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Monetary Policy Surprise Shocks under Different Fiscal Regimes: A Panel Analysis of the Euro Area

Abstract

We study the effect of monetary policy surprise shocks on real output and the price level, conditioned on different fiscal stances in the period 2001Q4-2021Q4 for a panel of the 19 countries of the Euro Area. Applying local projection methodology, we find that the effect of monetary shocks depends on each country's fiscal stance, specifically, if for output response the debt is more important in the effect of monetary policy, for prices, the "Ricardian" nature of fiscal policy appears to be far more crucial. However, regarding inflation targeting, monetary policy is most effective in the low debt regime and in the high fiscal sustainability one. Our results are robust to different specifications and models and have important policy implications notably for monetary policy, which should consider different fiscal stances when pursuing specific monetary policy objectives.

JEL-Codes: C320, E580, E620, E630.

Keywords: monetary policy surprises, public debt, fiscal sustainability, local-projection models, fiscal-monetary policy mix, Euro area.

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1. Introduction

There has been an increased ongoing debate about the relevance of the interaction between fiscal and monetary policy, since notably the Global and Financial Crisis (GFC). This discussion has become more pronounced due to the pandemic crisis and the subsequent fiscal and monetary policy responses. At the same time, the geopolitical crisis of 2022-2023 has triggered inflationary price dynamics. Some studies attribute inflation persistence not to the energy crisis but to fiscal and demand factors (Bianchi and Melosi, 2022). They see today's inflation as a result of the large pandemic fiscal packages, central banks' accommodative policies, and agents' expectations about the future conduct of government policy. Within the Euro Area, this debate is also paramount due to a particular institutional framework of a single monetary authority and multiple fiscal policymakers.

The Fiscal Theory of the Price Level (FTPL) (Sargent and Wallace (1981); Leeper (1991); Sims (1994); Woodford (1995) studies the interaction between fiscal and monetary policy, focusing on their alternation in stabilizing sovereign debt dynamics. Specifically, the theory shows how the standard monetary-dominant regime, in which monetary policy is active and fiscal policy is passive (Ricardian fiscal regime), alternates with the fiscal-dominant regime, in which the government chooses the primary budget balance independently of the debt-to-GDP ratio and prices adjust endogenously to satisfy the government budget constraint. Within this latter policy mix, monetary policy lacks the ability to control prices, leading to inflation as a fiscal phenomenon (Sims, 2011). Therefore, policy's effectiveness in terms of macroeconomic outcomes depends on the other policy in place. For instance, Bianchi and Ilut (2017), through the simulation of a DSGE model, illustrate that while monetary tightening within a monetary dominance framework results in price reduction, under a scenario of fiscal dominance, tighter policy can even lead to an increase in inflation.

However, more in general, there is not an extensive empirical literature on the effect of monetary policy under different fiscal regimes. De Luigi and Huber (2018) employ a Threshold SVAR analysis and show that the effect of monetary policy easing is less pronounced in "high" debt regimes than the "low" one; similar results were confirmed by Ahmed et al. (2021) for a panel of 18 advanced countries.

In accordance with this unexplored topic, the main goal of this paper is to investigate the effectiveness of Jaronciski and Karadi (2020)'s monetary policy surprise shocks on output and prices in the Euro Area, conditional on different two fiscal stances: low and high sovereign debt regimes and more fiscally sustainable and less sustainable fiscal regimes. For our analysis, we choose only the positive surprises indicating a tightening of the monetary policy.

We distinguish between high and low fiscal sustainability regimes by implementing a time-varying fiscal reaction function (Bohn, 1998) using the method of Schlicht (2003, 2021). The high sustainability regime represents the periods in which the estimated coefficient, of the response of the primary balance to the debt ratio, is larger than the sample average, and the low sustainability regime represents the periods in which the estimated coefficient is smaller.

We then employ a panel local projection method (Jordà 2005; 2015; Auerbach and Gorodnichenko 2013) spanning the period 2002Q1–2021Q4, for the 19 Euro-Area countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain. We compare the linear results with those of a threshold, and smooth transition models conditioned by our different definitions of fiscal stance. Finally, we study the four combinations of high-low debt and high-low sustainability to investigate which of the two fiscal stances is more relevant for the effectiveness of monetary policy in terms of output and prices.

One crucial contribution we offer is precisely the consideration of different fiscal stances regarding monetary policy shocks, Indeed, compared to the change in the debt ratio, changes in fiscal sustainability are less unaffected by fluctuations in the business cycle, in the interest rate, or external factors over which the fiscal authority has no control. Thus, they are closely related to the conduction/credibility of the policy authority, offering a cleaner measure of what we would see as related to discretionary fiscal stance. For this reason, we propose the study of different measures of fiscal stance separately (and making them interact with each other), trying to capture the difference in terms of monetary policy effectiveness.

In addition, to the best of our knowledge, this is the first study that analyzes this relationship for a panel of the 19 countries in the Euro Area, considering monetary policies shocks and time varying coefficient of fiscal sustainability. Hence, we provide a significant contribution to the analysis of this incomplete monetary union, institutionally characterized by a single and common monetary authority and different fiscal authorities.

As regards our results, both our threshold and smooth transition models confirm that the monetary policy effect depends on the fiscal regime in place. As suggested by the FTPL, in the "higher" sustainable regime output and prices tend to respond more strongly to monetary tightening, in contrast to the "lower" sustainable regime, where there are not even effects on prices. When we discriminate for the debt (using the 90% ratio to GDP), we find that in periods of high debt, output contracts more than in periods of low debt; instead, prices fall more in periods of low debt. Taking the debt average as a threshold, monetary surprises have no effect on prices in the high debt regime. Moreover, when we study the different combinations of the

fiscal stances, if for output, debt is more important in the effect of monetary policy, for prices, the "Ricardian" nature of fiscal policy appears to be far more crucial. This latter finding is consistent with the FTPL, in particular with the relationship between agent's expectations and the government's intertemporal budget constraint. Finally, we also find the presence of the so-called "fiscal inflation" in the High-Debt and Low-Sustainability regime. Our findings are robust to different specifications and models.

This paper is organized as follows: Section 2 reviews the literature; Section 3 describes the empirical strategy; Section 4 provides estimation results and related discussion. Section 5 concludes.

2. Related Literature

This paper is related to the literature on the interaction between fiscal and monetary policy. Specifically, to the Fiscal Theory of Price Level (FTPL) strand of literature. A seminal contribution to the understanding of the connection between fiscal policy and inflation is offered by Sargent and Wallace (1981). The authors demonstrate that, under specific assumptions, the monetary authority's ability to ensure price stability becomes constrained by the government's intertemporal budget constraint. This situation corresponds to Leeper (1991)'s scheme of an active fiscal policy and a passive monetary policy, which means that the fiscal authority is not committed to raising taxes to pursue fiscal sustainability, and the central bank does not strongly adjust the nominal interest rate in response to inflation deviations from the target, allowing inflation to stabilize the debt. Woodford (1995) also calls this a regime of "fiscal dominance" a "Non-Ricardian" regime. The main point of the FTPL is the fact that fiscal policy plays a role, as important as monetary policy, in determining the price level, through the channel of the government's intertemporal budget. Other relevant contributions can be attributed to Sims (1994, 2011), and Cochrane (2001, 2023). Additionally, these theoretical connections have been further explored from the perspective of DSGE modelling, along the others, Bianchi and Ilut (2017) demonstrate how the impact of a monetary policy shock is dependent on the prevailing regime: in a scenario of fiscal dominance, tighter monetary policy leads even to an increase in inflation, while in a situation of monetary dominance, it results in a decrease in inflation.

This paper also relates to the large field of fiscal sustainability literature. In assessing the sustainability stance, the literature divides empirical tests into two methodologies: a backward-looking approach (Bohn, 1998) and a forward-looking approach (Canzoneri et al., 2001). Within the first approach, fiscal policy is deemed sustainable when it adapts the primary

surplus in response to the lagged debt. As regards the forward-looking approach, a Ricardian policy is present when shocks to the primary surplus result in a reduction of debt. Many studies have applied these rules to investigate the sustainability of the Euro Area countries (among others Favero, (2002); Semmler and Zhang, (2004); Afonso and Jalles, (2017)). However, the assumption that fiscal and monetary rules are linear and constant over time does not seem to convince the literature: fiscal rules are time-varying. Due to the presence of ”structural breaks” and ”regime changes”, a growing number of studies are employing methodological techniques, particularly Markov-Switching specifications (Davig et al., 2006; Afonso and Toffano, (2013); Bianchi and Melosi, 2017).

Following this latter idea of the non-linearity of the fiscal regimes, our work tries to assess the effect of monetary policy conditional on varying degree of sustainability. One paper very related to our idea is that of De Luigi and Huber (2018), through a Threshold SVAR analysis, they discover that the effect of monetary policy is less pronounced in “high” debt regimes than the “low” ones, pointing to the different spending and investment behavior of private sector agents; similar results were confirmed by Ahmed et al. (2021) for a panel of 18 advanced countries. However, both studies examine a monetary easing. Kloosterman et al. (2022) estimate the effects of monetary policy shocks across different fiscal regimes through a panel smooth transition model for ten Euro-Area countries, where the fiscal regimes follow the cyclically adjusted primary balances. They show the dependence of the monetary policy on the fiscal one, finding that expansionary (contractionary) monetary policy shocks lead to significant increases (decreases) in inflation and output, but only when fiscal policy is also expansionary (contractionary). Finally, Afonso et al. (2023) study the effect of monetary policy surprises conditional to the sustainability stance for Germany, Italy, Portugal, and the Euro Area aggregated (taking each country as time series); they find that while output and prices respond to monetary tightening by contracting in the Ricardian regime, in the non-Ricardian regime, the response is insignificant or even positive.

What differentiates our paper from the above literature is that in order to assess the dependence of the monetary policy effect on the fiscal stances, we investigate the effect of a monetary tightening conditional to different types of fiscal stances: low and high debt regimes and sustainable and unsustainable regimes based on the estimation of time varying Bohn’s coefficients. We believe that taking two different stances it’s important, indeed, compared to the change in the debt ratio, changes in sustainability are less unaffected by external factors over which the fiscal authority has no control.

3. Empirical Analysis

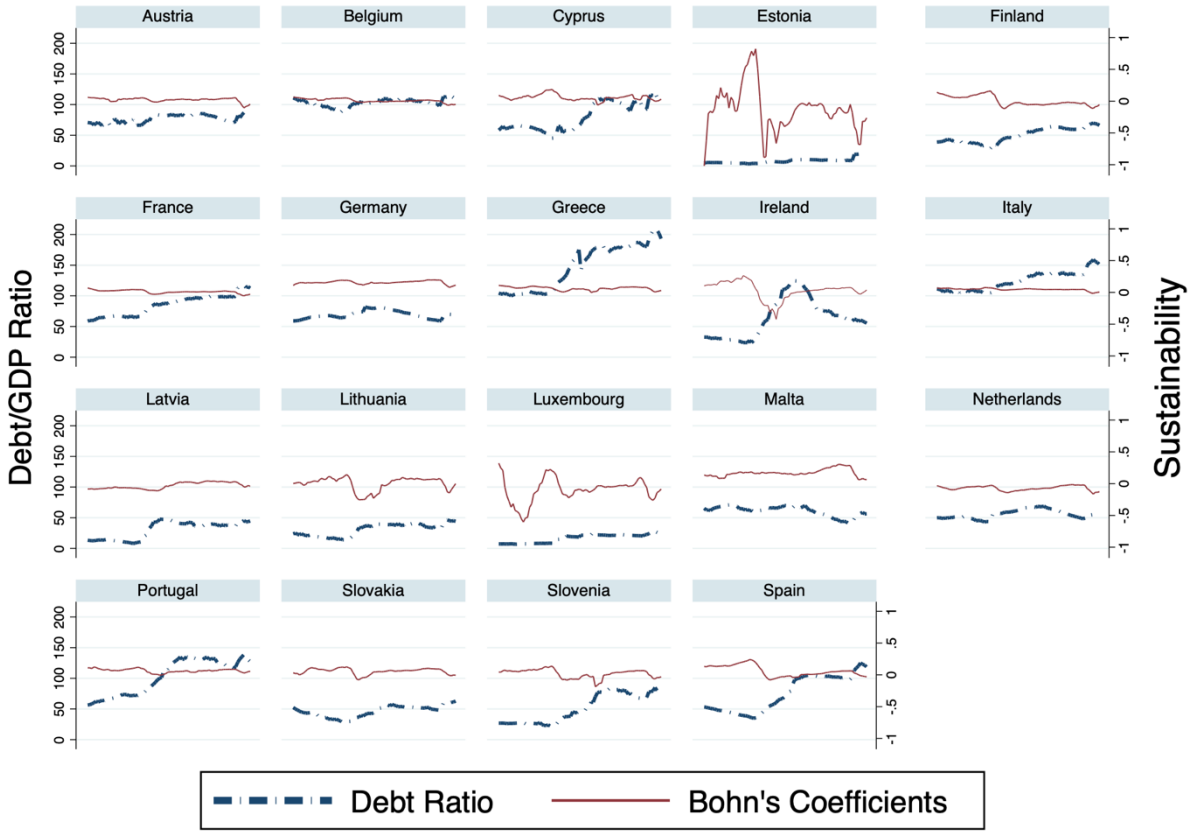
3.1 Data and Stylized Facts

The full panel covers the 19 Euro-Area countries between 2002Q1 to 2021Q4. Primary balances and government debt are taken from the Eurostat dataset and then annualized. The endogenous variables of the LP models are the logarithmic levels of real output and the price index, both taken from the FRED dataset. The shocks are common to all the countries and are taken from Jarociński's website.2 More information about the dataset are in the Appendix, in particular, Table A1 shows the data source, and Table A2 displays the descriptive statistics.

Figure 1 shows the path of the debt-to-GDP ratio and of the fiscal sustainability magnitude by country. In general, we note an increasing trend in the debt ratio and worsening fiscal sustainability for almost all countries, especially during the period of the last two crises. Furthermore, the debt trend exhibits an inverse relationship with fiscal sustainability. This connection is further substantiated by the correlation table (Table 1), wherein Pearson's coefficient signifies a negative correlation. Except for Latvia and Luxembourg, a decrease in the fiscal sustainability magnitude corresponds, in the opposite direction, to an increase in the debt ratio, and an improvement in sustainability corresponds to a decrease in debt. However, one can also have periods of increasing debt (which can be attributed to external causes such as interest rates, economic trends, etc.), and simultaneously improving sustainability, understood as a fiscal "responsibility", where the fiscal authority adjusts the surplus and does not have the control of the overall debt. In this framework, even if this primary surplus does not lead (at least in the short run) to a decrease in public debt, it can increase the credibility of the authority and still have implications for the agents, the market, and finally for the effects of economic policies. This is because an explicit fiscal rule can reduce uncertainty about the future path of government finances and may be independent of the level of debt stock inherited from the past. For this reason, we propose the study of different fiscal regimes separately, trying to capture the difference in terms of monetary policy effectiveness.

Figure 1: Debt-to-GDP Ratio and Sustainability Time Series (estimated Bohn coefficient)

[2] Jaroncinski's website is consultable on https://marekjarocinski.github.io.



The graph shows the trend from Q1-2002 to Q4-2021 of the debt-to-GDP ratio (Eurostat Datasource) and of the time varying coefficients that we estimated using the Bohn's Rule.
Source: authors' calculations.

Table 1: Correlations

Correlation between Bohn's Coefficient and Debt Ratio			
Austria	-0.5454	**Latvia**	0.5412
Belgium	-0.6030	**Lithuania**	-0.3329
Cyprus	-0.4912	**Luxembourg**	0.1535
Estonia	-0.3929	**Malta**	-0.6574
Finland	-0.7929	**Netherlands**	-0.3717
France	-0.7576	**Portugal**	-0.4667
Germany	-0.3693	**Slovakia**	-0.1728
Greece	-0.4068	**Slovenia**	-0.4088
Ireland	-0.5553	**Spain**	-0.6326
Italy	-0.7558		

Source: authors' calculations.

Table 2 presents the different fiscal combinations of each country at the beginning of the sample (2002-Q1), at the end of the sample (2021-Q4), and in terms of full sample average. Discrimination of high and low debt is based on the threshold of 90% debt-to-GDP ratio (a

threshold commonly mentioned in the literature, see, for instance, Afonso and Jalles, 2013), while high and low sustainability is determined by comparing Bohn's estimated coefficient to the country's respective average.

Table 2: Fiscal Stance Combinations

Beginning of the Sample (2002-Q1)		Sustainability (Bohn's coefficients)	
		High	Low
Debt Ratio (90%)	High	**BE, GR, IT**	**LT**
	Low	**AT, CY, FI, FR, IE, LU, NL, PT, SI, ES**	**EE, DE, LV, MT, SK**
End of the Sample (2021-Q4)		Sustainability (Bohn's coefficients)	
		High	Low
Debt Ratio (90%)	High		**BE, CY, FR, GR, IT, PT, ES**
	Low	**IE, LU**	**AT, EE, FI, DE, LV, LT, MT, NL, SK, SI**
Average of the Sample		Sustainability (Bohn's coefficients)	
		High	Low
Debt Ratio (90%)	High	**GR, IT, PT**	**BE, CY, LT**
	Low	**AT, IE, LU, NL, SK, SI, ES**	**EE, FI, FR, DE, LV, MT**

Discrimination of high and low debt are based on the 90% of the GDP, while high and low sustainability is determined by comparing Bohn's coefficient to the country's respective average. AT - Austria, BE - Belgium, CY - Cyprus, EE - Estonia, FI - Finland, FR - France, DE - Germany, GR - Greece, IE - Ireland, IT - Italy, LV - Latvia, LT - Lithuania, LU - Luxembourg, MT - Malta, NL - Netherlands, PT - Portugal, SK - Slovakia, SI - Slovenia, ES - Spain.
Source: authors' calculations.

On average, apart from Greece, Italy, Portugal, Belgium, Cyprus, and Lithuania, the countries are characterized by a debt ratio smaller than 90 percent; while in terms of fiscal behavior they are fairly homogeneous between High and Low Sustainability.[3] In addition, most of the countries at the beginning of the sample have a combination of Low Debt-High Sustainability moving at the end of the sample to several Low-Debt countries and several High-Debt countries, and mostly Low Sustainability, with a deterioration in the conduct of fiscal policy. Cyprus, France, Spain, and Portugal are the four countries that have shifted from a low debt position to a high debt one. Finally, Luxembourg and Ireland are the only two countries characterized at the beginning, at the end, and on average of the sample by a virtuous combination of low debt and high sustainability.

[3]This is particularly to be expected, since we have taken the average of the estimated coefficients as the threshold.

3.2 Methodology

As regards our empirical analysis, we assess the impact of monetary policy shocks on the level of real output and prices in a data panel framework. To do so, we employ the Local Projection (LP) methodology (Jordà, 2005). Among the advantages of the LP method over the traditional SVAR approach is that it is more suitable for nonlinear estimation.

We use a quarterly panel data set, spanning the period 2002Q1–2021Q4, for the 19 Euro-Area countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain; and we consider Jaronciski and Karadi (2020)'s monetary policy surprises as monetary policy shocks. The authors derive a monetary policy shock by focusing on the changes in the Euro Stoxx 50 index and the price difference between the EONIA interest swaps in the windows around press statements and conferences.[4] The surprises are aggregated by summing the shocks within the same quarter and divided by the standard deviation. For our analysis, we choose only the positive surprises indicating a tightening of monetary policy.

We estimate three different models: (1) an unconditional linear model (LM), (2) a conditional threshold model (TM) on the fiscal stances (Jordà, 2005), and (3) a conditional smooth-transition model (STM), based in Auerbach and Gorodnichenko (2012, 2017).

Regarding the TM model, we use 3 different thresholds: the 90% of debt-to-GDP ratio and the average of the ratio within each country's sample to discriminate between low and high debt, and the mean of the fiscal sustainability coefficients calculated using a time-varying fiscal reaction function to discriminate between periods of low and high sustainability.

As regards the STM, we employ, on the one hand, the debt burden measure of Auerbach and Gorodnichenko (2017) and on the other hand, a logistic function taking the sustainability coefficient as a state variable.

Finally, we study the four combinations of high-low debt and high-low sustainability to investigate which of the two fiscal stances is more relevant for the effectiveness of monetary policy on output and prices.

For the linear model, following Auerbach and Gorodnichenko (2013) and Jordà (2015), we estimate equation 1:[5]

$$y_{i,t+h} = \alpha_i{}^h + \beta^h shock_{i,t} + \phi^h x_{i,t} + u_{i,t+h}, \quad h = 0,1,\dots,H-1 \quad (1)$$

[4]The surprises are identified by imposing sign restrictions. An expansionary monetary shock shock is assumed to raise stock prices.

[5] We insert also the trend in all the specifications as a control, but the results don't change.

where y_{t+h} is our variable of interest or real output, ${\alpha_i}^h$ are counry-fixed effects, $shock_{i,t}$ are our monetary surprises, and x_{it} is the vector of control variables that includes two lags of the LHS variables. The coefficient β^hcorresponds to the response of y_{t+h} to the shock at time t. The impulse responses are the sequence of all estimated β^h. For all the estimations we calculate error bands based on Driscoll and Kraay (1998) standard errors, which are robust to both cross-sectional and serial dependence.

As regards the non-linearity, to discriminate between different fiscal sustainability regimes we first estimate a time-varying Bohn (1998)'s fiscal reaction function through Schlicht (2021)'s method for each country:

$$s_t = \alpha + \delta b_{t-4} + \psi outputgap_{t-4} + u_{t.} \quad (2)$$

Here s_t is the primary budget balance, b_{t-4} is the lagged public debt, both variables as a percentage of GDP, while the $outputgap_{t-4}$ is the output gap computed by the Hodrick-Prescott filter.[6] We take four lags for debt and output gap because the variables are annualized quarterly data.[7] We discriminate the periods based on the average of the δ coefficients (typically $\delta>0$), which indicate the magnitude of fiscal sustainability. Specifically, the larger the fiscal reaction coefficients' the stronger the so-called Ricardian regime.

The TM (equation 3) separates the data set into the different fiscal regimes, using a binary (dummy) variable I, which is one period lagged to the shock.[8] Hence, it is 1 when (i) the debt-to-GDP ratio is larger than 90%; (ii) the debt-to-GDP ratio is higher than the country average; (iii) the sustainability coefficient is higher than the country average.

$$y_{i,t+h} = {\alpha_i}^h + (1 - I_{t-1})\left[\beta_a^h shock_{i,t} + {\phi^h}_a x_{i,t} \right] + (I_{t-1})\left[\beta_b^h shock_{i,t} + {\phi^h}_b x_{i,t} \right] + u_{i,t+h}. \quad (3)$$

[6] We compute it choosing 1600 as the lamda for the HP filter. We divide the cyclical component on its trend, and we multiply by 100.

[7] We need to annualize the quarterly data for flow variables, namely primary balance and GDP. Therefore, the one-lag in annual data used for estimation of Bohn's coefficients is now set to four lags to have the homologous rationale.

[8] We follow the literature (Ramey and Zubairy, 2018), and we insert the dummy in a lagged manner because of a possible interference between the state and the shock at time t.

The sequence of the β_a^h estimated indicates the IRF in case of low-debt (low-sustainability), and the sequence of β_b^h indicates the IRF of high-debt (high sustainability).

The third model is a transition model which does not lose any observation as the previous model does using a dummy approach. When we consider as a fiscal stance the debt, following Auerbach and Gorodnichenko (2017) we estimate equation 4:

$$y_{i,t+h} = {\alpha_i}^h + \left(1 - D^*_{i,t-1}\right)\left[\ \beta_a^h shock_{i,t} + {\phi^h}_a x_{i,t}\right] + \left(D^*_{i,t-1}\right)\left[\ \beta_b^h shock_{i,t} + {\phi^h}_b x_{i,t}\right] + u_{i,t+h}. \quad (4)$$

The debt state $D^*_{i,t}$ is equal to $\frac{D_i - D_{i,min}}{D_{i,max} - D_{i,min}}$, which varies between 0 and 1 by construction (and is actually positively and perfectly correlated with the original debt ratio series). According to Auerbach and Gorodnichenko (2017), this state variable is the best option to make the units comparable across countries, since the absolute levels may provide a distortion.

As regards the fiscal sustainability measure, we employ a smooth transition model in equation 5:

$$y_{i,t+h} = {\alpha_i}^h + (1 - F^*_{i,t-1})\left[\ \beta_a^h shock_{i,t} + {\phi^h}_a x_{i,t}\right] + (F^*_{i,t-1})\left[\ \beta_b^h shock_{i,t} + {\phi^h}_b x_{i,t}\right] + u_{i,t+h} \quad (5)$$

where $F(\mathrm{z}_t) = \frac{e^{-\gamma(z_t)}}{(1+e^{-\gamma(z_t)})}$ is our logistic function, z_t is the standardized state variable that is our estimated coefficient, γ is the parameter which measures how abruptly the economy transitions between the two fiscal state regimes; we set it to 1.5.[9] When fiscal sustainability improves, our state variable z_t increases and causes $F(\mathrm{z}_t)$ to go to 0. On the other hand, $F(\mathrm{z}_t)$ tends towards 1 when fiscal sustainability worsens.

Finally, we are interested in the four combinations, and we estimate the following dummy model:

$$y_{i,t+h} = {\alpha_i}^h + (I_{t-1})(Y_{t-1})\left[\ \beta_a^h shock_{i,t} + {\phi^h}_a x_{i,t}\right] + (1 - I_{t-1})(Y_{t-1})\left[\ \beta_b^h shock_{i,t} + {\phi^h}_b x_{i,t}\right] + (I_{t-1})(1 - Y_{t-1})\left[\ \beta_c^h shock_{i,t} + {\phi^h}_c x_{i,t}\right] + (1 - I_{t-1})(1 - Y_{t-1})\left[\ \beta_d^h shock_{i,t} + {\phi^h}_d x_{i,t}\right] + u_{i,t+h}. \quad (6)$$

[9] Robustness tests have been done changing γ, and it does not change the findings of the estimates. This results are available upon request.

where now I_t is 1 when the debt is higher than 90% (higher than the debt average), and $Y_t$is 1 when the estimated sustainability coefficient is higher than the average of the sample. So β_a^h are the IRF of High Debt-High Sustainability, β_b^h of Low Debt-High Sustainability, β_c^h of High Debt-Low Sustainability, β_d^h of Low Debt-Low Sustainability.

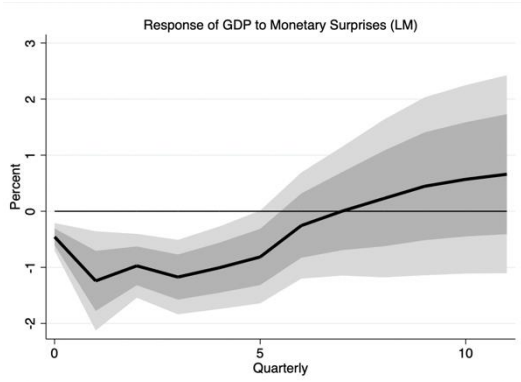
4. Results and Discussion

4.1. Two different fiscal regime measures

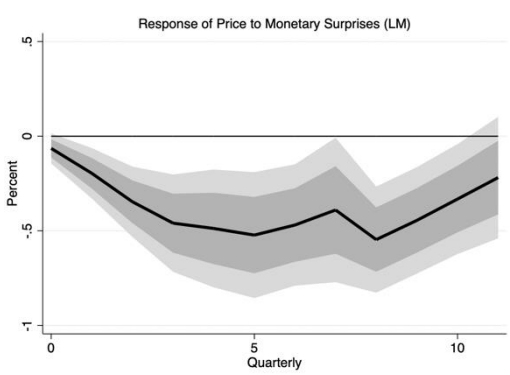
Figure 2 displays the reactions of GDP and the price level (first and second columns) in response to the monetary shocks. Table 3 presents the point estimates along with their corresponding significance levels for the impact, low peak, and average response. A tightening of monetary policy leads to a contraction in output and prices. While the significance persists across all horizons for prices, the contracting impact on output remains significant only up to the seventh quarter. Additionally, a difference in magnitude is observed, with an average output decrease of 0.255% compared to a greater price decrease of 0.347%. These linear results are consistent with the standard New-Keynesian transmission mechanism (Smets and Wouters, 2003). According to the intertemporal consumption choice, when the interest rate rises, agents prefer to postpone consumption, decreasing demand and output. The decline in output is also exacerbated by the dynamics of investment, which also declines. At the same time, employment, wages, and firms' marginal costs fall, putting downward pressure on the price level.

Figure 2: Linear Models

Linear Model: IRF of GDP



Linear Model: IRF of Price



The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 1), for the 12-quarter forecast horizon. The light (dark) grey bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998).

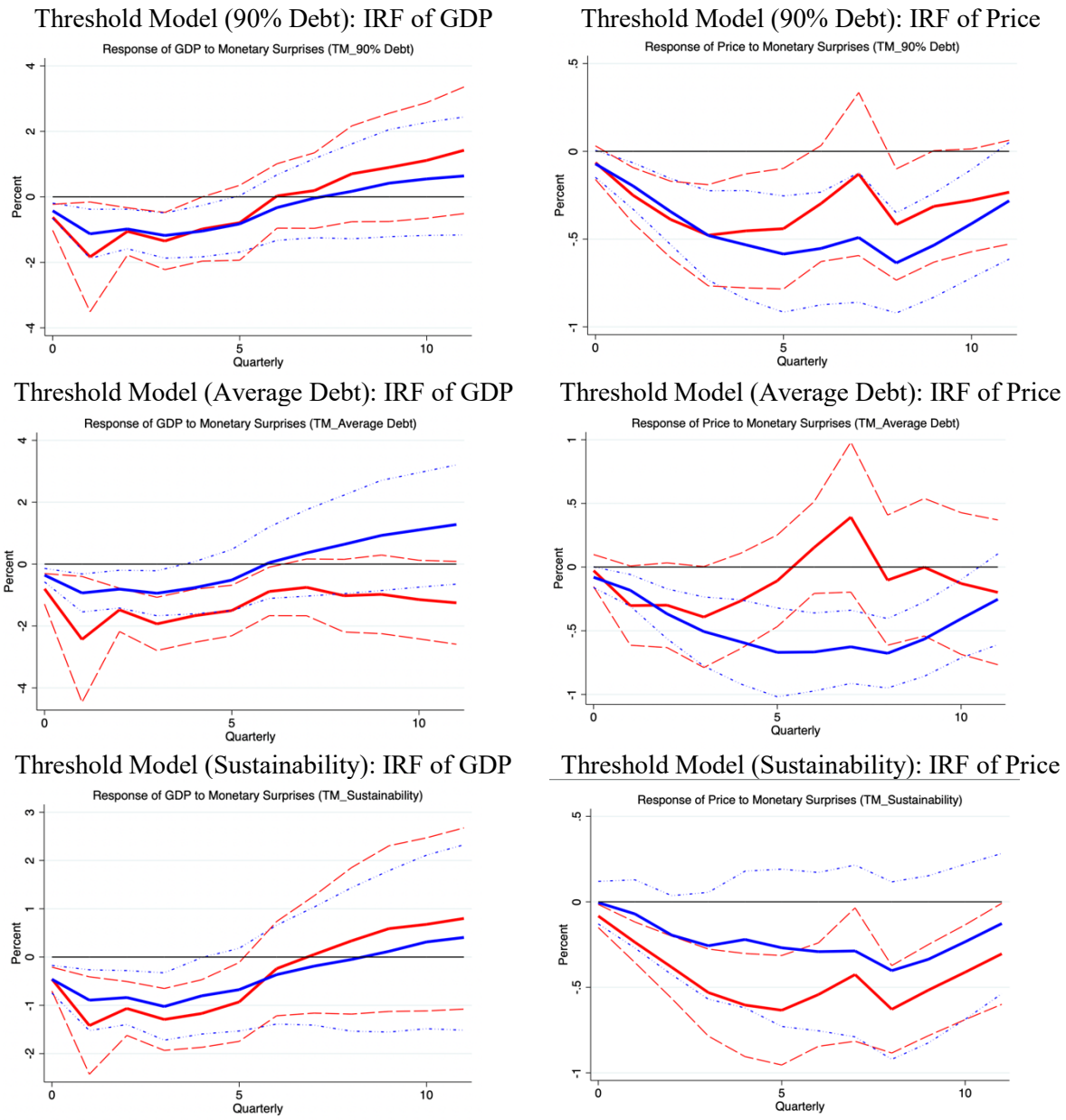
Consistent with the aim of this paper, we estimate the responses of the non-linear specification 3 (Figure 3). Using the debt ratio as a fiscal stance, we find that in the high debt regime (red line), a tightening leads to a greater reduction in output (minimum peak of -2.43 vs -0.942, debt average threshold). This can be traced to three reasons. The first is related to the perception of stability by the economic agents and more in general the financial risks: in high public debt regimes, restrictive monetary policies may increase the perception of financial risks, especially if there is concern that higher interest rates might strain the financial market. Economic agents may become more cautious in their spending and investment decisions, thereby reducing output (Jordà et al., 2016). The second reason regards the government and its reduction of public spending: the increase in interest rates caused by restrictive monetary policy can amplify the cost of servicing public debt, notably with eventually higher sovereign yields demanded by investors. This might compel governments to reduce public spending, including investment and economic support programs with a negative impact on economic growth. The third reason is more general and it is related to the complex and negative relationship between high public debt and output growth (Reinhart and Rogoff, 2010); this relationship can amplify the adverse effect in terms of magnitude.[10]

Regarding the effect on prices, the difference between high and low debt is even more pronounced. Indeed, in the first specification, the statistical significance fades after six quarters; furthermore, in the second row, monetary policy demonstrates no significant effect on prices

[10]On this third point, there is no unanimity in the literature; however, there is enough agreement that excessive public debt can have distorting effects on both growth and macroeconomic conditions (see notably Afonso and Jalles, 2013).

across all time spans. Notably, in the low debt state, a significant marginal decline of 0.677% is observed after nine time periods. These findings are in line with De Luigi and Huber (2018), who state that the price effect of monetary policy is less pronounced in "high" debt regimes.

Figure 3: Threshold Model



The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 3), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red indicates a high debt regime based on the mean of each country, and blue denotes a low debt regime. In the third row, red signifies a high sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a low sustainability regime. Standard errors are constructed using Driscoll and Kraay (1998). The bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values.

When we describe our fiscal regime by the level of the sustainability coefficient (third row), the effect on output is always contractionary, but the most contracting effect is in the high sustainability period (red line). This result marks a crucial point and the importance of considering different fiscal stances, since the most pronounced effect on output, previously identified within the high debt regime, is now observed within the high sustainability regime. We attribute this difference to the fact that the previously mentioned distortive nature of the high debt is now not statistically significant and also to the fact that, by construction, in the high sustainability regime the primary surplus adjusts to government debt dynamics. In addition, even if economic agents might be more optimistic about future public finances, they experience more fiscal contraction at the current time, becoming an additional channel of the GDP's drop.

Regarding the effect on the price level, our findings reveal a substantial contraction within the more Ricardian regime, while monetary surprises exhibit no discernible impact within the less Ricardian one. In addition, to test whether the answers we find are significantly different from each other, we do a t-test on the mean. What we find is a mostly significant difference in the response of the two regimes (for output more than prices), and a significant difference only for prices when we discriminate for sustainability. These t-test results fully confirm our previous analysis.

Table 3: IRF. Linear Model and Threshold Models

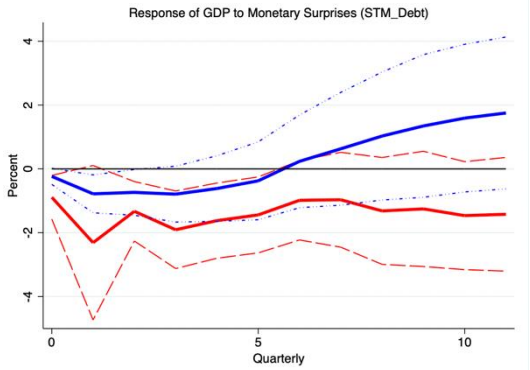
	Linear Model			**Threshold 90% Debt**						
				Low Debt			**High Debt**			
Variable	Impact	Mean	Min.	Impact	Mean	Min.	Impact	Mean	Min.	p-value
GDP	**-.456**	-.255	**-1.24**	**-.424**	-.265	**-1.18**	**-.624**	-.066	**-1.83**	0.116
Price	**-.064**	-.347	**-.547**	-.071	-.399	**-.636**	-.064	-.295	**-.478**	0.0148
	Threshold Average Debt									
	Low Debt			**High Debt**						
Variable	Impact	Mean	Min.	Impact	Mean	Min.	p-value			
GDP	**-.357**	.107	**-.942**	**-.799**	-1.31	**-2.43**	0			
Price	-.080	-.431	**-.677**	-.028	-.109	-.392	0.0073			
	Threshold Sustainability (Bohn's Rule)									
	Low Sustainability			**High Sustainability**						
Variable	Impact	Mean	Min.	Impact	Mean	Min.	p-value			
GDP	**-.461**	-.003	**-1.02**	**-.456**	-.25	**-1.42**	0.5446			
Price	-.005	-.202	-.402	**-.083**	-.416	**-.634**	0			

The table reports estimated responses of output and price to surprise shocks as regards the linear and threshold model. We present the impact, low peak, and average response. IRF Bold indicates at least 90% significance. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). P-value shows p-values for the t-test of the regime averages. For instance, for the threshold average debt case, we test the estimated coefficient of the impact of the monetary policy shock on GDP (which is 0.107 for low debt and -1.31) does not differ. This hypothesis is rejected which confirms that the monetary policy effect varies significantly across fiscal regimes.

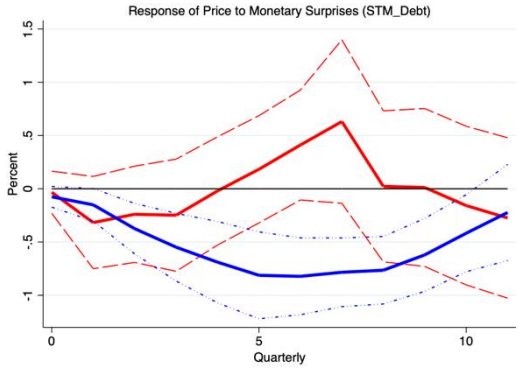
Figure 4 and Table 4 show the results of the smooth transition model. Unlike the threshold model, this model does not lose observations but assigns a weight to each of the two states (specifications 4 and 5). In general, the results confirm those previously illustrated, both in the high-debt and low-sustainability regimes, monetary tightening has no effect on prices. Furthermore, unlike the threshold model, in the low sustainability regime, the response of output is not significant. Moreover, our smooth transition model improves the significance of the differences between the responses of the two regimens, as shown by the p-values in Table 4, which are all significant for both variables in the different regimens considered.

Figure 4: Transition Model

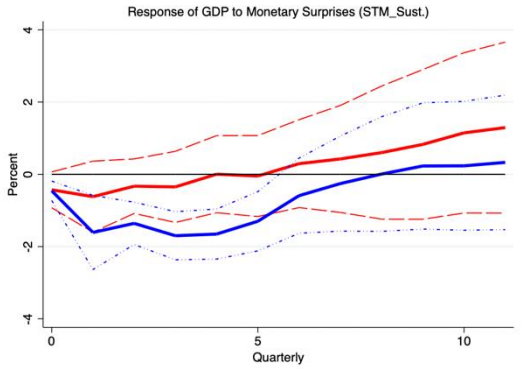
Transition Model (Debt Burden): IRF of GDP



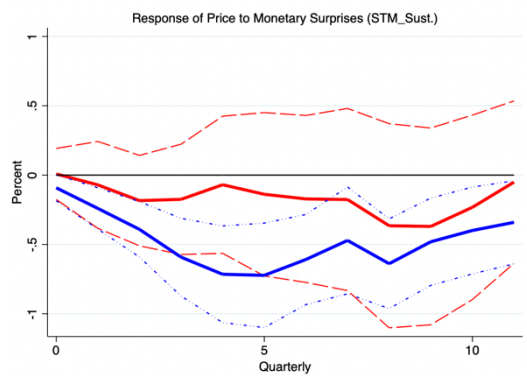
Transition Model (Debt Burden): IRF of Price



Transition Model (Sustainability): IRF of GDP



Transition Model (Sustainability): IRF of GDP



The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 4 for the debt and Equation 5 for the sustainability), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red signifies a low sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a high sustainability regime. The bands indicate the 90 percent confidence interval. Standard errors are constructed using Driscoll and Kraay (1998). The impulse responses can be interpreted as percentage deviations from their original values.

Table 4: IRF. Transition Model

	Transition Model (Debt)							Transition Model (Sustainability)						
	Low Debt			High Debt				High Sustainability			Low Sustainability			
Variable	Impact	Mean	Min.	Impact	Mean	Min.	p-value	Impact	Mean	Min.	Impact	Mean	Min.	p-value
GDP	-.236	-.378	-.792	**-.890**	-1.43	-2.31	0	**-.456**	-.590	**-1.70**	**-.429**	.313	-.619	0
Price	-.076	-.481	**-.822**	-.033	-.017	-.318	0.0088	-.091	-.452	**-.723**	.009	-.137	-.370	0

The table reports estimated responses of output and price to surprise shocks as regards the transition model. We present the impact, low peak and average response. IRF Bold indicates at least 90% significance. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). P-value shows p-values for the test that responses are significatively different in the two different states. P-value shows p-values for the t-test of the regime averages.

4.2. Combining fiscal regimes measures

According to our study, the effectiveness of monetary policy depends on the fiscal stance. Furthermore, depending on which of the two fiscal stances we adopt (debt or sustainability), significant differences arise. Precisely for this reason, we choose to interact the various combinations of fiscal stances and estimate equation 6. We do this to determine which of the two fiscal stances is more influential in shaping the impact of monetary policy on output and prices. Figure 5 shows the IRFs of the different combinations High (Low) Debt-High (Low) Sustainability when we take 90% as the debt threshold. As regards the GDP's response, it is always negative, especially in the high-debt states, with a peak low of -2%. Results do not change when we take the average debt of each country as the threshold (Figure 6); here we find an even more pronounced contraction in the High Debt-High Sustainability regime with a minimum peak of -4.21% (Table 5).

In terms of the price response, in the first specification of Figure 5, the more Ricardian states always display a significant reduction; even bigger if accompanied by Low Debt (with a peak of -.657). As regards the other two combinations, in the Low Debt and Low Sustainability regime there isn't a clear statistical significance, and in High Debt and Low Sustainability regimes, monetary restriction leads to an increase in prices after 5 quarters, a result which can be attributed to the "fiscal inflation" phenomena (Bianchi and Ilut, 2017).

As discussed by Sims (2011), with the presence of such beliefs about the future course of fiscal policy, an increase in the interest rate increases the inflation rate rather than reducing it. Even in the case of a recession caused by monetary contraction, a vicious circle could be triggered. If the recession increases further the debt-to-GDP ratio and monetary tightening is not supported by agents' expectations of future fiscal adjustment which incorporate future inflation into the present, the worsening of fiscal imbalances leads to even higher inflationary pressures and prolonged economic stagnation. This vicious cycle is called "Fiscal Stagflation"

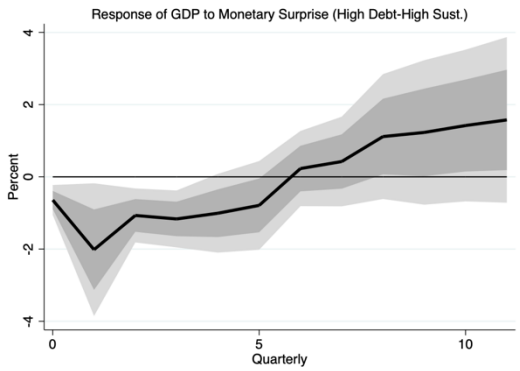
(Bianchi and Melosi, 2022). Our empirical findings in the regime of High Debt-Low Sustainability are consistent with these theoretical predictions.

The price response in Figure 6 does not differ too much notably from the previous of Figure 5, however now in the case of Low Debt-Low Sustainability after 3 quarters there is a more significant reduction than that of the previous results. No effect or even a price increase (albeit less significant than the previous results) is found for the High Debt-Low Sustainability combination.

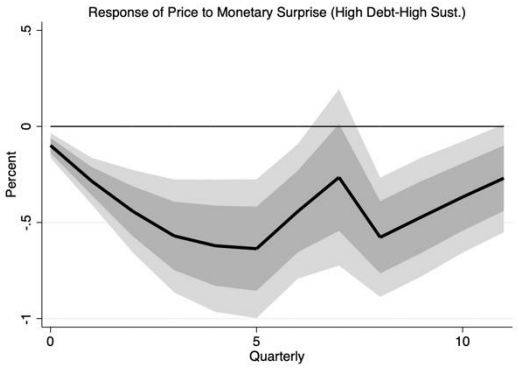
Therefore, monetary policy effects depend on the fiscal regime in place. As suggested by the FTPL, in the "higher" sustainable regime output and prices tend to respond more strongly to monetary tightening, in contrast to the "lower" sustainable regime. As for the model with debt, we find that in periods of high debt output contracts more than in periods of low debt; instead, prices fall more in periods of low debt. When we discriminate for the debt average, monetary surprises have no effect on prices. In addition, taking the combinations of the fiscal stances, if for output the debt is more important in the effect of monetary policy, for prices, the "Ricardian" nature of fiscal policy appears to be far more crucial. This last result relates to the fact that sustainability may better encapsulates economic agents' beliefs and expectations about the future ability to repay debt (relationship arising from the government's intertemporal constraint). Finally, we also find the presence of the so-called fiscal inflation in the High-Debt and Low-Sustainability regime.

Figure 5: Threshold Model. 90% Debt. 4 Combinations.

Threshold Model. High Debt-High Sustainability: IRF of GDP

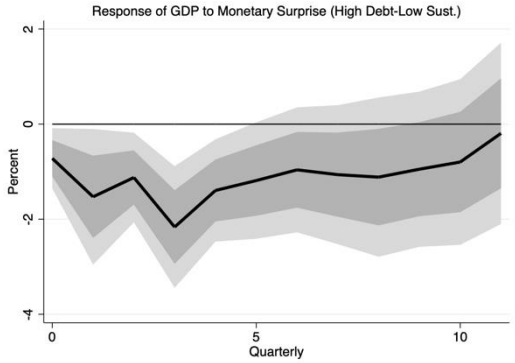


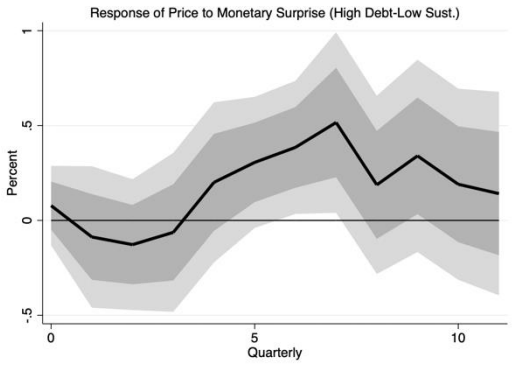
Threshold Model. High Debt-High Sustainability: IRF of Price



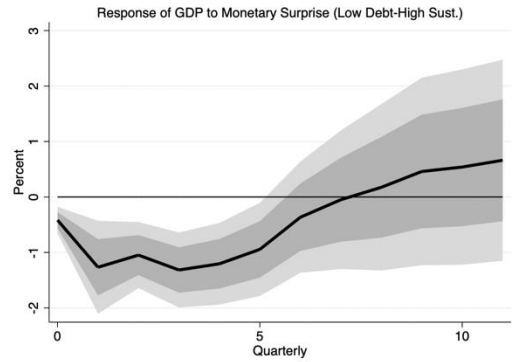
Threshold Model. High Debt-Low Sustainability: IRF of GDP

Threshold Model. High Debt-Low Sustainability: IRF of Price

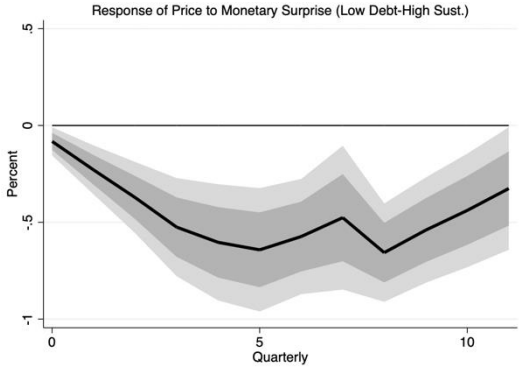




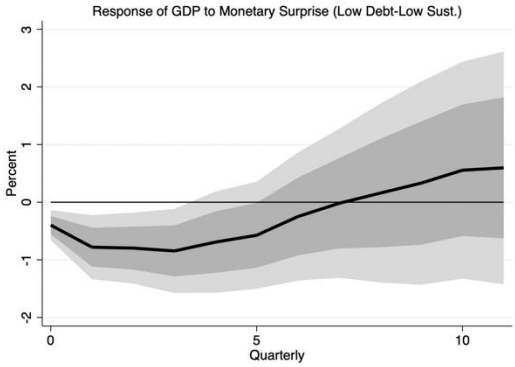
Threshold Model. Low Debt-High Sustainability: IRF of GDP



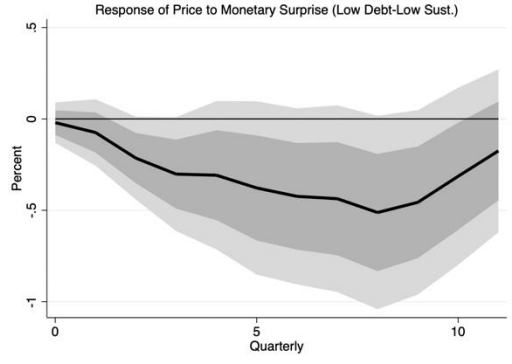
Threshold Model. Low Debt-High Sustainability: IRF of Price



Threshold Model. Low Debt- Low Sustainability: IRF of GDP



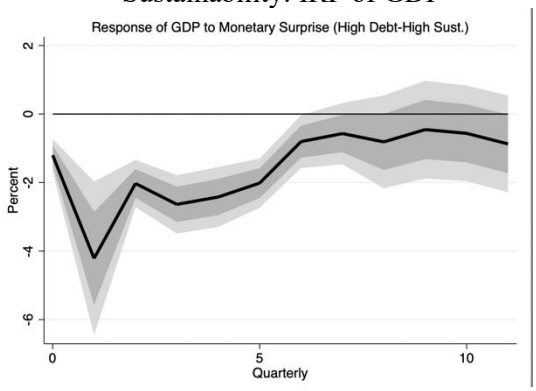
Threshold Model. Low Debt- Low Sustainability: IRF of Price



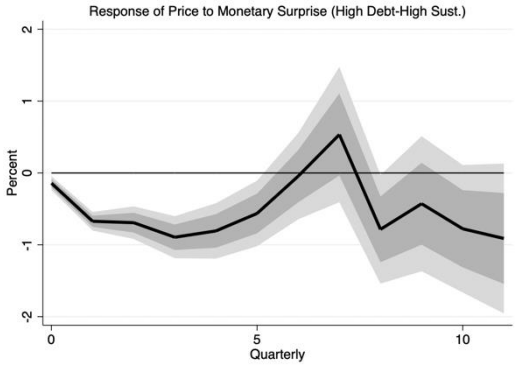
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) grey bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on the 90% ratio.

Figure 6: Threshold Model. Debt Average. 4 Combinations.

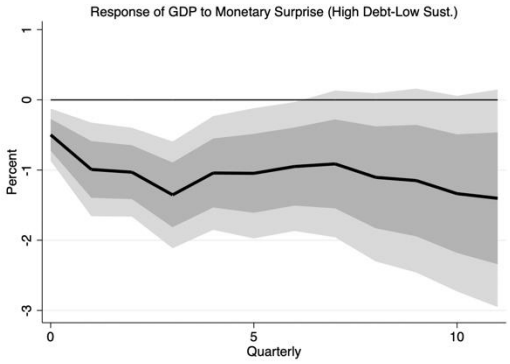
Threshold Model. High Debt- High Sustainability: IRF of GDP



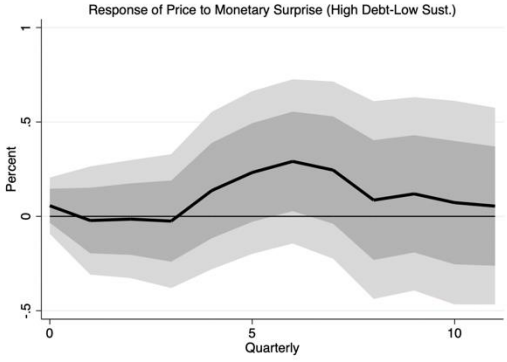
Threshold Model. High Debt- High Sustainability: IRF of Price



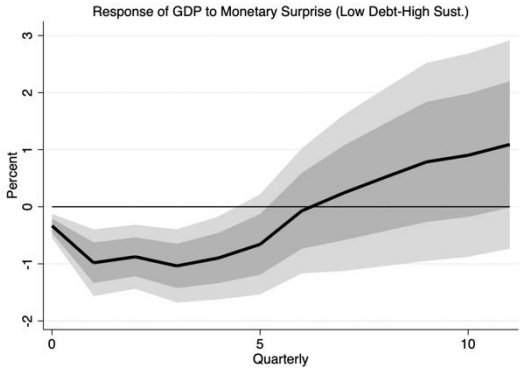
Threshold Model. High Debt- Low Sustainability: IRF of GDP



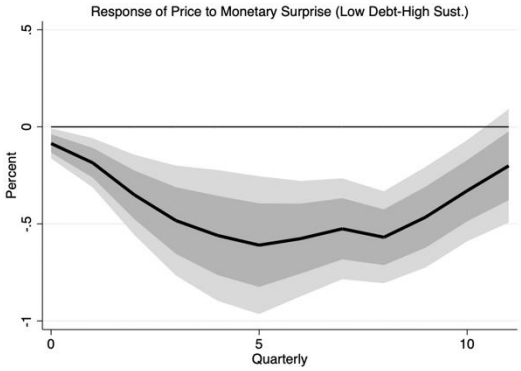
Threshold Model. High Debt- Low Sustainability: IRF of Price



Threshold Model. Low Debt- High Sustainability: IRF of GDP

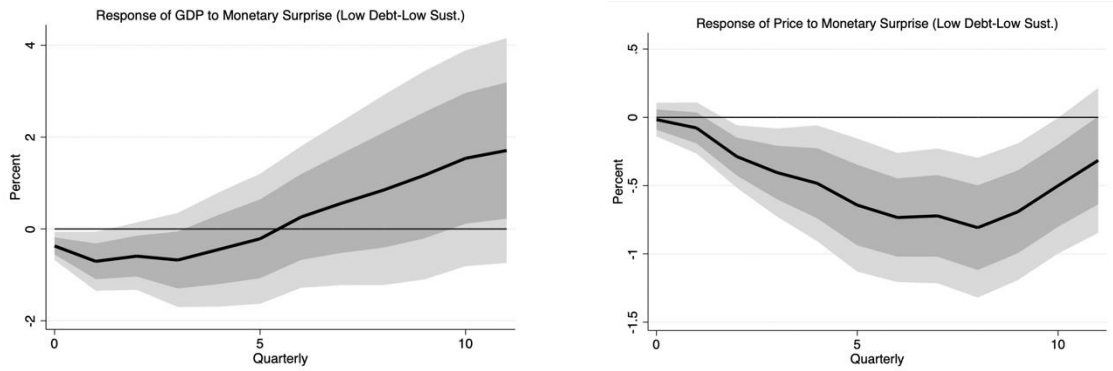


Threshold Model. Low Debt- High Sustainability: IRF of Price



Threshold Model. Low Debt- Low Sustainability: IRF of GDP

Threshold Model. Low Debt- Low Sustainability: IRF of Price



The IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) grey bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on each country debt average.

Table 5: IRF. Threshold Model. 4 Combinations.

	Threshold Model. 90% Debt. 4 Combinations.											
	High Debt-High Sustainability			**High Debt-Low Sustainability**			**Low Debt- High Sustainability**			**Low Debt- Low Sustainability**		
Variable	Impact	Mean	Min.	Impact	Mean	Min.	Impact	Mean	Min.	Impact	Mean	Min.
GDP	**-.642**	1.06	**-2.02**	**-.721**	-1.06	**-2.17**	**-.417**	-.307	**-1.32**	**-.399**	-.158	**-.846**
Price	**-.099**	-.396	**-.637**	.078	.177	-.128	**-.082**	-.430	**-.657**	-.020	.177	**-.512**
	Threshold Model. Each Average Debt. 4 Combinations.											
	High Debt-High Sustainability			**High Debt-Low Sustainability**			**Low Debt- High Sustainability**			**Low Debt- Low Sustainability**		
Variable	Impact	Mean	Min.	Impact	Mean	Min.	Impact	Mean	Min.	Impact	Mean	Min.
GDP	**-1.20**	-1.50	**-4.21**	**-.498**	-1.09	**-1.40**	**-.334**	-.009	**-1.04**	**-.370**	.372	**-.704**
Price	**-.142**	-.548	-.943	-.016	-.440	**-.808**	**-.086**	-.379	**-.61**	.056	.107	-.025

The table reports estimated responses of output and price to surprise shocks as regards the transition model. We present the impact, low peak and average response. Bold indicates at least 90% significance. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998).

Furthermore, in the Online Appendix we performed a robustness analysis, in which: (1) we insert all the monetary surprises, even the negative ones; (2) we do a panel analysis in which we take only the Euro Area core countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain. In general, the main results do not change.[11]

5. Conclusions and Policy Implications

Recently, the study of the interaction between fiscal and monetary policy has been of considerable interest. The literature highlights the presence of interdependence between these two policies in terms of their respective effectiveness. Following this idea, we have investigated

[11]We have also made some tests by using growth rates instead of the variables taken in log-levels, the results are available upon request and do not change much from those presented in this paper.

the effect of Jarociński and Karadi (2020) monetary policy surprises on output and price level under two different measures of fiscal stance: low and high debt regimes and more sustainable and less sustainable fiscal regimes based on the estimation of Bohn's fiscal reaction coefficients in a time varying fashion.

We use a panel of quarterly data, spanning the period 2002Q1–2021Q4, for the 19 Euro-Area countries. We estimate three Local Projection models: (1) a linear model, (2) a threshold model conditional on our fiscal regime, and (3) a conditional smooth transition model.

Furthermore, we assess the efficacy of monetary tightening within each of the four regime combinations (low/high debt with low/high fiscal sustainability), to determine which of the two fiscal stances predominantly influences the output and price responses.

According to our knowledge, no existing study has investigated the effect of monetary tightening by conditioning for low debt and high debt, high and low sustainability and by considering the interaction between these states. In addition, there is no study for the Euro Area.

Our findings can be summarized as follows. (i) The unconditional effect of monetary surprise shocks has a recessionary effect on the macroeconomic outcomes, compressing output, and the price level. (ii) When we use the debt as a measure of fiscal regime (using the 90% ratio to GDP as a threshold), we find a contraction of output in both regimes, but more pronounced in periods of high debt, and this can be attributed to the distortive nature of having high debt; on the other hand, prices fall more in periods of low debt. (iii) Taking the debt average as a threshold, monetary surprises have no effect on prices in the high debt regime. (iv) When we discriminate for Bohn's rule, in the "higher" sustainability Ricardian regime, output and prices tend to respond more strongly to monetary tightening, in contrast to the "lower" sustainability non-Ricardian regime, where there are no even effects on prices. However, there is a larger output effect in the most sustainable regime. (v) Taking the different combinations of the fiscal stances, if for output the debt is more important in the result of monetary policy, for prices, the "Ricardian" nature of fiscal policy appears to be far more crucial. This point relates to the fact that sustainability may better encapsulate economic agents' beliefs and expectations about the future ability to repay debt (relationship arising from the government's intertemporal constraint). (vi) Finally, in the High-Debt and Low-Sustainability regime we also find the presence of the so-called "fiscal inflation". These findings are robust with different specifications and models.

Hence, in general, fiscal stance matters for the monetary authority, and matters also how the proxies of the fiscal regime is defined, whether it is the level of debt inherited from the past or the "conduction" of fiscal policy based on the sustainability reaction function.

Our results have relevant policy implications. The most important one is related to the European Central Bank's ability to control macroeconomic variables. According to our study, the ECB's effectiveness also depends on the type of fiscal policy pursued by each member state, in particular, both sustainability regimes and the level of debt condition the response of output and prices. On the one hand, for the effects on output, having high debt seems to lead to an even more recessionary effect of the tight monetary stance. On the other hand, if we look at the effect on prices, as suggested by the FTPL, the level of sustainability seems to matter more (consistent with the government's intertemporal budget constraint). Consequently, we do not exclude that the slowdown in the inflation response to the monetary policy interest rate hikes could be attributed also to this relationship.

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Appendix

Table A1: Variables, definition, and data source

Countries: AT - Austria, BE - Belgium, CY - Cyprus, EE - Estonia, FI - Finland, FR - France, DE - Germany, GR - Greece, IE - Ireland, IT - Italy, LV - Latvia, LT - Lithuania, LU - Luxembourg, MT - Malta, NL - Netherlands, PT - Portugal, SK - Slovakia, SI - Slovenia, ES - Spain.		
Variable	**Definition**	**Source**
s_t	Primary Balance on GDP. Constructed Variable. Total General Government Expenditure - Total General Government Revenue + Interest on Debt. Quarterly data. Annualized and expressed as a percentage of GDP.	**Eurostat**
d_t	Public Debt on GDP. Constructed Variable. Quarterly Data. The ratio of cumulative Debt Quarter over Nominal GDP Year.	**Eurostat**
Monetary Surprises	Shock aggregated quarterly, through the sum of the monthly shocks. Divided by their Standard Deviation.	**Jaroncinski's website** https://marekjarocinski.github.io.
PI_t	Price Index. Harmonized Index of Consumer Prices: All Items. Index 2015=100, Quarterly. Seasonally Adjusted by Census-X13 (R Software). Variable taken in natural logarithm.	**FRED**
$RGDP_t$	Millions of Chained 2010 Euros, Quarterly, Seasonally Adjusted. Variable taken in natural logarithm.	**FRED**

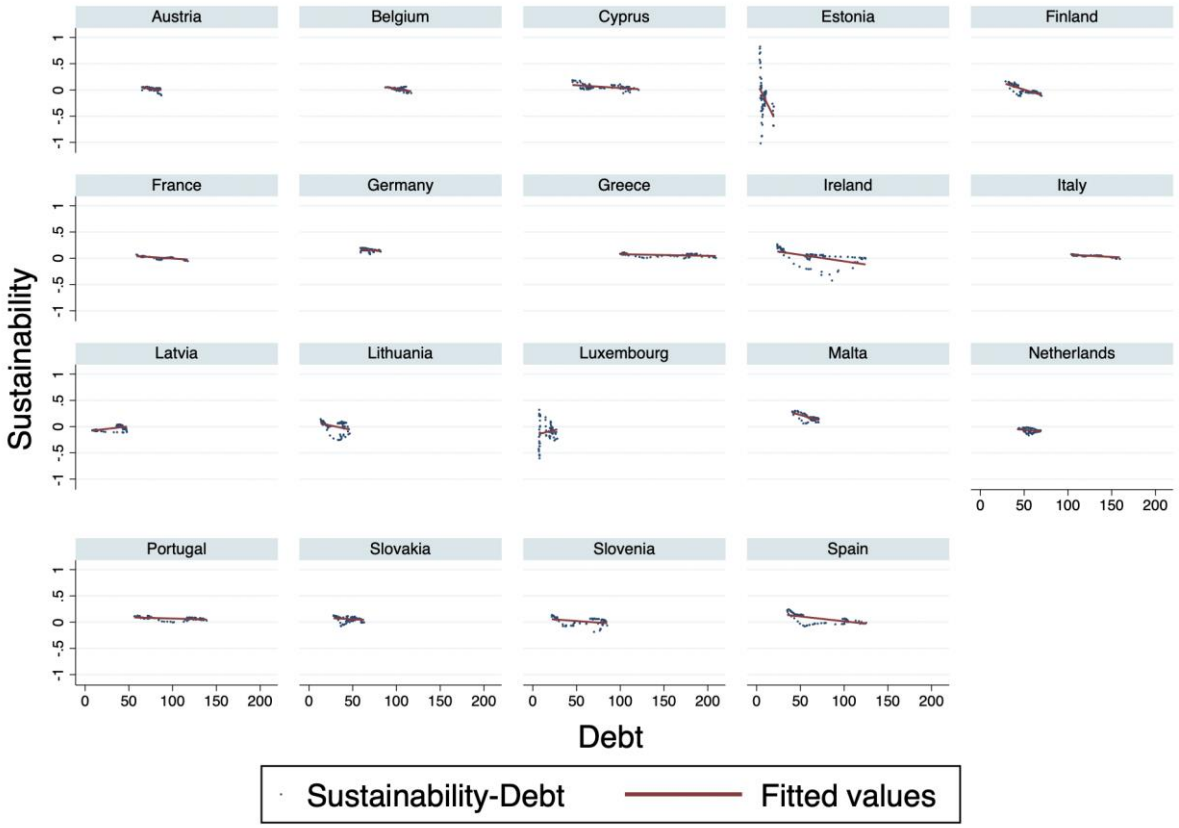
Table A2: Descriptive Statistics

Austria					
Variable	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
Debt	80	76.9548	6.494544	65.03127	87.10956
Bohn	80	.0218622	.0312544	-.104814	.0607942
Price	80	4.536735	.1100705	4.349369	4.729314
GDP	80	11.23037	.0755097	11.08264	11.35669
Belgium					
Debt	80	103.575	6.272428	87.32462	116.9524
Bohn	80	.0101536	.0285954	-.063108	.062179
Price	80	4.544941	.1101288	4.353495	4.744404
GDP	80	11.4297	.082192	11.26425	11.57561
Cyprus					
Debt	80	80.09042	22.53287	45.28985	120.9424
Bohn	80	.0569887	.0475035	-.0615772	.184488
Price	80	4.544234	.0834574	4.348274	4.644163
GDP	80	8.451673	.1134802	8.215736	8.681011
Estonia					
Debt	80	8.169308	4.049862	3.436055	19.66488
Bohn	80	-.127981	.3494706	-1.019	.824318
Price	80	4.487748	.1899085	4.146394	4.785076
GDP	80	8.329243	.155862	7.962346	8.619352

Finland					
Debt	80	50.1257	11.76469	28.69287	69.78576
Bohn	80	.0044059	.0767904	-.117998	.162327
Price	80	4.533005	.0950167	4.38149	4.676972
GDP	80	10.76591	.0619539	10.61709	10.8667
France					
Debt	80	85.18488	16.81936	58.71077	117.2895
Bohn	80	.0122095	.0251817	-.0540344	.0710569
Price	80	4.555303	.0829981	4.390936	4.692621
GDP	80	13.12932	.0638656	13.01246	13.24596
Germany					
Debt	80	69.14886	6.555909	58.8983	81.9947
Bohn	80	.1573291	.0260144	.0776417	.19716
Price	80	4.550942	.087562	4.398024	4.709403
GDP	80	13.40597	.0819091	13.21031	13.52721
Greece					
Debt	80	147.8772	36.74741	99.91925	209.2735
Bohn	80	.0628004	.0277625	-.002888	.111081
Price	80	4.551467	.0962999	4.323931	4.643489
GDP	80	10.86096	.1382435	10.60746	11.09479
Ireland					
Debt	80	63.74596	31.66978	23.63985	124.5099
Bohn	80	.0320482	.1406005	-.424615	.264796
Price	80	4.572665	.0550195	4.41379	4.664304
GDP	80	10.81091	.2689571	10.45408	11.42676
Italy					
Debt	80	124.408	15.27284	103.8895	159.3377
Bohn	80	.0476029	.0174543	-.0134143	.0769692
Price	80	4.572665	.0550195	4.41379	4.664304
GDP	80	12.89882	.0337	12.72244	12.96363
Latvia					
Debt	80	30.2919	14.10628	8.121444	47.69938
Bohn	80	-.0323383	.0506185	-.112707	.0420179
Price	80	4.484748	.2100845	4.051521	4.75506
GDP	80	8.5274	. 1498527	8.130383	8.740385
Lithuania					
Debt	80	30.83814	10.28402	13.37365	46.58362
Bohn	80	.0005329	.1061857	-.255633	.143268
Price	80	4.514099	.1680075	4.231448	4.795987
GDP	80	8.956872	.1817947	8.521942	9.270786
Luxembourg					
Debt	80	16.57405	6.791217	6.832632	28.01271
Bohn	80	-.0993793	.1884481	-.603302	.321923
Price	80	4.528628	.1189243	4.288102	4.719898
GDP	80	9.297371	.1386727	9.031859	9.529768
Malta					
Debt	80	61.13822	8.38037	40.72157	70.88347
Bohn	80	.1711188	.0589914	.0618085	.303157
Price	80	4.53079	.1089973	4.326542	4.685431
GDP	80	7.550781	.2545665	7.210523	8.025942
Netherlands					
Debt	80	55.73344	7.309076	42.98997	68.93313
Bohn	80	-.0713217	.0367973	-.164846	-.0142145
Price	80	4.550636	.0882937	4.38729	4.729899
GDP	80	11.99615	.073196	11.86785	12.13857
Portugal					
Debt	80	102.7889	28.96251	56.38472	138.9203
Bohn	80	.0668315	.029285	-.0048408	.12442

Price	80	4.55045	.0845873	4.357326	4.661047
GDP	80	10.69677	.0399968	10.58046	10.78892
Slovakia					
Debt	80	46.12565	9.40163	28.06632	63.07436
Bohn	80	.057401	.0469138	-.077463	.127236
Price	80	4.532108	.1280767	4.212276	4.736125
GDP	80	9.745375	.1989158	9.313488	10.01179
Slovenia					
Debt	80	50.99563	23.46008	21.78596	84.99723
Bohn	80	.0199265	.0690395	-.187081	.136716
Price	80	4.533223	.1146176	4.258098	4.694308
GDP	80	9.126884	.1086721	8.902741	9.366481
Spain					
Debt	80	75.52277	29.53125	34.97813	125.2341
Bohn	80	.0610297	.0865074	-.0802124	.240877
Price	80	4.543309	.1017174	4.315207	4.698345
GDP	80	12.48982	.0632469	12.34457	12.60403

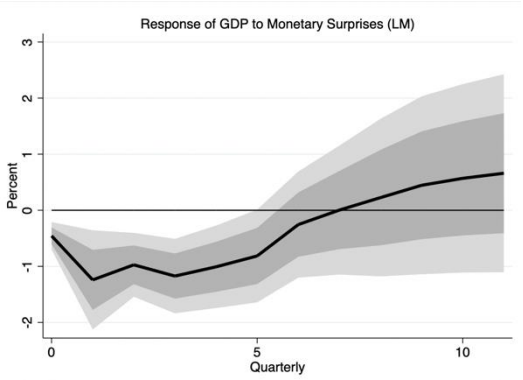
Figure A1: Debt/GDP Ratio and Sustainability Scatter Plot



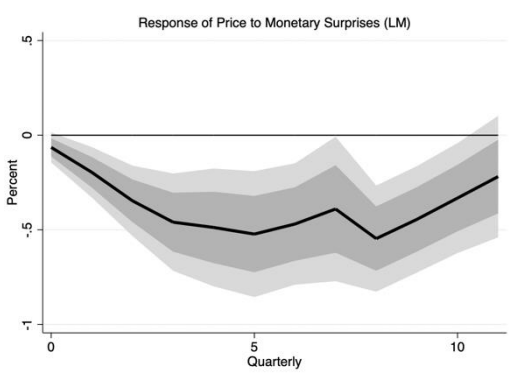
Online Appendix: Robustness Analysis

Table A1: Linear Model. Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Linear Model: IRF of GDP



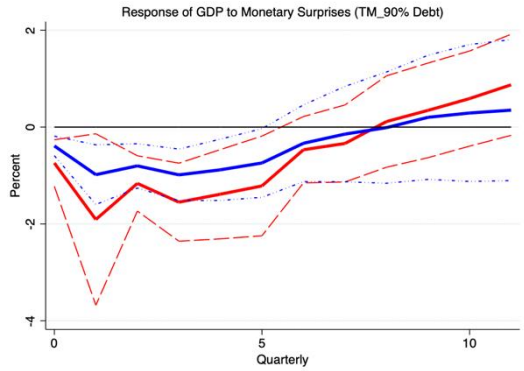
Linear Model: IRF of Price



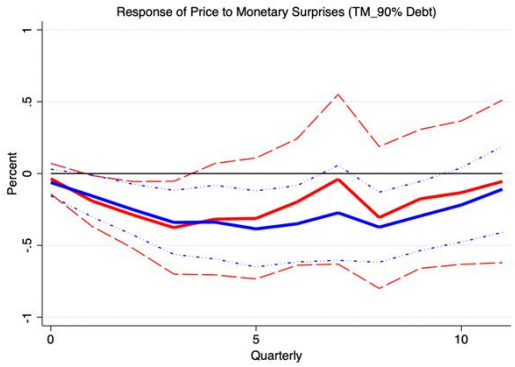
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 1), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Table A2: Threshold Model Estimation for Euro "Core". Without Cyprus, Estonia, Lettonia, Greece, Latvia. Lithuania, Malta, Slovakia, and Slovenia.

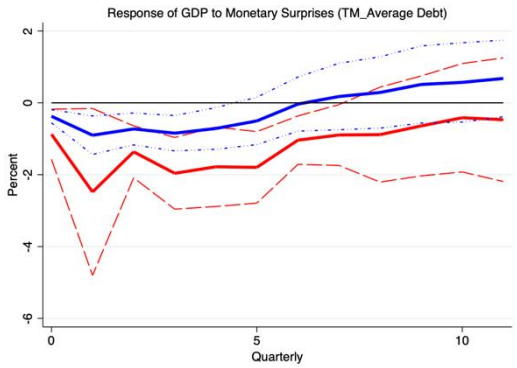
Threshold Model (90% Debt): IRF of GDP



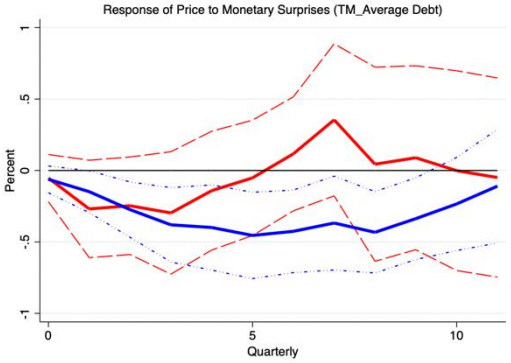
Threshold Model (90% Debt): IRF of Price



Threshold Model (Average Debt): IRF of GDP

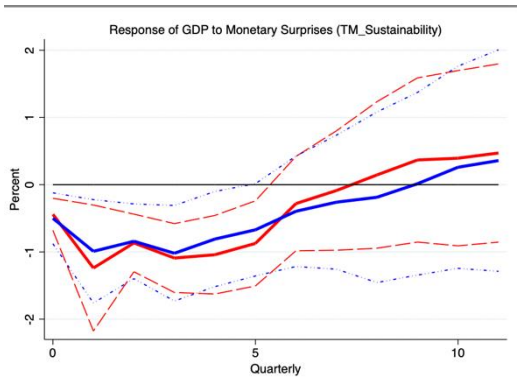


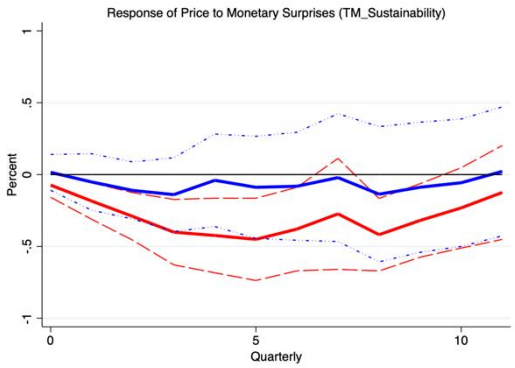
Threshold Model (Average Debt): IRF of Price



Threshold Model (Sustainability): IRF of GDP

Threshold Model (Sustainability): IRF of Price

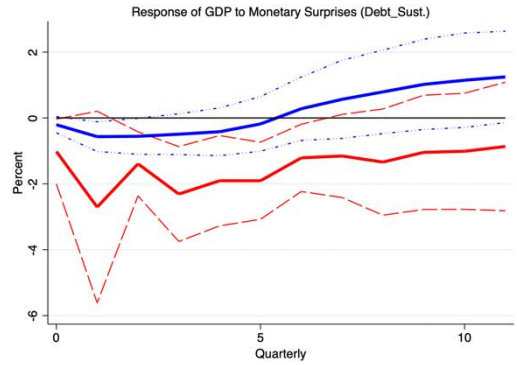




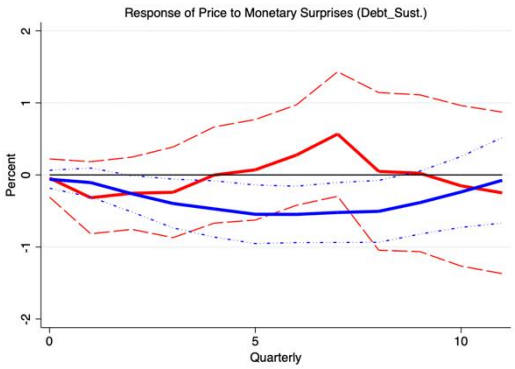
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 3), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red indicates a high debt regime based on the mean of each country, and blue denotes a low debt regime. In the third row, red signifies a high sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a low sustainability regime. Standard errors are constructed using Driscoll and Kraay (1998). The bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Table A3: Transition Model Estimation for Euro "Core". Without Cyprus, Estonia, Lettonia, Greece, Latvia. Lithuania, Malta, Slovakia, and Slovenia.

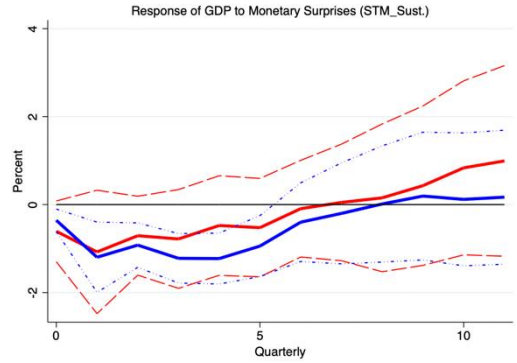
Transition Model (Debt Burden): IRF of GDP



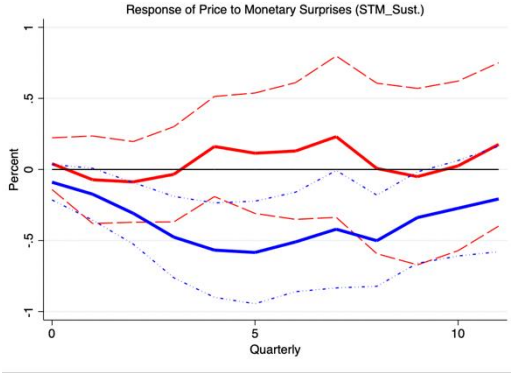
Transition Model (Debt Burden): IRF of Price



Transition Model (Sustainability): IRF of GDP



Transition Model (Sustainability): IRF of GDP

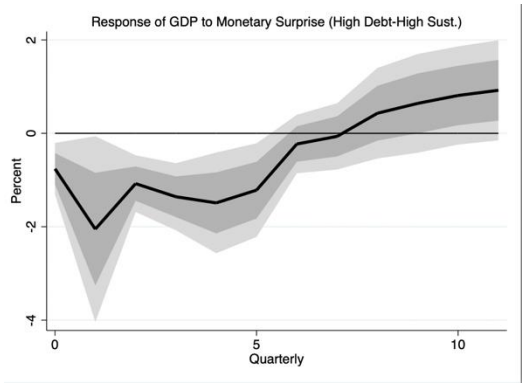


The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 4 for the debt and Equation 5 for the sustainability), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red signifies a low sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a high sustainability regime. The bands indicate the 90 percent confidence interval. Standard errors are constructed using Driscoll and Kraay (1998). The impulse responses can be interpreted as percentage deviations from their original values Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

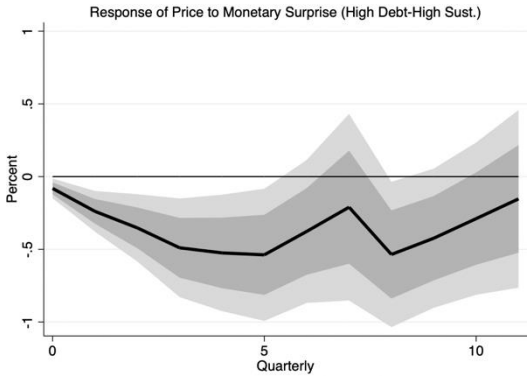
.

Table A4: Threshold Model. 90% Debt/GDP Ratio. Estimation for Euro "Core". Without Cyprus, Estonia, Lettonia, Greece, Latvia. Lithuania, Malta, Slovakia, and Slovenia.

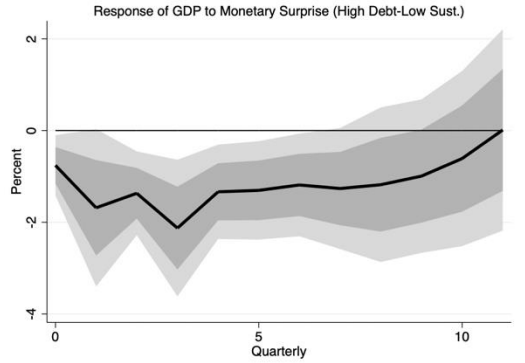
Threshold Model. High Debt-High Sustainability: IRF of GDP



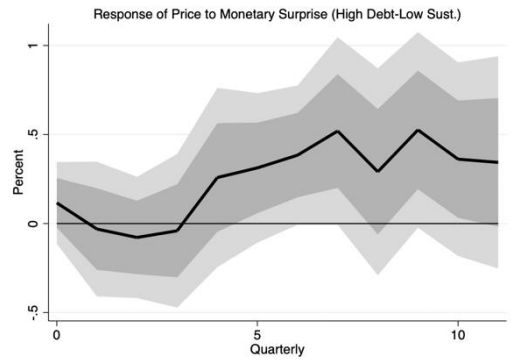
Threshold Model. High Debt-High Sustainability: IRF of Price



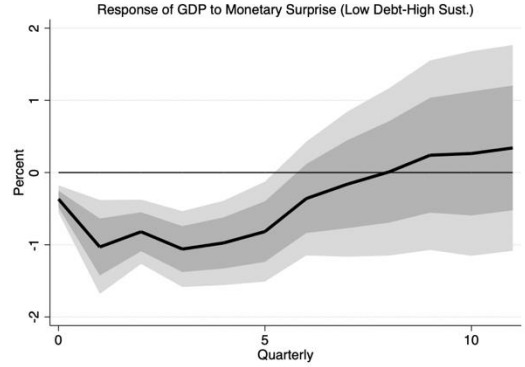
Threshold Model. High Debt-Low Sustainability: IRF of GDP



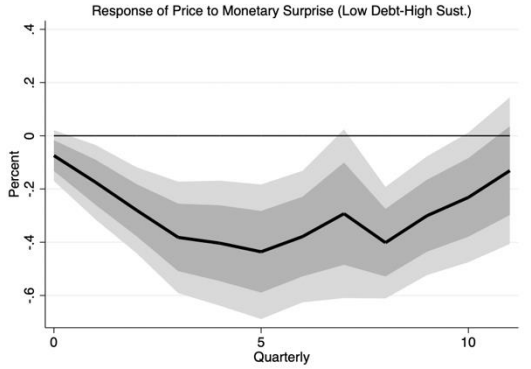
Threshold Model. High Debt-Low Sustainability: IRF of Price



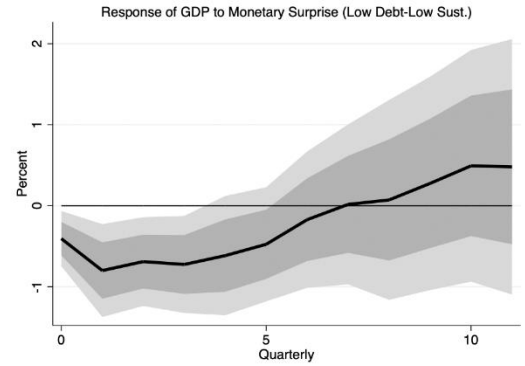
Threshold Model. Low Debt-High Sustainability: IRF of GDP



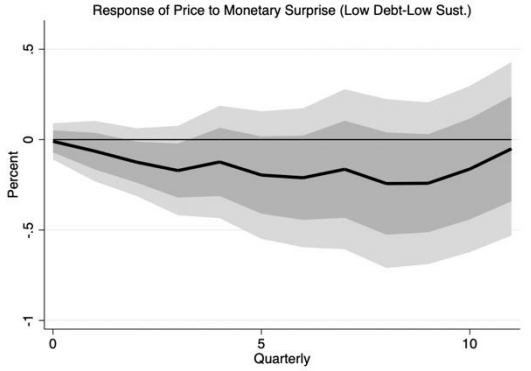
Threshold Model. Low Debt-High Sustainability: IRF of Price



Threshold Model. Low Debt- Low Sustainability: IRF of GDP



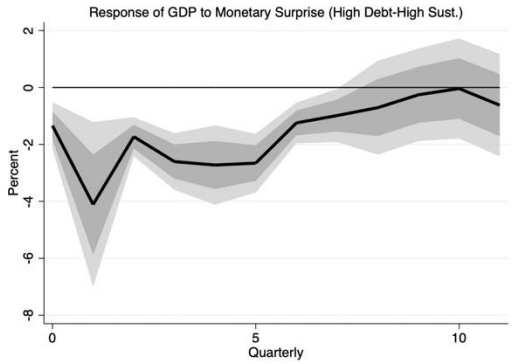
Threshold Model. Low Debt- Low Sustainability: IRF of Price



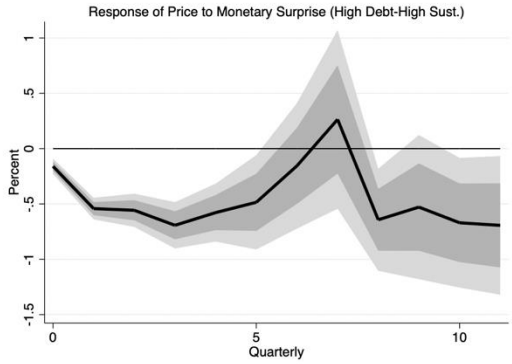
The IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on each country debt average. Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Table A5: Threshold Model. Mean Debt/GDP Ratio. Estimation for Euro "Core". Without Cyprus, Estonia, Lettonia, Greece, Latvia. Lithuania, Malta, Slovakia, and Slovenia.

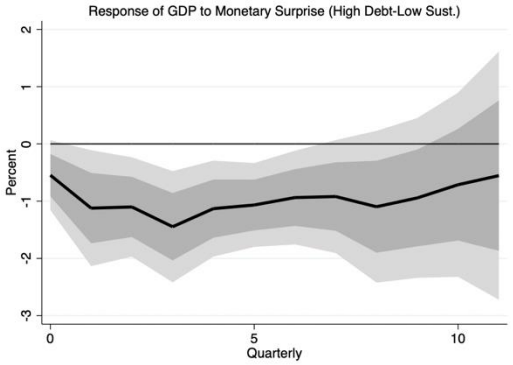
Threshold Model. High Debt- High Sustainability: IRF of GDP



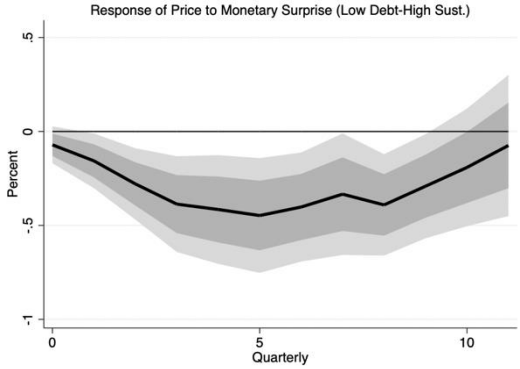
Threshold Model. High Debt- High Sustainability: IRF of Price



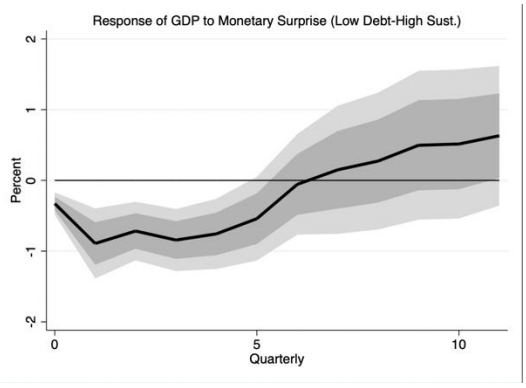
Threshold Model. High Debt- Low Sustainability: IRF of GDP



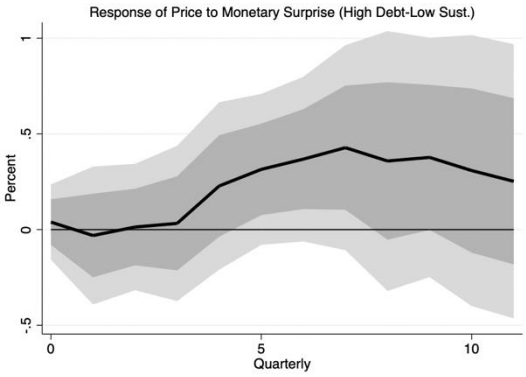
Threshold Model. High Debt- Low Sustainability: IRF of Price



Threshold Model. Low Debt- High Sustainability: IRF of GDP

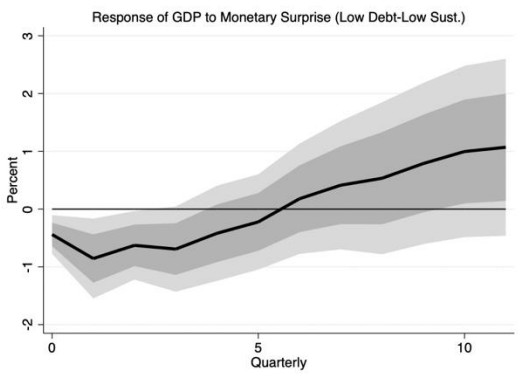


Threshold Model. Low Debt- High Sustainability: IRF of Price



Threshold Model. Low Debt- Low Sustainability: IRF of GDP

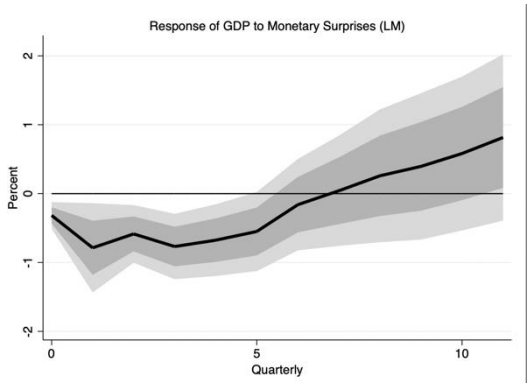
Threshold Model. Low Debt- Low Sustainability: IRF of Price



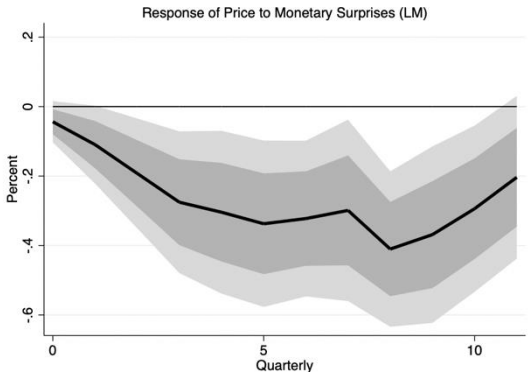
The IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on each country debt average. Estimation for Euro "Core": Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

Table A6: Linear Model. All monetary policy surprises

Linear Model: IRF of GDP



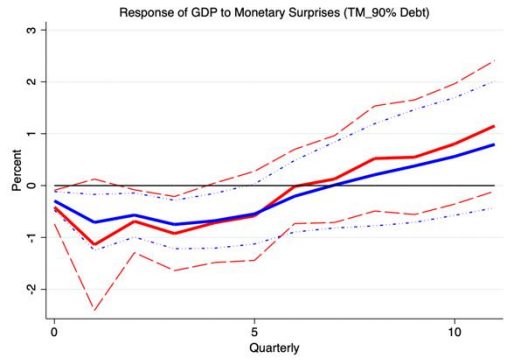
Linear Model: IRF of Price



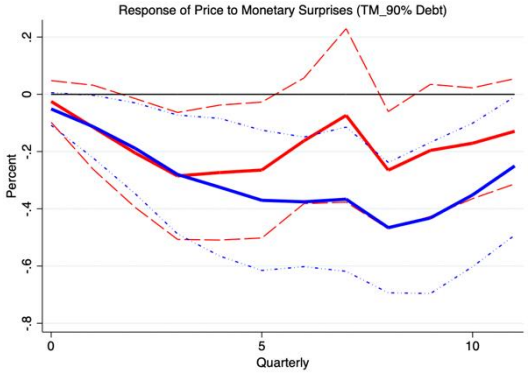
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 1), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). All monetary surprises shocks.

Table A7: Threshold Model. All monetary policy surprises

Threshold Model (90% Debt): IRF of GDP

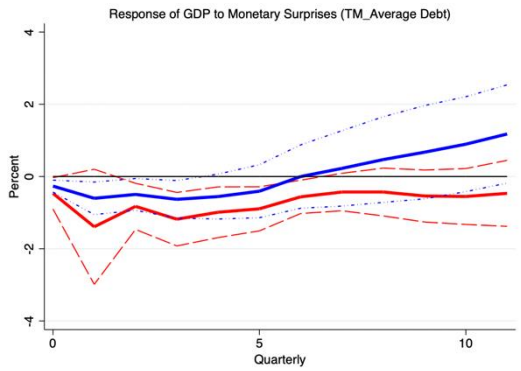


Threshold Model (90% Debt): IRF of Price

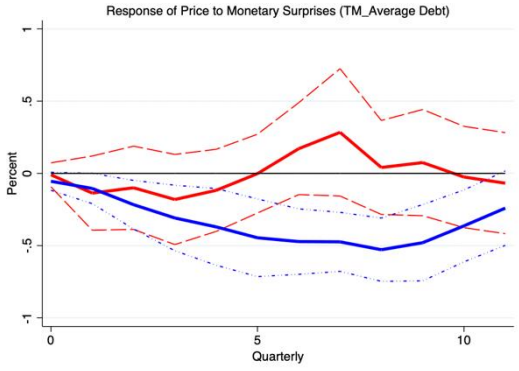


Threshold Model (Average Debt): IRF of GDP

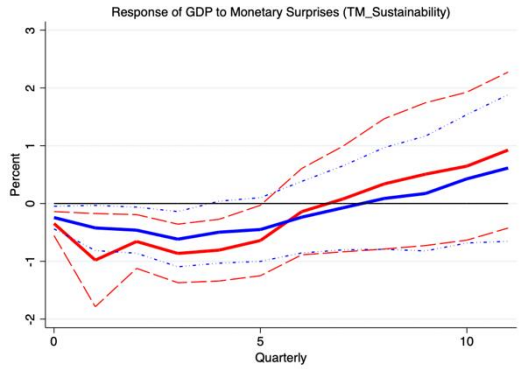
Threshold Model (Average Debt): IRF of Price

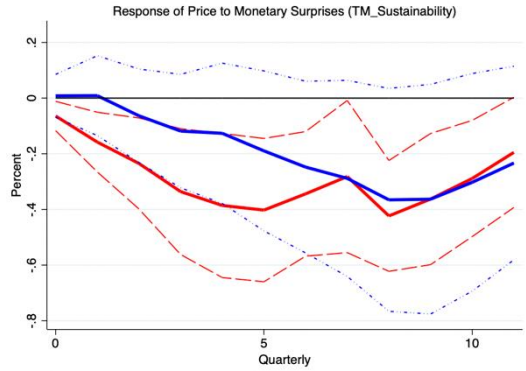


Threshold Model (Sustainability): IRF of GDP



Threshold Model (Sustainability): IRF of Price

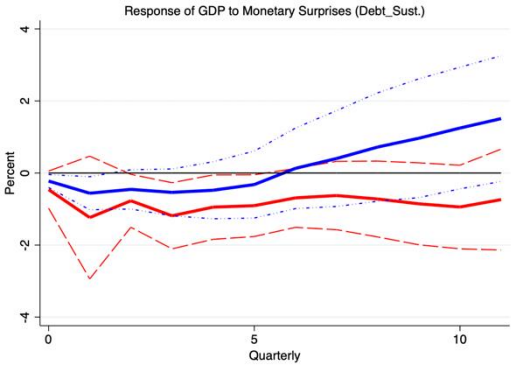




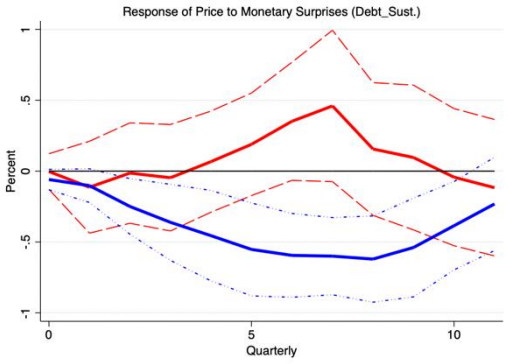
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 3), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red indicates a high debt regime based on the mean of each country, and blue denotes a low debt regime. In the third row, red signifies a high sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a low sustainability regime. Standard errors are constructed using Driscoll and Kraay (1998). The bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. All monetary surprises shocks.

Table A8: Transition. Model. All monetary policy surprises

Transition Model (Debt Burden): IRF of GDP

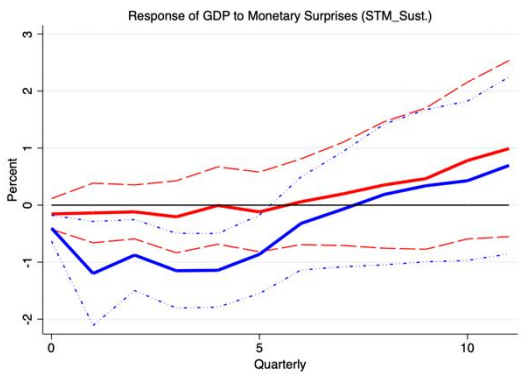


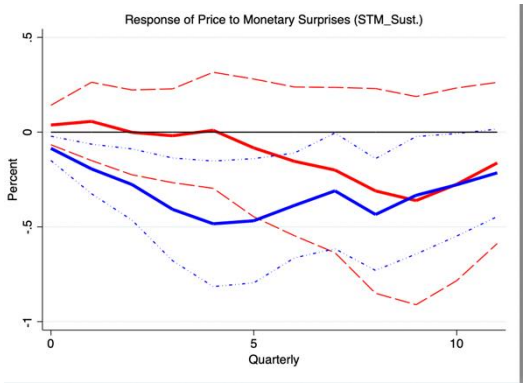
Transition Model (Debt Burden): IRF of Price



Transition Model (Sustainability): IRF of GDP

Transition Model (Sustainability): IRF of Price

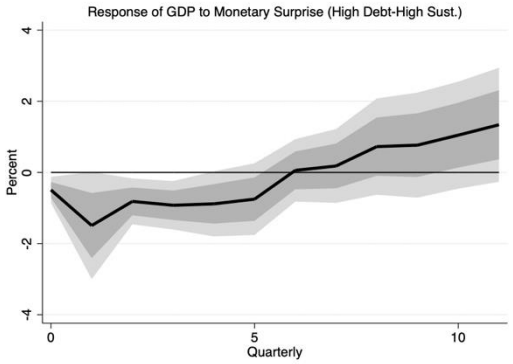




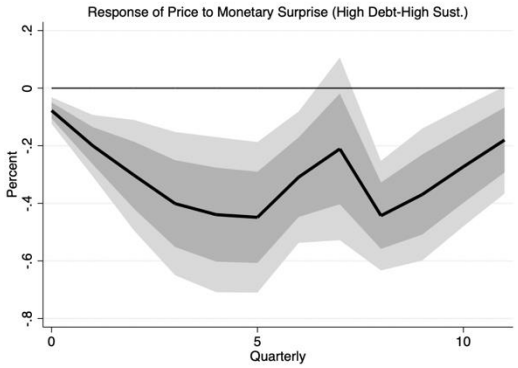
The cumulative IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 4 for the debt and Equation 5 for the sustainability), for the 12-quarter forecast horizon. In the first row, red lines represent a high debt regime based on the 90% threshold, while blue represents a low debt response. In the second row, red signifies a low sustainability regime based on the mean of each country sustainability coefficients, and blue indicates a high sustainability regime. The bands indicate the 90 percent confidence interval. Standard errors are constructed using Driscoll and Kraay (1998). The impulse responses can be interpreted as percentage deviations from their original values. All monetary surprises shocks.

Table A9: Transition Model. 90% Debt/GDP ratio. All monetary policy surprises

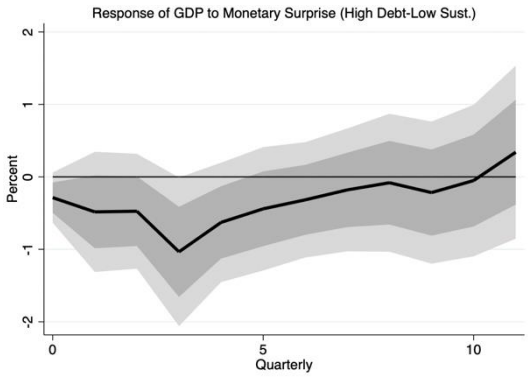
Threshold Model. High Debt-High Sustainability: IRF of GDP



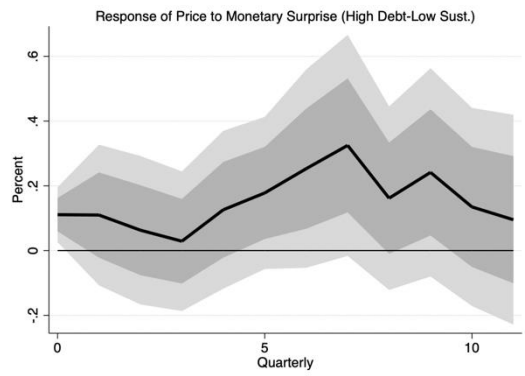
Threshold Model. High Debt-High Sustainability: IRF of Price



Threshold Model. High Debt-Low Sustainability: IRF of GDP

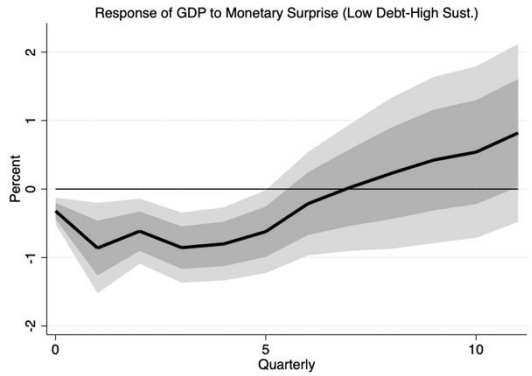


Threshold Model. High Debt-Low Sustainability: IRF of Price

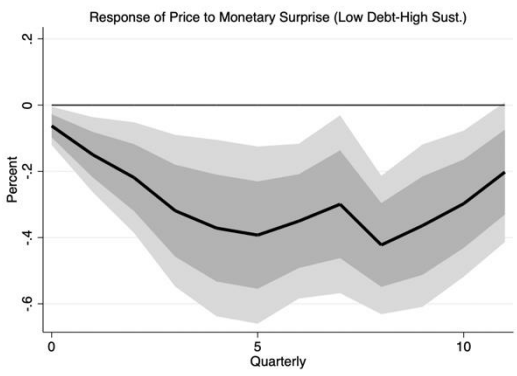


Threshold Model. Low Debt-High Sustainability: IRF of GDP

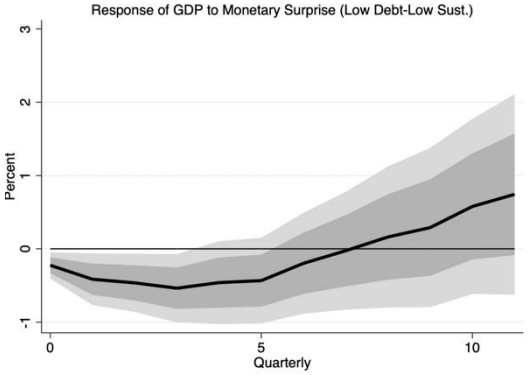
Threshold Model. Low Debt-High Sustainability: IRF of Price

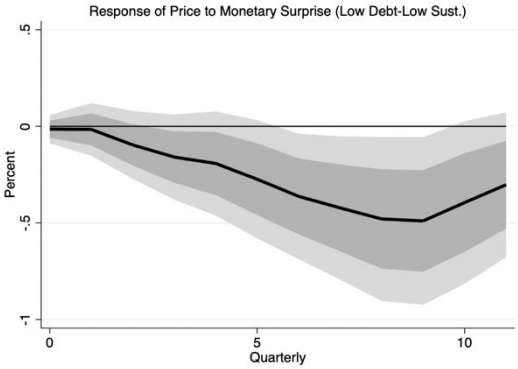


Threshold Model. Low Debt- Low Sustainability: IRF of GDP



Threshold Model. Low Debt- Low Sustainability: IRF of Price

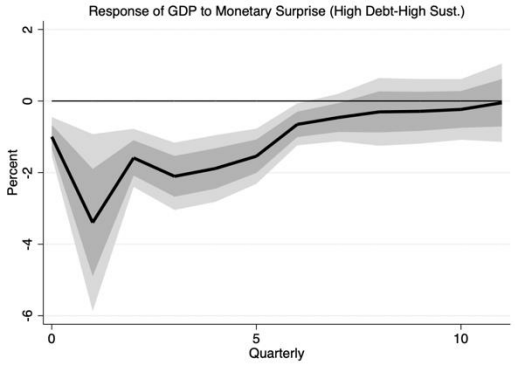




The IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on each country debt average. All monetary surprises shocks.

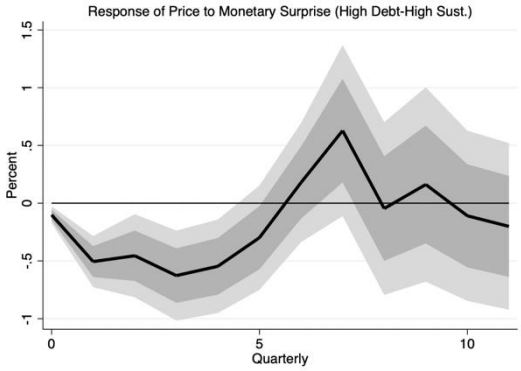
Table A10: Transition Model. Average Debt Ratio. All monetary policy surprises

Threshold Model. High Debt- High Sustainability: IRF of GDP

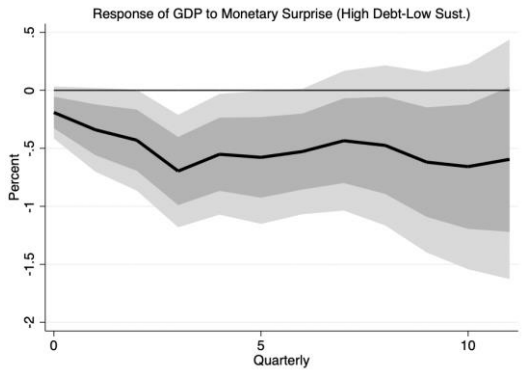


Threshold Model. High Debt- Low Sustainability: IRF of GDP

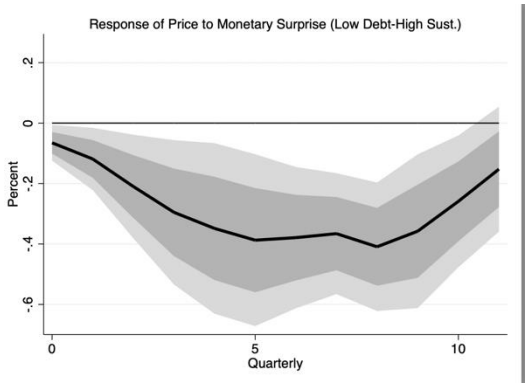
Threshold Model. High Debt- High Sustainability: IRF of Price



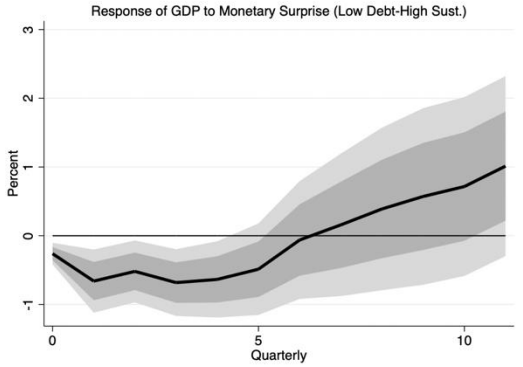
Threshold Model. High Debt- Low Sustainability: IRF of Price



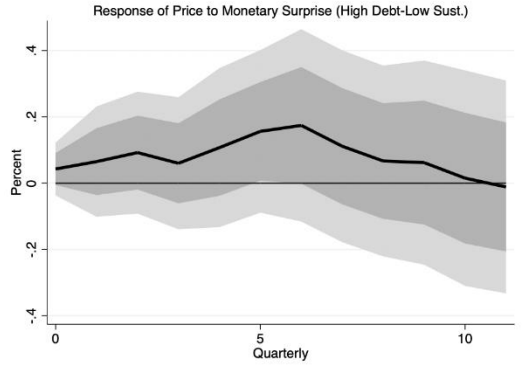
Threshold Model. Low Debt- High Sustainability: IRF of GDP



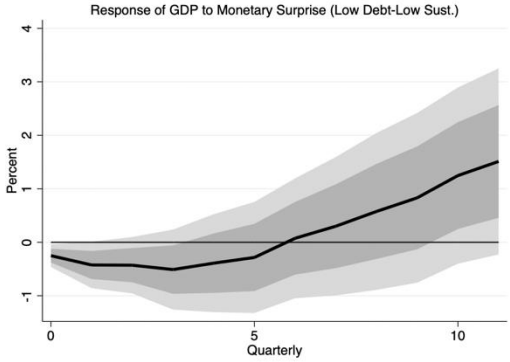
Threshold Model. Low Debt- High Sustainability: IRF of Price

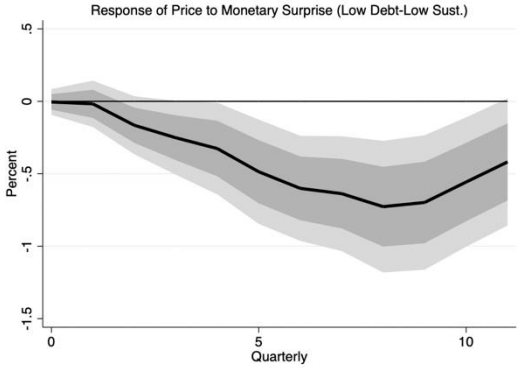


Threshold Model. Low Debt- Low Sustainability: IRF of GDP



Threshold Model. Low Debt- Low Sustainability: IRF of Price





The IRFs indicate the responses of real output and the price level to monetary policy surprises (Equation 6), for the 12-quarter forecast horizon. The light (dark) gray bands indicate the 90 (68) percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. Standard errors are constructed using Driscoll and Kraay (1998). The discrimination between high and low debt is based on each country debt average. All monetary surprises shocks.