Information and Policy Shocks in Monetary Surprises

Riccardo Degasperi[*]
University of Warwick

Giovanni Ricco[†]
University of Warwick
OFCE-SciencesPo, CEPR

9 June 2021

Abstract

This short note extends the approach proposed in Miranda-Agrippino and Ricco (2021), that disentangles monetary policy surprises into macroeconomic information and policy shocks, to include the zero lower bound (ZLB) period and the introduction of unconventional monetary policy which followed the Great Recession. The note details the construction of the information-robust instrument used to identify conventional monetary policy shocks, and provides some discussion on the Delphic and Odyssean components in the forward path of monetary policy surprises at longer maturities.

Keywords: Monetary Policy; Information Channel; External Instruments; VARs
JEL Classification: E52; G14

[*]Department of Economics, The University of Warwick, Social Sciences Building, Coventry, West Midlands CV4 7AL, UK. Email: R.Degasperi@warwick.ac.uk Web: www.riccardo-degasperi.com

[†]Department of Economics, The University of Warwick, Social Sciences Building, Coventry, West Midlands CV4 7AL, UK. Email: G.Ricco@warwick.ac.uk Web: www.giovanni-ricco.com

We thank Refet Gürkaynak for kindly providing the surprises in asset prices around FOMC meetings.
The extended instruments can be downloaded from https://github.com/riccardo-degasperi/info-policy-surprises.

1 Introduction

High-frequency surprises in asset prices have rapidly become the leading instrument in the study of the effects of monetary policy. This approach stems from the seminal works of Kuttner (2001) and Gürkaynak et al. (2005). The former proposed the use of surprises in the price of Federal Funds Futures contracts at the moment of a policy announcement to measure monetary news. The latter then showed that monetary policy announcements are multi-dimensional, and that these asset price movements can be decomposed into a factor absorbing the surprise in the policy action (the target) and another capturing the surprise in the policy communication (the path). More recently, Swanson (2021) has extended the methodology to include a third factor capturing the effects of quantitative easing.

The event-study literature has initially adopted monetary policy surprises as an independent variable to study the responses of a variety of asset prices to the policy news. Subsequently, and in a major innovation in the macroeconomic literature, Gertler and Karadi (2015) adopted monetary policy surprises as an instrument for monetary shocks in a proxy/IV Structural VAR.[1] However, the use of monetary policy surprises revealed interesting research problems, in the form of puzzles and instabilities in VARs and Local Projections (LPs) (see Ramey, 2016, for a thorough examination of the evidence).

From an econometric point of view, the use of monetary surprises in event-studies is uncontroversial, since in those studies the surprises are only to be thought of as news with respect to the information set of market participants. Conversely, VARs can identify the casual effect of monetary policy shocks only if the instrument is both capturing innovations to the information set of market participants and it is orthogonal to the state of the economy. Such an assumption is violated if the information sets of the policy makers and the agents do not coincide, as it is the case in the presence of informational frictions (see Miranda-Agrippino and Ricco, 2021 and Gürkaynak et al., 2021, for a discussion on this point). To imperfectly informed agents, policy actions can convey information both about monetary policy and the the state of the economy (see Romer and Romer, 2000; Melosi, 2017), even if the central bank has not superior information.

A rapidly growing literature has pointed to the information effects of policy an-

[1]The methodology has been introduced in Stock and Watson (2012a) and in Mertens and Ravn (2013). See Stock and Watson (2018) and Miranda-Agrippino and Ricco (2019) for a discussion on the conditions under which IV methods deliver successful identification in VARs and LPs.

nouncements as a possible confounding factor and the potential explanation of the observed puzzles (see Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Miranda-Agrippino and Ricco, 2021; Cieslak and Schrimpf, 2019; Lunsford, 2020; Andrade and Ferroni, 2016, among others). The key insight of this literature is that, in the presence of information frictions, policy announcements can disclose information about economic fundamentals in the short and in the long term. In studying information effects, the recent literature on monetary surprises has followed up on the lead of Campbell et al. (2012), that initially proposed a distinction between Delphic and Odyssean monetary policy. The former is the disclosure of information on the likely path of the policy rates, conditional on the bank's macroeconomic forecast, and hence endogenous to the state of the economy. Conversely, the latter corresponds to the central bank announcing a path of the interest rates, irrespectively of the macroeconomic conditions and hence as a deviation from its usual policy function.

Recent literature has provided two different ways of disentangling policy innovations from macroeconomic information. The first approach is to directly control for the information set of the central bank, as represented by the staff's internal forecasts, as done in Miranda-Agrippino and Ricco (2021).[2] The surprise component correlating with the macroeconomic projections captures the endogenous reaction function of the bank to economic conditions. Its presence in the monetary surprises is an indication of the presence of information frictions, and is due to the signalling channel of monetary policy. Conversely, the component orthogonal to the bank's projections can be thought of as the policy shock, orthogonal to economic conditions.

The other approach, as in Jarociński and Karadi (2020), Cieslak and Schrimpf (2019) and Cieslak and Pang (2020), is to use the response of stock markets to separate a component of the surprises that moves interest rates and asset prices in the same direction (macroeconomic news), from a component rising interest rates but depressing asset prices or vice-versa (policy shocks). It is important to observe that, in this approach, only information from markets is employed and hence shocks are defined as understood by

[2] A similar approach has been introduced by Campbell et al. (2012) that used survey of professional forecasters (SPF) data. While central bank's forecasts are a more direct measure of the expectations of policymakers, the mean SPF forecast is likely to be a good proxy of the bank's forecast in the presence of private signals and dispersed information. It is important to stress that being the policy action a public signal, it would shift the distribution of the agents' expectations even if the bank did not have superior information, as compared to the median SPF forecast. Hence, it is not sufficient to show that the mean SPF forecast and the Greenbook forecasts have similar performances to rule out information effects.

market participants at the moment of the announcement. Conversely, when the central bank's forecasts are adopted, shocks are defined at the intersection between the information sets of the markets and the policymakers. The two approaches can differ given the structure of the information flow in the economy.

This set of notes focuses on the 'central bank's expectational' approach of Miranda-Agrippino and Ricco (2021) to extend it to the zero lower bound (ZLB) period and the introduction of unconventional monetary policy that followed the Great Recession. First, we extend to 2015:12 the high-frequency instruments for the identification of conventional monetary policy shocks provided in Miranda-Agrippino and Ricco (2021).[3] In doing this, we discuss several details of the methodology. Second, we show that by applying the same methodology it is possible to disentangle policy and information components in surprises to contracts at longer maturity, capturing the forward path of monetary policy. Finally, we compare the information content of macro and policy components as obtained with the expectational approach and with the 'asset prices' approach of Jarociński and Karadi (2020).

The paper is structured as follows. Section 2 details the construction of the instruments for the identification of monetary policy shocks and replicates the main results in Miranda-Agrippino and Ricco (2021), using the instrument that includes the ZLB period in the identification of the shocks. Section 3 extends the expectational approach employing the Fed's forecast to a wider class of future contracts. Finally, Section 4 concludes.

2 Information and Conventional Monetary Policy

This section describes in detail the 'central bank's expectational' approach to disentangle monetary policy shocks and information effects in monetary surprises, following Miranda-Agrippino and Ricco (2021). It also extends to the ZLB period the instruments for the identification of conventional monetary policy shocks, derived from surprises to the fourth federal funds future rate (FF4). The full sample used includes 234 FOMC meetings, both scheduled and unscheduled, between January 1990 and December 2015.

[3]The original instruments span the period 1991:1 – 2009:12, due to Greenbook forecast availability and the focus on conventional monetary policy pre-ZLB. The extended series constructed for this work are available at https://github.com/riccardo-degasperi/info-policy-surprises.

The procedure consists of two steps. The first focuses on the signalling channel of monetary policy actions and controls for the information set of the central bank. The second accounts for the potential slow absorption of information in the presence of information frictions that may induce autocorrelation in expectation revisions, as discussed by the literature on informational frictions (Mankiw et al., 2003; Sims, 2003; Coibion and Gorodnichenko, 2015).

The high-frequency surprises in the FF4, computed in 30-minute windows around the FOMC announcement, are regressed on the Greenbook forecasts and revisions. The Greenbook forecasts are thought of as a representation of the information set of the Fed on the basis of which the decision was taken. Importantly, the forecasts are not part of the market participants' information set at the moment of the announcement. Indeed they are released with a 5-year lag.

Specifically, the following regression is estimated at the FOMC meeting frequency:

$$MPS_d^{FF4} = \underbrace{\alpha_0 + \sum_{j=j_x}^{J_x} \theta_j F_d^{CB} x_{q+j} + \sum_{j=k_x}^{K_x} \vartheta_j \left[F_d^{CB} x_{q+j} - F_{d-1}^{CB} x_{q+j} \right]}_{INFO_d^{FF4}} + MPI_d^{FF4} \ , \tag{1}$$

where the subscript d indexes the day of the meeting, $F_d^{CB} x_q$ represents the Greenbook forecast for variable x at quarter q on the day of meeting d, and $F_d^{CB} x_q - F_{d-1}^{CB} x_q$ is the revision in the forecast for variable x at quarter q from the Greenbook release associated to the day of the last FOMC meeting.[4]

Overparametrisation is not a cause for concern when obtaining the instrument for monetary policy, MPI_d^{FF4}, since the focus is on the residual of a regression used to project out the endogenous component of the surprise. In fact, as discussed in the original paper, results are robust to a reasonable expansion or reduction of the horizons included. However, to obtain $INFO_d^{FF4}$ we need to specify the model more carefully. Therefore, we obtain MPI_d^{FF4} and $INFO_d^{FF4}$ from two separate models.

The model used to obtain the monetary policy instrument includes the 1-quarter back-

[4] In general there is a gap of a few days between Greenbook releases and FOMC meetings. In the case of unscheduled meetings, this gap often implies that the latest available Greenbook is released in the quarter prior the current meeting. When this happens, we simply carry over the forecast to the next quarter. For instance, the Greenbook relative to the meeting on 06.07.1995 has been published on 28.06.1995. We equal the nowcast for the meeting to the nowcast of the latest Greenbook. In the Appendix, Section A.2, we show that aligning FOMC and Greenbook dates differently leaves the results unchanged.

cast, the nowcast, and the forecast up to three quarters for the growth rates of real GDP and GDP deflator. We also include the nowcast for the unemployment rate.[5] Moreover, we add the revisions for the backcast, the nowcast, and the forecasts of the first two quarters. The residual monetary policy instrument, MPI_d^{FF4}, incorporates only the variation in the surprises that is orthogonal to the information set of the Fed, and therefore is not due to the 'information channel' of monetary policy actions, whereby the systematic response of the policy rate to economic conditions reveals to market participants information on the Fed's view of the state of the economy.

In the model used to obtain $INFO_d^{FF4}$, as in the original paper, we include the backcast and the nowcast for the growth rates of real GDP and GDP deflator. We also include the nowcast for the unemployment rate. In terms of revisions, we include those for the nowcast and the 1-quarter-ahead forecast of all three variables. The fitted part of this new regression is our $INFO_d^{FF4}$ series.

The first two columns of Table 1 report the regression statistics for the regressions in Eq. (1).[6] The columns refer to the regressions to obtain MPI_d^{FF4} and $INFO_d^{FF4}$ respectively. The F and the adjusted R^2 statistics show that information effects in the FF4 surprises are significant but small, as one would expect from price revisions on assets at short horizons. However, this relatively small contamination can induce significant distortions of the impulse response functions obtained in a VAR due to the fact that business cycle shocks are very pervasive in the economy (see Miranda-Agrippino and Ricco, 2018, for a discussion on this point). We refer to Miranda-Agrippino and Ricco (2021) for a detailed discussion on these results.

The second step consists in removing the autoregressive components from both $INFO_d^{FF4}$ and MPI_d^{FF4}. High-frequency surprises are in fact forecastable from past surprises. By removing the autoregressive component we purge the current surprises from the effect of past surprises. While this may be almost immaterial in a large enough VAR that controls for past information, a local projection with few or no controls is more sensitive to contamination from past shocks.

Due to the fact the FOMC meetings do not take place every month, one has to proceed carefully in two passages. First, we align the timing of the instruments to that

[5]In this we follow Romer and Romer (2004). Including backcast, nowcast and all forecasts of unemployment would not add any additional information, while creating collinearity issues with the GDP growth series.

[6]The full set of estimates is reported in Table A.2, in the Appendix.

Table 1: Projection on Greenbook Forecasts and AR component removal

	GB Projection		AR Component	
	(1)	(2)	(1)	(2)
N	234	234	209	209
adj. R^2	0.069	0.075	0.005	0.534
F	2.113	2.418	1.412	15.357
p	0.003	0.007	0.163	0.000

First two columns: projection of high-frequency surprises in the fourth federal funds futures (FF4) on Greenbook forecasts and revisions. Columns (1) and (2) report the estimates for the regressions used to obtain MPI_d^{FF4} and $INFO_d^{FF4}$ respectively. Estimation sample: 1990:01–2015:12. *Last two columns:* projection of $\overline{MPS}_m^{FF4}$ (column 1) and $\overline{INFO}_m^{FF4}$ (column 2) on 12 own lags. Estimation sample: 1991:01–2015:12. The full set of estimates is reported in Tables A.2 and A.3, in the Appendix.

of the macro variables we will later use in our analysis. We aggregate the surprises at monthly frequency by adding the surprises within the same month and replacing with a zero the observations for those months without a FOMC meeting, thus obtaining the series $\overline{MPI}_m^{FF4}$ and $\overline{INFO}_m^{FF4}$. Second, for both series, we run the regression in Eq. (2):

$$\overline{Z}_m = \phi_0 + \sum_{j=1}^{12} \phi_j \overline{Z}_{m-j} + Z_m \tag{2}$$

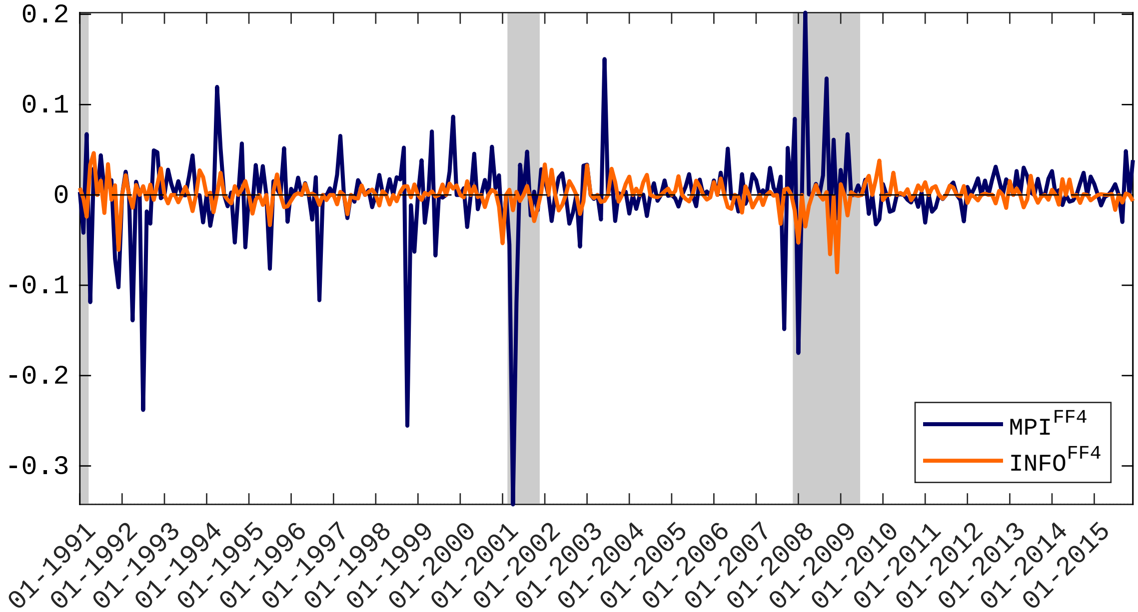
where $\overline{Z}_m$ is either $\overline{MPI}_m^{FF4}$ or $\overline{INFO}_m^{FF4}$. The residuals from these two regressions are the instruments for monetary policy shocks, MPI_m^{FF4}, and information, $INFO_m^{FF4}$, at monthly frequencies. Importantly, we run these regressions using only the observations in months when there was at least one FOMC meeting.[7] In months without meetings the value of Z_m is set to zero.

The last two columns of Table 1 report the regression statistics of Eq. (2) for both the monetary policy and the information components.[8] It is interesting to observe that while the autocorrelation coefficients are mostly insignificant for the monetary policy instrument, the information component is more strongly autocorrelated. Also, while the first two coefficients are negative for the monetary policy instrument, as it would be the case for overreaction to news, they are positive for information (see Table A.3, in the Appendix). This is in line with a pattern of slow absorption of news due to information

[7] First, we generate the lagged variables $\overline{Z}_{m-j}$ for $j = 1, \ldots, 12$. Only then we drop the observations where $\overline{Z}_m$ equals zero.

[8] The full set of estimates is reported in Table A.3, in the Appendix.

Figure 1: INSTRUMENTS FOR MONETARY POLICY SHOCKS AND INFORMATION



Notes: The chart shows the instruments at monthly frequencies for monetary policy and information shocks. These are the series MPI_m^{FF4} and $INFO_m^{FF4}$ obtained from the second step of the cleaning in Eq. (2). The series cover the period 1991:01–2015:12. Shaded areas represent NBER recessions.

frictions (Coibion and Gorodnichenko, 2015).

Figure 1 plots the two instruments over the period from January 1991 to December 2015. The blue line is the instrument for monetary policy shocks and the orange line is the instrument for information shocks.[9] It is interesting to observe that during the ZLB period, surprises in the FF4 show little variation, as expected.

2.1 The Transmission of Conventional Monetary Policy

Using the instruments for monetary policy and information shocks extended to December 2015, in Figure 2, we replicate one of the main results in Miranda-Agrippino and Ricco (2021). Specifically, we replicate Figure 6 in that paper, which estimates the domestic response of 8 macro variables to monetary policy and information shocks in the US. We do this using the full-length new IV on the sample 1979:1–2015:12. As a robustness check, in Section A.1 in the Appendix we use the original sample (1979:1–2014:12) and cut the

[9]Both instruments end in December 2015 because that is the date of the latest publicly available Greenbook forecasts. Greenbooks are published with a lag of 5 years. The instruments start in January 1991 because data on high-frequency surprises in future rates starts in January 1990 and we lose a few observations removing the autoregressive part. The market for Fed funds futures was established in 1989 at the Chicago Board of Trade.

new IV at 2009:12, to match the length of the original IV.

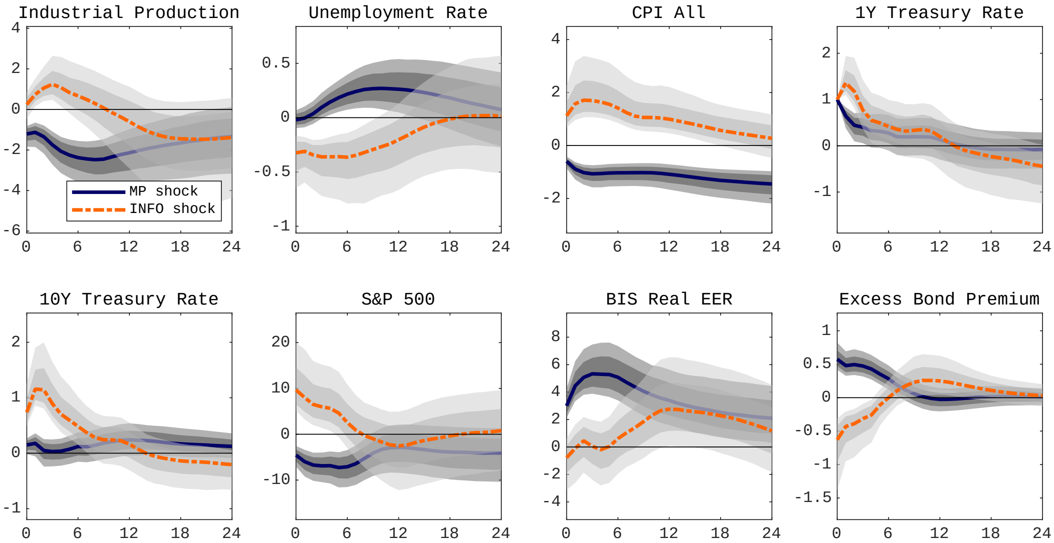
We estimate a Bayesian VAR that includes 12 lags of the endogenous variables. These variables are industrial production, unemployment rate, CPI, 1-year and 10-year treasury rates, the S&P 500, the real exchange rate for the US dollar, and Gilchrist and Zakrajšek (2012)'s excess bond premium (EBP). For the 1-year treasury rate, we use end-of-month values.[10] We apply a standard Normal-Inverse-Wishart prior that we implement using dummy observations (Bańbura et al., 2010). The confidence regions are constructed using a standard Gibbs sampler. Hyperparameters are selected optimally (Giannone et al., 2015). The structural shocks of interest are identified using external instruments (Stock and Watson, 2012b; Mertens and Ravn, 2013). Importantly, identification is obtained on the sample that spans the length of the IV. The reduced-form parameters of the VAR, however, may be estimated on a longer sample.

Figure 2 displays the impulse responses to the two shocks. Both the monetary policy and the information shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. Results are virtually indistinguishable from those reported in the original paper. The only difference is that the bands for the responses to an information shock are tighter in the current version.

This is not at all surprising. Between 2009 and 2016, the 1-year treasury rate has remained close to zero. Similarly, the variance of the surprises in the FF4 dropped considerably, as markets anticipated correctly the no-change decision for most of the FOMC meetings during the ZLB period. Including or excluding the ZLB period, when focussing on conventional monetary policy surprise is immaterial. The same is not true if we switch the focus from FF4 to futures contracts that provide information on market expectation of the path of the federal funds rate over longer horizons. This will be the focus of the next section.

[10]See Table A.1 in the Appendix for additional details on the endogenous variables.

Figure 2: Transmission of monetary policy and info shocks in the US



Notes: Solid blue: responses to a contractionary monetary policy shock. dash-dotted orange: responses to an information shock. Both shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. BVAR(12). Shaded areas represent 68% and 90% posterior coverage bands. Sample: 1979:1–2015:12. Both proxies span the period 1991:1–2015:12.

3 Information and Monetary Policy along the Path

In this section, we assess the importance of information effects in the transmission of unconventional monetary policy that can affect the medium and long end of the yield curve. To this aim, we consider surprises around FOMC announcement to prices of a broader term structure of futures contracts. Following Gürkaynak et al. (2005), the five contracts we consider are the current-month and three-month-ahead federal funds futures and the two-, three-, and four-quarter-ahead Eurodollar futures contracts. The federal funds futures are adjusted to account for the timing of the announcement within the month.

As in Gürkaynak et al. (2005),, we extract from the surprises in these contracts a 'target' and a 'path' factors capturing respectively the movements at the short end of the yield curve and at longer maturities.[11] The two factors can be given an interpretation as the current federal funds rate target and the future path of monetary policy, respectively. The path factor captures changes in future rates with maturities up to one year that are

[11] The target and path factors are constructed over the period 1990:01–2015:12 to match the length of the Greenbook forecasts, that end in 2015:12. When estimating the factors, we remove the FOMC announcement of the unscheduled meeting of 17th September 2001, following 9/11, which is a large outlier in the sample.

orthogonal to the target factor. Changes at these horizons are usually associated with forward guidance and large scale asset purchases.

We decompose the two factors in information and monetary policy using two procedures. First we regress the target and path factors onto the same set of the Greenbook forecasts adopted in Section 2. Then, as an alternative, we expand the controls by regressing the surprises onto factors extracted from a more complete set of variables and horizons covered by the Greenbook forecasts.

3.1 Controlling for the Greenbook forecasts

Following the procedure detailed in the previous section, we run the following regressions:

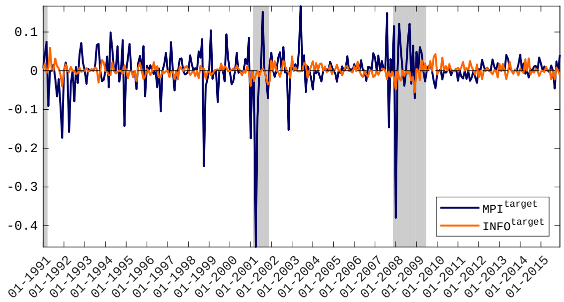
$$Target_d = \underbrace{\bar{\alpha}_0 + \sum_{j=j_x}^{J_x} \bar{\theta}_j F_d^{CB} x_{q+j} + \sum_{j=k_x}^{K_x} \bar{\vartheta}_j \left[F_d^{CB} x_{q+j} - F_{d-1}^{CB} x_{q+j}\right]}_{INFO_d^{target}} + MPI_d^{target} \ , \quad (3)$$

$$Path_d = \underbrace{\tilde{\alpha}_0 + \sum_{j=j_x}^{J_x} \tilde{\theta}_j F_d^{CB} x_{q+j} + \sum_{j=k_x}^{K_x} \tilde{\vartheta}_j \left[F_d^{CB} x_{q+j} - F_{d-1}^{CB} x_{q+j}\right]}_{INFO_d^{path}} + FWG_d \ . \quad (4)$$

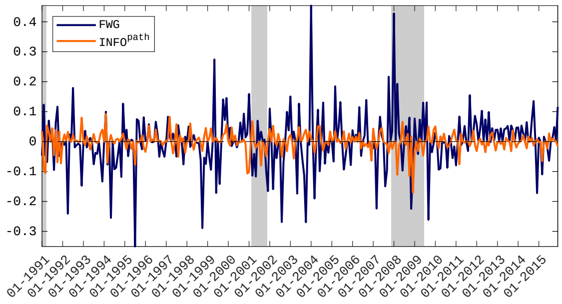
We obtain two monetary policy IVs, one capturing conventional monetary policy shocks, MPI_d^{target}, and the other potentially capturing the effects of forward guidance, FWG_d, along with two measures of the information revealed at the moment of the announcements. As described in Section 2, we then aggregate the instruments at monthly frequency and we remove the autocorrelation components, obtaining the instruments for monetary policy shocks for the target, MPI_m^{target}, and for the path, FWG_m, and the relative instruments for information effects (reported in Figures 3a and 3b). Then we study the IRFs to the identified shocks in a VAR model for the US economy.

The procedure separates the policy action from information effects even when applied to surprises on the path of the policy rate (Figure 4b). For the target, the responses to a tightening identified using MPI_m^{target} show a contraction in industrial production and prices, and an increase in unemployment (Figure 4a). The dollar appreciates and the EBP rises on impact. However, production, stock prices, and credit spreads rebound quite sharply, possibly indicating that there might be some residual information at longer horizons we are not controlling for. The results for the path offer similar conclusions.

Figure 3: MP AND INFO COMPONENTS FROM THE TARGET AND PATH FACTORS



(a) MP and INFO components from the target



(b) MP and INFO components from the path

Notes: The chart shows the instruments at monthly frequencies for monetary policy and information shocks constructed from Gürkaynak et al. (2005)'s target and path factors, as described in Section 3.1. The series cover the period 1991:01–2015:12. Shaded areas represent NBER recessions.

The responses to a contractionary monetary policy shock identified with FWG_m indicate an overall contraction in the domestic economy. However, the responses of real exchange rate and EBP may indicate residual information and risk premia effects (Figure 4b). One potential reason is that we need to expand the set of Greenbook forecasts and revisions to include more horizons and possibly more variables. We will do this next.

3.2 Incorporating the Information Set of the Fed

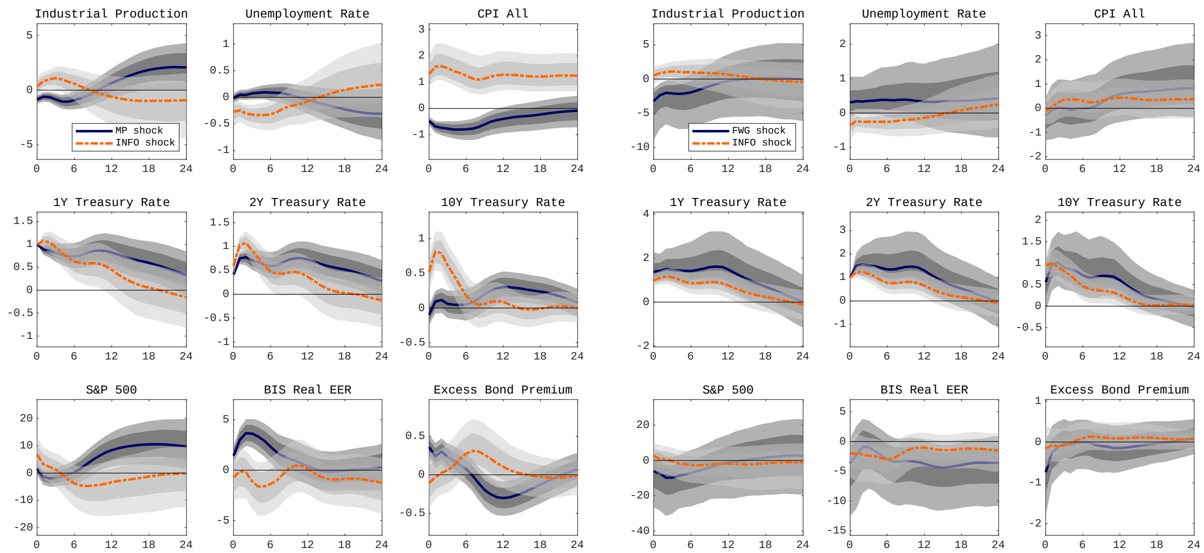
We now expand the set of controls that proxy the information set of the Fed. Specifically, for each horizon of the Greenbooks we estimate the first two principal components across all variables. We do this separately for forecasts and revisions, so that in the end we obtain 18 factors for the forecasts and 18 factors for the revisions.[12]

We then regress the target and path factors on the set of 36 principal components. Specifically, we estimate the following regressions:

$$\begin{aligned} Target_d &= \widehat{\alpha}_0 + \sum_{i=1}^{2}\sum_{j=-2}^{6} \widehat{\theta}_{ij} PC^F_{d,i}(q+j) + \sum_{i=1}^{2}\sum_{j=-2}^{6} \widehat{\vartheta}_{ij} PC^R_{d,i}(q+j) + MPI^{target}_d \ , & (5)\\ Path_d &= \breve{\alpha}_0 + \sum_{i=1}^{2}\sum_{j=-2}^{6} \breve{\theta}_{ij} PC^F_{d,i}(q+j) + \sum_{i=1}^{2}\sum_{j=-2}^{6} \breve{\vartheta}_{ij} PC^R_{d,i}(q+j) + FWG_d \ . & (6) \end{aligned}$$

[12]In the construction of the principal components, we do not consider forecasts that go beyond 6 quarters and backcasts beyond 2 quarters because forecasts at these horizons are provided only for a subset of Greenbook releases. Hence, we consider the horizons between the 2-quarter backcast and the 6-quarter forecast. Moreover, we drop the forecasts relative to headline and core PCE inflation, as they start in 2000.

Figure 4: Transmission to the US (original cleaning)



(a) Target factor

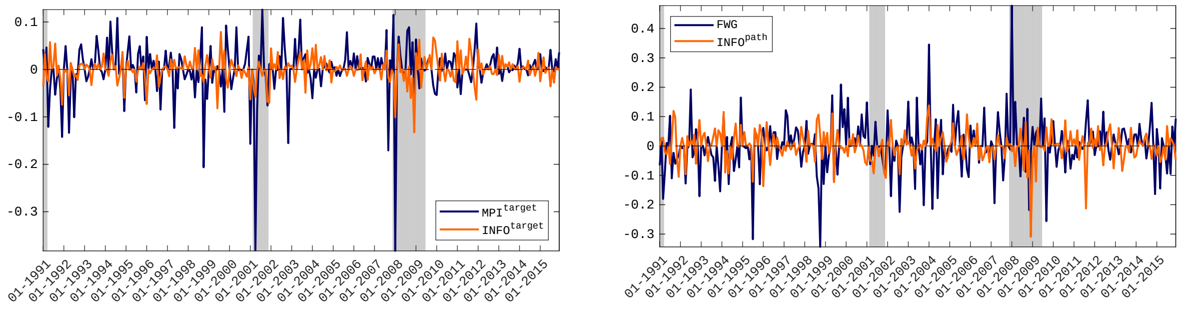
(b) Path factor

Notes: Left panel – Solid blue: responses to a monetary policy shock identified using MPI_m^{target}. Dash-dotted orange: responses to an information shock identified using $INFO_m^{target}$. Both shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. Right panel – Solid blue: responses to a monetary policy shock identified using FWG_m. Dash-dotted orange: responses to an information shock identified using $INFO_m^{path}$. Both shocks are normalised to induce a 1% increase in the US 2Y treasury constant maturity rate. BVAR(12). Shaded areas represent 68% and 90% posterior coverage bands. VAR sample: 1990:01–2019:12. All instruments span the period 1991:1–2015:12.

where $PC_{d,i}(q+j)$ indicates the ith principal component, computed over all Greenbook variables at horizon $q+j$. PC^F indicates principal components estimated over the forecasts. PC^R indicates principal components estimated over the revisions. The regression is run at FOMC meeting frequency, where d indexes the FOMC announcement day. q represents the quarter corresponding to day d. As before, the autoregressive component is removed and the instruments are aggregated at monthly frequency, the instruments for monetary policy shocks for the target, MPI_m^{target}, and for the path, FWG_m, and the relative instruments for information effects, $INFO_m^{target}$ and $INFO_m^{path}$ (all instruments are reported in Figures 5a and 5b).

Figure 6b shows the responses to a monetary tightening identified with the instrument for information shocks, $INFO_m^{path}$ (dash-dotted orange) and with the instrument for monetary policy shocks, MPI_m^{target} (solid blue). Although we are now controlling for more variables and more forecast horizons, therefore enlarging the information set of the Fed, the responses show little improvement with respect to the procedure of the previous

Figure 5: MP and INFO components from the target and path factors

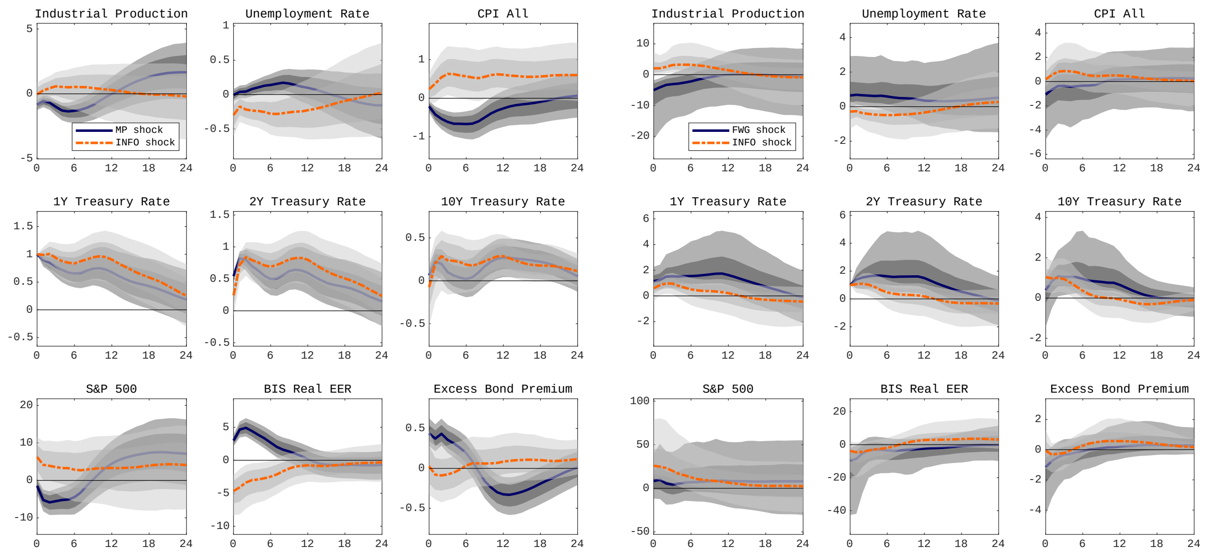


(a) MP and INFO components from the target

(b) MP and INFO components from the path

Notes: The chart shows the instruments at monthly frequencies for monetary policy and information shocks constructed from Gürkaynak et al. (2005)'s target and path factors, using the refined cleaning described in Section 3.2. The series cover the period 1991:01–2015:12. Shaded areas represent NBER recessions.

Figure 6: Transmission to the US (alternative cleaning)



(a) Target factor

(b) Path factor

Notes: Left panel – Solid blue: responses to a monetary policy shock identified using MPI_m^{target}. Dash-dotted orange: responses to an information shock identified using $INFO_m^{target}$. Both shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. Right panel – Solid blue: responses to a monetary policy shock identified using FWG_m. Dash-dotted orange: responses to an information shock identified using $INFO_m^{path}$. Both shocks are normalised to induce a 1% increase in the US 2Y treasury constant maturity rate. BVAR(12). Shaded areas represent 68% and 90% posterior coverage bands. VAR sample: 1990:01–2019:12. All instruments span the period 1991:1–2015:12.

section.

Table 2: Projection of Target Factor on Greenbook Forecasts

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.072	0.002	0.012	0.064	0.066	0.021	0.014	-0.003	-0.001	-0.002
F	1.763	2.237	3.223	5.405	4.080	3.132	2.730	2.142	2.304	2.155
p	0.008	0.066	0.013	0.000	0.003	0.016	0.030	0.076	0.059	0.075

Notes: Projection of Gürkaynak et al. (2005)'s target factor, extended to 2015:12, on the 36 principal components of Greenbook forecasts and revisions, as detailed in Eq. (5). From the second column onward, the regressors are the first two principal components computed on all Greenbook variables and the first two principal components computed on revisions, at a specific horizon. The column header indicates the horizon considered. Estimation sample: 1990:01–2015:12. Tables A.4 and A.5 in the Appendix report the full set of estimates.

Table 3: Projection of Path Factor on Greenbook Forecasts

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.135	0.000	0.025	0.064	0.100	0.039	0.012	0.033	0.026	0.011
F	2.050	1.523	1.986	3.363	5.394	3.881	3.693	4.489	3.658	1.945
p	0.001	0.196	0.098	0.011	0.000	0.005	0.006	0.002	0.007	0.104

Notes: Projection of Gürkaynak et al. (2005)'s path factor, extended to 2015:12, on the 36 principal components of Greenbook forecasts and revisions, as detailed in Eq. (6). From the second column onward, the regressors are the first two principal components computed on all Greenbook variables and the first two principal components computed on revisions, at a specific horizon. The column header indicates the horizon considered. Estimation sample: 1990:01–2015:12. Tables A.6 and A.7 in the Appendix report the full set of estimates.

3.3 Information Regressions

A closer look at the informational content of the principal components used in the first step of the cleaning reveals information effects that become stronger at all horizons, as expected. Table 2 reports the regression statistics of Eq. (5), where the target factor is used as dependent variable.[13] We provide these results also for the path factor (Table 3).[14]

The first columns of the two tables report the regression statistics for all the controls we use in Eq. (5) and Eq. (6). To assess the horizon-specific informational content of the Greenbooks, in the remaining columns we include information about one horizon at the time. Specifically, we include the first two principal components computed on all Greenbook variables, and the first two principal components computed on revisions, at a specific horizon. The column header indicates the horizon considered.

[13]The full set of estimates is reported in Tables A.4 and A.5 in the Appendix. We split the results on two tables for convenience, so that the same column across tables refers to one equation. In other words, the coefficients reported in column 1 of Table A.4 and those in column 1 of Table A.5 are estimated jointly. Table A.4 reports the coefficient estimates for the principal components computed on the Greenbook forecasts. Table A.5 reports the estimates for the principal components computed on the Greenbook revisions.

[14]The full set of estimates is reported in Tables A.6 and A.7 in the Appendix. Also in this case, we split the results on two tables, so that the same column across tables refers to one equation.

Table 4: Removal of the Autoregressive Component

Lags	Target		Path	
	MPI	INFO	FWG	INFO
N	208	208	208	208
adj. R^2	0.055	0.210	-0.006	0.129
F	1.890	4.185	0.929	3.156
p	0.037	0.000	0.519	0.000

First two columns: Projection of the residuals (MPI) and the fitted part (INFO) of Eq. (5) on 12 own lags. *Last two columns:* Projection of the residuals (FWG) and the fitted part (INFO) of Eq. (6) on 12 own lags. For the first two columns, the dependent variable of Eq. (5) is the target factor of Gürkaynak et al. (2005), extended to 2015:12. For the latter two columns, the dependent variable of Eq. (6) is the path factor. Estimation sample: 1991:01–2015:12. The full set of estimates is reported in Table A.8, in the Appendix.

This gives us an indication on which horizon of the forecasts has the highest explanatory power over the surprises in the target and path of monetary policy. The F statistics suggest that most of the information in the Greenbooks that correlates with the surprises in the target is concentrated around the nowcast. Whereas the surprises in the path correlate with information at longer horizons.

Finally, Table 4 reports the statistics for the regression used to remove the autoregressive component.[15] Similarly to what we find using surprises in the FF4, the autocorrelation coefficients are mostly insignificant for the monetary policy instrument. However, the information component is more strongly autocorrelated and indicates slow absorption of news by the market due to information frictions.

3.4 A Comparison Across Methodologies

How do different approaches in disentangling information and monetary policy compare? Some clue can be gathered by looking at Table 5, that reports the correlations among the different instrument discussed in this note, and the two components obtained by Jarociński and Karadi (2020) using movements in asset prices to distinguish policy shocks from information about fundamentals.

Results indicate that the two methods differ in the outcome, even if the identified shocks have broadly similar properties when studied in a VAR model. Looking at the first two rows, the correlation between the FF4 monetary policy components is relatively

[15] The full set of estimates is reported in Table A.8, in the Appendix.

Table 5: Instruments correlation matrix

	JK_{mp}	JK_{info}
MPI^{FF4}	0.73*	0.42*
$INFO^{FF4}$	0.24*	0.15*
$target_{raw}$	0.73*	0.39*
MPI^{target}	0.69*	0.32*
$INFO^{target}$	0.29*	0.21*
$path_{raw}$	0.40*	-0.03
FWG	0.27*	-0.14*
$INFO^{path}$	0.19*	0.12*

Notes: JK_{mp} and JK_{info} are respectively the monetary policy and central bank information shocks of Jarociński and Karadi (2020) obtained with sign restrictions. MPI^{FF4} and $INFO^{FF4}$ are the extended version of Miranda-Agrippino and Ricco (2021)'s instruments. $target_{raw}$ and $path_{raw}$ are the two factors of Gürkaynak et al. (2005) extended to 2015:12. The remaining four entries are the target and path factors decomposed into monetary policy and information as described in Section 3.2. Sample: 1991:01 – 2015:12.
* $p < 0.05$.

high (0.73). Yet the correlation between information components is sensibly lower (0.15). Moreover, there is a significant correlation across instruments that are supposed to be orthogonal. The information component of Jarociński and Karadi (2020) correlates more with the monetary policy component identified from the Greenbooks, MPI^{FF4}, than with the information component, $INFO^{FF4}$.

The same holds true when looking at the correlation between the components of Jarociński and Karadi (2020) and the components identified from the target factor. Again, JK_{mp} and MPI^{target} correlate quite strongly (0.69), but the correlation between JK_{info} and $INFO^{target}$ is limited, and lower than the correlation between JK_{info} and MPI^{target}. The correlations deteriorate even more when considering the components extracted from the path factor.

While these results are preliminary, they point to the fact that markets' and Fed's information sets are misaligned and therefore the short-term assessment of the policy actions by market participants, and the medium-term outlook of policymakers may not coincide. Also, the two methods are likely to absorb movements in risk premia in different components. While these movements are likely to be small at short horizon, they are more important at longer maturities.

4 Conclusions

This short note provides updated series of information and monetary policy shocks in monetary policy surprises, following the methodology of Miranda-Agrippino and Ricco (2021). It expands the application of the approach for conventional monetary policy to the period of the zero lower bound, and to longer maturities to disentangle Delphic and Odyssean components in the forward path of monetary policy, as defined by Gürkaynak et al. (2005). Additional results are available from the authors on request.

References

Andrade, Philippe and Filippo Ferroni, "Delphic and Odyssean monetary policy shocks: Evidence from the euro-area," School of Economics Discussion Papers 1216, School of Economics, University of Surrey October 2016.

Bańbura, Marta, Domenico Giannone, and Lucrezia Reichlin, "Large Bayesian vector auto regressions," *Journal of Applied Econometrics*, jan 2010, *25* (1), 71–92.

Campbell, Jeffrey R., Charles L. Evans, Jonas D.M. Fisher, and Alejandro Justiniano, "Macroeconomic Effects of Federal Reserve Forward Guidance," *Brookings Papers on Economic Activity*, 2012, *44* (1 Spring), 1–80.

Cieslak, Anna and Andreas Schrimpf, "Non-monetary news in central bank communication," *Journal of International Economics*, 2019, *118* (C), 293–315.

_ **and Hao Pang**, "Common shocks in stocks and bonds," CEPR Discussion Papers 14708, C.E.P.R. Discussion Papers May 2020.

Coibion, Olivier and Yuriy Gorodnichenko, "Information rigidity and the expectations formation process: A simple framework and new facts," *American Economic Review*, 2015, *105* (8), 2644–2678.

Gertler, Mark and Peter Karadi, "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 44–76.

Giannone, Domenico, Michele Lenza, and Giorgio E. Primiceri, "Prior Selection for Vector Autoregressions," *Review of Economics and Statistics*, may 2015, *97* (2), 436–451.

Gilchrist, Simon and Egon Zakrajšek, "Credit spreads and business cycle fluctuations," *American Economic Review*, 2012, *102* (4), 1692–1720.

Gürkaynak, Refet S., A. Hakan Kara, Burçin Kısacıkoğlu, and Sang Seok Lee, "Monetary policy surprises and exchange rate behavior," *Journal of International Economics*, 2021, *130*, 103443. NBER International Seminar on Macroeconomics 2020.

Gürkaynak, Refet S., Brian P. Sack, and Eric T. Swanson, "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 2005, *1* (1), 55–93.

Jarociński, Marek and Peter Karadi, "Deconstructing monetary policy surprises-The role of information shocks," *American Economic Journal: Macroeconomics*, 2020, *12* (2), 1–43.

Kuttner, Kenneth N., "Monetary policy surprises and interest rates: Evidence from the Fed funds futures market," *Journal of Monetary Economics*, June 2001, *47* (3), 523–544.

Lunsford, Kurt G., "Policy Language and Information Effects in the Early Days of Federal Reserve Forward Guidance," *American Economic Review*, September 2020, *110* (9), 2899–2934.

Mankiw, N. Gregory, Ricardo Reis, and Justin Wolfers, "Disagreement about inflation expectations," *NBER Macroeconomics Annual*, 2003, *18*, 209–248.

Melosi, Leonardo, "Signalling Effects of Monetary Policy," *The Review of Economic Studies*, 2017, (January).

Mertens, Karel and Morten O. Ravn, "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States," *American Economic Review*, jul 2013, *103* (4), 1212–1247.

Miranda-Agrippino, Silvia and Giovanni Ricco, "Identification with external instruments in structural VARs under partial invertibility," Sciences Po publications 24, Sciences Po July 2018.

_ **and** _ , "Identification with External Instruments in Structural VARs under Partial Invertibility," CEPR Discussion Papers 13853, C.E.P.R. Discussion Papers July 2019.

— **and** — , "The Transmission of Monetary Policy Shocks," *American Economic Journal: Macroeconomics*, 2021, *forthcoming.*

Nakamura, Emi and Jón Steinsson, "High Frequency Identification of Monetary Non-Neutrality: The Information Effect," *The Quarterly Journal of Economics, forthcoming*, 2018.

Ramey, V.A., "Chapter 2 - Macroeconomic Shocks and Their Propagation," in John B. Taylor and Harald Uhlig, eds., *John B. Taylor and Harald Uhlig, eds.*, Vol. 2 of *Handbook of Macroeconomics*, Elsevier, 2016, pp. 71–162.

Romer, Christina D. and David H. Romer, "Federal Reserve Information and the Behavior of Interest Rates," *The American Economic Review*, 2000, *90* (3), 429–457.

— **and** — , "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review*, 2004, *94* (4), 1055–1084.

Sims, Christopher A., "Implications of rational inattention," *Journal of Monetary Economics*, 2003, *50* (3), 665–690.

Stock, James H. and Mark W. Watson, "Disentangling the Channels of the 2007-09 Recession," *Brookings Papers on Economic Activity*, 2012, *44* (1 (Spring), 81–156.

— **and** — , "Disentangling the Channels of the 2007–09 Recession," *Brookings Papers on Economic Activity*, 2012.

— **and** — , "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments," *The Economic Journal*, 2018, *128* (610), 917–948.

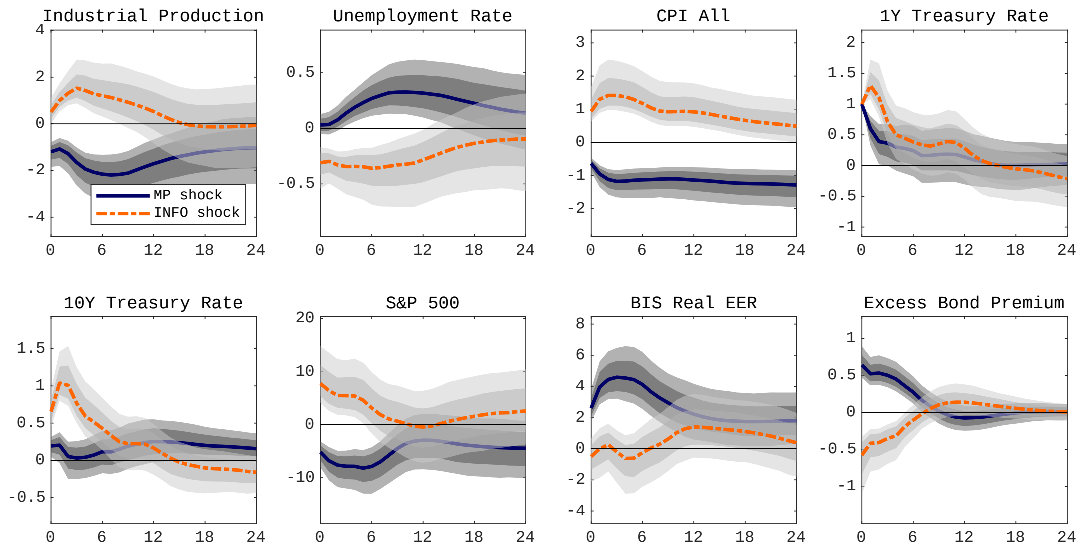
Swanson, Eric T., "Measuring the effects of federal reserve forward guidance and asset purchases on financial markets," *Journal of Monetary Economics*, 2021, *118*, 32–53.

A Appendix

A.1 Replica of Figure 6 in Miranda-Agrippino and Ricco (2021)

Figure A.1 replicates Figure 6 in the original paper by using our new IV, cut at 2009:12. Both the monetary policy and the information shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate.

Figure A.1: Domestic transmission – cutting the IV at 2009:12



Notes: Solid blue: responses to a contractionary monetary policy shock. dash-dotted orange: responses to an information shock. Both shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. BVAR(12). Shaded areas represent 68% and 90% posterior coverage bands. Sample: 1979:1–2014:12. Both proxies span the period 1991:1–2009:12.

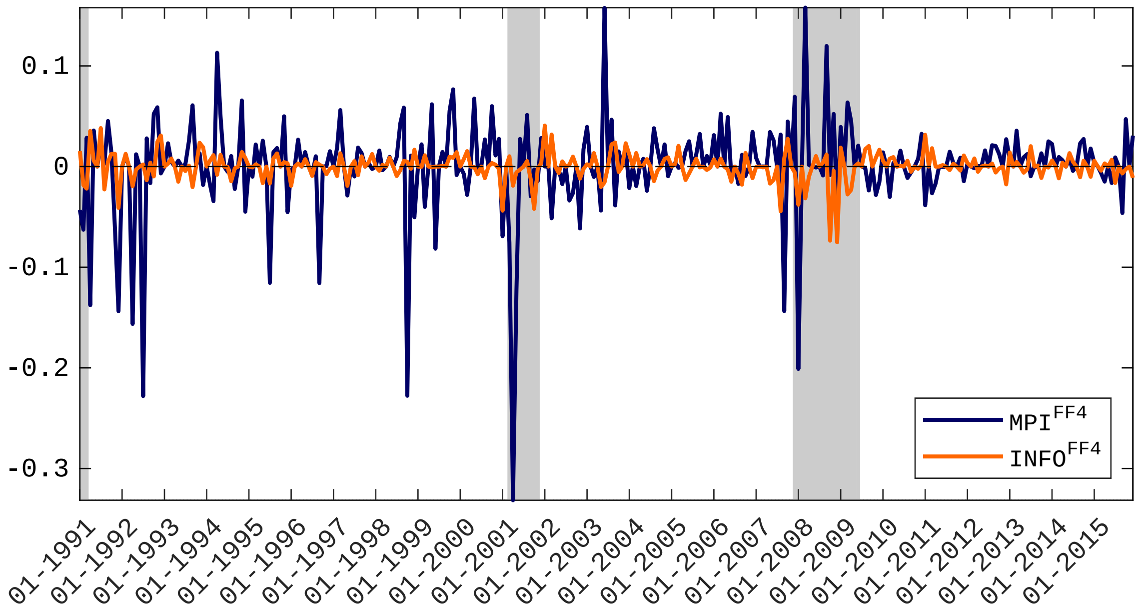
A.2 Alternative alignment of FOMC and Greenbook dates

In a few cases, the latest Greenbook is released in the quarter prior the current FOMC meeting. In this situation, we simply carry over the forecast to the next quarter. For instance, if the Greenbook relative to the FOMC meeting on 18.04.1994 has been published on 16.03.1994. We equal the nowcast for the meeting to the nowcast of the latest Greenbook. In doing so, we follow Romer and Romer (2004).

An alternative way of aligning Greenbook and FOMC dates would be to equal the nowcast for the meeting to the 1-quarter-ahead forecast of the latest Greenbook. Figure A.2 shows the two instruments obtained if we aligned the dates this way.

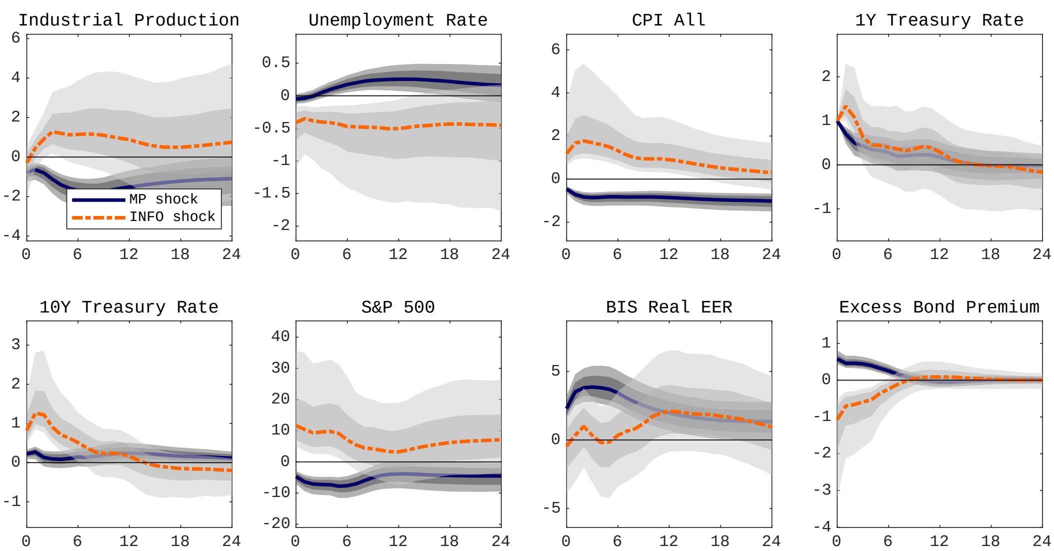
As can be seen from Figure A.3, the results obtained with the alternative alignment match the ones discussed in the main text.

Figure A.2: Instruments, alternative alignment



Notes: The chart shows the instruments for monetary policy and information shocks constructed aligning FOMC and Greenbook release dates such that when the meeting happens in the next quarter with respect ot the forecasts, the forecasts are adjusted to reflect this. The series cover the period 1991:01–2015:12. Shaded areas represent NBER recessions.

Figure A.3: Replica, alternative alignment



Notes: Solid blue: responses to a contractionary monetary policy shock. dash-dotted orange: responses to an information shock. Both shocks are normalised to induce a 1% increase in the US 1Y treasury constant maturity rate. BVAR(12). Shaded areas represent 68% and 90% posterior coverage bands. Sample: 1979:1–2014:12. Both proxies span the period 1991:1–2009:12.

A.3 Additional tables

Table A.1: Variables included in the VAR

Description	Source (Code)	100×Log	RW Prior
Industrial Production	FRED (INDPRO)	•	•
Unemployment Rate	FRED (UNRATE)		
CPI All	FRED (CPIAUCSL)	•	•
1Y Treasury Rate, eom	FRED (DGS1)		
2Y Treasury Rate, avg	FRED (GS2)		
10Y Treasury Rate, avg	FRED (GS10)		
S&P 500, avg	FRED-MD	•	•
BIS Real EER	BIS	•	•
Excess Bond Premium	Federal Reserve		

Notes: 100×*Log* indicates whether a variable has been logged and multiplied by 100. *RW Prior* indicates assignment of a random walk prior. *eom* stands for end-of-month. *avg* stands for monthly averages.

Table A.2: Projection of Surprises on Greenbook Forecasts

	(1)	(2)
Real GDP Forecast:		
$h = -1$	-0.001	-0.002
	(-0.28)	(-0.78)
$h = 0$	0.009*	0.011***
	(1.98)	(3.61)
$h = 1$	0.003	
	(0.35)	
$h = 2$	-0.003	
	(-0.47)	
$h = 3$	-0.004	
	(-0.50)	
GDP Deflator Forecast:		
$h = -1$	0.000	-0.001
	(0.10)	(-0.21)
$h = 0$	-0.001	-0.004
	(-0.16)	(-0.71)
$h = 1$	-0.007	
	(-0.54)	
$h = 2$	0.011	
	(0.75)	
$h = 3$	-0.012	
	(-0.85)	
Unemployment Forecast:		
$h = 0$	0.002	0.002
	(0.81)	(0.82)
Real GDP Revisions:		
$h = -1$	-0.002	
	(-0.48)	
$h = 0$	0.001	-0.001
	(0.21)	(-0.12)
$h = 1$	0.008	0.005
	(0.74)	(0.63)
$h = 2$	0.008	
	(0.92)	
GDP Deflator Revisions:		
$h = -1$	0.001	
	(0.12)	
$h = 0$	0.008	0.010
	(0.80)	(1.08)
$h = 1$	0.017	0.009
	(0.96)	(0.88)
$h = 2$	-0.004	
	(-0.23)	
Unemployment Revisions:		
$h = -1$	0.038	
	(0.81)	
$h = 0$	-0.003	0.001
	(-0.08)	(0.02)
$h = 1$	-0.122	0.006
	(-1.86)	(0.17)
$h = 2$	0.142**	
	(2.76)	
constant	-0.016	-0.037
	(-0.42)	(-1.33)
N	234	234
adj. R^2	0.069	0.075
F	2.113	2.418
p	0.003	0.007

Notes: Projection of high-frequency surprises in the fourth federal funds futures on Greenbook forecasts and revisions. Column (1) and (2) report the estimates for the regressions used to obtain MPI_d^{FF4} and $INFO_d^{FF4}$ respectively. t statistics based on robust standard errors in parentheses. Estimation sample: 1990:01–2015:12.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Removal of the Autoregressive Component

	MPI^{FF4}	INFO^{FF4}
$l = 1$	-0.094	0.354***
	(-0.85)	(5.81)
$l = 2$	-0.175	0.522***
	(-1.72)	(4.44)
$l = 3$	0.021	0.019
	(0.16)	(0.22)
$l = 4$	0.051	-0.086
	(0.57)	(-1.31)
$l = 5$	-0.015	0.037
	(-0.24)	(0.39)
$l = 6$	0.040	-0.073
	(0.34)	(-0.94)
$l = 7$	0.117	0.122
	(1.66)	(1.09)
$l = 8$	0.047	0.099
	(0.55)	(1.04)
$l = 9$	-0.060	-0.022
	(-1.03)	(-0.22)
$l = 10$	0.071	-0.145
	(1.23)	(-1.35)
$l = 11$	-0.032	0.043
	(-0.41)	(0.54)
$l = 12$	-0.058	0.096
	(-0.79)	(1.00)
constant	-0.001	-0.004**
	(-0.19)	(-3.18)
N	209	209
adj. R^2	0.005	0.534
F	1.412	15.357
p	0.163	0.000

Notes: Projection of $\overline{MPS}_m^{FF4}$ and $\overline{INFO}_m^{FF4}$ on their own lags. t statistics based on robust standard errors in parentheses. Estimation sample: 1991:01–2015:12.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.4: Projection of Target Factor on Greenbook Forecasts (part 1)

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
$PC_1^F(B2)$	-0.003	0.000								
	(-0.93)	(0.19)								
$PC_1^F(B1)$	-0.003		0.002							
	(-0.40)		(1.33)							
$PC_1^F(F0)$	0.003			0.007^{**}						
	(0.32)			(3.13)						
$PC_1^F(F1)$	0.017				0.010^{**}					
	(1.51)				(3.03)					
$PC_1^F(F2)$	0.006					0.006^{**}				
	(0.66)					(2.61)				
$PC_1^F(F3)$	-0.014						0.006^{*}			
	(-1.33)						(2.59)			
$PC_1^F(F4)$	-0.011							0.004^{*}		
	(-0.74)							(2.08)		
$PC_1^F(F5)$	-0.009								0.004^{*}	
	(-0.36)								(2.44)	
$PC_1^F(F6)$	0.015									0.004^{*}
	(0.92)									(2.26)
$PC_2^F(B2)$	0.008	-0.006^{*}								
	(1.42)	(-2.46)								
$PC_2^F(B1)$	-0.007		-0.007^{***}							
	(-1.46)		(-3.51)							
$PC_2^F(F0)$	-0.011			-0.009^{***}						
	(-1.00)			(-3.36)						
$PC_2^F(F1)$	0.000				-0.005^{*}					
	(0.04)				(-2.20)					
$PC_2^F(F2)$	-0.030^{*}					-0.004				
	(-2.43)					(-1.54)				
$PC_2^F(F3)$	0.028						-0.001			
	(1.93)						(-0.20)			
$PC_2^F(F4)$	-0.000							-0.001		
	(-0.01)							(-0.32)		
$PC_2^F(F5)$	-0.002								-0.000	
	(-0.06)								(-0.17)	
$PC_2^F(F6)$	-0.003									0.000
	(-0.11)									(0.05)
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.072	0.002	0.012	0.064	0.066	0.021	0.014	-0.003	-0.001	-0.002
F	1.763	2.237	3.223	5.405	4.080	3.132	2.730	2.142	2.304	2.155
p	0.008	0.066	0.013	0.000	0.003	0.016	0.030	0.076	0.059	0.075

Notes: Projection of Gürkaynak et al. (2005)'s target factor, extended to 2015:12, on the principal components of Greenbook forecasts and revisions. PC_i^F indicates the ith principal component over the forecasts. The argument in brackets indicates the horizon at which the principal components are estimated (B stands for backcast and F for forecast). t statistics based on robust standard errors in parentheses. Estimation sample: 1990:01–2015:12.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.5: Projection of Target Factor on Greenbook Forecasts (part 2)

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
$PC_1^R(B2)$	0.001	-0.000								
	(0.39)	(-0.04)								
$PC_1^R(B1)$	0.002		-0.000							
	(0.60)		(-0.18)							
$PC_1^R(F0)$	-0.001			-0.001						
	(-0.14)			(-0.56)						
$PC_1^R(F1)$	-0.000				-0.002					
	(-0.01)				(-0.75)					
$PC_1^R(F2)$	0.003					-0.003				
	(0.60)					(-1.37)				
$PC_1^R(F3)$	-0.008						-0.003			
	(-1.53)						(-1.63)			
$PC_1^R(F4)$	-0.001							-0.000		
	(-0.13)							(-0.02)		
$PC_1^R(F5)$	0.002								0.001	
	(0.36)								(0.75)	
$PC_1^R(F6)$	0.002									0.001
	(0.63)									(0.69)
$PC_2^R(B2)$	-0.003	-0.003								
	(-1.08)	(-1.64)								
$PC_2^R(B1)$	-0.001		0.001							
	(-0.21)		(0.55)							
$PC_2^R(F0)$	0.009			0.007*						
	(1.92)			(2.46)						
$PC_2^R(F1)$	0.002				0.003					
	(0.54)				(0.98)					
$PC_2^R(F2)$	0.008					0.003				
	(1.49)					(1.01)				
$PC_2^R(F3)$	-0.001						0.004			
	(-0.25)						(1.52)			
$PC_2^R(F4)$	0.001							-0.002		
	(0.09)							(-0.73)		
$PC_2^R(F5)$	0.012*								0.000	
	(2.34)								(0.11)	
$PC_2^R(F6)$	0.003									0.001
	(0.75)									(0.57)
constant	0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.00)	(-0.00)	(0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)	(-0.00)
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.072	0.002	0.012	0.064	0.066	0.021	0.014	-0.003	-0.001	-0.002
F	1.763	2.237	3.223	5.405	4.080	3.132	2.730	2.142	2.304	2.155
p	0.008	0.066	0.013	0.000	0.003	0.016	0.030	0.076	0.059	0.075

Notes: Projection of Gürkaynak et al. (2005)'s target factor, extended to 2015:12, on the principal components of Greenbook forecasts and revisions. PC_i^R indicates the ith principal component over the revisions. The argument in brackets indicates the horizon at which the principal components are estimated (B stands for backcast and F for forecast). t statistics based on robust standard errors in parentheses. Estimation sample: 1990:01–2015:12.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.6: Projection of Path Factor on Greenbook Forecasts (part 1)

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
$PC_1^F(B2)$	-0.007	0.005								
	(-1.02)	(1.10)								
$PC_1^F(B1)$	0.011		0.011*							
	(1.43)		(2.39)							
$PC_1^F(F0)$	0.001			0.011*						
	(0.05)			(2.51)						
$PC_1^F(F1)$	0.027*				0.011*					
	(2.39)				(2.07)					
$PC_1^F(F2)$	-0.040*					0.004				
	(-2.60)					(0.71)				
$PC_1^F(F3)$	0.048						0.001			
	(1.94)						(0.17)			
$PC_1^F(F4)$	0.017							-0.003		
	(0.71)							(-0.71)		
$PC_1^F(F5)$	-0.025								-0.004	
	(-0.90)								(-1.21)	
$PC_1^F(F6)$	0.004									-0.005
	(0.17)									(-1.36)
$PC_2^F(B2)$	-0.000	-0.003								
	(-0.05)	(-0.72)								
$PC_2^F(B1)$	0.014		-0.001							
	(1.51)		(-0.19)							
$PC_2^F(F0)$	0.012			0.003						
	(0.89)			(0.69)						
$PC_2^F(F1)$	0.006				0.007					
	(0.41)				(1.78)					
$PC_2^F(F2)$	0.066**					0.008				
	(3.21)					(1.87)				
$PC_2^F(F3)$	-0.055*						0.005			
	(-2.00)						(0.82)			
$PC_2^F(F4)$	-0.054							0.004		
	(-1.39)							(0.78)		
$PC_2^F(F5)$	0.026								0.003	
	(0.66)								(0.58)	
$PC_2^F(F6)$	0.006									0.003
	(0.20)									(0.51)
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.135	0.000	0.025	0.064	0.100	0.039	0.012	0.033	0.026	0.011
F	2.050	1.523	1.986	3.363	5.394	3.881	3.693	4.489	3.658	1.945
p	0.001	0.196	0.098	0.011	0.000	0.005	0.006	0.002	0.007	0.104

Notes: Projection of Gürkaynak et al. (2005)'s path factor, extended to 2015:12, on the principal components of Greenbook forecasts and revisions. PC_i^F indicates the ith principal component over the forecasts. The argument in brackets indicates the horizon at which the principal components are estimated (B stands for backcast and F for forecast). t statistics based on robust standard errors in parentheses. Estimation sample: 1990:01–2015:12.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.7: Projection of Path Factor on Greenbook Forecasts (part 2)

	All	B2	B1	F0	F1	F2	F3	F4	F5	F6
$PC_1^R(B2)$	0.003	0.007*								
	(0.79)	(2.06)								
$PC_1^R(B1)$	-0.003		0.003							
	(-0.54)		(0.70)							
$PC_1^R(F0)$	0.004			0.008						
	(0.87)			(1.57)						
$PC_1^R(F1)$	0.004				0.010*					
	(0.59)				(2.13)					
$PC_1^R(F2)$	0.001					0.008*				
	(0.06)					(2.07)				
$PC_1^R(F3)$	-0.009						0.007			
	(-0.92)						(1.86)			
$PC_1^R(F4)$	0.021							0.011**		
	(1.82)							(3.26)		
$PC_1^R(F5)$	-0.000								0.011**	
	(-0.01)								(2.85)	
$PC_1^R(F6)$	-0.005									0.005
	(-0.87)									(1.68)
$PC_2^R(B2)$	-0.005	-0.002								
	(-1.16)	(-0.59)								
$PC_2^R(B1)$	-0.010		-0.002							
	(-1.49)		(-0.50)							
$PC_2^R(F0)$	0.016			0.004						
	(1.96)			(0.67)						
$PC_2^R(F1)$	-0.002				-0.006					
	(-0.18)				(-1.11)					
$PC_2^R(F2)$	-0.001					0.003				
	(-0.10)					(0.66)				
$PC_2^R(F3)$	-0.011						-0.003			
	(-0.98)						(-0.45)			
$PC_2^R(F4)$	-0.019							-0.005		
	(-1.68)							(-0.69)		
$PC_2^R(F5)$	0.014								-0.004	
	(1.40)								(-0.66)	
$PC_2^R(F6)$	-0.003									0.007
	(-0.53)									(1.44)
constant	-0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	233	233	233	233	233	233	233	233	233	233
adj. R^2	0.135	0.000	0.025	0.064	0.100	0.039	0.012	0.033	0.026	0.011
F	2.050	1.523	1.986	3.363	5.394	3.881	3.693	4.489	3.658	1.945
p	0.001	0.196	0.098	0.011	0.000	0.005	0.006	0.002	0.007	0.104

Notes: Projection of Gürkaynak et al. (2005)'s path factor, extended to 2015:12, on the principal components of Greenbook forecasts and revisions. PC_i^R indicates the ith principal component over the revisions. The argument in brackets indicates the horizon at which the principal components are estimated (B stands for backcast and F for forecast). t statistics based on robust standard errors in parentheses. Estimation sample: 1990:01–2015:12.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.8: Removal of the Autoregressive Component

	Target		Path	
Lags	MPI	INFO	FWG	INFO
$l = 1$	-0.147	0.373***	-0.005	0.154
	(-1.15)	(4.40)	(-0.05)	(1.95)
$l = 2$	-0.173**	0.116	-0.061	0.262
	(-2.62)	(1.36)	(-0.71)	(1.79)
$l = 3$	0.149	0.053	-0.089	0.117
	(1.04)	(0.74)	(-0.89)	(1.05)
$l = 4$	0.105	0.038	-0.192*	-0.072
	(0.61)	(0.49)	(-2.22)	(-0.74)
$l = 5$	-0.023	-0.100	0.111	0.144
	(-0.26)	(-1.08)	(1.18)	(1.93)
$l = 6$	0.018	0.006	-0.026	-0.023
	(0.27)	(0.08)	(-0.35)	(-0.29)
$l = 7$	0.021	-0.010	-0.124	0.086
	(0.26)	(-0.14)	(-1.32)	(0.91)
$l = 8$	-0.169*	-0.028	-0.010	0.038
	(-2.02)	(-0.36)	(-0.11)	(0.51)
$l = 9$	-0.041	0.017	0.016	0.173*
	(-0.93)	(0.23)	(0.18)	(1.98)
$l = 10$	-0.141	-0.003	-0.043	-0.013
	(-1.88)	(-0.06)	(-0.40)	(-0.18)
$l = 11$	-0.087	0.074	0.055	-0.001
	(-1.17)	(0.74)	(0.67)	(-0.01)
$l = 12$	-0.062	0.173	0.062	0.064
	(-0.84)	(1.92)	(0.83)	(0.93)
constant	-0.003	0.002	-0.002	-0.001
	(-0.62)	(1.06)	(-0.26)	(-0.34)
N	208	208	208	208
adj. R^2	0.055	0.210	-0.006	0.129
F	1.890	4.185	0.929	3.156
p	0.037	0.000	0.519	0.000

First two columns: Projection of the residuals (MPI) and the fitted part (INFO) of Eq. (5) on 12 own lags. *Last two columns:* Projection of the residuals (FWG) and the fitted part (INFO) of Eq. (6) on 12 own lags. For the first two columns, the dependent variable of Eq. (5) is the target factor of Gürkaynak et al. (2005), extended to 2015:12. For the latter two columns, the dependent variable of Eq. (6) is the path factor. t statistics based on robust standard errors in parentheses. Estimation sample: 1991:01–2015:12.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.9: Greenbook variables

gRGDP	Greenbook projections for Q/Q growth in real GDP, chain weight (annualized percentage points) Before December 11, 1991: Real GNP, fixed weight December 11, 1991 to December 14, 1995: Real GDP, fixed weight
gPGDP	Greenbook projections for Q/Q growth in price index for GDP, chain weight (annualized percentage points) Before December 11, 1991: Price index for GNP implicit deflator December 11, 1991 to March 21, 1996: Price index for GDP implicit deflator
UNEMP	Greenbook projections for the unemployment rate (percentage points).
gPCPI	Greenbook projections for Q/Q headline CPI inflation (annualized percentage points)
gPCPIX	Greenbook projections for Q/Q core CPI inflation (annualized percentage points)
gPPCE	Greenbook projections for Q/Q headline PCE inflation, chain weight (annualized percentage points)
gPPCEX	Greenbook projections for Q/Q core PCE inflation, chain weight (annualized percentage points)
gRPCE	Greenbook projections for Q/Q growth in real personal consumption expenditures, chain weight (annualized percentage points) Before January 26, 1996: Fixed weight
gRBF	Greenbook projections for Q/Q growth in real business fixed investment, chain weight (annualized percentage points) Before January 26, 1996: Fixed weight
gRRES	Greenbook projections for Q/Q growth in real residential investment, chain weight (annualized percentage points) Before January 26,1996: Fixed weight
gRGOVF	Greenbook projections for Q/Q growth in real federal government consumption and gross investment, chain weight (annualized percentage points) Before January 26,1996: Real federal government purchases of goods and services, fixed weight
gRGOVSL	Greenbook projections for Q/Q growth in real state & local government consumption and gross investment, chain weight (annualized percentage points) Before January 26,1996: Real state and local government purchases of goods and services, fixed weight
gNGDP	Greenbook projections for Q/Q growth in nominal GDP (annualized percentage points) Before December 11, 1991: Nominal GNP, fixed weight December 11, 1991 to December 14, 1995: Nominal GDP, fixed weight
HSTART	Greenbook projections for housing starts (millions of units)
gIP	Greenbook projections for Q/Q growth in the industrial production index (annualized percentage points)

Notes: The Greenbooks provide forecasts up to 9 quarters ahead and backcasts up to 4 quarters back, for a total of 14 horizons. However, not all releases provide forecasts (and backcasts) for the longer horizons. Therefore, in Section 3 we exclude forecasts that go beyond 6 quarters and backcasts beyond 2 quarters. The Greenbook forecasts have been collected starting as early as 1967. Only two variables, headline and core PCE inflation, start after 1990 and therefore are not used in our analysis. The Greenbook forecasts can be downloaded from the Philadelphia Fed website.