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Identifying fiscal inflation

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Identifying Fiscal Inflation*

Ferre De Graeve Virginia Queijo von Heideken

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Abstract

Fiscal theorists warn about the risk of future inflation as a consequence of current fiscal imbalances in the US. Because actual inflation remains historically low and data on inflation expectations do not corroborate such risks, warnings for fiscal inflation are often ignored in policy and academic circles. This paper shows that a canonical NK-DSGE model enables identifying an anticipated component of inflation expectations that is closely related to fiscal policy. Estimation results suggest that fiscal inflation concerns have induced a 1.6%-points increase in long-run inflation since 2001. The model also rationalizes why data on inflation expectations do not reveal such concerns outright.

Keywords: Fiscal policy, inflation, news

JEL: E31, E62

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1 Introduction

In light of debt-levels around the globe reaching historically unprecedented levels, Cochrane (2011), Leeper and Walker (2012) and Sims (2011) have been predicting fiscal inflation. Fiscal theory implies that if government debt is not backed by expected future surpluses, inflation will ensue, immediately or - depending on the maturity structure of debt - in the future (Cochrane, 2001).

Despite the dire current fiscal situation (Figure 1), both actual inflation and inflation expectations are low by any measure. As a result, policy makers (e.g. the Federal Reserve), academics (e.g. Galí, 2012) and opinion makers (e.g. Krugman) alike dismiss fiscal inflation concerns.

Identifying fiscal inflation is generally fraught with difficulty. There are at least three hurdles that substantially burden identification. First, other things happen: fiscal news does not occur in isolation. It typically arrives at times when the economy undergoes other shocks and its instantaneous effects may be quantitatively small relative to those of concurrent shocks. A second hurdle is the formalization of fiscal policy. Recent years have brought great progress in modelling the fiscal authority, yet no consensus view has emerged. On the one hand, the models grow increasingly complex and involve fiscal limits (e.g. Davig, Leeper and Walker, 2011), policy switches (e.g. Bianchi and Ilut, 2012), or time-varying volatility (e.g. Fernández-Villaverde, Kuester, Guerrón-Quintana and Rubio-Ramírez, 2011). On the other hand, assumptions on behalf of the fiscal authority are frequently seen as ad hoc and models often leave important aspects unmodelled, such as the maturity structure of debt. The third factor burdening identification is the econometric challenge posed by anticipation. Commonly used econometric techniques break down when agents respond to information about the future that the econometrician does not have (e.g. L'Huillier, Blanchard and Lorenzoni, 2013; Leeper, Walker and Yang, 2013).

This paper takes a straightforward approach that simultaneously tackles all three chal-

lenges. Particularly, we show how the canonical New Keynesian DSGE model (à la Christiano, Eichenbaum and Evans, 2005; Smets and Wouters, 2007) can help to identify the expected inflationary effect of the current fiscal stance. To the workhorse DSGE model, we add the possibility of long-horizon anticipated changes in the model's inflation target. Future inflationary pressures are identified largely through bond yields and the expectations hypothesis. If agents anticipate inflation down the road, they demand higher yields today on bonds with long maturities. We then simply re-estimate the DSGE model and investigate the properties of the inflation target news shock.

Given theoretically plausible ties between expected inflation and the stance of fiscal policy implied by formal models of fiscal inflation, we inspect whether the anticipated inflation identified by the DSGE estimation is in any way related to fiscal policy. The result is striking. While the estimation receives no information about fiscal variables as debt or deficits, the identified anticipated long-run component of inflation strongly correlates with innovations to such measures of fiscal policy. In fact, the identified part of inflation anticipated in the medium run almost perfectly comoves with debt projections into the future. This strongly suggests there is a discernible low-frequency fiscal component to inflation and inflation expectations. This bodes well with the story told by fiscal inflation "vigilantes": subdued inflation today does not mean it is not coming in the future. In fact, they argue, it is unavoidable down the road: if deficits are not backed by future surpluses, inflation needs to erode the debt eventually.

The model indicates that the worry of fiscal inflation in the US is present today: the accumulation of deficits since the start of the Bush administration has exerted a permanent upward pressure on inflation of about 1.6%-points. The model also explains why we do not observe fiscal inflation concerns in the data today. While there is *conditional* fiscal inflation, supporting the vigilantes' claim, the model shows how that inflationary pressure is dwarfed by disinflationary forces during the Great Recession. Particularly, recessionary slack and

the Fed's response to the crisis (forward guidance and quantitative easing) push yields and measured inflation expectations down, which results in invariably low *unconditional* measures of inflation and inflation expectations. Our results thus reconcile the two sides of the debate.

The advantage of our approach immediately relates to the common identification challenges referred to above. First, by its very design the canonical DSGE model controls for a multitude of factors happening in the economy. This enables separating concurrent influences from inflation anticipation. Second, the model we estimate is essentially void of structure with regard to the fiscal authority. While inflation anticipation is identified through estimation, its link with fiscal policy is established post estimation. We thus sidestep the challenges that come with formalizing fiscal policy. Third, DSGE estimation, by formally taking account of agents' responses to information about the future, is a commonly used solution to the econometric challenges posed by anticipation (e.g. L'Huillier et al., 2013; Schmitt-Grohé and Uribe, 2012).

Finally, our results complement recent empirical work that argues that the 1970's inflation is related to fiscal policy, such as Sims (2011), Bianchi and Ilut (2012), Bhattarai, Lee and Park (2012) and Kliem, Kriwoluzky and Sarferaz (2013). The same theoretical models that rationalize the fiscal inflation of the 70's rationalize our findings. The crucial difference with our work is that we show there is a current *expectation* of inflation that is related to fiscal policy, while in the 70's inflation actually materialized *at the same time* fiscal policy was loose.

The paper is organized as follows. Section 2 first briefly describes the DSGE model, which is essentially Smets and Wouters (2007) coupled with the expectations hypothesis of interest rates. We then lay out the key identifying feature of our approach. Section 3 contains the main results. In Section 4 we use the model to quantify both sides of the debate. The relevance of our results for the macroeconomy is discussed in Section 5. We evaluate robustness in Section 6 and subsequently conclude.

2 The model

The model we use is a close variant of Smets and Wouters (2007). As in De Graeve, Emiris and Wouters (2009, henceforth DEW), we append a term structure of interest rates to the Smets-Wouters model and allow for a time-varying inflation target. The dynamics of model-implied yields are fully determined by the expectations hypothesis.

In addition to these features, this paper adds news shocks to the model's long-run inflation target. Formally, we capture this by allowing the inflation target, $\bar{\pi}_t$, expressed in deviations from steady state, to evolve as

$$\Delta\widehat{\bar{\pi}}_t = \rho_{\bar{\pi}}\Delta\widehat{\bar{\pi}}_{t-1} + \epsilon_t^{\bar{\pi}} + \eta_{t-i}^{\bar{\pi}}.$$

The target essentially evolves as a random walk. Positive values of $\rho_{\bar{\pi}}$ imply smoother changes in the target, relative to a random walk. Traditional, non-anticipated inflation target shocks are captured by $\epsilon_t^{\bar{\pi}}$. Target news shocks are captured by $\eta_{t-i}^{\bar{\pi}}$, a random innovation in $t-i$ that materializes in t. A detailed description of the full log-linearized model can be found in the Appendix.

An inflation target news shock, $\eta_{t-i}^{\bar{\pi}}$, has the distinguishing feature documented in Figure 2. Particularly, it is the only shock that can generate contemporaneous movements in long rates without affecting short rates. Other shocks in DSGE models cannot generate such a pattern. On the one hand, typical business cycle shocks generate movements in the slope of the yield curve through changes in short rates while leaving long rates unaffected. Figure 3 exemplifies this pattern by plotting the response to standard monetary policy shocks.[1] On the other hand, traditional inflation target shocks imply a level shift across interest rates of different maturities. The response to such a non-anticipated target shock, $\epsilon_t^{\bar{\pi}}$, is contained in Figure 4.

[1] Alternative news shocks, as in Kurmann and Otrok (2012), will not generate the pattern in Figure 2, since they also affect the slope of the yield curve by influencing the short end rather than the long end.

Thus, key to identifying news to long-run inflation is the combination of using information on the yield curve and allowing for inflation anticipation. Through the expectations hypothesis, the model interprets surprise increases in long-term interest rates, independent of short rates, as anticipated inflationary pressure down the road.

We estimate the model using Bayesian methods. Our sample period starts in 1966:Q1 and ends in 2011:Q2. The data used for the estimation is an update of that in DEW and consists of the log difference of real GDP, real consumption, real investment and the real wage, log hours worked, the log difference of the GDP deflator and the federal funds rate. The observable bond yields are four zero coupon bonds with maturities of one, three, five and ten years. A detailed description of the data can be found in the Appendix. Prior distributions are the same as in DEW and also presented in the Appendix. The only parameter which is new in this paper is the standard error of the news shocks which, similar to other shocks, is given an Inverse-Gamma prior distribution with a mean of 0.01 and two degrees of freedom. In the baseline model we set the anticipation horizon to five years, while we study alternative horizons in Section 6.

As in DEW, the empirical specification allows for deviations of model-implied yields from actual yields in two ways. First, we include free constants to capture the mean of the yields. Second, the measurement equations for the yields are augmented with measurement errors. In general, our estimation results are very similar to those in DEW. Hence, in what follows, we primarily focus on the properties of the news shocks.

3 Anticipated inflation and fiscal policy

Section 2 laid out how inflation target news shocks generate a pattern of responses that is absent in contemporary DSGE models. The same impulse response functions are, however, also perfectly in line with anticipated fiscal inflation. In fact, Figure 2 is the estimated model equivalent of Figure 8 in Cochrane (2011), which represents the latter's most likely scenario

of how inflation will materialize following a shock to expected fiscal surpluses.[2] In addition, Leeper and Walker (2012) show how government bond valuation depends naturally on the present value of future inflation, which is intimately tied to the inflation target. Given these theoretically plausible ties between inflation target news shocks in our model and explicit models of fiscal policy, we now inspect whether the anticipated inflation identified by the DSGE estimation is in any way related to fiscal policy.

Figure 5 plots the estimated time series for the news shock (solid/blue line). In addition, the figure plots one measure of fiscal policy surprises. Particularly, the dashed/red line depicts the smoothed innovations to an AR(1) for the primary deficit-to-GDP ratio. Other measures of fiscal policy innovations (which control for automatic stabilizers or are based on debt data) convey a similar message and are contained in Section 6. Strikingly, while the estimation receives no information about fiscal policy, the news shock strongly correlates with it. The correlation over the full sample is 0.44, and increases to 0.70 after 1984, the start of the "Great Moderation". Incidentally, this is also the time when the level of government debt rose above 30% of GDP (see Figure 1). It also coincides with a sharp increase in the maturity of government debt (e.g. Greenwood, Hanson and Stein, 2012), which in models of fiscal inflation leads to longer anticipation horizons (Cochrane, 2011).

Figure 6 shows the contribution of news shocks to inflation, along with actual inflation. Starting in 2006, news shocks exert a continuously increasing influence on inflation. This corresponds well with the accumulation of deficits since the start of the Bush administration: since news shocks anticipate inflation five years ahead, a positive contribution to inflation starting in 2006 points to positive news shocks arriving from 2001 onward. While anticipated inflation target shocks did not matter much relative to actual inflation in the past, their

[2]Relative to Cochrane (2011), the present model's inflation response is noticeable already before the anticipation horizon (due to a forward looking Phillips curve) and more sluggish after (due to the smoothness in the target, $\rho_{\bar{\pi}}$, as well as the presence of various frictions in the model). This behaviour transmits into interest rates.

contribution is now at an all time high and is also high relative to the level of inflation. The 2016:Q2 inflation forecast conditional on only news shocks is 2.8%, reflecting an increase of 1.6%-points in the last ten years.

The rapid increase in debt during the last decade witnessed in Figure 1 provides one candidate explanation for the increase in anticipated inflation. To shed more light on that, Figure 7 compares the news shock contribution to inflation with projected debt-to-GDP five years ahead, as reported by the Congressional Budget Office (CBO). The observed increase in debt projections aligns almost perfectly with the model's assessment of anticipated inflation. From a theoretical perspective, the gradual rise in inflation conditional on news shocks is reminiscent of how fiscal inflation plays out in models of the "fiscal limit", as in Davig et al. (2011).

In light of the above evidence it seems hard to dispute there is an anticipated component of inflation (expectations) that is related to fiscal policy. Related to this result, Bhattarai, Lee and Park (2012), Bianchi and Ilut (2012), Kliem, Kriwoluzky and Sarferaz (2013) and Sims (2011) argue for fiscal interpretations of the 70's. Note that the present story is different from these papers in that the current episode is characterized by anticipation, while in the 70's inflation actually materialized. In the present model, if both inflation and inflation expectations spike as in the 70's, this is picked up by traditional inflation target shocks. As documented in DEW and as remains true in the present model, non-anticipated inflation target shocks play an important role in the 70's. That said, we anticipate that future estimation of switching models, provided they incorporate yield curve data, will explain the recent years by an increased probability of switching to an active fiscal regime.

4 Revisiting the debate

We now address why one does not observe fiscal inflation in data on inflation expectations or yields. Figure 8 plots the decomposition of the five year yield during the Great Reces-

sion.[3] On the one hand, the current recession implies slack is very high. The persistent disinflationary effect of all the macro shocks - which jointly explain slack in the model - is captured by the magenta/starred line: slack exerts a substantial downward pressure on inflation expectations and thus on yields. On the other hand, central bank actions geared toward lowering yields of longer maturity (forward guidance and QE) imply a level effect on the term structure which can only be captured by regular inflation target shocks, measured by the blue/diamond line.[4] As a result, inflation expectations derived from yields - through the expectations hypothesis - are subdued, too. In this way, the presence of slack as well as the Fed's crisis response push inflation, its expectations and yields down. As a result, even though there is substantial conditional anticipated fiscal inflation, measured by the red/circled line, absent a model one does not measure it in observed data.

5 Discussion

We have so far focused on the relation between news about the inflation target and fiscal policy. The historical decomposition in Figure 8 already suggested that factors other than inflation anticipation are important in understanding yields and inflation expectations during the Great Recession. This holds on a broader level, too: target news shocks do not matter much in an unconditional sense, not for yields (around 3%), nor for macro fluctuations ($< 1\%$). Recall that news became more important in the last decade, as corroborated by the historical contributions in Figures 6 and 8. The quantitatively small role of news shocks implies that there is only a limited impact on other features of the model compared to the results in DEW. The fact that these anticipated shocks matter very little for macro-dynamics is consistent with models of fiscal/monetary interactions, such as e.g. Bianchi and

[3] DEW provide a detailed analysis of yields and inflation expectations up to 2007.

[4] News shocks cannot since they do not affect the short rate. Monetary policy (and alternative business cycle) shocks cannot because they are not persistent enough to affect yields as far out. See Campbell, Evans, Fisher and Justiniano (2012) for alternative ways of assessing forward guidance.

Ilut's (2012) policy switches or Sims' (2011) hyper-rational expectations, so long as there is a small probability attached to switching to the active fiscal policy regime. Put differently, if fiscal inflation receives some probability but does not materialize, these models often imply limited macro consequences.

6 Robustness

We here evaluate the robustness of the link between anticipated inflation and fiscal policy. First we compare the estimated series of inflation target news shocks to alternative measures of fiscal innovations. Next, we change the anticipation horizon of agents in the model.

6.1 Measures of fiscal policy

The comovement between target news shocks and fiscal policy does not depend on a particular measure of fiscal policy. We check the robustness of our results by comparing the estimated news shocks to different measures of fiscal surprises. In addition to our benchmark measure - innovations to an AR(1) on the primary deficit-to-GDP ratio -, we use three other measures that control for "automatic stabilizers". Automatic stabilizers are systematic changes in revenues and outlays that are attributable to cyclical movements in real output and unemployment. Table 1 shows the correlation between the inflation news shocks estimated by the DSGE model and the different measures of fiscal news. A first measure replaces the primary deficit with CBO data of government deficits without automatic stabilizers. A second measure controls for automatic stabilizers by adding the output gap (as implied by the DSGE model) to the autoregression, while a third measure controls for output growth. The bottom two rows of Table 1 consider two additional alternative proxies. The first scales the primary deficit by debt instead of GDP. The second considers innovations to the debt-to-GDP ratio. In all cases we use smoothed residuals of the regressions to control for high-frequency variation.

All measures show a substantial correlation with target news shocks, especially during the "Great Moderation"-period. This confirms our main result, namely the high correlation between long-horizon inflation anticipation and fiscal surprises. As noted before, the period with the highest correlation is also that in which both the level and the maturity of government debt increased markedly. Theory suggests the concern for fiscal inflation (anticipation) is largest then (Cochrane, 2011).

Additionally, Figure 9 plots the estimated inflation target news shocks together with dates of major legislative announcements on federal income taxes and defense expenditures, as reported in Yang (2007) and Ramey (2011), respectively. Vertical lines above zero mark positive surprises to the deficit while lines below zero correspond to negative shocks. Note that since these measures of fiscal policy only pertain to parts of the budget, they should be seen as indicative, rather than representative of the entire fiscal stance. Nonetheless, Figure 9 suggests there is a relation between the chronology of deficit surprises and our measure of inflation target news shocks.

6.2 Anticipation horizon

To evaluate the importance of the assumption that inflation target news arrives five years ahead, we re-estimate the model for different anticipation horizons. Table 2 reports the correlation between the estimated news shocks in those models and our benchmark measure of news to fiscal deficits. At short and long horizons, there is no evident relation between the two series. However, there is a relatively strong positive correlation between target news shocks and fiscal surprises in the medium term, at anticipation horizons of 4 and 5 years. Interestingly, these horizons correspond well with the maturity of US debt, which averaged between 4 and 5 years over our sample period (see e.g. Greenwood et al., 2012). This is consistent with Cochrane (2001, 2011) who shows that the extent to which fiscal inflation can be pushed into the future (i.e. our anticipation horizon) is intimately tied to the maturity

of government debt.

7 Concluding remarks

The model identifies an anticipated part of the inflation target in the canonical NK-DSGE model. While there exist alternative interpretations for the evolution of target inflation, the basic Sargent and Wallace (1981) arithmetic suggests fiscal policy to be a particularly plausible one. The fact that the evolution of anticipated target changes aligns very well with measures of fiscal policy lends credibility to fiscal inflation concerns.

In the model fiscal inflation is entirely exogenous. It implies that monetary policy cannot counter it and that - while not necessarily the most likely scenario - post-crisis the US may be stuck with an inconveniently high level of inflation.

As a final caveat, note that the purpose of the model is identifying anticipated inflation and evaluating whether it is related to fiscal policy. The model we estimate is essentially void of structure when it comes to the modelling of the fiscal authority. This has the advantage that we avoid making highly debatable assumptions on behalf of the fiscal policy maker, but also that we can resort to standard DSGE model estimation, thus avoiding the pitfalls of alternative econometric methods in the face of anticipation. At the same time, the model takes no particular stance on the desirability of various policy options.

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Table 1: Correlation between inflation target news shocks and different measures of fiscal innovations

Fiscal innovations	1966-2011	1966-1983	1984-2011
Primary deficit/GDP	0.44	0.12	0.70
CBO without stabilizers	0.37	0.09	0.56
Controlling for output gap	0.43	0.06	0.64
Controlling for output growth	0.45	0.16	0.58
Primary deficit/debt	0.37	0.15	0.67
Debt/GDP	0.29	0.26	0.32

Table 2: Correlation between inflation target news shocks at different anticipation horizons and fiscal innovations

Anticipation horizon	1966-2011	1966-1983	1984-2011
1 year	-0.03	0.08	-0.12
2 years	-0.21	-0.32	-0.13
3 years	0.01	-0.18	0.17
4 years	0.32	0.17	0.44
5 years	0.44	0.12	0.70
6 years	0.17	-0.11	0.39
7 years	0.11	0.13	0.09
8 years	0.01	-0.13	0.13

Figure 1: Deficit and debt: US (1970-2011, in percent)

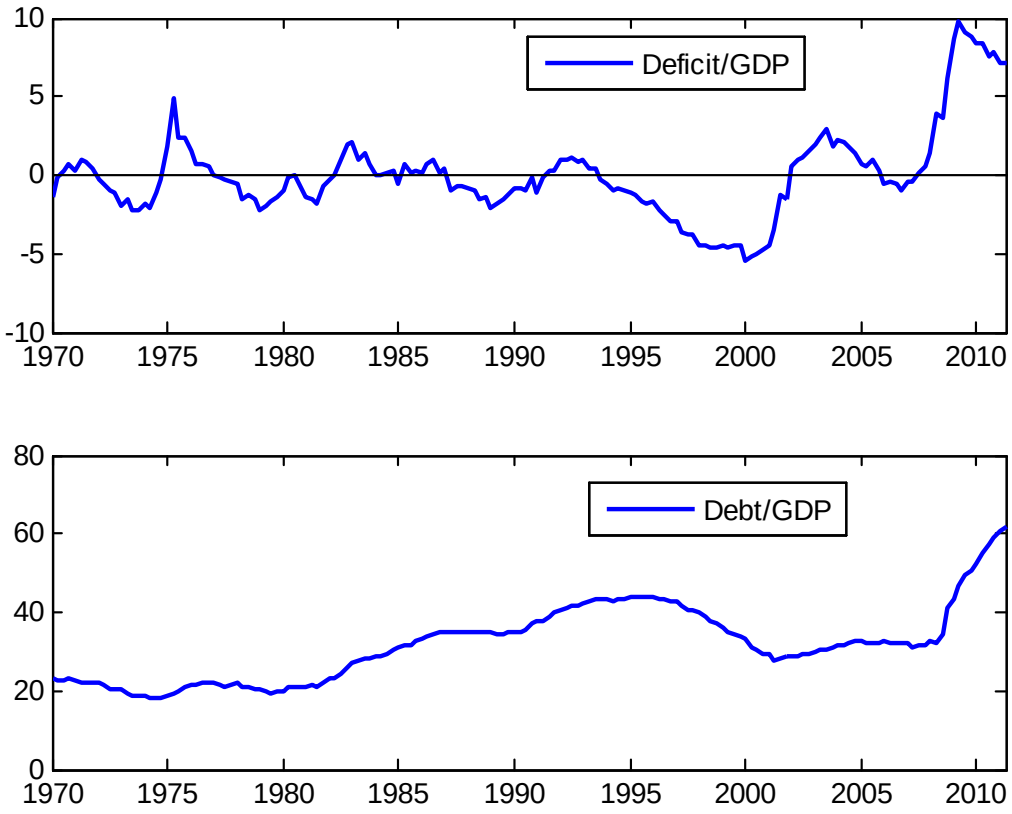
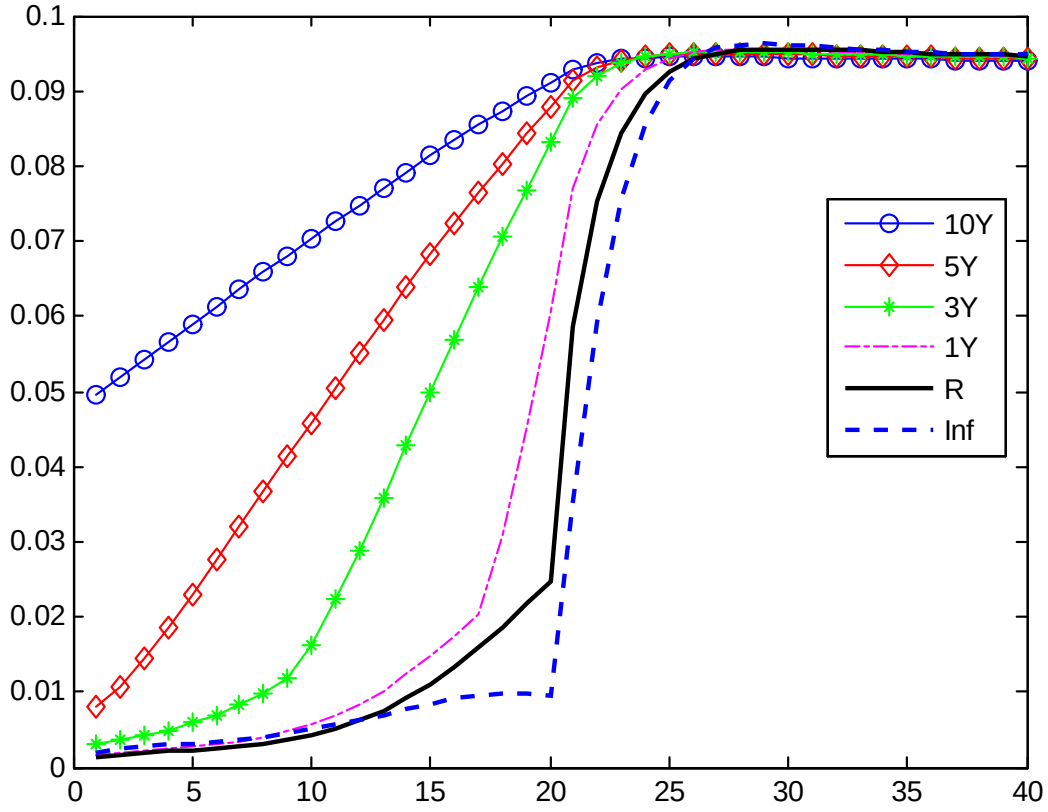
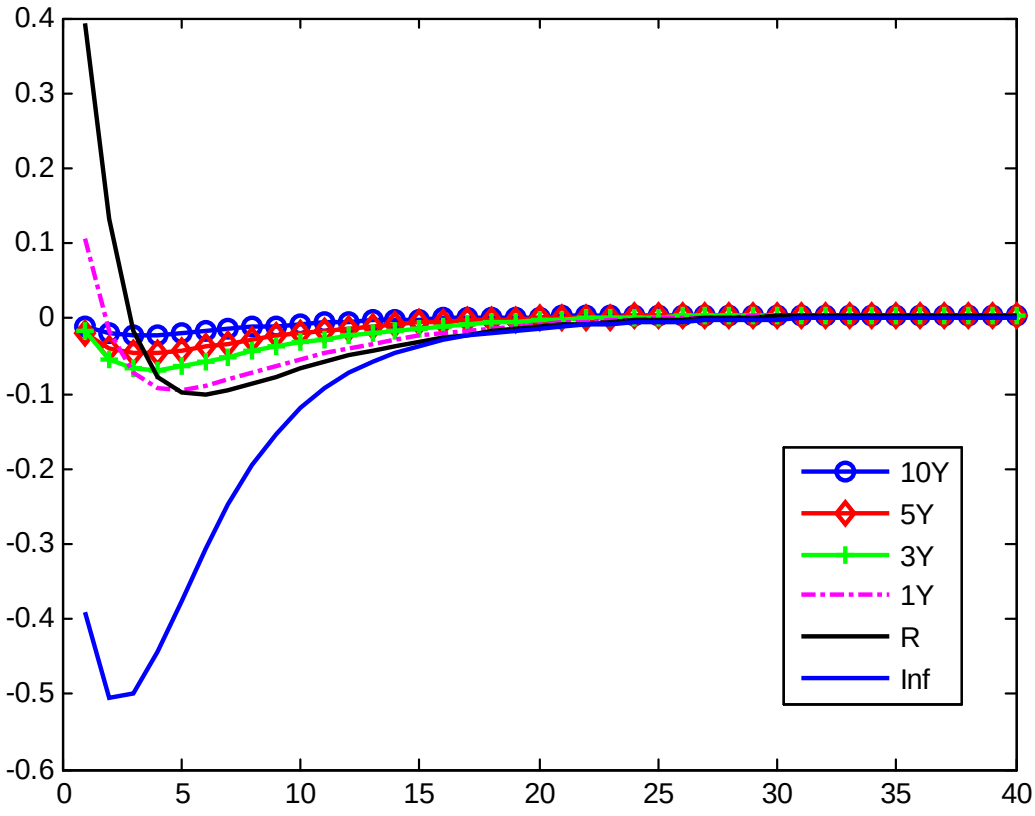


Figure 2: Impulse responses to an inflation target news shock



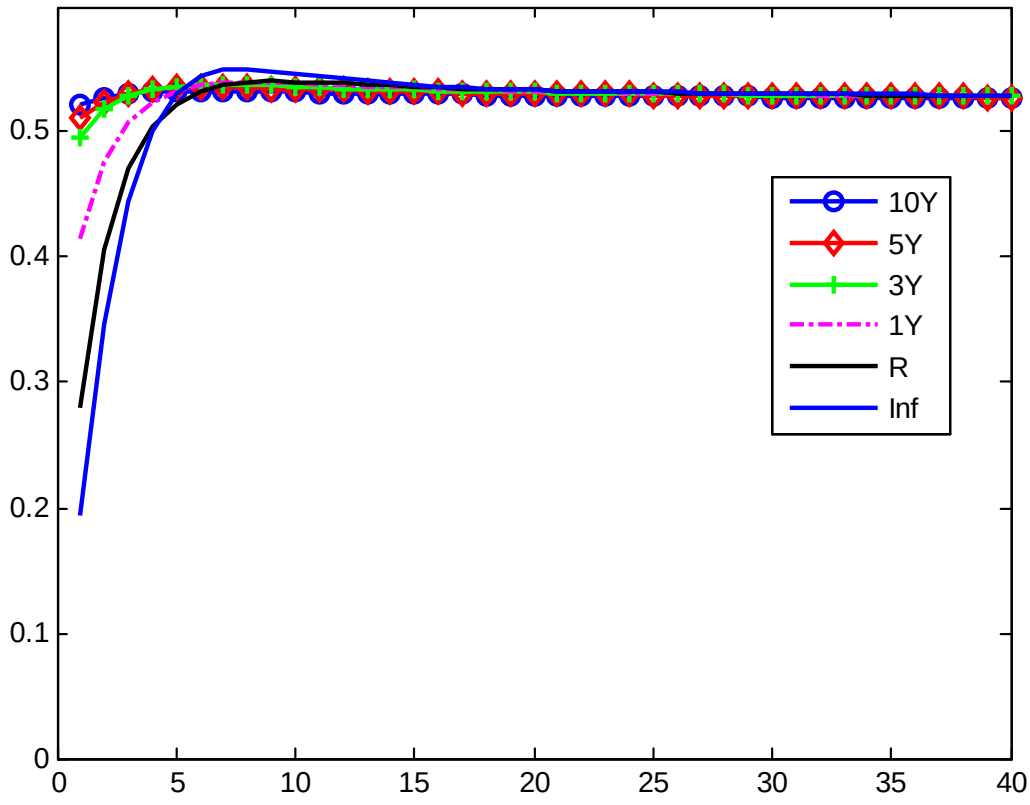
Note: Yields are denoted by their maturity, in years, R: Fed funds rate, Inf: Inflation. The anticipation horizon i is 20 quarters.

Figure 3: Impulse responses to a temporary monetary policy shock



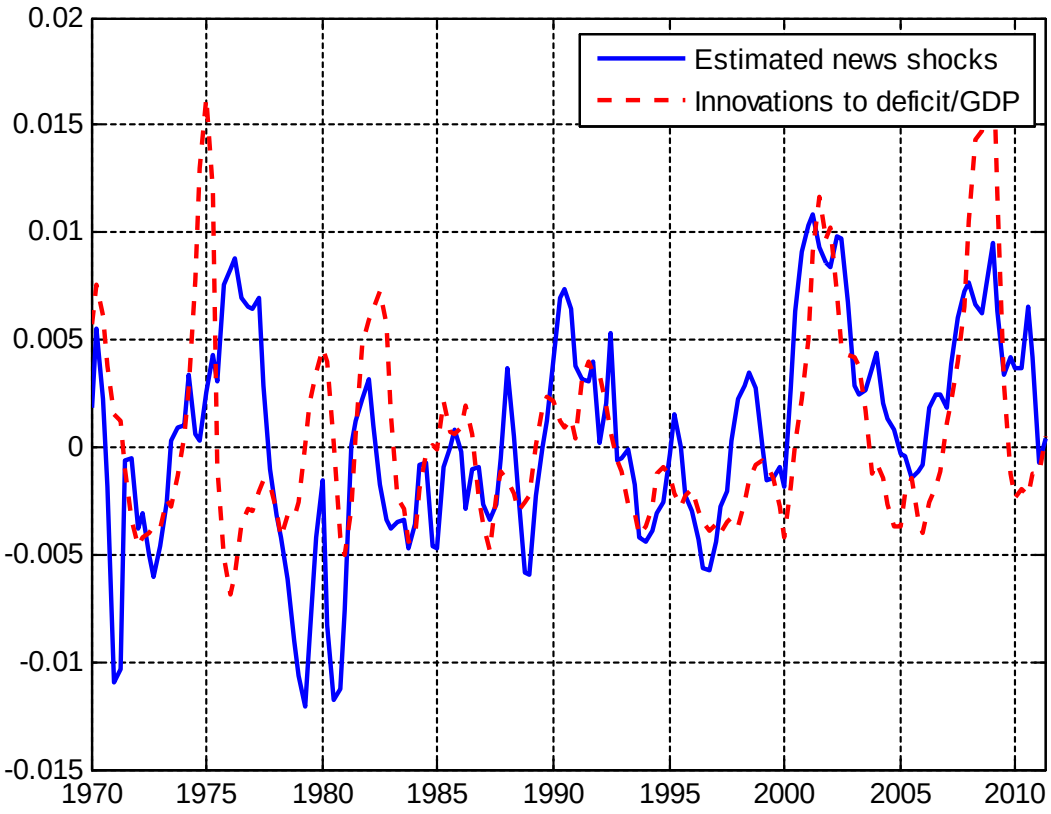
Note: Yields are denoted by their maturity, in years, R: Fed funds rate, Inf: Inflation.

Figure 4: Impulse responses to an inflation target shock



Note: Yields are denoted by their maturity, in years, R: Fed funds rate, Inf: Inflation.

Figure 5: News shocks and fiscal innovations



Note: The dashed line plots $\frac{1}{3}(\varepsilon_{t+1} + \varepsilon_t + \varepsilon_{t-1})$, where ε_t is the residual of a regression of the primary deficit-to-GDP ratio on its own lag.

Figure 6: News contribution and inflation

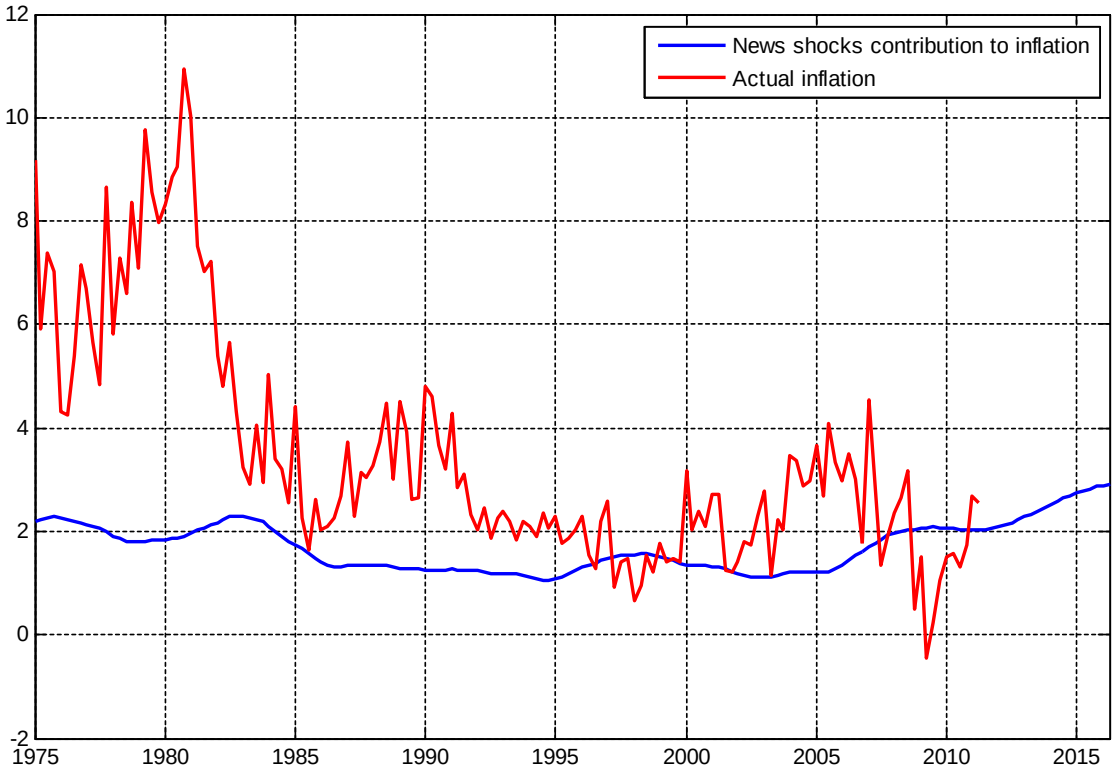


Figure 7: News contribution and debt projections

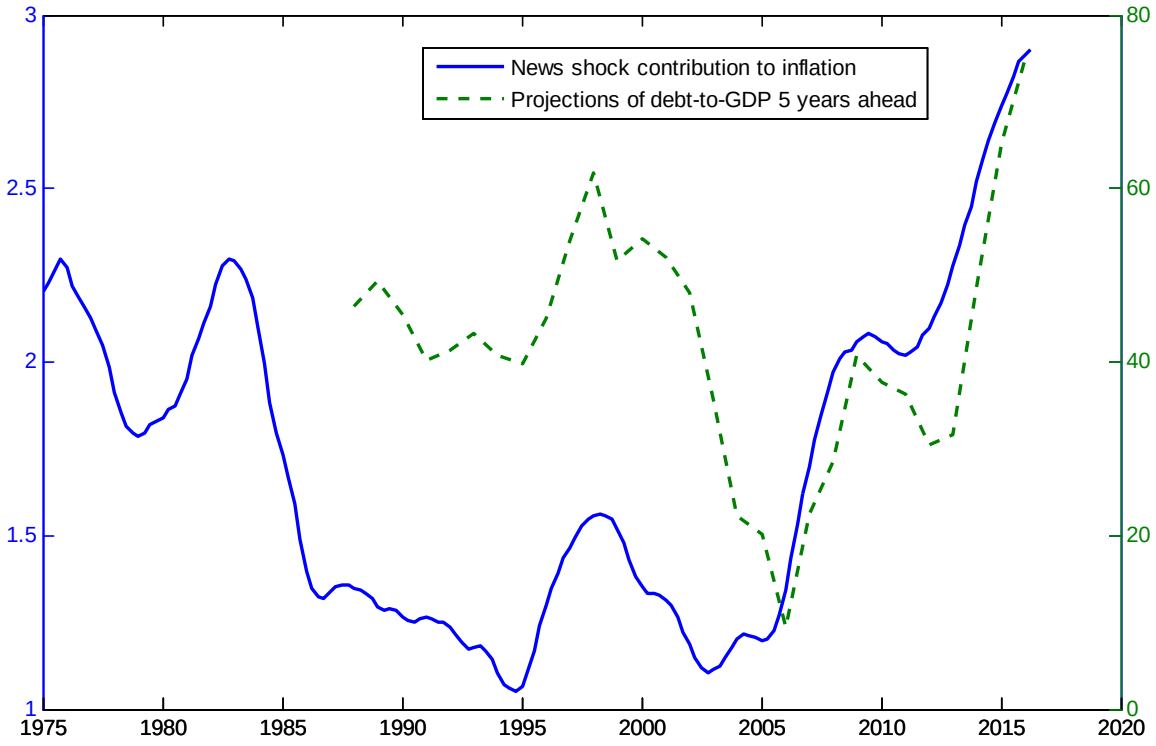
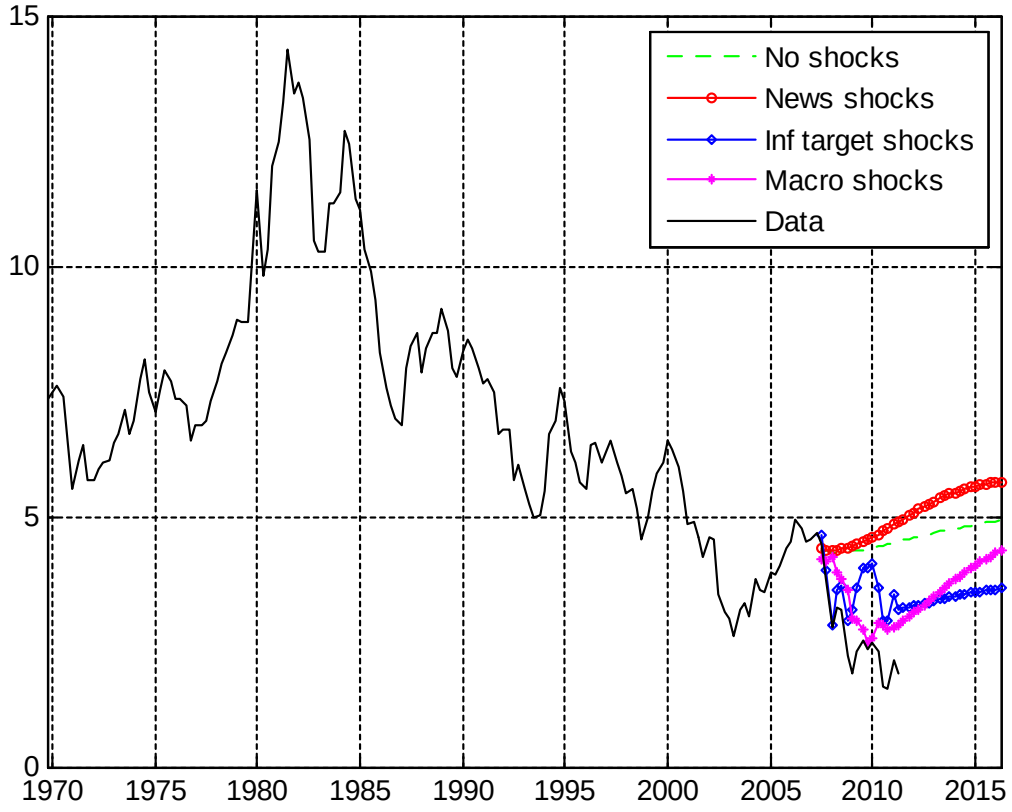
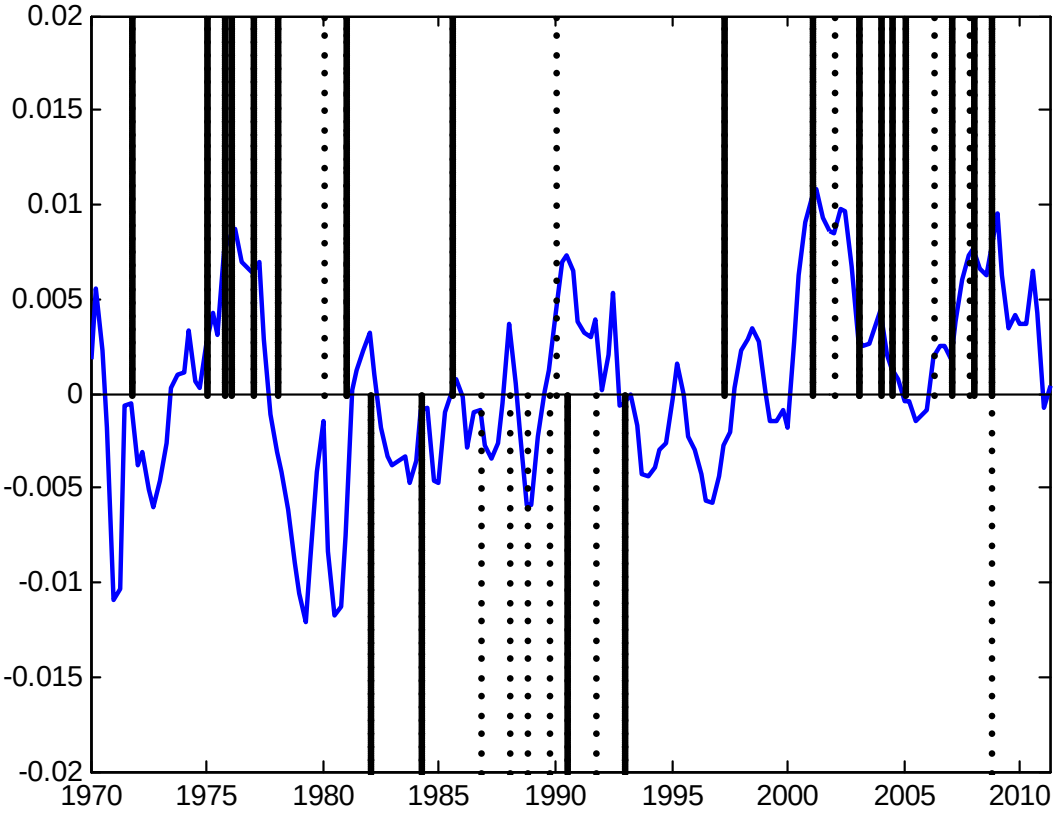


Figure 8: 5-Year yield in the Great Recession



Note: The dashed line plots the evolution of the 5-year yield if all shocks from 2007 onward are set to zero. The circled line shows what the yield would have been if only news shocks were operative in that period. Similarly, the diamond (resp. starred) line plots the case of only inflation target (resp. macro) shocks. The solid line is the data, or what happens with all shocks operational.

Figure 9: Inflation target news shocks and fiscal announcements



Note: Vertical lines above zero mark positive surprises to the deficit while lines below zero correspond to negative shocks. Solid lines depict announcements dates regarding federal income taxes, taken from Yang (2007), while vertical dashed lines pertain to defense announcements, taken from Ramey (2011).

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