaded bands and blue dashed lines denote the associated 90% confidence intervals for the system.

Figure A.2: Coibion (2012): Hybrid-SVARs with R&R monetary shock

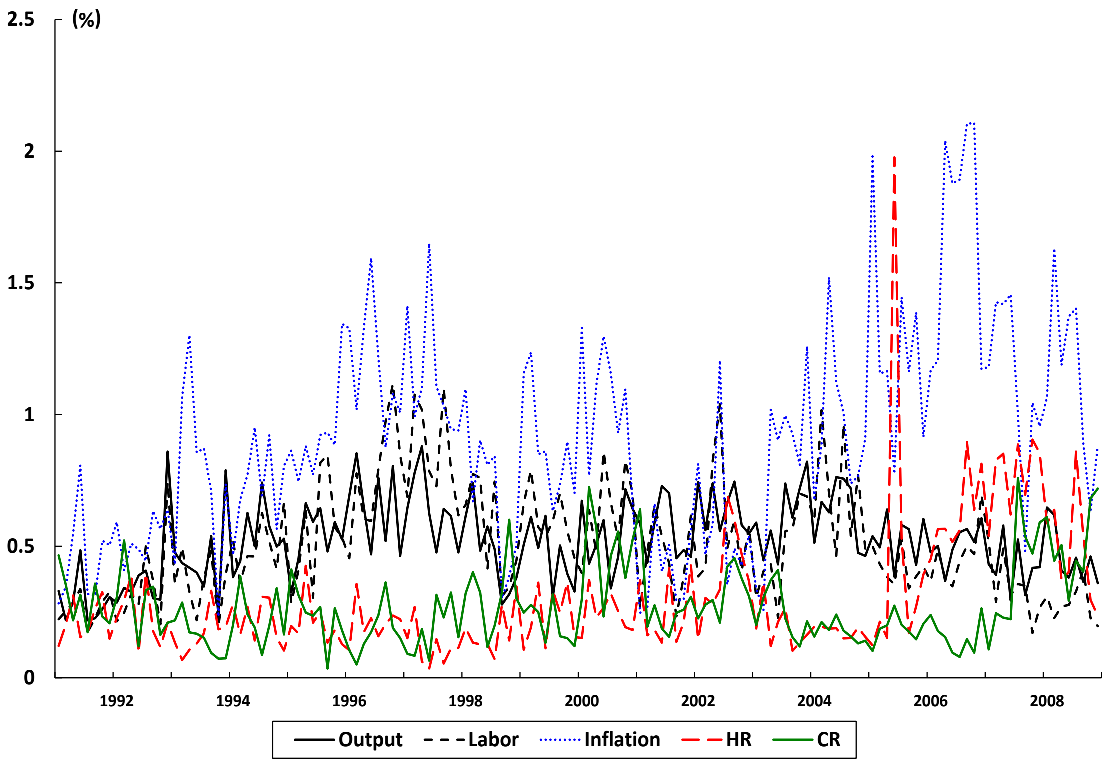


Note: The solid black line in each panel depicts the impulse response function of the specified variable (federal funds rate, real industrial production, the unemployment rate, and headline CPI) to 100 basis point changes in standard deviation of monetary policy shock for 1969 - 1990. The blue dotted line in each panel shows the response function of the specified variable to 100 basis point changes in standard deviation of monetary policy shock for 1991 - 2008. Shaded bands and blue dashed lines denote the associated 90% confidence intervals for the system.

Table A.1: Frequency of terms expressed by the group across the sample

Group	Full sample: 91-08		Pre-period: 91-99		Post-period: 00-08	
	/ total	/ all groups	/ total	/ all groups	/ total	/ all groups
Output	0.52	20.18	0.5	20.51	0.54	19.85
	[0.15]	[5.226]	[0.17]	[4.397]	[0.125]	[5.954]
Labor	0.51	19.45	0.54	21.48	0.48	17.43
	[0.218]	[6.612]	[0.238]	[5.711]	[0.193]	[6.866]
Inflation	0.91	33.52	0.81	33.09	1	33.95
	[0.407]	[10.036]	[0.317]	[8.054]	[0.463]	[11.73]
Housing	0.3	11.23	0.2	8.85	0.4	13.61
	[0.245]	[7.001]	[0.092]	[4.676]	[0.301]	[8.083]
Credits	0.39	15.62	0.36	16.08	0.42	15.16
	[0.194]	[8.329]	[0.165]	[8.53]	[0.217]	[8.158]
All groups	2.63		2.4		2.85	
	[0.612]		[0.581]		[0.561]	
Total terms	19431	521	15549	373	23314	670
Observations	144		72		72	

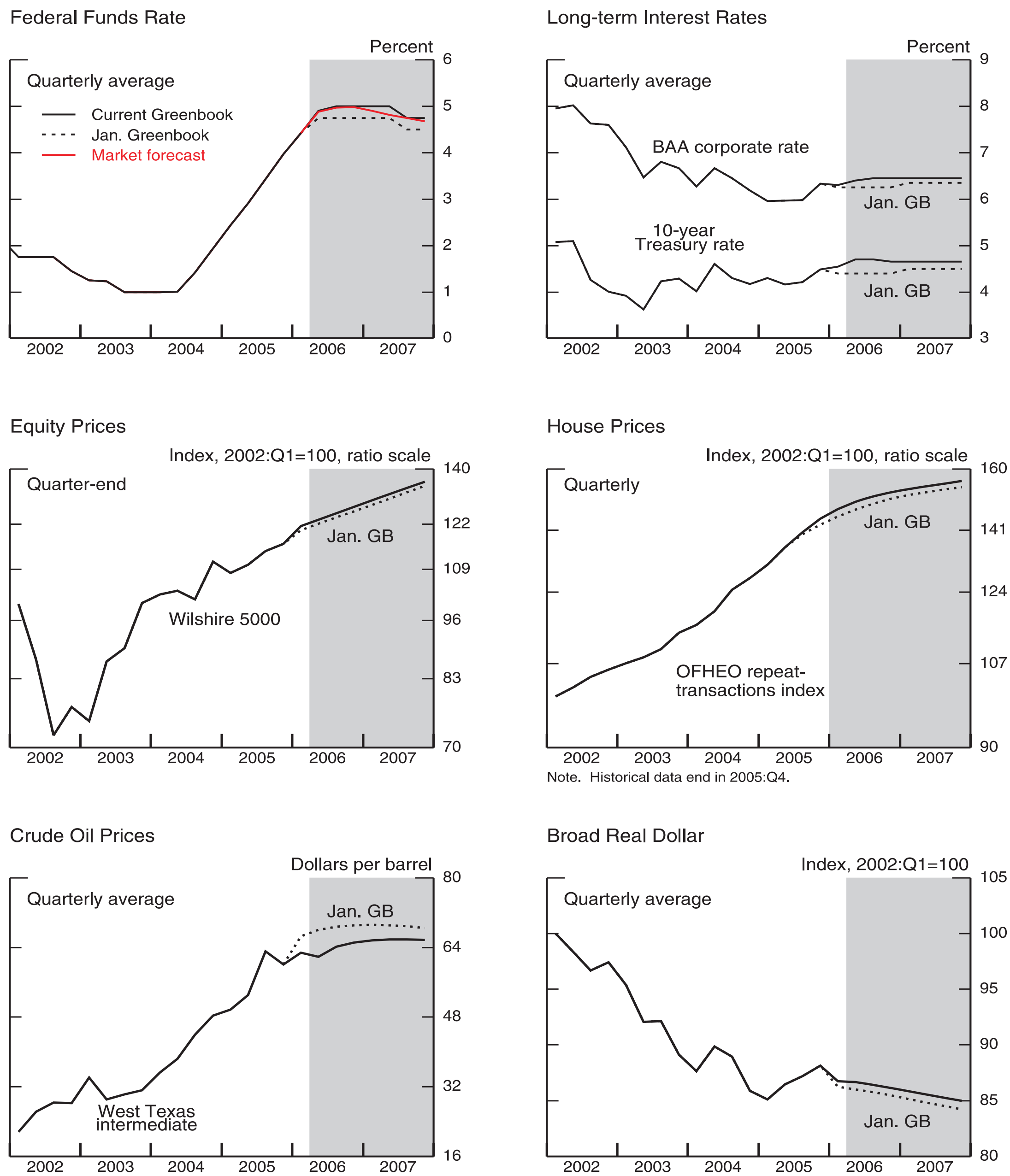
Figure A.3: Frequency of word count for each group, FOMC transcripts, 1991 - 2008



Note: Each line shows the series of frequency (%) for each group to the total number of words expressed at each FOMC meeting over the period February 1991 through December 2008; Black-Solid line represents the group "Output"; Black-Dashed line represents the group "Labor"; Blue-Dotted line shows the group "Inflation"; Red-Dashed and Green-Solid line illustrate the frequency of terms that are related to housing and credits, respectively.

Figure A.4: Greenbook forecasts for key background factors, March 2006

Key Background Factors Underlying the Baseline Staff Projection



Note. Shading represents the projection period.