DNB Working Paper
No 821/November 2024

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DeNederlandscheBank
EUROSYSTEEM

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 821

November 2024

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November 17, 2024

Abstract

Employing two different effective measures of future tax expectations in a local projection analysis on post-war U.S. data reveals that the effects of an anticipated government spending shock depend solely on expectations about future taxes. In contrast, tax foresight does not affect the transmission of unanticipated shocks. When agents expect taxes to rise (fall), the economy response to an anticipated government spending shock aligns with a monetary (fiscal) regime. Hence, tax foresight is a sufficient statistic to identify the effects of anticipated government spending shocks. We argue that this is consistent with recent literature on monetary and fiscal policy interaction.

Keywords: Monetary policy and fiscal policy interactions, Government spending, Fiscal foresight.

JEL classification: E52, E62, E63.

*We thank Efrem Castelnuovo, Luca Gambetti, Eric Leeper, Leonardo Melosi and Giovanni Ricco for their valuable comments. Florio acknowledges financial support from the Italian Ministry of Education, Universities, and Research (PRIN 2022, grant 2022A9PAT3)

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1 Introduction

Over the last sixty years, with the exception of a brief period from 1998 to 2001, the United States has consistently run a federal budget deficit. According to the fiscal theory of the price level (FTPL), deficits are not inherently inflationary. The stimulative effects of public spending hinges on the anticipation of higher future deficits, rather than in the current deficit itself (Sims, 1994; Woodford, 1994; Cochrane, 2005). The effects of fiscal spending differ according to how and whether agents anticipate the fiscal burden to be repaid. If agents anticipate future tax adjustments, the wealth effects induced by public debt will be minimal. In contrast, if they expect taxes to remain unchanged or decline, wealth effects will be significant. However, expectations of future taxes are not observed directly, complicating efforts to measure the perceived level of fiscal backing for public debt.

This paper addresses this challenge by employing two indirect measures of tax expectations available for the post-WWII period. Incorporating these measures into the estimation of smooth-transition local projections, we find that the effects of government spending shocks critically depend on the state of expected taxes, provided the shock is anticipated by agents. In particular, when agents expect taxes to remain stable or decline, an anticipated increase in government spending generates a strong macroeconomic expansion, while the effect is muted or even contractionary if the shock occurs when taxes are predicted to rise.

Our approach departs from the previous empirical studies on monetary and fiscal interactions that typically define the prevailing regime from the behavior of observable macroeconomic variables, implicitly assuming that expectations of future tax align with the identified regime, as theory prescribes. Following an increase in spending, a monetary regime assumes future tax increases, while a fiscal regime suggests stable or declining taxes. Consequently, actual and expected tax patterns are simply assumed to conform with the mechanism of the prevailing regime. By contrast, our analysis places tax expectations at the forefront. We investigate how anticipated and unanticipated government spending shocks affect the economy under different expectations about future taxes. In case of anticipated shocks, the direction of expected taxes emerges as a critical determinant of their effects: anticipated spending shocks align with a fiscal regime when taxes are expected to remain stable or decline, and with a monetary regime when taxes are expected to rise. Thus, incorporating tax expectations alongside anticipated spending shocks proves to be a powerful tool for identifying the prevailing policy regime in an economy.

In contrast, for unanticipated spending shocks, the expected tax path appears irrelevant, as their effects are broadly consistent regardless of agents' expectations about future taxes.

We consider two measures of anticipated taxes. Specifically, Section 3.1 employs narrative deficit-driven tax changes as built by Mertens and Ravn (2012), employing tax data by Romer and Romer (2008, 2010), recording when taxes are modified because of *"inherited deficit concerns"*. These taxes offer significant information to economic agents, as they are announced by the government before implementation, thus with a high likelihood of realization. Section 3.2 uses an alternative measure of expected taxes, which is market-based rather than reconstructed from legislative activity, and so entirely independent of any future effective implementation. Following Leeper et al. (2012), we consider the spread between treasury bond yields and municipal bond yields over the one-to-five year horizon as a measure of the average expected path of future tax rates. For both measures, we differentiate between periods when agents anticipate tax increases and periods when agents expect taxes to decrease or remain stable.

Building on the empirical literature on the state-dependent effects of fiscal policy (e.g., Ramey and Zubairy, 2018), we then use these two measures in a smooth-transition local projection approach on U.S. data for the post-WWII period, allowing impulse response functions to depend on expected taxes. Crucially, we distinguish between the effects of *anticipated* and *unanticipated* government spending shocks, following Ascari et al. (2023). For both measures, results show that in periods of anticipated tax increases, responses to *anticipated* spending shocks are contractionary, decreasing output, consumption, investment, and increasing debt and real interest rates. These variables respond in the opposite way if agents do not expect any future increase in taxes, as wealth effects kick in and stimulate output, consumption, and investment. Conversely, following an *unanticipated* spending shock, the responses of the variables are not significantly different between the two states of high and low expected taxes. Hence, when the government shock is unanticipated, the path of expected future taxes does not provide additional insight, rendering tax foresight ineffective in identifying different monetary or fiscal regimes.[1]

Our work, therefore, shows that tax foresight is a sufficient statistic to identify the effects of anticipated government spending shocks. Expectations of future fiscal backing are all one needs to know.

[1]These results are in line with the theoretical analysis in Ascari et al. (2023) about the effects of (un)anticipated changes in government expenditures under a fiscal-backed monetary regime and a fiscal-unbacked fiscal regime.

Related Literature. This paper is related to various streams of literature. The first and most obvious connection is with the extensive literature on monetary and fiscal policy interaction, following the seminal contribution by Leeper (1991). Specifically, we relate to studies on the identification of monetary/fiscal policy regimes in US data[2] (see, among others, Davig and Leeper, 2011; Bianchi, 2012; Bianchi and Melosi, 2014, 2017, 2022; Bhattarai et al., 2016; Bianchi and Ilut, 2017; Ascari et al., 2020, 2023; Bianchi et al., 2023; Chen et al., 2022).

The second stream deals with fiscal foresight and the identification of fiscal policy shocks. This literature examines the impact on the economy of fiscal policy in VAR models (see, among others, Ramey and Shapiro, 1998; Blanchard and Perotti, 2002; Fisher and Peters, 2010; Ramey, 2011; Mertens and Ravn, 2011, 2012; Auerbach and Gorodnichenko, 2012; Forni and Gambetti, 2016; Ben Zeev and Pappa, 2017) and stresses the importance of accurately distinguishing between anticipated and unanticipated government shocks. Legislative and implementation lags imply that private agents can adjust their behavior during the time between the announcement of a fiscal measure and its application. Indeed, those who analyze the effects of an anticipated increase in taxes (see Mertens and Ravn, 2012, 2011) find that output increases during the anticipation period and, as it happens for unanticipated shocks, decreases once the tax increase is implemented. Ramey (2011), who analyses the effects of an anticipated government spending shock, finds that such a shock increases output but decreases consumption. Ascari et al. (2023) extend the results by Beck-Friis and Willems (2017), who study unanticipated changes in government expenditures under a fiscal-backed monetary regime and a fiscal-unbacked fiscal regime, to consider anticipated public spending shocks. They consider two sample periods that have been identified in the literature as a monetary and a fiscal regime and find that both an unanticipated and an anticipated government spending shock increase output in both the regimes at implementation. However, these shocks have very different effects during the anticipation period: in the monetary regime they are contractionary; in the fiscal regime they are expansionary, as consumption increases through the expectation of positive wealth effects.

Our empirical results are consistent with Ascari et al. (2023). Rather than splitting our sample period ex-ante in two distinct regimes, however, we analyze a unique extended sample period to determine whether the effects of a public expenditure shock differ, as their theoretical

[2] In Leeper's (1991) terminology: a monetary regime features an active monetary policy adhering to the Taylor principle, combined with a passive fiscal policy where fiscal expansions are backed by future surpluses. Conversely, a fiscal regime combines a passive monetary policy with an active fiscal policy, so that fiscal expansions are unbacked, generating wealth effects.

analysis predicts, distinguishing between two states: one characterized by an expectation of rising taxes and another by an expectation of decreasing taxes.

As discussed below in Section 3.3, our approach connects with other contributions in the literature suggesting that the clear-cut Leeper's (1991) distinction between different regimes might not be the most appropriate way to describe actual data. First, Bianchi and Melosi (2014, 2017) within a Markov-switching framework, and Eusepi and Preston (2018) in the context of the learning literature emphasize the role of expectations about the future fiscal repayments in generating wealth effects, independently from the definition of a particular regime in place. Second, Bianchi et al. (2023) proposes a model in which the policy mix is described by a hybrid regime, where some government spending is fiscally backed while some is not. The economy, therefore, operates in a blurred regime, which combines the fiscal and the monetary regime with a time-varying relative weight between the two. The effects of a government spending shock then depend both on agents' expectations about future regimes and the mix of hybrid regimes, making inference and prediction regarding these effects potentially very challenging.

The paper links also to the large literature on state dependence of spending multipliers (see among others, Auerbach and Gorodnichenko, 2012; Ramey and Zubairy, 2018; Caggiano et al., 2015; Barnichon et al., 2022). Finally, this paper is also connected to Mountford and Uhlig (2009) who analyze the differences in the effects of a government spending shock under a deficit spending scenario versus a balanced budget scenario. Although our results are not directly comparable to theirs, since in our case the expected path of taxes is unrelated to the given spending shock, there are some similarities. With deficit spending, they find that the responses of the anticipated shocks are more persistent and stronger if compared to those of unanticipated shocks. When considering the balance budget scenario - where an increase in government spending is matched by an increase in taxes - they find a decrease in output, consumption, and investment. This is the same result we observe following an anticipated spending shock when taxes are expected to increase.

The remainder of the paper is structured as follows. Section 2 introduces the empirical method and describes the dataset. Section 3 presents the main results for both measures of tax foresight and connects empirical findings with theory. Section 4 is devoted to sensitivity analysis, while Section 5 concludes.

2 Methodology and data

This section describes the data and methodology we use to estimate impulse responses after a government spending shock. The literature on monetary/fiscal policy mix predicts different outcomes based on the prevailing regime. Under a monetary regime, wealth effects should be neutralized by the expectation of higher future surpluses. In contrast, under a fiscal regime, wealth effects emerge due to the anticipation of increasing deficits. However, expectations about future surpluses, and hence about future taxes, are usually just assumed, and researchers often investigate different samples to identify monetary/fiscal regimes (e.g., Bianchi, 2012; Ascari et al., 2023). Here, instead, we can control directly for agents' expectations of future taxes. Following the recent literature on fiscal multipliers, we exploit the flexibility of the local projection approach (Jorda, 2005) to account for potential state-dependence in impulse responses and understand whether the effects of a government spending shock are influenced by agents' expectations about future taxes.

2.1 Linear and smooth-transition local projections

Both linear and state-dependent impulse responses are estimated using local projections. Linear impulse responses to a government spending shock can be obtained from a series of regressions such as

$$y_{t+h} = \alpha_h + \beta_h x_t + \sum_{k=1}^{p} \boldsymbol{\gamma}_k' \boldsymbol{w}_{t-k} + v_{t+h}, \tag{1}$$

estimated with OLS for $h = 0, 1, ..., H$. In our notation y_{t+h} is the outcome variable of interest at horizon h, x_t is a measure of the government spending shock, $\boldsymbol{w}_{t-k}$ is a vector of lagged control variables, v_{t+h} is the error term for the regression at horizon h. The coefficient β_h corresponds to the impulse response at horizon h, with confidence intervals computed using the Newey and West (1987) estimator to account for autocorrelation and heteroskedasticity.

To assess the relationship between government spending shocks and tax foresight, we estimate state-dependent local projections. This method is widely used in the literature investigating nonlinear effects of fiscal and monetary policy shocks. Our work refers in particular to the study of Ramey and Zubairy (2018), who do not detect significant differences in government spending multipliers during recessions and expansions. Using similar data (though limiting our analysis to the postwar period), we want to allow for the possibility that the effect of government spending shocks may instead depend on whether agents expect taxes to increase or decrease in the future. State-dependent local projections are given by the set of regressions

$$y_{t+h} = F(z_{t-1}) \left(\alpha_h^{\text{HI}} + \beta_h^{\text{HI}} x_t + \sum_{k=1}^{p} \left(\boldsymbol{\gamma}_k^{\text{HI}} \right)' \boldsymbol{w}_{t-k} \right) + (1 - F(z_{t-1})) \left(\alpha_h^{\text{LO}} + \beta_h^{\text{LO}} x_t + \sum_{k=1}^{p} \left(\boldsymbol{\gamma}_k^{\text{LO}} \right)' \boldsymbol{w}_{t-k} \right) + v_{t+h}, \tag{2}$$

for $h = 0, 1, ..., H$. With respect to the linear specification, we have introduced two new terms: z_t and $F(z_t)$. z_t is an indicator of anticipated taxes, which takes a larger value when taxes are expected to increase and a lower value when taxes are expected to decrease. $F(z_t)$ is a smooth transition function that translates the indicator variable into a weight comprised between 0 and 1. Following Granger and Terasvirta (1993), we specify $F(\cdot)$ to be a logistic function with the form

$$F(z_t) = \frac{\exp \gamma(z_t - c)/\sigma_z}{1 + \exp \gamma(z_t - c)/\sigma_z} \in [0, 1]. \tag{3}$$

In accordance, the coefficients β_h^{HI} and β_h^{LO} are the impulse responses at horizon h for the higher expected tax regime (HI) and the lower expected tax regime (LO), respectively. Note that we distinguish the two regimes based on the tax expectations already existing at time $t-1$, one period before the government shock is announced.

2.2 Data

We estimate impulse response for eight macroeconomic variables: government spending, GDP, tax revenues, consumption of services and non-durables, investment, government debt, the inflation rate, and the real interest rate. All the series were taken from Ramey (2016), so the first six variables are constructed using the Gordon-Krenn transformation: nominal series from the NIPA tables are divided by the GDP deflator and by potential output, estimated as a quadratic trend of real GDP. Inflation is given by the log-differences of the GDP deflator, while the real interest rate is given by the 3-month nominal rate minus realized inflation.

We look, first, at *anticipated* government spending shocks and then to *unanticipated* ones. Our main measure of anticipated government spending shocks is based on the data on expected federal government purchases from the Survey of Professional Forecasters (SPF). Since forecasters predicted real federal spending starting from 1981q3 only, we follow Ramey (2011) who, for the years 1968q4-1981q2, employs the SPF prediction of nominal defense spending and converts it into real terms using the forecast of the GDP deflator.[3] We consider the forecast of future spending growth from one quarter ahead to three quarters ahead, i.e. the cumulated forecast F(1,3) in the notation of Forni and Gambetti (2016).

For unanticipated government spending shocks, we follow Auerbach and Gorodnichenko (2012). To account for expectations not already included in the VAR, they combine government spending forecasts from Federal Reserve staff (Greenbook data, available from 1966 to 2004) and professional forecasters (SPF data, available since 1981), thereby constructing a continuous forecast series from 1966 to the present. They impose a Cholesky identification scheme with the forecast error for the growth rate of government spending ordered first and government spending ordered second. In this specification, they interpret an innovation in the forecast error as an unanticipated shock.

The largest sample for our analysis spans from 1947q1 to 2007q4. We exclude the financial crisis because both alternative measures we use for expected taxes are reliably available only up to that date. Our baseline case covers a sample that begins at the end of the sixties. In the sensitivity analysis in Section 4, we adopt alternative anticipated and unanticipated government spending shocks, which also allow us to extend the sample period.

The measures of anticipated/unanticipated government spending shocks are then used as the x_t variable in the state-dependent local projections (2), while the indicator of expected taxes is the z_t variable of the smooth-transition function (3), used in (2). In each of the following exercises we include as controls three lags of the outcome variable and of the shock variable, as well as three lags of government spending, output, and taxes.

3 Baseline results

The main goal of the paper is to check whether government spending shocks have different effects depending on the expectations of future taxes. We use two different measures of tax foresight in Section 3.1 and Section 3.2. For both measures, we study the effects of a pre-announced government spending shock as well as those of an unanticipated government spending shock.

[3] For this period, Ramey (2011) *"defines the news as the difference between actual real defense spending growth between $t-1$ and t and the forecast growth of defense spending for the same period, where the forecast was made in quarter $t-1$. I construct the news based on the difference in the actual and predicted growth of real federal spending from period $t-1$ to t."*

3.1 Deficit-driven anticipated taxes

The anticipated "deficit-driven" tax shocks (DD in what follows) used by Mertens and Ravn (2012) is the first measure of future expected taxes we employ. These shocks are available from 1945q1 up to 2007q4. These are particularly suitable to discriminate among the working of a monetary or a fiscal regime as they are tax increases designed to reduce an inherited budget deficit.[4]

Mertens and Ravn (2012) define for each tax act the announcement date and the implementation date of the tax liability change. The announcement date is when the policy intervention was signed into law, while the implementation date is when the tax provisions took effect. If the lag between the announcement and the implementation date is longer than 90 days, the tax changes are classified as anticipated, otherwise they are unanticipated. We build only on anticipated tax changes to construct an indicator of expected taxes. Specifically, if a tax change is announced at time t with implementation at time $t + h$, our indicator takes the value of the tax change (in percentage of GDP) throughout the period from t to $t + h$; otherwise it is equal to zero if there are no pre-announced tax shocks in the future. Note that the values of tax changes announced for a future period $t + h$ in different past periods are cumulated. Therefore, our indicator variable, shown by the solid-blue line in Figure 1, distinguishes periods when taxes are expected to increase from periods when agents have no news of tax change.

3.1.1 Anticipated shocks

As an anticipated shock, we use the forecast of future spending growth from the SPF for the following three quarters, i.e. the cumulated forecast F(1,3). The sample period is 1968q4-2007q4. Figure 2 shows the results. The first column of the figure reports the impulse response functions for the linear case (solid-black line), as in (1); the second column reports the impulse response functions from the state dependent local projection in (2): when taxes are expected to grow (dashed-dotted-blue line), and when they are expected to remain unchanged (dashed-red line). The third column depicts the t-statistic for the null hypothesis of no statistical significant difference between the two cases of high and unchanged expected taxes responses (dotted-black

[4] This is just one type of taxes classified by Romer and Romer (2010) through their narrative approach. The other three categories of taxes include spending-driven, countercyclical and those aimed at for long-run growth. From Romer and Romer (2008), page 6: *"A tax increase to pay for a past spending increase is classified as spending-driven if it occurs within a year of the spending increase, and as deficit-driven if it occurs more than a year after."* Although these deficit-driven tax have occurred throughout the postwar era, they were most prevalent in the 1980s.

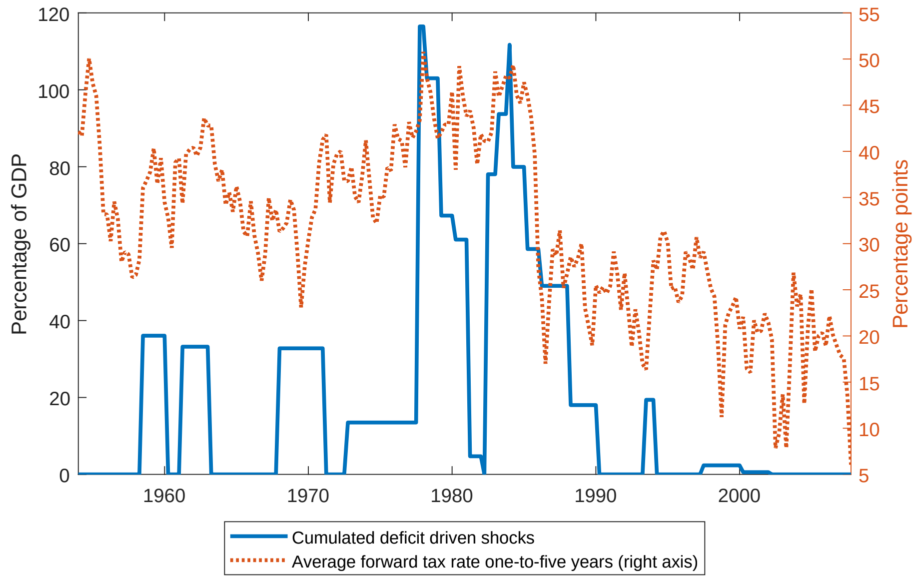

Figure 1: **Measures of expectations of future taxes.** The solid-blue line corresponds to the deficit-driven measure by Mertens and Ravn (2012); the dashed-red line correspond to the measure based on the differential returns on federal and municipal bonds (AFTR15) by Leeper et al. (2012). The correlation between the two measures is 0.53

line), together with 90% confidence interval (shaded area). A positive (negative) value of the t-statistic means that the high (no) expected taxes response is larger.

In the linear case, the response of the variables are not significant or slightly so.

In the state-dependent cases, the responses of the variables to an anticipated government spending shock depend on the expected tax regimes and are, most of the time, statistically significantly different. In particular, periods with high (zero) expected taxes go together with a reduction (increase) in output, consumption, investments and inflation. Moreover, real interest rates and debt increase when expected deficit-driven taxes are increasing, while they are not significant or they decrease when there are no expectations of tax change.[5]

Finally it is worth noting that, in the non-linear case, the difference in actual taxes in the impulse response functions between the two regimes is not statistically significant, except at short and at long horizons when, in the high expected taxes regime, taxes are higher and marginally statistically significant. As stated in the Introduction, this does not contrast with the prediction of the fiscal theory of the price level, which is based on the expected future surplus in the perceived intermporal budget constraint of the government. Therefore, the different reaction of the macroeconomic variables depend on the expected future tax path rather than the actual

[5]Government spending does not seem to be very reactive to a F(1,3) shock when higher expected taxes are considered. The next section and the appendix show that this feature is absent, while results are confirmed, when other specifications are employed.

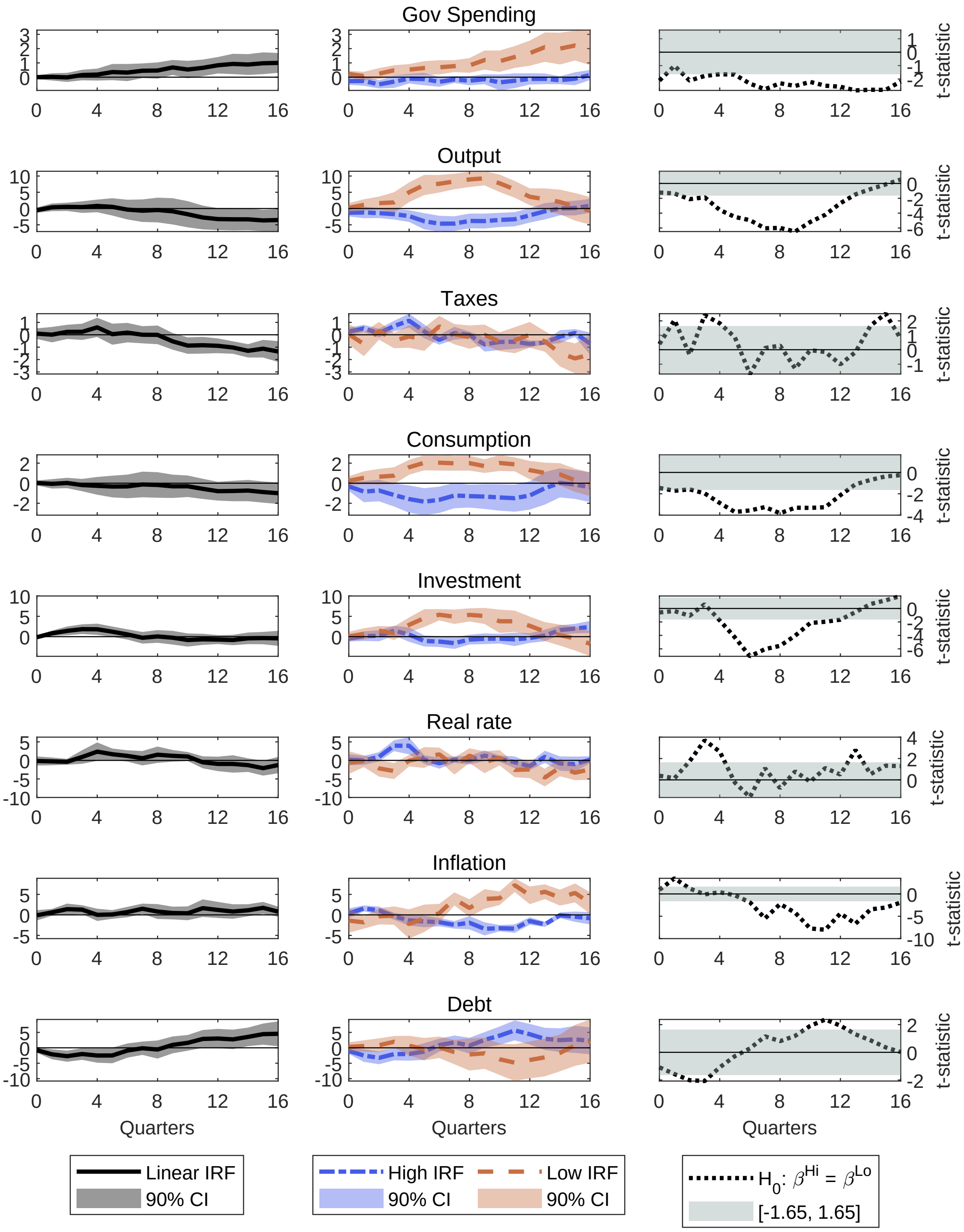

Figure 2: **The effects of anticipated government spending shocks depend on expected future taxes (DD).** Sample period: 1968q4-2007q4, 3 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and cumulated SPF forecast errors on government spending F(1,3). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

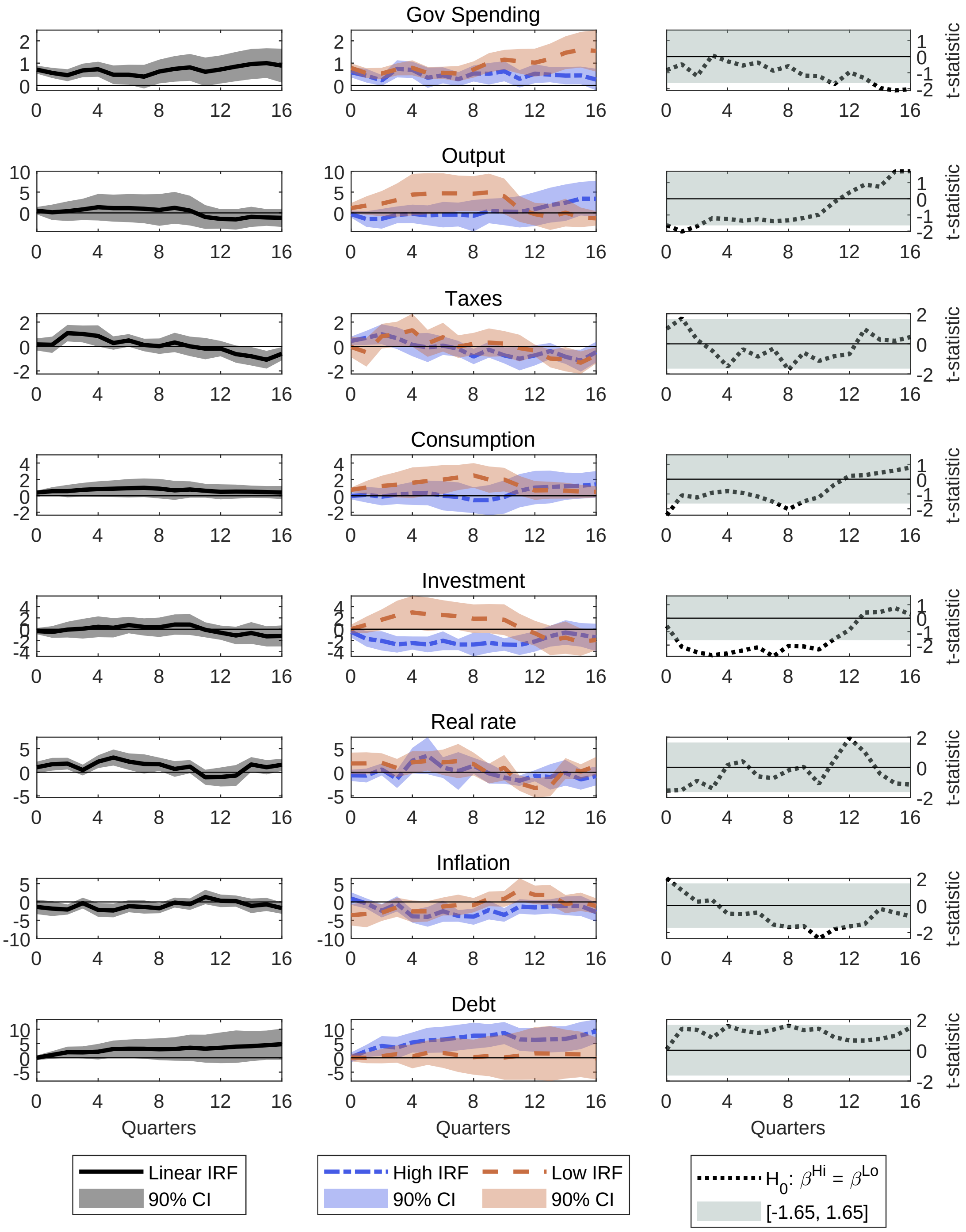

Figure 3: **The effects of unanticipated government spending shocks do not depend on expected future taxes (DD)**. Sample period: 1966q4-2007q4, 3 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and unanticipated government spending shock as in Auerbach and Gorodnichenko (2012). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

one.

3.1.2 Unanticipated shocks

We now want to check if and how previous results differ when we consider unanticipated government spending shocks. Inserting Auerbach and Gorodnichenko's (2012) forecast error variable in our state-dependent local projection (2) yields Figure 3 for the sample period 1966q4-2007q4. Differently from the case of an anticipated shock, the impulse response functions of the economic variables do not differ if one compares the linear case and the two states of high and no change in expected taxes. From the third column one can realise that, except for investments, the difference in the IRFs between the two regimes is never statistically significant.

To sum up, the results in this section suggest that, when the government shock comes as a surprise, the expected path of future taxes does not influence neither agents' consumption choices nor the other variables. On the contrary, whenever a government shock is announced, agents' behavior is affected by the expected path of taxes and, what is more, they react in an opposite way to the anticipated spending shock according to the state of higher or lower expected taxes.

3.2 An alternative market-based measure of tax foresight

Anticipated taxes are those preannounced but not yet implemented. The announcement date is the date at which the policy intervention became law, while the implementation date is the date when tax changes are then introduced according to the tax legislation. Mertens and Ravn (2012) anticipated deficit-driven taxes are those that were subsequently implemented. Recently, Sims (2024) argued that expectations regarding future fiscal policy exert a strong influence, even in cases where those expectations prove to be erroneous. To investigate this assertion, we replicate our analysis replacing the deficit-driven tax rate with an alternative measure of expected taxes, not directly linked to actual future implementation of tax changes. We follow Leeper et al. (2012), and we use the municipal bond yield curve (see also Fortune, 1996) as a measure of the average expected path of future tax rates. In the United States, differently from treasury bonds, municipal bonds are exempt from federal taxes. The rate at which the investor is indifferent between tax-exempt and taxable bonds, the implicit tax rate, is given by one minus the ratio between the yield on a municipal bond and that on a taxable bond. With forward-looking participants in the municipal bond market, the implicit tax rate should predict subsequent movements in individual tax rates.[6] Considering implicit tax rates over two different maturity lengths, we have a time series of the implied forward tax rate.

We use the average expected future (forward) tax rate at 1-5 year horizons (AFTR15), as municipal bond yields provide more insight into tax events in the near future rather than over the long term. Using this series, we construct an indicator of expected taxes for the period 1954q1-2007q4.[7] This measure of fiscal foresight was employed by Leeper et al. (2013) to examine how the effects of fiscal policy shocks might differ when well-known exercises, such as Blanchard and Perotti (2002) and Mountford and Uhlig (2009), were augmented with a direct measure of tax news, such as the implicit tax rate.[8]

Figure 1 shows our AFTR15 tax foresight measure (dashed-red line) and it compares it with the deficit driven one (DD, solid-blue line) used in the previous analysis. Before examining their similarities, we first look at their differences. First, DD and AFTR15 refer to the expectations of two different kinds of taxes: under DD, we consider only deficit-driven tax changes, which are tax increases designed to reduce an inherited budget deficit. Under AFTR15, we consider municipal bonds that respond to changes in individual income taxes only. Second, these tax foresight measures entail different kinds of expectations: under the DD measure, they represent anticipation of future taxes communicated by the government to the public in advance of implementation. In contrast, AFTR15 captures expected movements in individual taxes based on implicit tax rate, the tax rate at which investors are indifferent between tax exempt and taxable bonds. Under the DD measure, if the announcement is credible, agents' beliefs and policy actions would be perfectly aligned, whereas under the AFTR15 measure, belief formation is market based. Third, the expectation horizon for these measures differ: while the foresight horizon for the AFTR15 case ranges from 1 to 5 years, the DD case has an average anticipation

[6] For example, if investors expect individual tax rates to rise (fall), they will demand higher (lower) yields on taxable bonds until they are indifferent between taxable and nontaxable bonds.

[7] The behavior of municipal bond yields became erratic from 2008q1 onwards, as liquidity and flight-to-quality started affecting the bond markets after the outburst of the 2007–2008 financial crisis. As Kochin and Parks (1988) notes: "in a well-arbitraged market, the forward tax rates could be interpreted as expected future tax rates. Under this interpretation, we would expect them to be bounded between zero and one. [. . .] The finding of negative forward tax rates is clearly inconsistent with the interpretation of forward tax rates as expected future tax rates." For this reason, we exclude the period starting in 2008q1 when the average expected future tax rate becomes negative, very volatile, and sometimes larger than one. See Appendix A for more details.

[8] Blanchard and Perotti (2002) identified a tax shock by estimating a quarterly VAR with output, government revenues and spending. Using an instrumental variable to account for foresight – assuming agents had one quarter of foresight – they found that a surprise tax increase led to a weak positive response in output, in contrast to the negative response observed in a VAR that ignores foresight. Leeper et al. (2013), by incorporating implicit tax rates, found that anticipated tax increases substantially boosted output for about three years before a decline. The differing results are attributed to fiscal foresight identification: Blanchard and Perotti (2002) allows for one quarter of foresight, whereas the implicit tax rate approach extends up to five years. They conclude that modeling information flows is crucial to the results.

horizon lower than 3 years (and, in some cases, even less than one year). Finally, the definitions of the two states also vary: in AFTR15, expected taxes may increase or decrease, whereas DD considers only tax increases, with the complementary state representing no change in taxes).

Despite the stated differences in the series, and apart from some exceptions, especially at the very start of the seventies, Figure 1 shows that the two series exhibit a similar pattern. Spikes in DD occur close to the spikes in AFTR15, and when AFTR15 decreases, DD either decreases or is zero. The similarity is rather striking given the different nature of these two measure. Moreover, the imperfect coincidence in the timing of peaks and troughs is due to the temporal misalignment of the expectation horizon (third point above) for the two methods.

To more clearly distinguish in our local projection analysis periods when taxes are expected to grow from those when taxes are expected to decrease, we decompose AFTR15 into the trend and cycle components using the HP filter and consider the first difference of the trend component. Hereafter, we refer to this adjusted measure of expected tax behavior as AFTR15TD. Finally, from these two measures we compute the implied smooth transition functions $F(z_t)$ in (3), used in the state dependent local-projection (2). $F(z_t)$ represents varying intensity in the degree of fiscal backing.[9]

3.2.1 Anticipated shock

Figure 4 shows the impulse response functions to an increase in the cumulated forecast of future spending growth F(1,3) for the sample period 1968q4-2007q4, employing this different measure of expected taxes. The figure follows the same format as the previous ones.

Again, in the linear case, the response of the variables is not significant or slightly so. On the contrary, the last column shows that the responses of the variables in the high and low expected taxes states are statistically significantly different both at short and at long horizons. Periods with high (low) expected taxes exhibit a reduction (increase) in output, consumption, and investments and an increase (reduction) of real interest rates and debt.[10] Moreover, the difference in effective taxes in the IRFs between the two regimes is now statistically significant and they increase (decrease) in the high (low) expected taxes regime.

[9] Appendix B.3 displays the series of AFTR15TD and of the implied smooth transition functions for the two cases (DD and AFTR15TD).

[10] In comparison with Figure 2, note that government spending now increases following a F(1,3) shock, while there is not clear evidence on inflation behavior.

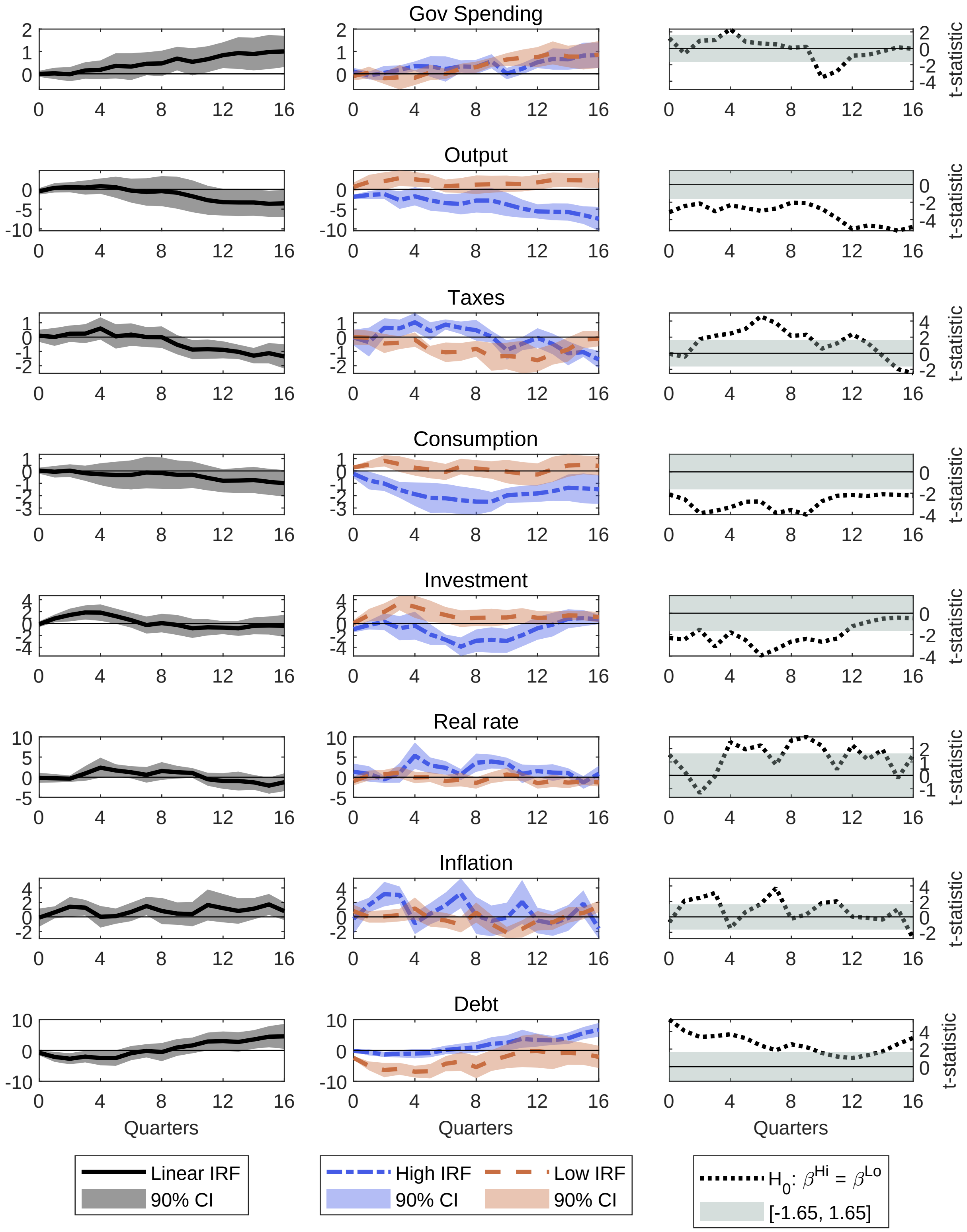

Figure 4: **The effects of anticipated government spending shocks depend on (market-based) expected future taxes.** Sample period: 1968q4-2007q4, 3 lags, AFTR15TD as from Leeper et al. (2013) and cumulated SPF forecast errors on government spending F(1,3). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

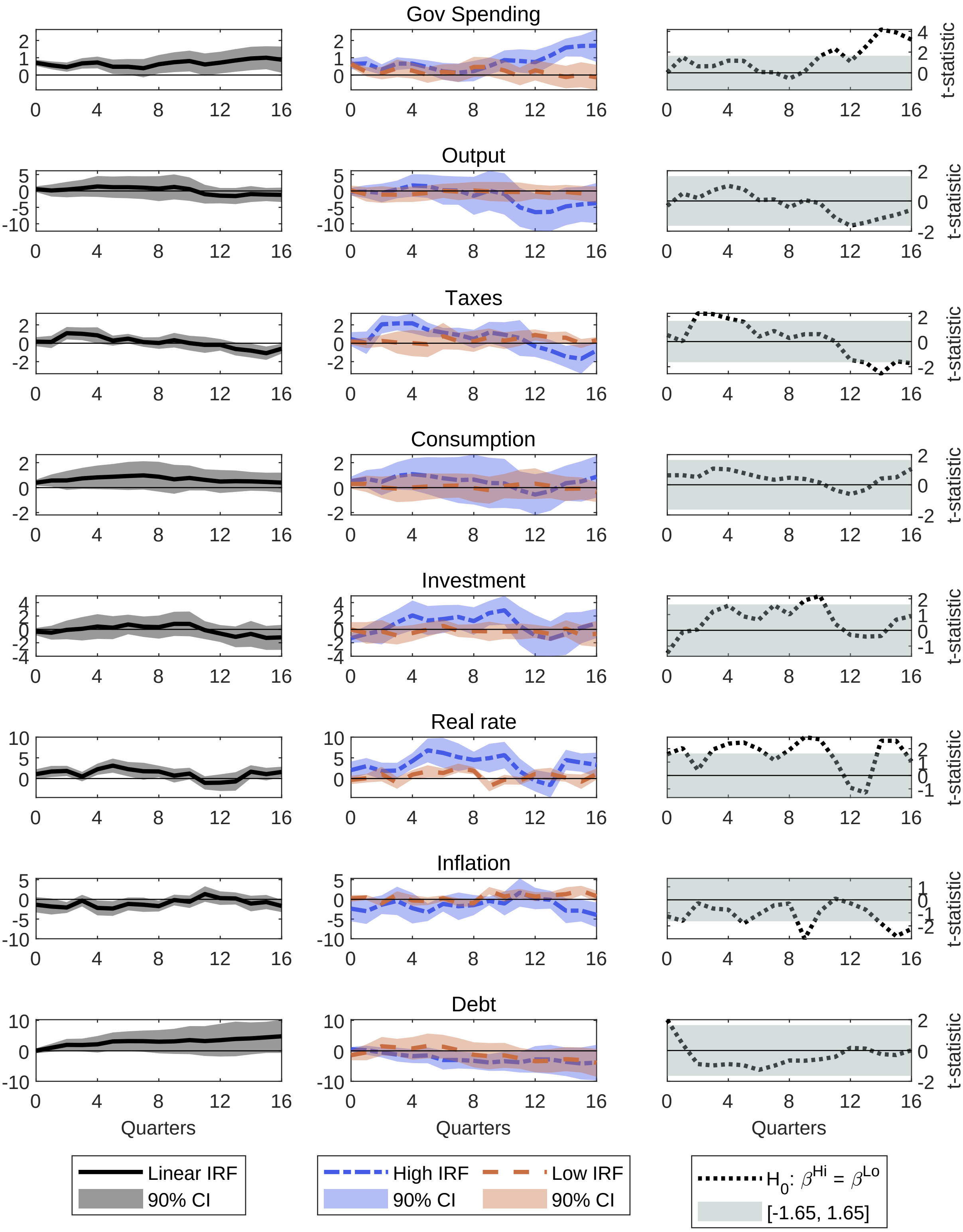

Figure 5: **The effects of unanticipated government spending shocks do not depend on (market-based) expected future taxes**. Sample period: 1966q4-2007q4, 3 lags, AFTR15TD as from Leeper et al. (2013) and cumulated SPF forecast errors on government spending F(1,3). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

3.2.2 Unanticipated shock

As before, we want to check whether and how previous results differ when considering unanticipated shocks. Employing Auerbach and Gorodnichenko (2012) forecast error variable and accounting for the two regimes yields Figure 5 for the sample period 1966q4-2007q4.

In line with the results for unanticipated shocks with the DD specification, the IRFs differ from those observed in the case of an anticipated shock discussed earlier. In this case, the responses of the variables are not significantly different between the two states of high and low expected taxes – with the exception of the real rate – and they are similar to the IRFs in the linear case. This confirms that tax foresight does not provide additional insight when government spending shocks are unexpected. For unanticipated shocks, information on future expected taxes offers no added value, as agents can only react at the time of implementation due to the shock's unexpected nature. In contrast, anticipated government spending shocks can affect the economy before their implementation, as agents receive advance signals and adjust their behavior based on the expected future path of government revenues (see, e.g., Ascari et al., 2023).

3.3 Connecting empirical findings with theory

The previous section provides evidence that the effects of anticipated government spending shocks depend on the state of expected taxes. This Section discusses this main empirical finding in the context of the theoretical literature.

Ascari et al. (2023) show that in a medium-scale DSGE theoretical model anticipated governments spending shocks have different effects in the two regimes defined in Leeper (1991). In the monetary regime, where increases in government expenditure are assumed to be fiscally backed, anticipated governments spending shocks are contractionary – output, consumption and investment fall during the anticipation period. In contrast, in the fiscal regime, where fiscal expansions are unbacked, the same shocks are expansionary, as they increase private consumption and investments, and so output, through the expectation of positive wealth effects. According to the empirical results in the previous section, expectations of tax increases generate effects akin to those predicted by theory for a monetary regime, while expectations of non-increasing taxes generate effects akin to those that theory would predict for a fiscal regime. Hence, measures of tax foresight serve as a tool to identify the different effects of anticipated government spending shocks.

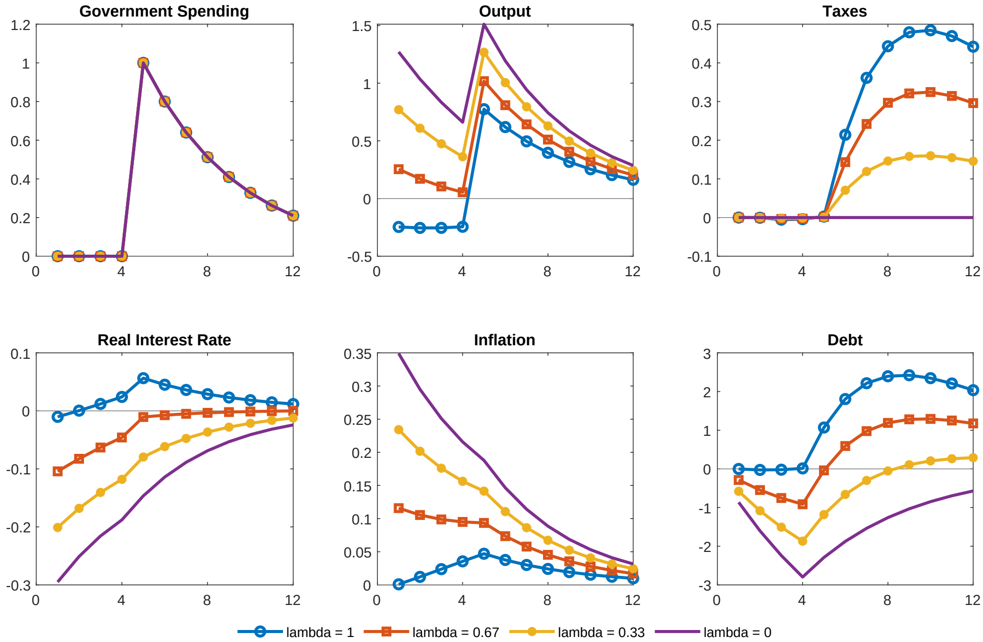

Figure 6: **Theoretical impulse responses to an anticipated government spending shock.** The figure plots the impulse responses for different degrees of fiscal backing (λ) using a small-scale New Keynesian model based on Bianchi et al. (2023) (see Section II.B therein).

However, the idea of the policy mix as a series of alternating, well-defined regimes may not be the most accurate. A more fitting description might involve a single, blurred regime in which elements of both monetary and fiscal policies coexist to varying degrees over time. Bianchi et al. (2023) propose a model of a hybrid regime, where government spending is partially backed by taxes while the remaining portion is fiscally unbacked. Consequently, the economy's response to spending shocks would vary depending on the fraction of spending that is funded—producing responses akin to a monetary regime—or unfunded—inducing responses typical of a fiscal regime.

This novel and compelling characterization of the interaction between monetary and fiscal policy aligns well with the interpretation of our findings because from the measures of tax foresight in Figure 1, we define the implied smooth transition functions $F(z_t)$ in (3), used in the state dependent local-projection (2). This variable represents varying degrees of fiscal backing within a single hybrid regime, without the need to assign each period to a distinct well-defined regime.

To illustrate the connection between their theoretical framework and our empirical results, we draw on the small-scale New Keynesian model in Bianchi et al. (2023) (see Section II.B therein). Figure 6 shows the responses to an anticipated government spending shock, announced at time 0 and implemented with a four-period delay, for different values of λ, representing different degrees of fiscal backing. Here, $\lambda = 1$ reflects full fiscal backing, or a monetary regime, while $\lambda = 0$ reflects no fiscal backing, or a fiscal regime.

Intermediate values of λ characterize a hybrid regime where λ identifies the degree of fiscal backing. In this hybrid regime, monetary and fiscal policy rules respond to a fraction (λ) of the anticipated increase in spending as they would under a monetary regime, whilst for the remaining fraction $(1 - \lambda)$ the monetary and fiscal authorities act as they would in a fiscal regime.[11] An anticipated government spending shock leads to a decrease in output (and consumption, not shown) during the anticipation period in the polar cases of $\lambda = 1$ (circled-blue line), and to an increase in the other polar case of $\lambda = 0$ (solid-purple line). In this latter case, the typical FTPL dynamics unfold: inflation jumps up, the real interest rate drops, so that the value of the debt decreases. Note that when $\lambda = 0$, taxes do not move, while in the other cases taxes do move to counteract the increase in debt, tough the extent of this adjustment depends on λ. Hybrid states, characterized by intermediate values of λ, exhibit dynamics that lie between the two polar cases depending on the degree of fiscal backing, i.e., the value of λ. Our empirical measure of tax foresight, $F(z_t)$, can be interpreted as the counterpart of λ in Figure 6, because it measures the expected degree of fiscal backing by the agents. Our result, thus, provides a direct strategy that uses the direction of expected taxes as a tool to identify the diverse effects of anticipated government spending shock depending on the different degrees of fiscal backing.

Our empirical analysis unveils another important aspect: what matters are expectations of future taxes, not necessarily actual realizations. Resulting from an impulse response function, the dynamics in Figure 6 assume perfect foresight after the impact period, so that actual and expected taxes are bound to be the same. There is no uncertainty in these impulse responses so expectations align accordingly. However, in reality people might be uncertain about the policy mix in place. Our results are in line with previous studies in the literature that point out that expectations are key to determine the behavior of the economy after a fiscal shock both in a regime switching environment between monetary and fiscal regime (Bianchi and Melosi, 2014, 2017), or because of imperfect knowledge and learning (Eusepi and Preston, 2018). Bianchi and

[11] Following Bianchi et al. (2023), the model defines a "shadow" economy to determine the "notional" responses of variables to an anticipated spending shock under a fiscal regime, thereby calculating the levels of inflation and debt that are fiscally driven and tolerated. The fiscal policy rule then responds only to debt levels exceeding those fiscally unbacked, while the monetary policy rule responds only to inflation levels exceeding those fiscally driven. See Appendix C for details and calibration.

Melosi (2014) stress that when agents are uncertain about the way debt will be stabilized, the strict distinction between monetary and fiscal regimes becomes nuanced and it is replaced by a series of intermediate regimes that reflect the evolution of agents' expectations about the future conduct of both fiscal and monetary policies. In their model, agents' expectations ultimately shape the economy's response. If agents expect fiscal backing even in an unbacked fiscal regime, the economy initially behaves as if in a monetary regime. Over time, however, agents recognize the unbacked policy, and the economy shifts to a fiscal regime. Similarly, if the economy starts in a monetary regime but agents foresee a potential shift to a fiscal regime, the dynamics will align with a fiscal regime, as expectations ultimately shape the outcome. Bianchi and Melosi (2017) show that agents' expectations about policymakers' actions at the zero lower bound — implying passive monetary policy — significantly shape macroeconomic outcomes. Even a small perceived probability of shifting to a fiscally-led regime can prevent deflation and a deep recession, suggesting that policy uncertainty regarding future monetary and fiscal actions may help explain the absence of deflation during the Great Recession. In a setting where agents learn about the long-term averages of inflation and taxes, Eusepi and Preston (2018) show that wealth effects hinge on the expected present value of taxation relative to the market value of public debt.[12] Hence, also in their framework, incorrect expectations about fiscal backing play a key role in shaping the behavior of the economy. Our empirical findings align with the insights from these important contributions.

Finally, note that our empirical findings are independent of monetary policy expectations. Our focus is on tax foresight, so we do not include information about expected future conduct of the central bank. According to the seminal Leeper (1991) taxonomy, the fiscal behavior alone does not determine a well specific monetary and fiscal mix, but one would also need to characterize the (expected) behavior of monetary policy. Our empirical analysis reveals

[12] As Eusepi and Preston (2018, p. 2552) put it: *"At the heart of our paper is the realistic assumption that agents face fundamental uncertainty about long-run fiscal and monetary policy. Consider standing at the peak of the Great Inflation in the late 1970s. It is simply implausible to suppose agents at that time correctly anticipated subsequent macroeconomic developments, such as the Volcker disinflation, the long-term decline in inflation and inflation expectations, and the formal adoption of an inflation target by the Federal Reserve some 30 years later. Ten-year inflation and interest-rate expectations from professional surveys tell us they didn't. Incorrect expectations led to public debt that was incorrectly priced relative to what a hypothetical agent would pay, who anticipates these developments and predicts a decline in interest rates over subsequent decades. We show forecast errors of this kind lead to departures from Ricardian equivalence and to wealth effects on aggregate demand."* and again at p. 2553: *"The theory underscores that the knife-edge results of Leeper (1991) [...] are special, and that imperfect knowledge blurs the clean separation of monetary and fiscal policy. [...] wealth effects are always present in our model [...] And while the fiscal theory of the price level has the same basic mechanism, our result obtains even under the conventional assignment of policy in which monetary policy stabilizes the price level, and tax policy stabilizes the public debt."*

that, regardless of the regime, expectations of increasing taxes lead to economic dynamics typical of a monetary regime, while expectations of decreasing taxes lead to dynamics typical of a fiscal regime. Therefore, the effects of government spending shocks depend solely on agents' expectations about future fiscal backing, and are entirely independent of monetary policy expectations. Expectations of future fiscal backing are all one needs to know.

4 Robustness to alternative measures of government spending shocks

In this section, we aim to assess the robustness of our results by using different specifications for both anticipated and unanticipated government spending shocks, which also allows us to extend the sample period backward, in some cases as early as the late 1940s. We employ the same two measures of expected taxes – DD and AFTR15TD– and the same local projection specification in (2). Additionally, due to the extended period, we decided to use four lags for the controls. For the sake of brevity, we relegate the impulse response functions to Appendix B, including only a brief description in the main text.

4.1 Anticipated shocks

Ramey and Shapiro (1998). The Ramey and Shapiro (1998) narrative approach identifies shocks to government spending by war dates. In Appendix B.1, we report the corresponding impulse responses in Figure 8 for the DD case (1947q1-2007q4) and in Figure 9 for the AFTR15TD case (1954q1-2007q4). Results are confirmed under both tax specifications. Periods with high (low) expected taxes exhibit a reduction (increase) in output, consumption and investments, a decreasing (increasing/not significant) inflation and an higher (lower) level of real interest rates and debt.

Ben Zeev and Pappa (2015). The anticipated measure of Ben Zeev and Pappa (2015) identifies defence news shocks as the shocks that best explain future movements in defence spending over a horizon of five years, and which are orthogonal to current defence spending. Figures 10 and 11 shows the impulse response functions using this shock identification and looking at the sample 1948q1-2007q4 for the DD case and 1954q1-2007q4 for the AFTR15 case. The main results are mainly confirmed under both specifications The difference in the impulse responses between the two regimes is statistically significant even if, in some cases, only marginally so.

Ramey (2011). The defense news variable by Ramey (2011) captures fluctuations in the anticipated present value of government spending in reaction to military events. Figures 12 for the DD case (1947q1-2007q4) and 13 for the AFTR15 case (1954q1-2007q4) show that previous results are mainly confirmed.

4.2 Unanticipated shocks

Blanchard and Perotti (2002). Blanchard and Perotti (2002) identify government spending shocks using a traditional VAR approach with Cholesky decomposition and government spending ordered before the other variables. This identification does not explicitly differentiate between anticipated and unanticipated shocks, thus they are typically regarded as "surprises" or unanticipated shocks. Consequently, we expect results akin to those obtained using Auerbach and Gorodnichenko's (2012) shocks, where no distinction was found between the linear and non-linear cases.

Figures 14 and 15 in Appendix B.2, respectively, for the DD case in the sample 1947q1-2007q4 and for the AFTR15TD in the sample 1954q1-2007q4, show that the variables exhibit similar behavior in both states of high and low expected taxes and, with few exceptions, they usually behave as in the linear case. This confirms that when the government shock is not anticipated, the path of expected taxes is not able to identify different effects depending on tax foresight.

5 Conclusions

The effects of fiscal spending are theoretically linked to the prevailing monetary or fiscal regime. A crucial insight in this literature is that agents' expectations about the path of future taxes is key for the response of the economy to government spending shocks. This paper provides empirical evidence that conditioning on expected taxes is enough to determine the impacts of anticipated government spending shocks, thus supporting this insight.

We propose two methods, adapted from significant contributions in the existing literature, to directly measure agents' expectations about future taxes: (i) deficit-driven tax changes, as defined by Mertens and Ravn (2012); and (ii) a market-based tax measure based on the municipal bond yield curve, as suggested by Leeper et al. (2012). Using smooth-transition local projections on post-WWII U.S. data, we analyze the differential responses of economic variables to anticipated versus unanticipated spending shocks, conditioning on these measures of expected taxes. For both measures, *anticipated* spending shocks lead to declines in output, consumption, investment, alongside increases in the real rate and debt-to-GDP ratio, when agents expect higher future taxes, while the opposite occurs when tax increases are not expected. Hence, if taxes are expected to rise, the economy responds as under a monetary regime; otherwise, responses mirror those of a fiscal regime. Moreover, the empirical evidence shows that this is not the case for *unanticipated* government spending shocks.

Tax expectation is all one needs to know to identify the effects of anticipated government spending shocks.

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Appendix

A A market-based measure of tax foresight

Our alternative measure of tax foresight is taken from Leeper et al. (2013), who use the implicit tax rate, measured by the yield spread between the one year tax-exempt municipal bond and the one-year taxable Treasury bond, to isolate news about changes in future taxes. This tax rate represents the rate at which investors are indifferent between the tax-exempt municipal bond and the taxable Treasury bond. We use the average expected future (forward) tax rate at 1-5 year horizons (AFTR15). In Figure 7, we report this measure together with the same measure at 5-10 year horizons (AFTR510). As the Figure shows, the behavior of municipal bond yields became erratic from 2008q1 onwards, as liquidity and flight-to-quality started affecting the bond markets after the outburst of the 2007–2008 financial crisis. For this reason, we exclude the period starting in 2008q1 when the average expected future tax rate becomes negative, very volatile, and sometimes larger than one. Leeper et al. (2012) compares AFTR15 and actual taxes and stresses that the accuracy of tax foresight changes over time. The literature highlights poor tax foresight during the 1970s, (see, among others, Park, 1997; Fortune, 1996). One reason may be the increase in the proportion of non-savers during this high inflation period. When many households operate hand-to-mouth, their ability to smooth consumption over time is limited, leading to reduced responsiveness to tax news. Furthermore, the 1970s was a period of tax code stability, with tax reforms primarily aimed at short-term economic stimulus. In contrast, attention shifted to addressing growing budget deficits in the 1980s. Since budget deficits persist longer than cyclical changes in the economy, economic agents in the 1980s likely had better tax foresight compared to those in the 1970s.

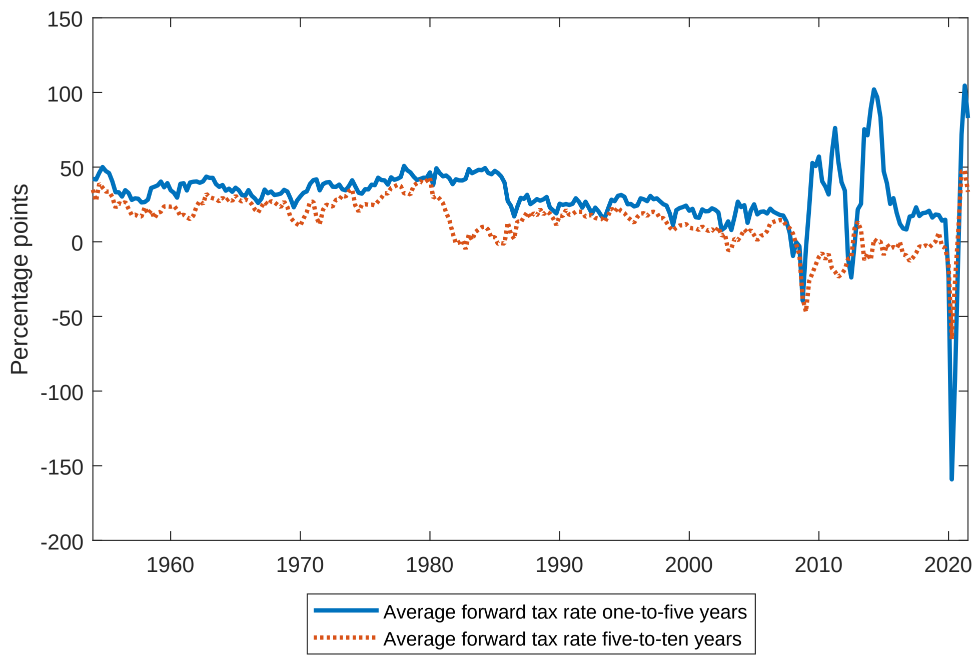


Figure 7: AFTR15 and AFTR510: Market based measures of expectations of future taxes based on Leeper et al. (2013).

B Alternative measures of government spending shocks

This section displays the impulse response functions of the various robustness checks described in Section 4.1.

B.1 Anticipated shocks

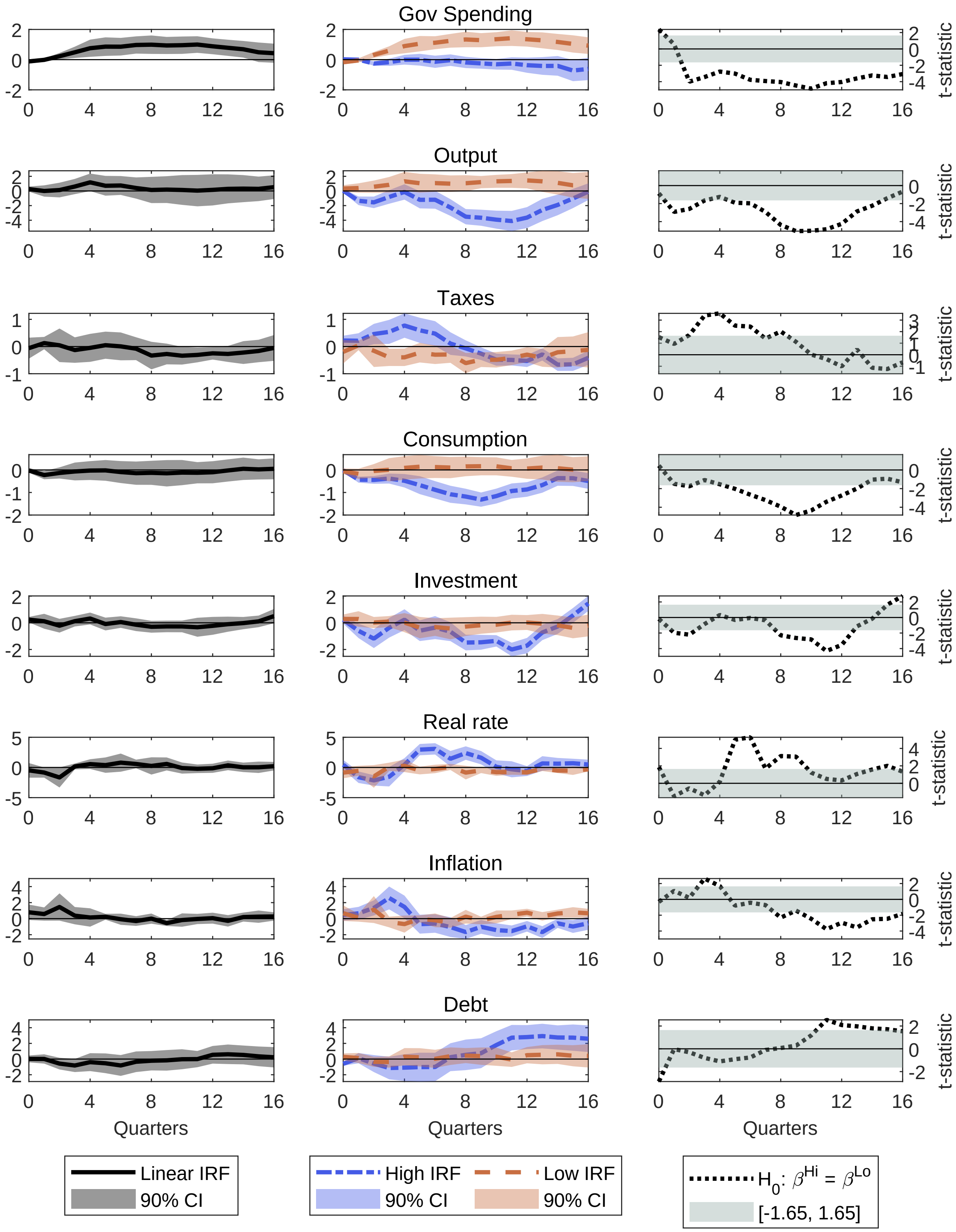


Figure 8: **The effects of anticipated government spending shocks (war dates from Ramey and Shapiro (1998)) depend on expected future taxes (DD).** Sample period: 1947q1-2007q4, 4 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and government spending instrumented by the war dates measure from Ramey and Shapiro (1998). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

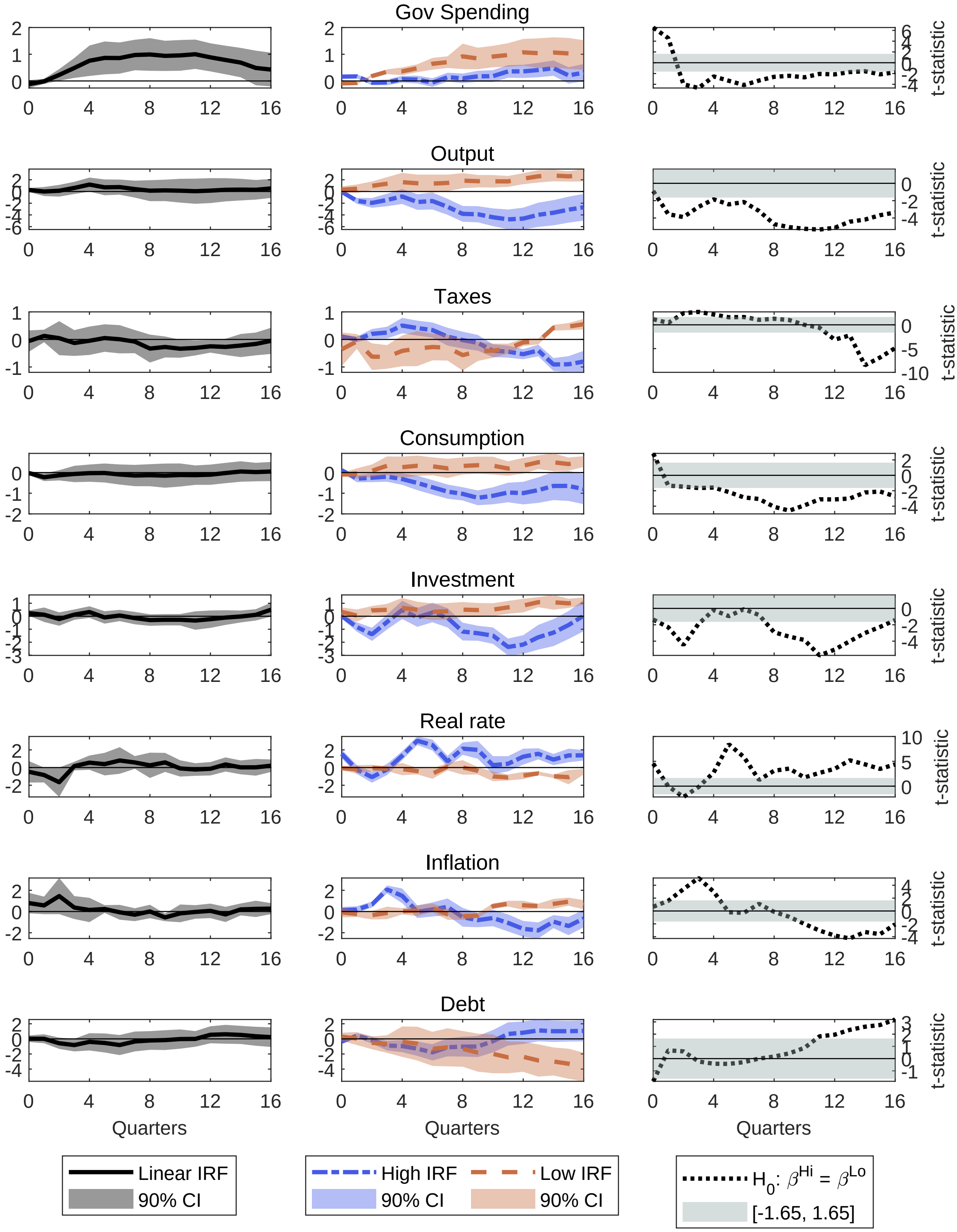


Figure 9: **The effects of anticipated government spending shocks (war dates from Ramey and Shapiro (1998)) depend on (market-based) expected future taxes.** Sample period: 1954q1-2007q4, 4 lags, AFTR15TD as from Leeper et al. (2013) and government spending instrumented by the war dates measure from Ramey and Shapiro (1998). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

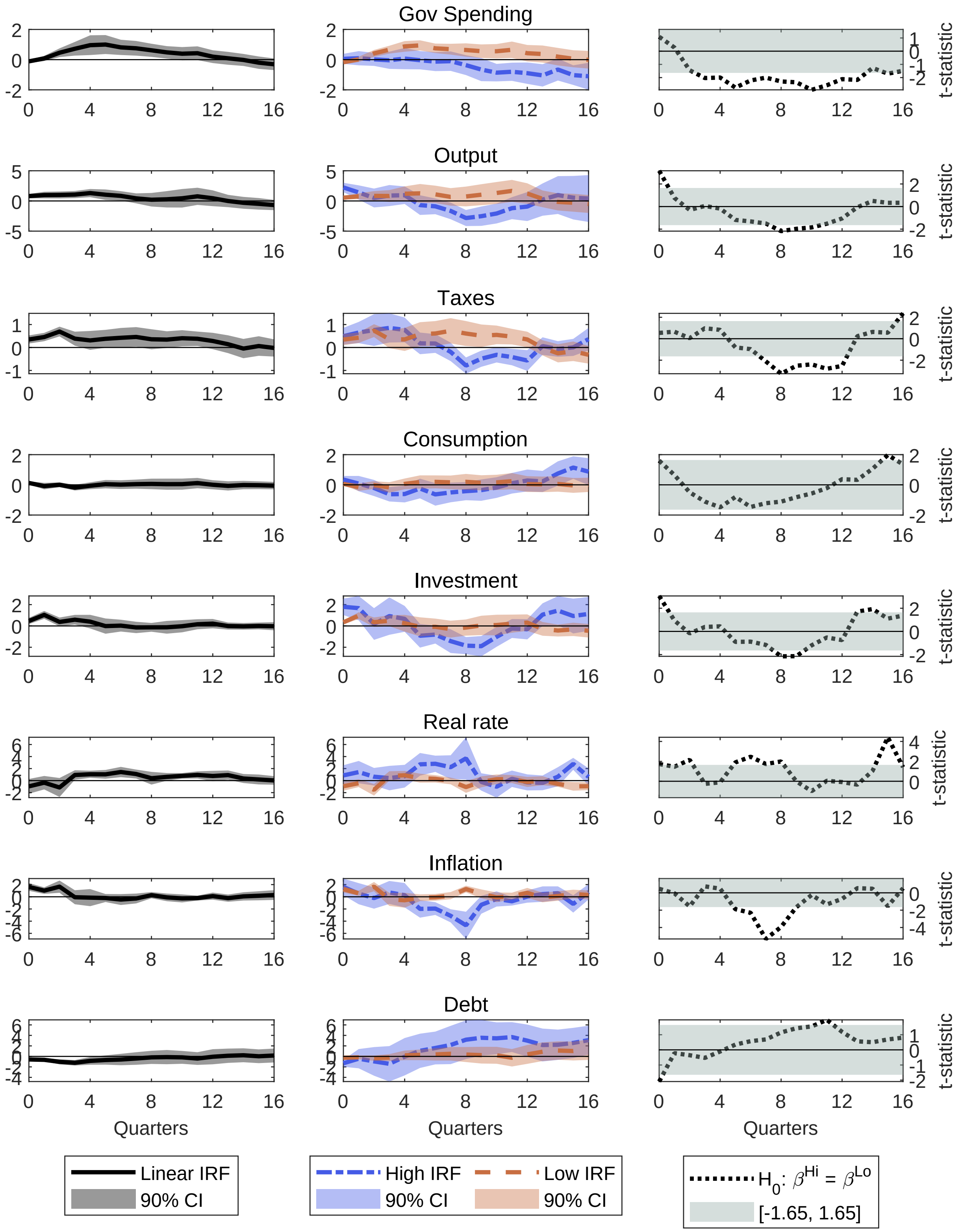


Figure 10: **The effects of anticipated government spending shocks from Ben Zeev and Pappa (2015) depend on expected future taxes (DD).** Sample period: 1948q1-2007q4, 4 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and government spending shocks from Ben Zeev and Pappa (2015). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

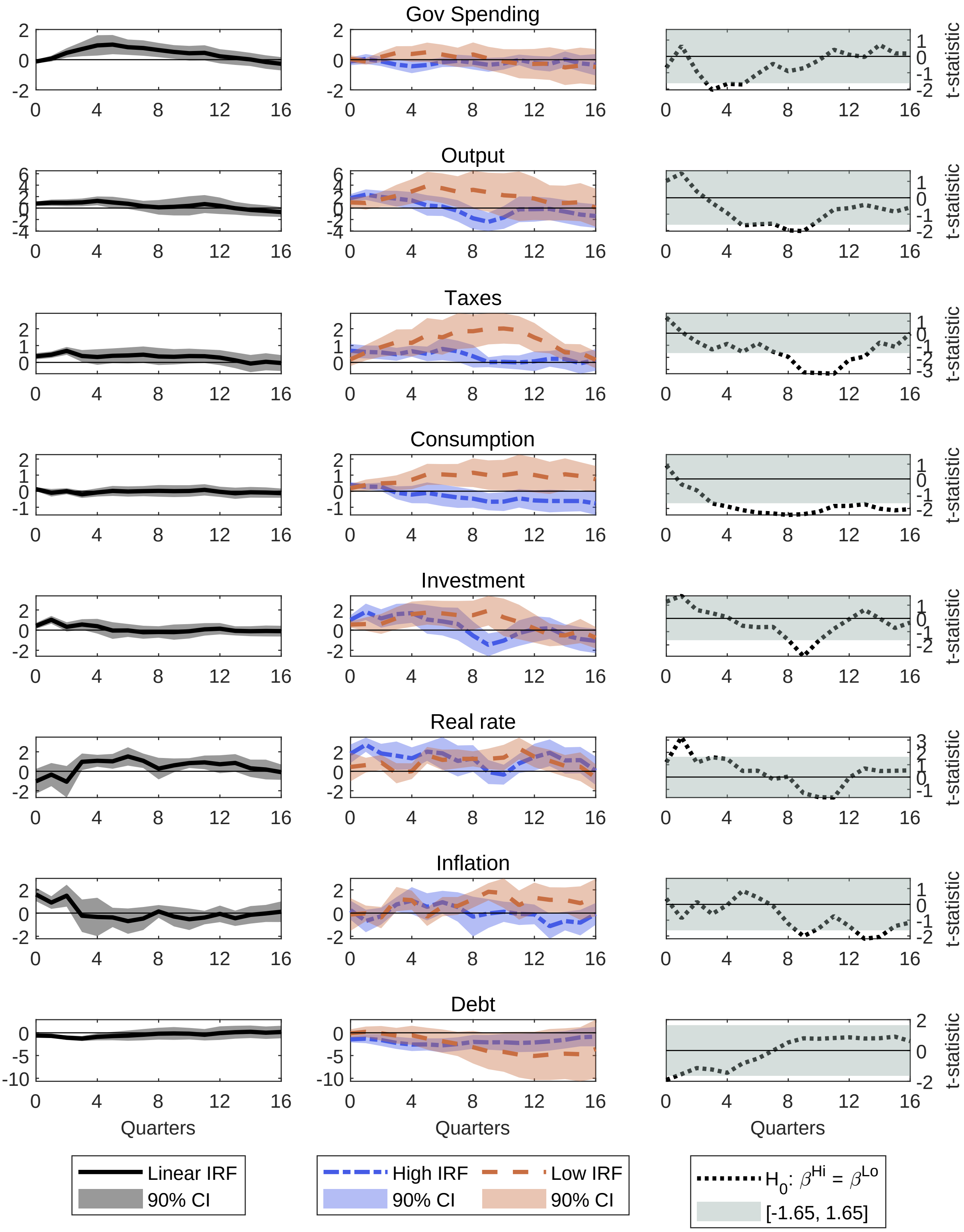


Figure 11: **The effects of anticipated government spending shocks from Ben Zeev and Pappa (2015) depend on (market-based) expected future taxes.** Sample period: 1954q1-2007q4, 4 lags, AFTR15TD as from Leeper et al. (2013) and government spending shocks from Ben Zeev and Pappa (2015). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

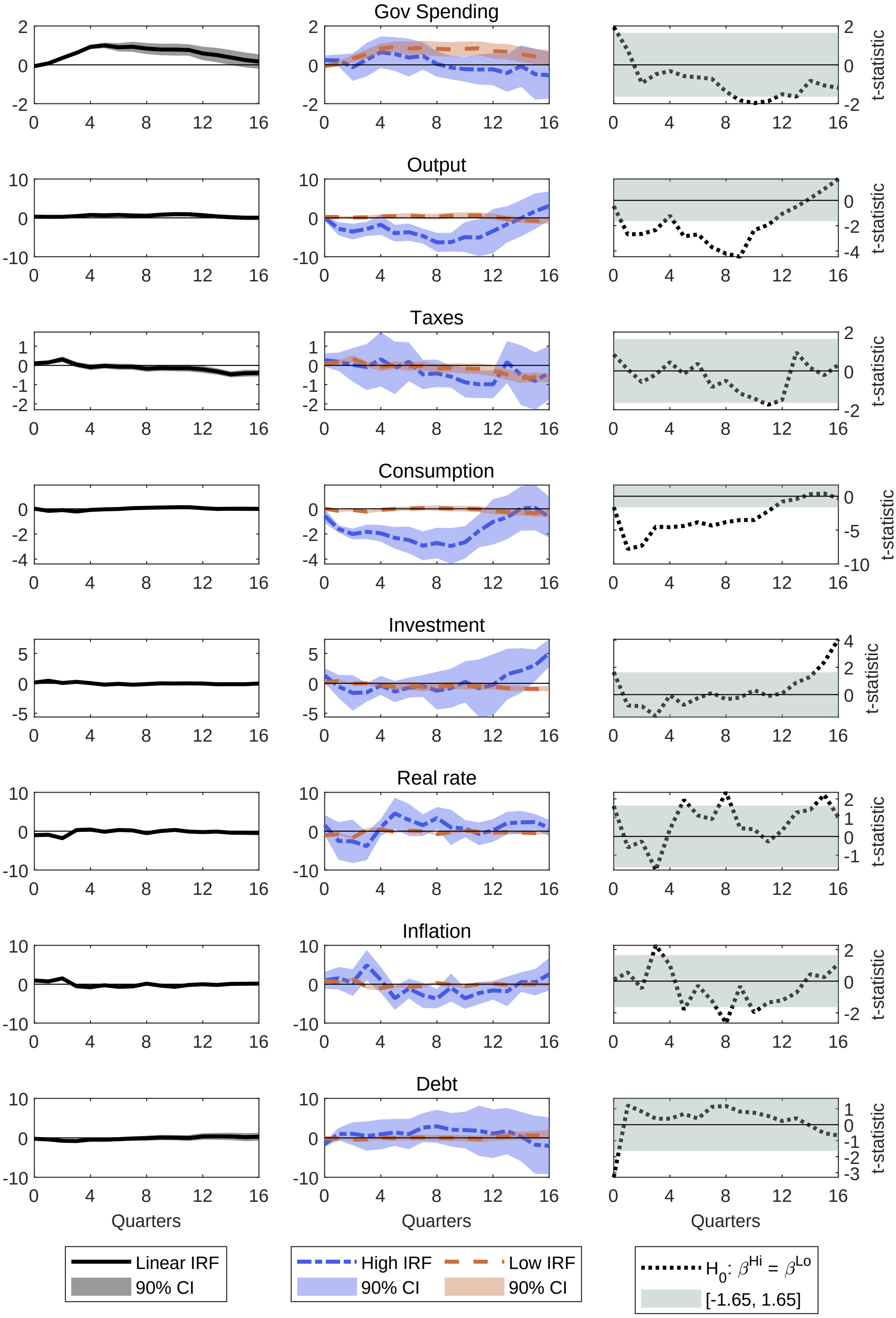


Figure 12: **The effects of anticipated government spending shocks from Ramey (2011) depend on expected future taxes (DD).** Sample period: 1947q1-2007q4, 4 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and government spending shocks from Ramey (2011). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

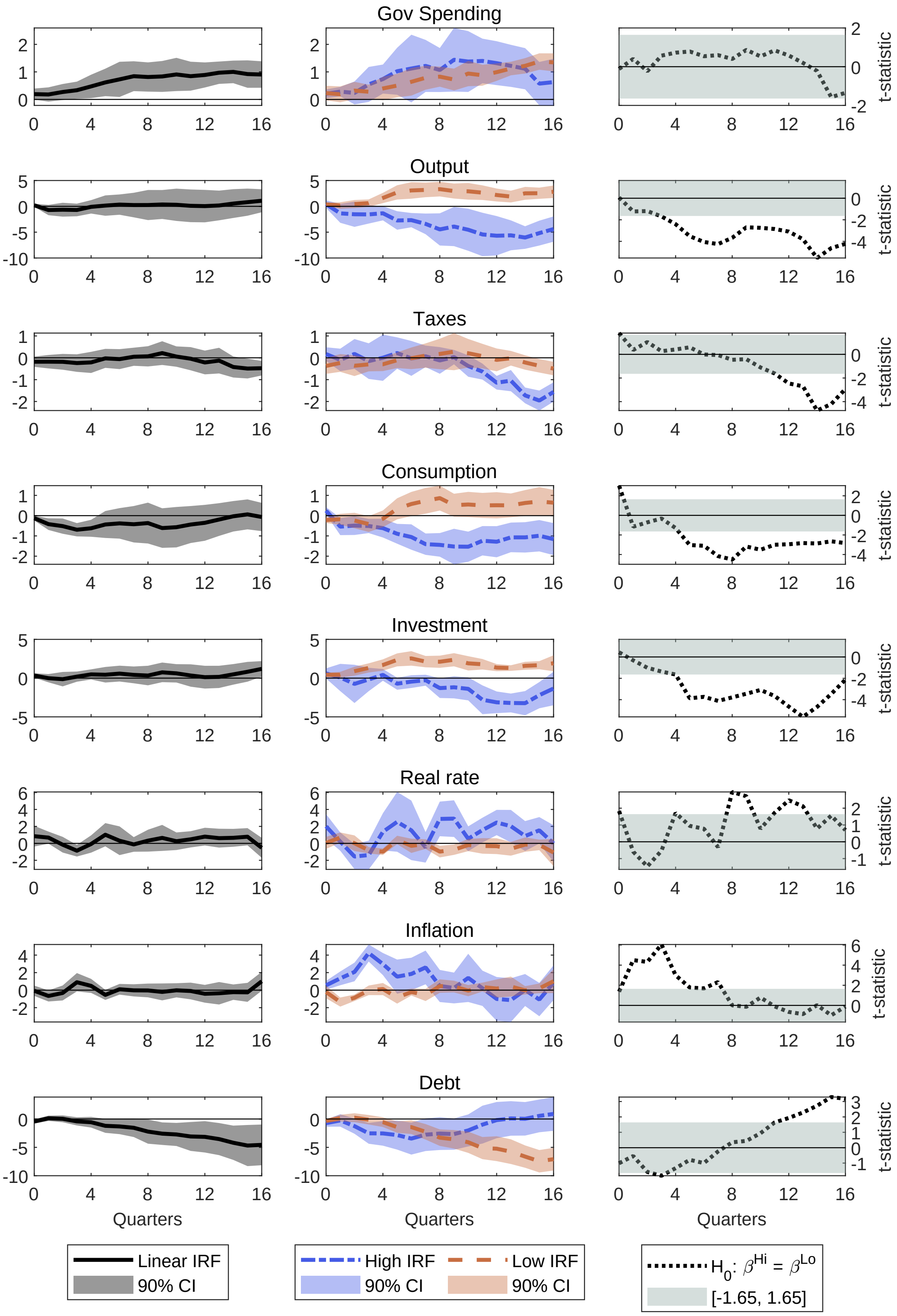


Figure 13: **The effects of anticipated government spending shocks from Ramey (2011) depend on (market-based) expected future taxes.** Sample period: 1954q1-2007q4, 4 lags, AFTR15TD as from Leeper et al. (2013) and government spending shocks from Ramey (2011). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

B.2 Unanticipated shocks

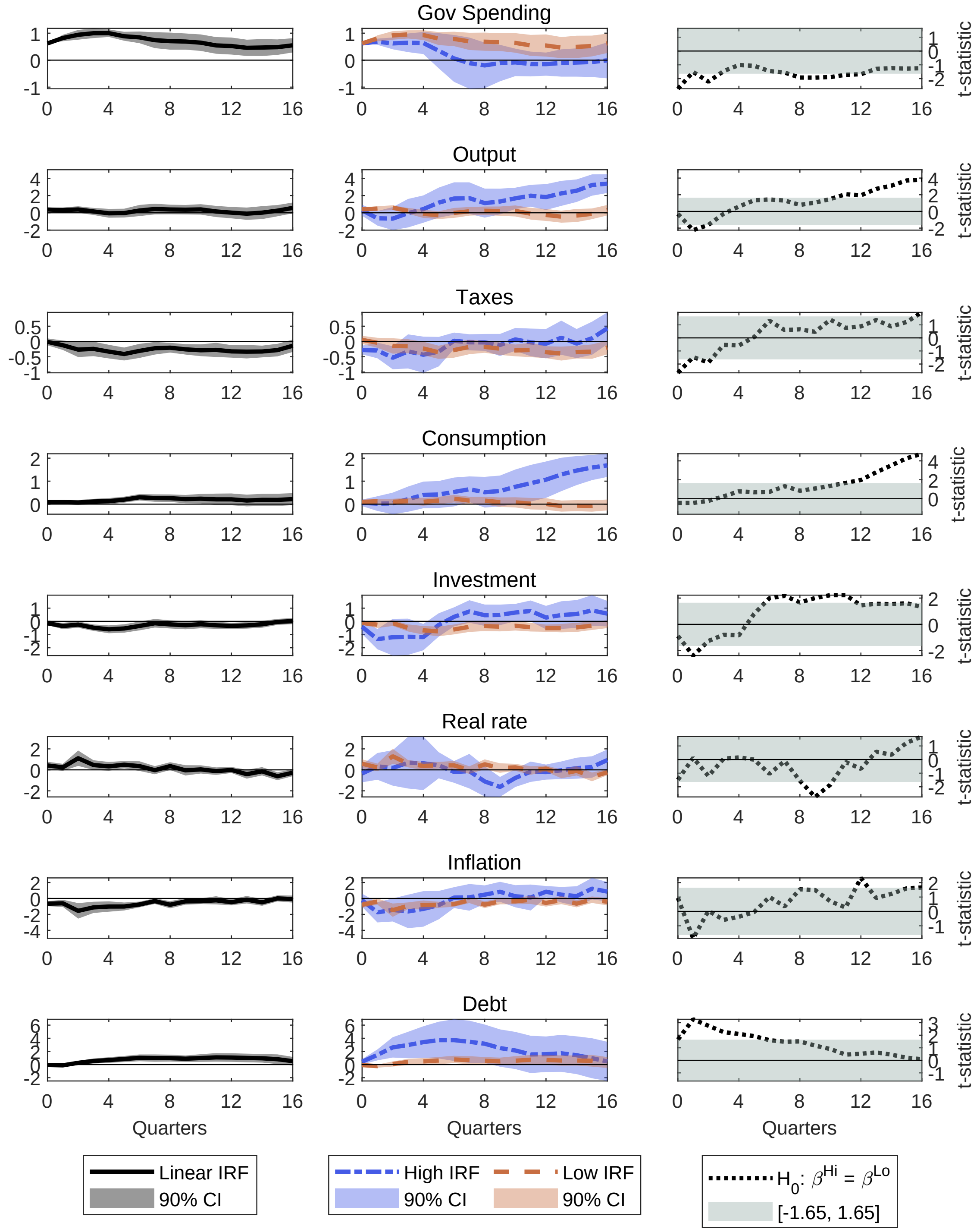


Figure 14: **The effects of unanticipated government spending shocks from Blanchard and Perotti (2002) do not depend on expected future taxes (DD).** Sample period: 1947q1-2007q4, 4 lags, deficit-driven expected taxes as in Mertens and Ravn (2012) and unanticipated government spending shock from Blanchard and Perotti (2002). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

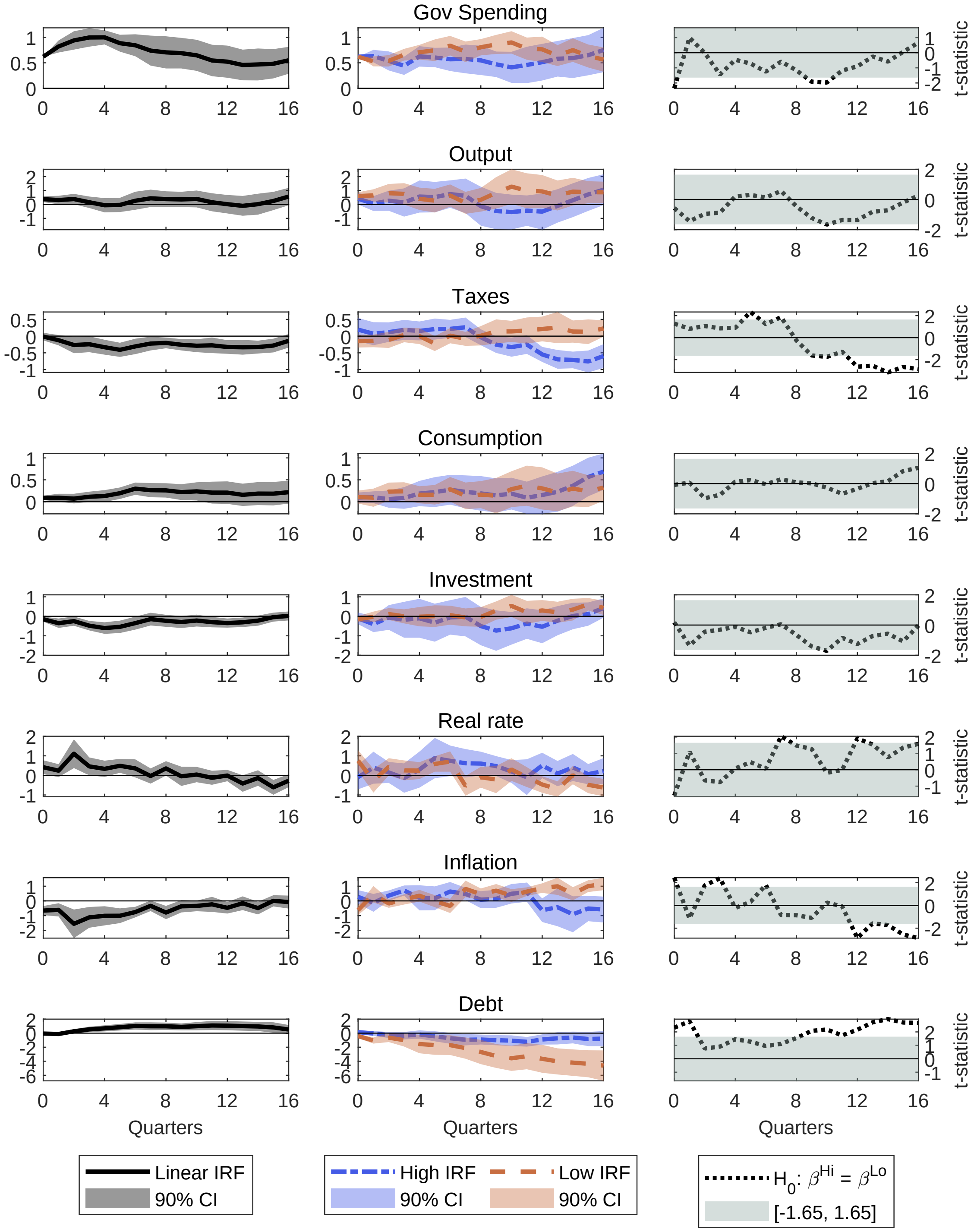
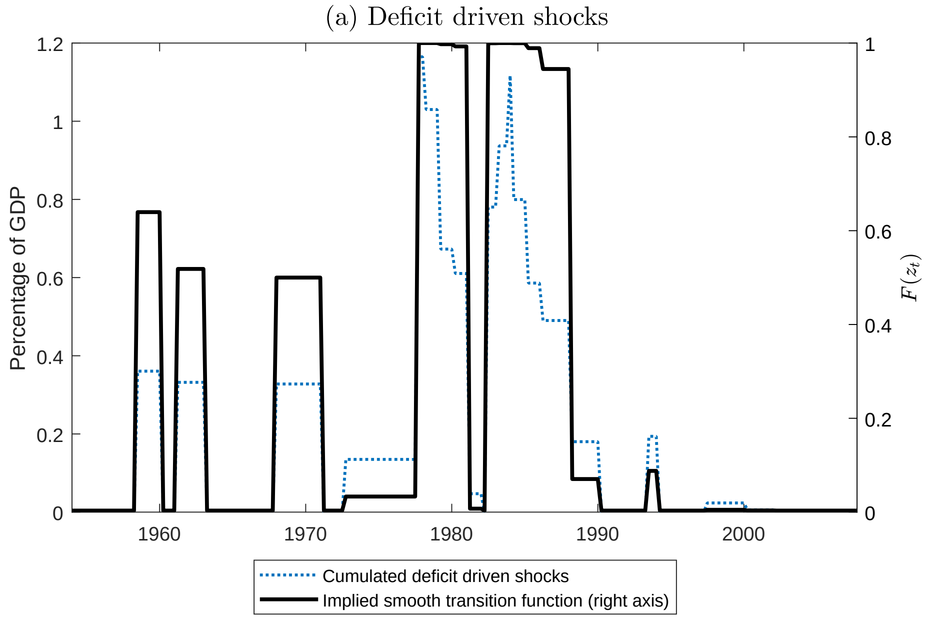


Figure 15: **The effects of unanticipated government spending shocks from Blanchard and Perotti (2002) do not depend on (market-based) expected future taxes.**Sample period: 1954q1-2007q4, 4 lags, AFTR15TD as from Leeper et al. (2013) and unanticipated government spending shock from Blanchard and Perotti (2002). Column one depicts the point estimates for the linear case (solid-black line). Column two depicts the high expected taxes (dashed–dotted-blue line) and no change in taxes (dashed-red line) impulse responses, together with their 90% confidence bands. Column three depicts the t-statistic for the null hypothesis of equality of the two states' responses (dotted line), together with 90% confidence interval (shaded area). The impulse responses are depicted over a four-year horizon.

B.3 Smooth transition function probabilities



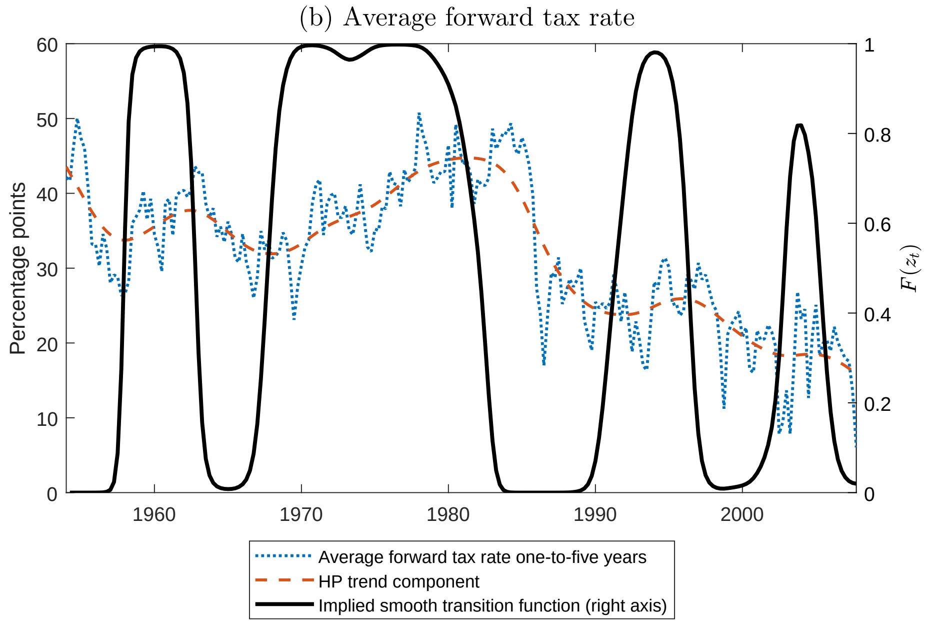


Figure 16: Smooth transition function probabilities implied by our two measures of anticipated taxes.

C A New Keynesian model with hybrid monetary/fiscal regime

Figure 6 is obtained using a small-scale New Keynesian model with a fiscal block that closely resembles the stylized sticky price model in Bianchi et al. (2023). In our notation, variables with a "hat" are log-deviations from steady state, while variables with a "tilde" are deviations from steady state as a fraction of steady state output (y), that is, $\hat{x}_t = (x_t - x)/x$, and $\tilde{x}_t = (x_t - x)/y$. Table 1 contains a description of the parameters and their calibration.

The linearized Euler equation is

$$\hat{\imath}_t - \mathbb{E}_t \hat{\pi}_{t+1} = \mathbb{E}_t \hat{c}_{t+1} - \hat{c}_t, \tag{A1}$$

where $\hat{\imath}_t$ is the nominal interest rate, $\hat{\pi}_t$ is the inflation rate and $\hat{c}_t$ is consumption. The labour supply is

$$\frac{n}{1-n}\hat{n}_t = \hat{w}_t^r - \hat{c}_t, \tag{A2}$$

where $\hat{n}_t$ is hours worked and $\hat{w}_t^r$ is the real wage. The New Keynesian Phillips curve is

$$\hat{\pi}_t = \beta \mathbb{E} \hat{\pi}_{t+1} + \kappa \hat{w}_t^r, \tag{A3}$$

while the linearized aggregate production function is

$$\hat{y}_t = (1-\alpha)\hat{n}_t. \tag{A4}$$

The real interest rates is defined as

$$\hat{r}_t = \hat{\imath}_t - \mathbb{E}_t \hat{\pi}_{t+1}. \tag{A5}$$

The aggregate resource constraint is

$$\hat{y}_t = \left(1 - \frac{g}{y}\right) \hat{c}_t + \tilde{g}_t, \tag{A6}$$

where $\tilde{g}_t$ is government spending. The linearized government budget constraint is

$$\tilde{b}_t = \frac{1}{\beta}\left[\tilde{b}_{t-1} - \frac{b}{y}\hat{\pi}_t + \frac{b}{y}\hat{\imath}_{t-1}\right] - \tilde{\tau}_t + \tilde{g}_t, \tag{A7}$$

where real debt is defined as $b_t \equiv B_t/(i_t P_t)$, P_t is the price level, and $\tilde{\tau}_t$ are lump-sum taxes. Anticipated government spending is determined by the exogenous process

$$\tilde{g}_t = \rho_g \tilde{g}_{t-1} + \varepsilon_{t-4}^g \tag{A8}$$

where ε_t^g is and i.i.d. shock, affecting government spending with a lag of four periods. The Taylor rule is

$$\hat{\imath}_t = \phi_\pi^M(\hat{\pi}_t - \hat{\pi}_t^F) + \phi_\pi^F \hat{\pi}_t^F. \tag{A9}$$

Notably, the central bank reacts strongly (i.e., with a response coefficient $\phi_\pi^M > 1$) only to the portion of total inflation due to funded government spending shocks, while it accommodates ($\phi_\pi^F < 1$) the portion of inflation arising from unfunded shocks, denoted as $\hat{\pi}_t^F$. Similarly, the fiscal rule for lump-sum taxes is

$$\tilde{\tau}_t = \phi_b^M(\tilde{b}_{t-1} - \tilde{b}_{t-1}^F) + \phi_b^F \tilde{b}_{t-1}^F. \tag{A10}$$

According to this rule, the government stabilizes ($\phi_b^M > \beta^{-1} - 1$) only the portion of past debt due to funded shocks, while it tolerates ($\phi_b^F < \beta^{-1} - 1$) the amount of debt generated by unfunded shocks, denoted as $\tilde{b}_t^F$.

As in Bianchi et al. (2023), we close the model with a shadow economy that determines the evolution of $\hat{\pi}_t^F$ and $\tilde{b}_t^F$. This economy consists in an additional block of equations identical to (A1) to (A7), where any variable appearing in the actual economy is replaced by its shadow counterpart, denoted with the superscript "F". In addition, equation (A8) is replaced by

$$\tilde{g}_t^F = \rho_g \tilde{g}_{t-1}^F + (1 - \lambda)\varepsilon_{t-4}^g, \tag{A11}$$

while equations (A9) and (A10) are replaced by

$$\hat{\imath}_t^F = \phi_\pi^F \hat{\pi}_t^F \tag{A12}$$

and

$$\tilde{\tau}_t^F = \phi_b^F \tilde{b}_{t-1}^F, \tag{A13}$$

respectively. As such, the shadow economy is characterized by a fiscally-led policy configuration and its variables display non-Ricardian dynamics after a government spending shock. In particular, parameter λ captures the degree of fiscal backing in the model, following Smets and Wouters (2024). When $\lambda = 1$, government spending shocks are fully backed by future taxes, the shadow economy is effectively switched off and the dynamics of the overall economy is fully Ricardian. When $\lambda = 0$, government spending shocks are fully unbacked, each variable coincides with its shadow counterpart (e.g., $\hat{\pi}_t = \hat{\pi}_t^F$) and the overall economy adheres to the fiscal theory of the price level. When $\lambda \in (0, 1)$, government spending shocks are partly unbacked and the overall economy is characterized by both monetary-led and fiscally-led dynamics.

Table 1. Parameters calibration

Parameter	**Value**	**Description**
β	0.99	Intertemporal discount factor
n	0.4	Steady state hours worked
α	0.33	Elasticity parameter in the production function
κ	0.02	Slope of the New Keynesian Phillips curve
g/y	0.2	Government spending to output ratio
b/y	2.45	Debt to output ratio
ρ_g	0.5	Autocorrelation of government spending
ϕ_π^M	2	Interest rate response to funded inflation
ϕ_π^F	0	Interest rate response to unfunded inflation
ϕ_b^M	0.2	Tax response to funded debt
ϕ_b^F	0	Tax response to unfunded debt
λ	$\in [0, 1]$	Degree of fiscal backing

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