CESifo WORKING PAPERS

10558
2023

July 2023

The Effects of Monetary Policy Surprises and Fiscal Sustainability Regimes in the Euro Area

António Afonso, José Alves, Serena Ionta

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 10558*

The Effects of Monetary Policy Surprises and Fiscal Sustainability Regimes in the Euro Area

Abstract

We study the effect of monetary surprise shocks on real output and the price level, conditioned on different fiscal sustainability regimes in the period 2001Q4-2021Q4. First, we estimate time-varying fiscal sustainability coefficients based on Bohn's (1998) approach through Schlicht's (2003) method. Then, by taking these sustainability coefficients in a nonlinear local projection model for the Euro Area (aggregate data), Germany, Italy, and Portugal, we analyze the interaction between both policies under (un)sustainable fiscal regimes. Our results show that in a Ricardian regime, output and prices respond to monetary tightening by contracting, while in a non-Ricardian regime the effect on output and price levels is negligible (or even positive). The dependence of the effectiveness of monetary policy on fiscal solvency is valid for Euro-Area and all the countries assessed, and does not depend on whether a country is "core" or "periphery", but on the policy conduct over time.

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

Keywords: monetary surprises, fiscal sustainability, local-projection models, fiscal-monetary policy mix, Euro area, Germany, Italy, Portugal.

António Afonso
ISEG – Lisbon School of Economics and Management
Universidade de Lisboa
Lisbon / Portugal
aafonso@iseg.ulisboa.pt

José Alves
ISEG – Lisbon School of Economics and Management, Universidade de Lisboa
Lisbon / Portugal
jalves@iseg.ulisboa.pt

Serena Ionta
Department of Economics
Roma Tre University
Rome / Italy
serena.ionta@uniroma3.it

The authors acknowledge financial support from FCT – Fundação para a Ciência e Tecnologia (Portugal), national funding through research grant UIDB/05069/2020. The opinions expressed herein are those of the authors and do not necessarily reflect those of the authors' employers. Any remaining errors are the authors' sole responsibility.

1. Introduction

There has been a recurring ongoing debate about the importance of the interaction between fiscal and monetary policy since notably the Global and Financial Crisis (GFC) of 2008-2009. This debate has intensified with the pandemic crisis and the consequent fiscal and monetary policy responses. In addition, the geopolitical crisis of the past two years has triggered an inflationary dynamic that is still in place. Some studies attribute its persistence not to the energy crisis but to demand and fiscal factors (Bianchi and Melosi, 2022; Cochrane, 2022). In particular, they see today's inflation as a consequence of the large pandemic fiscal packages, central banks' accommodative monetary policies, in the context Quantitative Easing, and agents' expectations about the future conduct of government policy.

Within the Euro Area, this debate is even more pronounced due to the specific institutional framework of an asymmetric area with a single monetary authority and multiple fiscal policy makers. Here, fiscal rules and treaties are designed to ensure a strict separation between monetary and fiscal policies. This is a legal consequence of the conviction that macroeconomic stability is best achieved through a combination of a credible and independent central bank that seeks price stability and fiscal authorities that keep debt on a stable path. More recently, however, the Pandemic Emergency Purchase Program (PEPP) and the activation of the general escape clause of the Stability and Growth Pact in March 2020 have challenged this setup, requiring stronger policy coordination, which was already in place after the sovereign debt crisis (2011-2012).

The changing evolution of economic policy coordination is a topic that has been studied extensively in the theoretical literature, but less so in the empirical one. For example, the Fiscal Theory of the Price Level (FTPL) shows the existence of different policy coordination schemes. The monetary-dominant regime, in which monetary policy is active and fiscal policy is passive (Ricardian fiscal regime, with the government adjusting primary balances), alternates with the fiscal-dominant regime. In the fiscally led regime, the government chooses the primary budget balance independently of the public debt-to-GDP ratio and prices adjust endogenously to satisfy the government budget constraint (the central bank allows the inflation rate to adjust). Hence, it would be then up to the government budget constraint to play a key role in the determination of the price level. Several studies have dealt with such topic, notably Sargent and Wallace (1981), Leeper (1991), Sims (1994), Woodford (1995) and Cochrane (2001). In this framework, one policy's effectiveness on macroeconomic outcomes depends on the other policy in place.

The main goal of this paper is to investigate the effectiveness of Jaronciski and Karadi (2020)'s monetary surprises in the Euro Area, conditional on different degrees of fiscal sustainability. In line with this, we first distinguish between high and low fiscal sustainability regimes by implementing the time-varying fiscal reaction function (Bohn, 1998) using the method of Schlicht (2003). The high sustainability regime represents the periods in which the estimated coefficient is larger than the sample average, and the low sustainability regime represents the periods in which the estimated coefficient is smaller. Second, we use the local projection method (Jordà, 2005) and compare the results of the linear, threshold, and smooth transition models. The linear model is not conditional on the fiscal stance and serves as a theoretical benchmark. The difference between the threshold and smooth transition models is that the first is a dummy approach conditional on the two fiscal stances, while the smooth transition model is also conditional on the stances, but does not lose observations like the dummy approach, using all available information in estimation. We use quarterly data for Euro Area (aggregated), Germany, Italy, and Portugal.

The main contribution of our paper is to incorporate fiscal sustainability regimes as determinants of monetary policy effectiveness. To the best of our knowledge, this paper is the first attempt that uses a time-varying fiscal reaction function coefficients to distinguish between Ricardian and non-Ricardian regimes and, in accordance with this, to assess how monetary shocks affect real output and price dynamics, conditional on fiscal (un)sustainable fiscal regimes. In fact, the existing (empirical) literature that has paid attention to the FTPL subject has mostly focused only on the role of fiscal rules or, in turn, examined the set of both monetary and fiscal policies as separate.

We apply our methodology to the Euro Area, Germany, Italy, and Portugal, in the period 2001Q4-2021Q4. This allows us to disclose the dependence of the European Central Bank's policy on the fiscal stance of each group of Euro-area economy (Euro Area as a whole, the largest economy in the Euro Area – Germany, a peripheral Euro Area country as Portugal, and a large economy displaying unsustainable fiscal stance as Italy). This is something unexplored in the literature and provides a comprehensive view of the Fiscal Theory within an incomplete monetary union such as the European one.

As regards our results, we show that the effect of monetary shocks indeed depends on each country's fiscal sustainability degree. Our results show that in a Ricardian regime, output and prices respond to monetary tightening by contracting, while in a non-Ricardian regime the effect on economic growth and price levels are negligible (or even positive). The dependence of the effectiveness of monetary policy on fiscal solvency is valid for Euro-Area and all the

countries assessed, and does not depend on whether a country is "core" or "periphery", but on the policy conduct over time. The findings are robust with 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 and policy implications derived from our study.

2. Related Literature

Our paper is related notably to the Fiscal Theory of Price Level (FTPL) literature. The seminal work on the relationship between fiscal policy and inflation is by Sargent and Wallace (1981). The authors show how, under certain assumptions, the monetary authority loses control over price stability and is bound by the government's intertemporal budget. In particular, when fiscal policy "dominates" monetary policy, deficits are not financed solely by new bond sales, and the monetary authority is forced to create money and tolerate additional inflation (even if initially tries to control the monetary supply growth).

As defined by Leeper (1991), this scenario is also referred to as an active fiscal policy and a passive monetary policy regime;[2] where "passive" stands for the policy that does not freely and independently control its policy variable and fiscal activism does not prevent an explosive path of government debt. The latter policy is constrained by the actions of the active authority, which specifies the policy and uniquely determines the equilibrium price function. A stable and unique equilibrium solution requires a combination of active and passive policies, corresponding to the "fiscal dominance" or "monetary dominance" regimes. Other related contributions can be attributed to Sims (1994, 2011), Woodford (1994), and Cochrane (1998, 2001, 2023).[3]

Bianchi and Ilut (2017) studying the FTPL equilibrium in a Markov-switching DSGE model, show how the effect of a monetary policy shock depends on the regime in place: tighter monetary policy causes inflation to rise under fiscal dominance and fall under monetary dominance.

The second strand of the literature concerns empirical studies on fiscal sustainability and the consequent determination of fiscal regimes. The literature divides empirical tests into a backward-looking approach (Bohn, 1998) and a forward-looking approach (Canzoneri et al.,

[2] Woodford (1995) also calls this regime a "Non-Ricardian" regime.
[3] It is important to mention other works which have studied the equilibrium within MS-DSGE models, focusing on the underlying theoretical relationships such as Davig et al. (2006), Leeper and Leith (2016), Bianchi and Melosi (2017).

2001). According to the first approach, fiscal policy is sustainable (or even Ricardian/passive) if it adjusts the primary surplus to the increase in lagged debt. According to the forward-looking approach, a Ricardian policy is observed if the shocks to the primary surplus lead to a reduction in debt.

Moreover, another way to assess the degree of fiscal sustainability is based on unit root tests and the cointegration study of the relationships between the two sides of the government budget (Hakkio and Rush, 1991; Quintos, 1995; Afonso, 2005).

There is no consensus in the literature regarding the sustainability outcomes of the Euro Area. On the one hand, some studies do not find empirical evidence for Ricardian regimes; for example, Semmler and Zhang (2004) find non-Ricardian regimes in both France and Germany. Afonso (2005) finds a lack of fiscal sustainability within the EU-15 sample and calls it "unpleasant" from a policymaker's point of view.[4] Afonso and Jalles (2017), who study 11 European countries, show that fiscal policy has been sustainable only in the cases of Belgium, France, Germany, and the Netherlands. On the other hand, a number of works show the existence of fiscal Ricardian regimes in Europe (Favero, 2002; Creel and Bihan, 2006; Afonso 2008; Afonso et al., 2017; Afonso and Jalles, 2018).[5] Panjer et al. (2020) study the existence of Ricardian regimes in the Eurozone using the Area Wide Model fiscal database (Paredes et al., 2014), they take into account the structural breaks and show how fiscal sustainability is time-varying. The authors find no evidence in favor of either regime for the period before the Euro Convergence Criteria (ECC), and a Ricardian regime after the ECC until the Global Financial Crisis, when fiscal policy became active.

This latter idea of non-linearity is also related to the broader emerging literature on Markov-switching methodology (e.g., Davig et al., 2006, and Bianchi and Melosi, 2017, for the US, and Afonso and Toffano, 2013, for the EU). Hence, in this paper we do not examine the presence or absence of fiscal sustainability, but rather the effect of monetary policy conditional on this varying degree of sustainability.

Finally, this study relates to empirical studies of the interactions between monetary and fiscal policies. For the EMU countries, Melitz (2002) finds evidence of policy substitutability, namely coordinated macroeconomic policy: an easier fiscal policy leads to tighter monetary policy and an easier monetary policy to tighter fiscal policy. Muscatelli et al. (2002) estimate a VAR for G7 countries with both fiscal and monetary policy instruments and show that policy

[4] The author does cointegration tests for the annual sample period 1970-2003.
[5] There is also a strand of literature that has dealt with the impact that European treaties have had on the degree of sustainability: Buti and Giudice (2002) and Galì and Perotti (2003) among others.

interdependence is asymmetric and differs across countries; however, complementarity seems to dominate substitutability. Kliem et al. (2016a) estimate the low-frequency time-varying relationship between fiscal deficits and inflation for the U.S., and Kliem et al. (2016b) extend the same analysis to Germany and Italy. According to the authors, the low-frequency relationship between the fiscal stance and inflation is around zero for periods to which narrative accounts assign an independent central bank and a responsible fiscal authority (e.g. when Paul Volcker became chairman of the Federal Reserve, and Italy joined the EMU).[6] Instead, the low-frequency relationship is high whenever the narrative accounts point to a fiscal authority which did not stabilize its outstanding government debt together with a central bank that accommodated this behavior. De Luigi and Huber (2018), through a Threshold SVAR analysis, 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.

Afonso and Gonçalves (2020) use a SVAR approach to investigate on the effects of fiscal and monetary policies, as well as their interactions with the US and the Euro Area; they find in both cases that the policies act as complements. Hülsewig and Rottmann (2022) discover that the fiscal balance improves in response to monetary policy surprises that bring down yields on sovereign bonds. Kloosterman et al. (2022) estimate the effects of monetary policy shocks across different fiscal regimes through a panel smooth transition local projection model for ten Euro-Area countries, where the fiscal regimes are characterized by the change in the cyclically adjusted primary balance. They show that expansionary (contractionary) monetary policy shocks lead to significant increases (decreases) in inflation and output, but only when fiscal policy is also expansionary (contractionary). Reichlin et al. (2023) study the fiscal-monetary policy mix in Euro-Area. Their findings suggest that conventional monetary easing is accompanied by an expansionary fiscal policy, but unconventional monetary easing is not.

What differentiates our paper from the above literature is the distinction we make between fiscal regimes. Our fiscal stance indicates neither an expansionary/restrictive fiscal policy (Kloosterman et al., 2022) nor a low/high level of public debt (De Luigi and Huber, 2018). We are interested in the sustainability behavior of the fiscal authority, and we estimate it through a Bohn (1998)'s time-varying fiscal reaction function coefficients. Therefore, our belief is that splitting our sample into periods of more or less fiscal sustainability is a more appropriate methodology for a better empirical assessment of the FTPL.

[6] This low-frequency relationship between the fiscal stance and inflation is the procedure described in Sargent and Surico (2011), based on Lucas (1980)'s regression.

3. Methodology, Data, and Monetary Policy Surprises

We assess the impact of monetary policy shocks on the level of real output and prices. To do so, we use the Local Projection (LP) methodology (Jordà, 2005). The LPs method offers several advantages over the traditional SVAR approach. For example, it performs a better estimation than the VAR when the latter is misspecified, and at the same time, LPs are suitable for a nonlinear estimation – contrarily to SVAR –, which will deserve our attention as well.[7]

With respect to the period of our analysis, we resort to quarterly data ranging from 2002Q4 to 2021Q4 for the aggregated Euro Area, and from 2001Q4 to 2021Q4 for Germany, Italy, and Portugal. We then estimate three different models: (1) an unconditional linear model (LM), (2) a conditional threshold model (TM) on the fiscal stance (Jordà, 2005), and (3) a conditional smooth-transition model (STM), based in Auerbach and Gorodnichenko (2012).

We have chosen these countries for specific reasons. We study the euro area as an aggregate (i) because monetary surprises are common to all countries, and (ii) because we want to have an overall and summarized view of the aggregate economic and political structure of the euro area; furthermore, we analyze the other three countries because of their different characteristics, especially from a fiscal point of view. We believe that Germany is the largest economy in Euro Area, usually displaying fiscal discipline; Italy is an example of a large economy but with some registered fiscal imbalances, which may display an important risk for the overall Euro Area. Lastly, we also analyze the Portuguese economy in order to analyze the fiscal and monetary policies' interaction for a Euro Area "periphery" country case.

To discriminate between different fiscal regimes and to perform time-varying fiscal regression, we follow Afonso and Jalles (2017), and we estimate Bohn (1998)'s rule through Schlicht (2003)'s method. The approach proposed by Schlicht (2003) has several advantages compared to other methods to compute time-varying coefficients (TVC), such as rolling windows. It uses all observations in the sample to estimate the magnitude of spillover in each period, which by construction is not possible in the rolling windows approach. In addition, changes in the size of estimated TVC in a given year come from innovations in the same year, rather than from shocks occurring in neighboring years; it reflects the fact that changes in policy are slow and depend on the immediate past. Lastly, it reduces reverse causality problems when the estimated TVC is used as an explanatory variable since it depends on the past (Afonso and Coelho, 2022).

[7] For a discussion of the local projection method see Ramey (2016) or Kilian and Kim (2011).

Hence, we follow a two-step approach. First, we estimate the following time-varying equation:

$$s_t = \alpha + \delta . b_{t-4} + \psi . outputgap_{t-4} + \varepsilon_t \quad (1)$$

where 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.[8] We take four lags for debt and output gap because the variables are annualized quarterly data[9]. We discriminate the periods based on the average of the δ coefficients, which indicate the magnitude of fiscal sustainability. In specific, the larger the fiscal reaction coefficients' the stronger the so-called Ricardian regime.

As for the monetary shocks, we follow Ramey and Zubairy (2018), and we insert an exogenous shock already identified: the surprises of Jaronciski and Karadi (2020). 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. The surprises are identified by imposing sign restrictions. An expansionary shock is assumed to raise the stock price.

The surprises are then aggregated by summing the shocks within the same quarter, and then divided by the standard deviation. The first model is an estimation of the following equation:

$$y_{t+h} = \alpha^h + \beta_h shock_t + \phi x_t + u^h{}_{t+h}, \quad h = 0,1, \dots, H-1 \quad (2)$$

where y_{t+h} is our variable of interest, real output and inflation, α^h denotes the constant, $shock_t$ is our monetary surprises shock, and x_t is the vector of control variables that includes two lags of the LHS variable and one lag of the shock. The coefficient β_h corresponds to the response of $y_{t+h}$to the shock at time t. The impulse responses are the sequence of all estimated β_h.

The second model (Equation 3) is a nonlinear extension of the first one and it separates data into the two fiscal regimes, using a binary (dummy) variable I, which is one period lagged

[8] 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.

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

to the shock.[10] Hence, it is 1 when the sustainability coefficient is higher than the average, 0 otherwise:

$$y_{t+h} = (1 - I_{t-1})[\alpha^{ah} + \beta_{ah} shock_t + \phi_a x_t] + (I_{t-1})[\alpha^{bh} + \beta_{bh} shock_t + \phi_b x_t] + u^h{}_{t+h} \quad (3)$$

The third model (Equation 4) is a smooth transition model which computes state probabilities with a logistic function that does not lose any observation, preserving the magnitude of the fiscal stance:

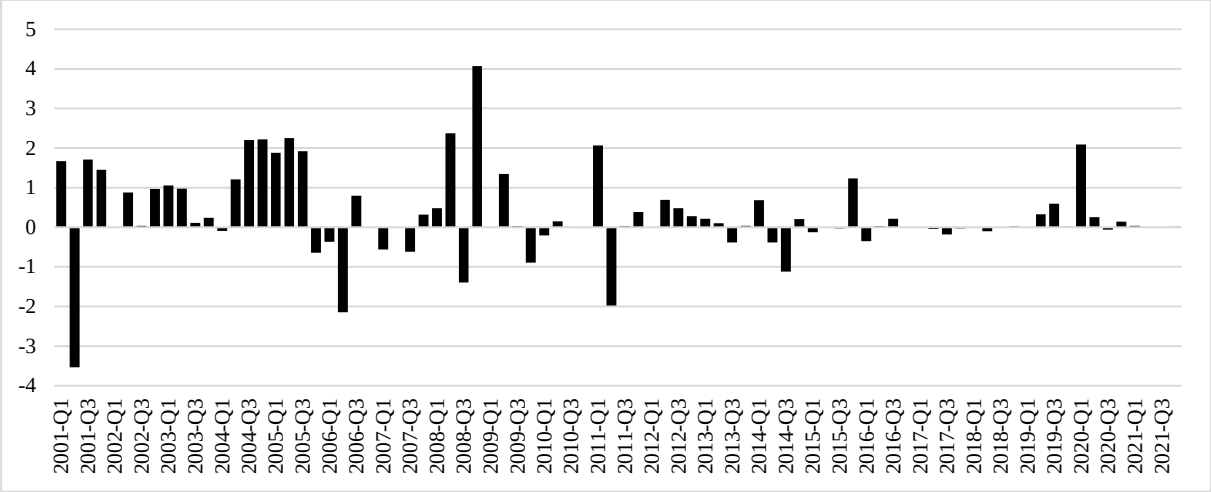
$$y_{t+h} = F(z_{t-1})[\alpha^{ah} + \beta_{ah} shock_t + \phi_a x_t] + (1 - F(z_{t-1}))[\alpha^{bh} + \beta_{bh} shock_t + \phi_b x_t] + u^h{}_{t+h} \quad (4)$$

where $F(z_t) = \frac{e^{-\gamma(z_t)}}{(1+e^{-\gamma(z_t)})}$ is our logistic function, z_t is the standardized state variable, γ is the parameter which measures how abruptly the economy transitions between the two fiscal state regimes; we set it to 1.5.[11] When fiscal sustainability improves, our state variable z_t increases and causes $F(z_t)$ to go to 0. On the other case, $F(z_t)$ tends towards 1 when the fiscal sustainability gets worse.

Regarding the fiscal variables, 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 taken from the FRED dataset. The shocks are common to all the countries and are taken from Jarociński's website (Figure 1).[12] More information about the dataset is in the Appendix, in particular, Table 1 shows the data source, and Table 2 displays the descriptive statistics.

[10] 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.
[11] Robustness tests have been done changing γ, and it does not change the findings of the estimates. This results are available upon request.
[12] Jaroncinski's website is consultable on https://marekjarocinski.github.io.

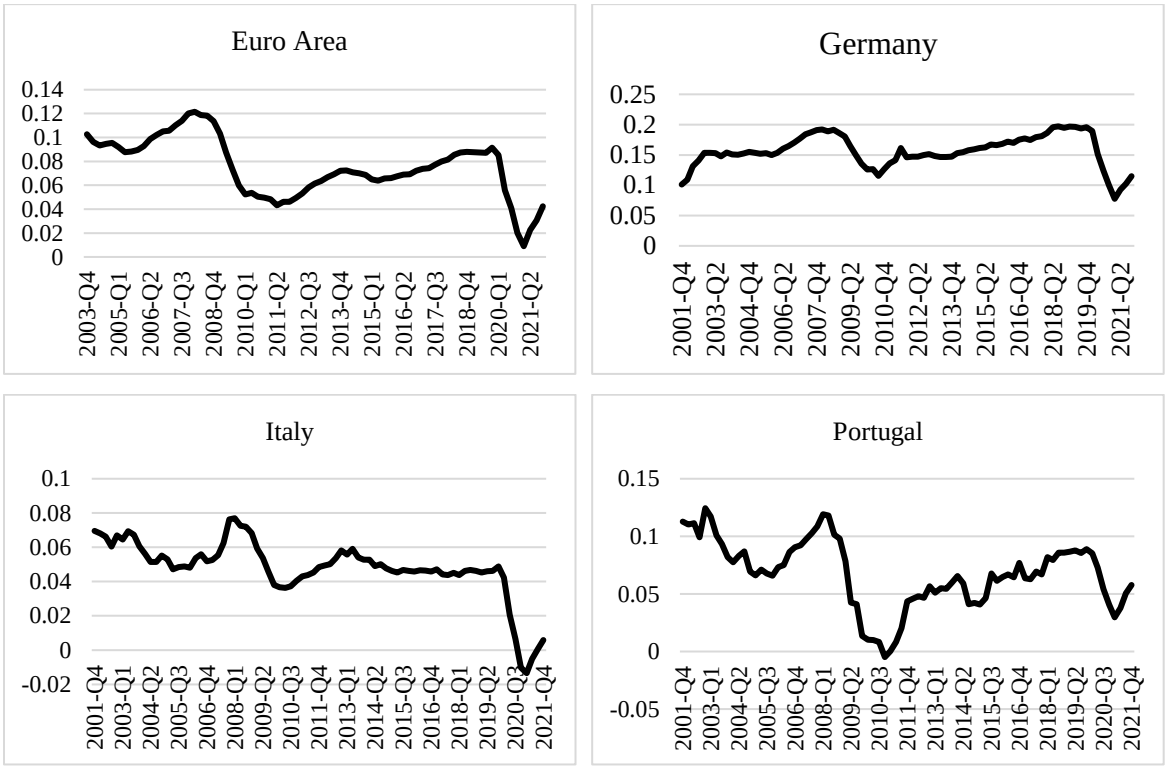
Figure 1: ECB Monetary Surprises Shocks



Note: Monetary surprises are taken from Jarociński and Karadi (2020), quarterly aggregated, and divided by the standard deviation.

Figure 2 shows the TVC estimated magnitude of fiscal sustainability for the countries studied. The figure shows a common trend for all countries: the impact of the 2008 and 2020 crises is clear, with the coefficients tending to decrease over this period. In addition, there is an improvement in fiscal solvency following the sovereign debt crisis of 2011 and the related debt restructuring, especially for Italy and Portugal. Finally, the coefficients for Portugal show greater variability than the others.

Figure 2: Time-Varying Sustainability (Bohn's Rule)



Note: Schlicht (2003)'s Time-Varying coefficients of regression of primary balance on the lagged debt-to-GDP ratio (Bohn, 1998).

4. Empirical Analysis

4.1 Main Model with Bohn's Rule

Figures 3, 4, 5, and 6 respectively show the IRF for the Euro Area, Germany, Italy and Portugal to a one standard deviation monetary policy shock. The shaded areas reflect the 90% error bands.[13] The endogenous variables have been expressed in logarithms and multiplied by 100 so that the impulse responses can be interpreted as percentage deviations from their original values.

In the first column, we present the results of the linear model not conditional on the fiscal stance. Our responses do not show the presence of the "*price puzzle*", that is the general increase in prices due to a monetary contraction. They are consistent with the standard New-Keynesian transmission mechanism: a (contractionary) monetary policy shock leads to a reduction in output and prices (Smets and Wouters, 2003). According to the intertemporal consumption choice, when the interest rate rises, agents prefer to postpone consumption and

[13] We also have the 65% and 95% estimates which preserve the results obtained. We can show them upon request.

save more at the current time, which reduces 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. We find these results for almost all countries, except for the price response in Germany, which declines but not significantly; in addition, for the Euro Area, Germany, and Italy, output tends to increase after about 10 quarters.

The second column shows the IRFs of the threshold model, where our threshold variable is the average of the estimated sustainability TVCs for each country. In the more Ricardian regime, output and prices tend to respond more strongly to monetary tightening. In addition, the output contraction in the second regime is much more pronounced than in the linear model. This is particularly evident in the impact. For Euro Area, Germany, and Portugal the results show that the price level rises in the "less" Ricardian regime, as opposed to falling in the "more" Ricardian regime. This is in line with the simulation of Bianchi and Ilut (2017). Regarding Italy, the results show that while the responses are not significant for the "less" fiscally responsible regime, for the more responsible one we find that output and prices are reduced. Hence, a sounder fiscal behavior seems to help the transmission channel of monetary policy shocks through the economy.

Figure 3: Monetary contraction, Euro-Area Results (2003Q4-2021Q4). Bohn's Rule.

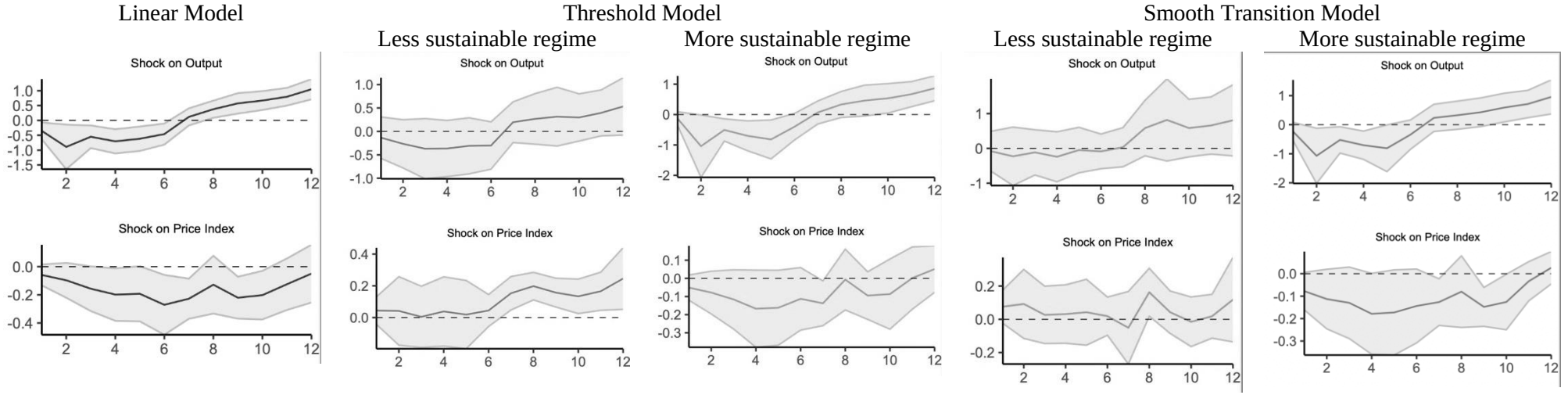


Figure 4: Monetary contraction, Germany Results (2001Q4-2021Q4). Bohn's Rule

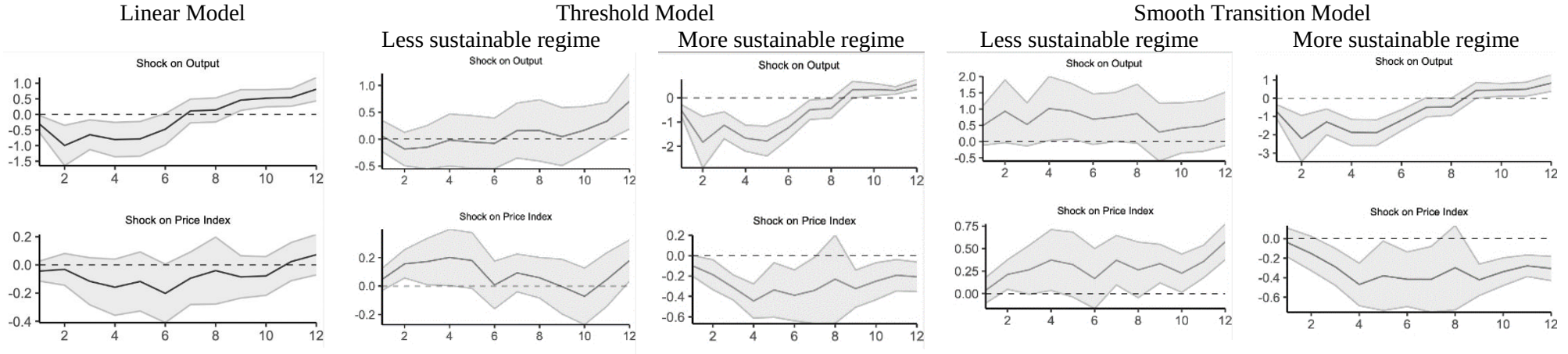


Figure 5: Monetary contraction, Italy Results (2001Q1-2021Q4). Bohn's Rule.

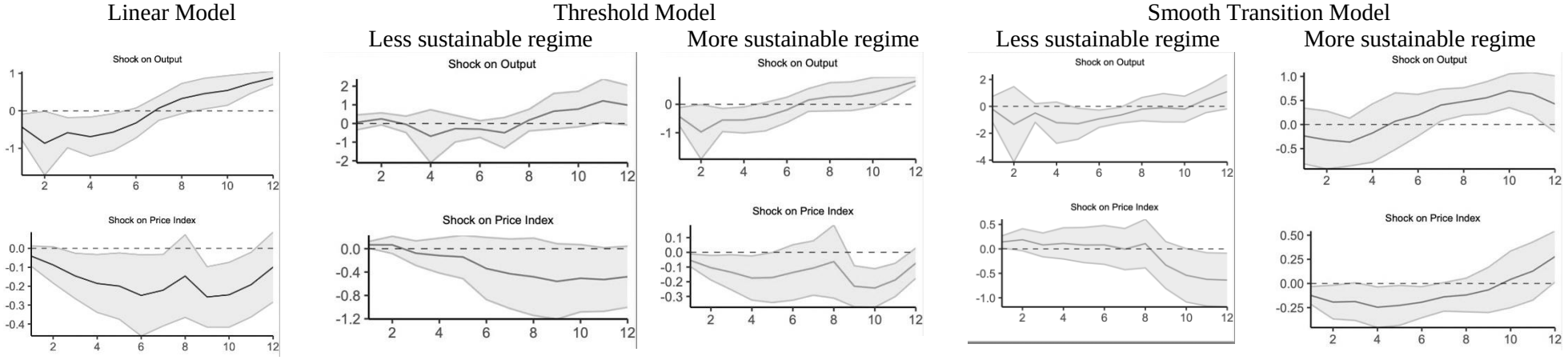
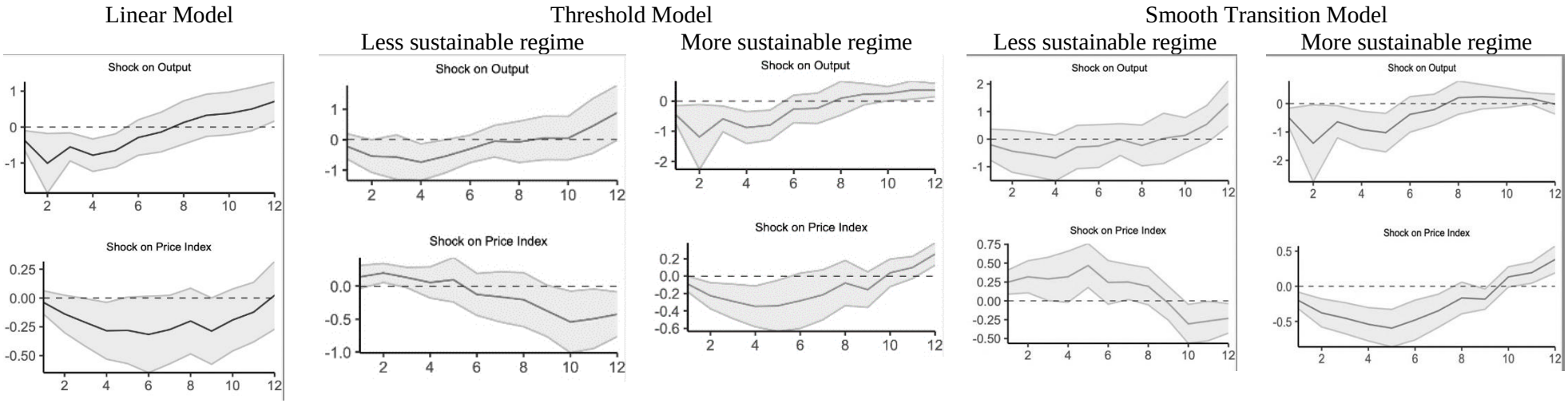


Figure 6: Monetary contraction, Portugal Results (2001Q4-2021Q4). Bohn's Rule.



The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively.

As for the third model, the results obtained are again confirmed and the estimation significantly improves. In fact, the smooth transition model does not lose observations as the dummy approach does. It uses all available information in the estimation. The results of this model manage to capture the differences between regimes better than the second one. Regarding the Italian case, we find that in the unsustainable regime, the monetary shock leads to an increase in prices at the impact. Moreover, in Germany, the growth of output as a response stands for "a wealth effect" combined with the rise in the price level.

In relation to the literature reviewed in Section 2, our results underscore the importance of the fiscal stance for the ability of monetary policy to influence macroeconomic outcomes. In times of fiscal irresponsibility, the monetary authority is more "passive" and therefore less successful, to the point of losing its effectiveness in targeting inflation and output. For example, according to De Luigi and Huber (2018), the response of output growth and consumption to monetary easing becomes negative in a regime characterized by high debt. This can be attributed to the rational expectations of economic agents, who anticipate a higher tax burden in the future and thus reduce spending and hence output growth. The inflation response is weaker in the high debt regime than in the low debt regime. The same argument can be applied to a monetary contraction, where the role of expectations is very important. Our findings are related to the "*Stepping on a rake*" effect of Sims (2011), or the loss of inflation control by the central bank if its actions are not adequately supported by the fiscal authority (Bianchi and Ilut, 2017). With the presence of such beliefs about the future course of the policy, an increase in the interest rate increases the inflation rate rather than reducing it (Sims, 2011). There are two mechanisms that can guide this response: the first is related to the government's intertemporal budget constraint and the need for inflation, while the second is related to the income effect, i.e., the fact that a monetary tightening leads to an increase in nominal debt in the hands of the public, causing a net wealth effect that in turn increases consumption, demand, and prices. Here, there is a direct link between the wealth effect, unexpected fiscal inflation, and the intertemporal budget constraint (Leeper and Leith, 2016; Cochrane, 2023). However, according to the literature, even in the case of a recession caused by monetary contraction, a vicious circle could be triggered. In particular, if the recession increases the debt-to-GDP ratio and monetary tightening is not supported by agents' expectations of future fiscal adjustment, 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 are consistent with these theoretical predictions. In particular, beyond the general price increase associated with FTPL in the unsustainable regime for all countries,

we find the prevalence of the wealth effect for Germany (SM), given the increase in output, and a candidate "*Fiscal Stagflation*" framework for Portugal (TM), given the contraction.

Furthermore, it is well known that periods of deficit and sustainability are often associated with economic crises. This is due to the countercyclical nature of fiscal policy. Indeed, Figure 2 shows the deterioration of the sustainability TVC in the last two crises. We cannot exclude that this could be an additional rather than alternative channel of interpretation. In particular, in times of crisis and high uncertainty, the effectiveness of monetary policy may again be hampered by agents' expectations, mainly due to risk aversion and pessimism about future developments (Paoli and Zabczyk, 2013; Tenreyro and Thwaites, 2016; Aastveit et al., 2017).

Finally, despite the different characteristics of the countries we study, there is not much difference in the estimated responses across countries. Our results confirm the same theoretical relationship suggested by the literature for a "peripheral" country such as Portugal, for a more "core" country (Germany), for a large economy with some fiscal imbalances as the Italian economy, and for an aggregation of countries such as the Euro Area.

In addition, we report the results of the model in which the monetary surprises are positive, indicating an even sharper monetary tightening than in the baseline model. Overall, the results not only confirm those of the previous model (with all shocks) but also accentuate even more the recessionary effect on the economy in the less Ricardian regime.

Figure 7: Monetary contraction, Euro-Area Results (2003Q4-2021Q4). Bohn's Rule. Only Positive Surprises

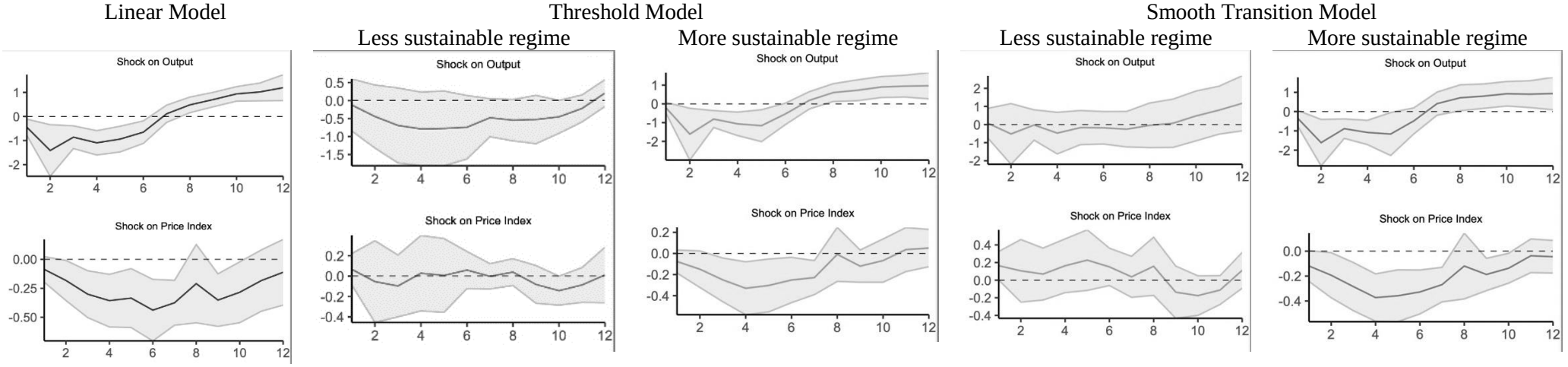


Figure 8: Monetary contraction, Germany Results (2001Q4-2021Q4). Bohn's Rule. Only Positive Surprises.

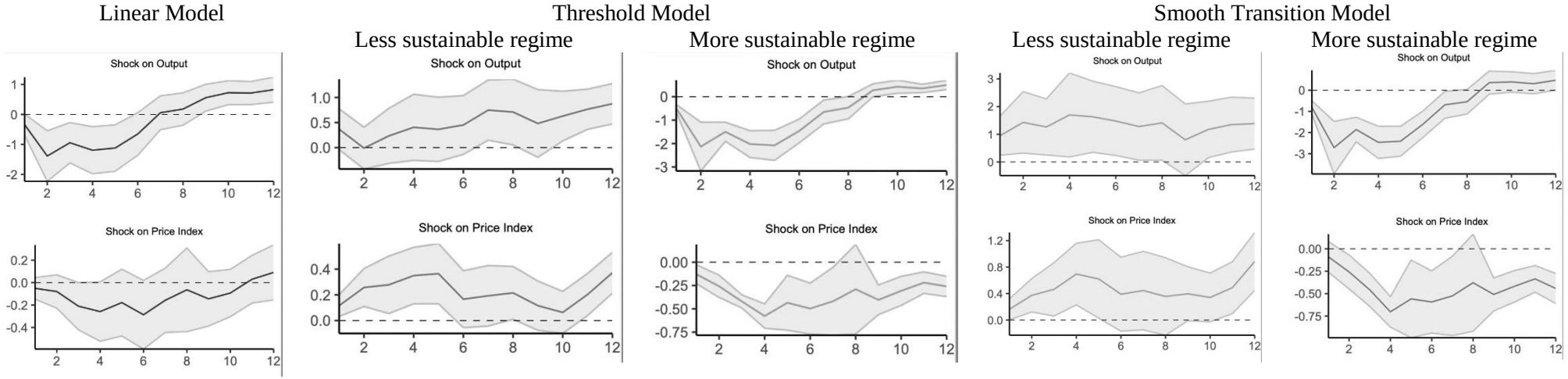


Figure 9: Monetary contraction, Italy Results (2001Q4-2021Q4). Bohn's Rule. Only Positive Surprises.

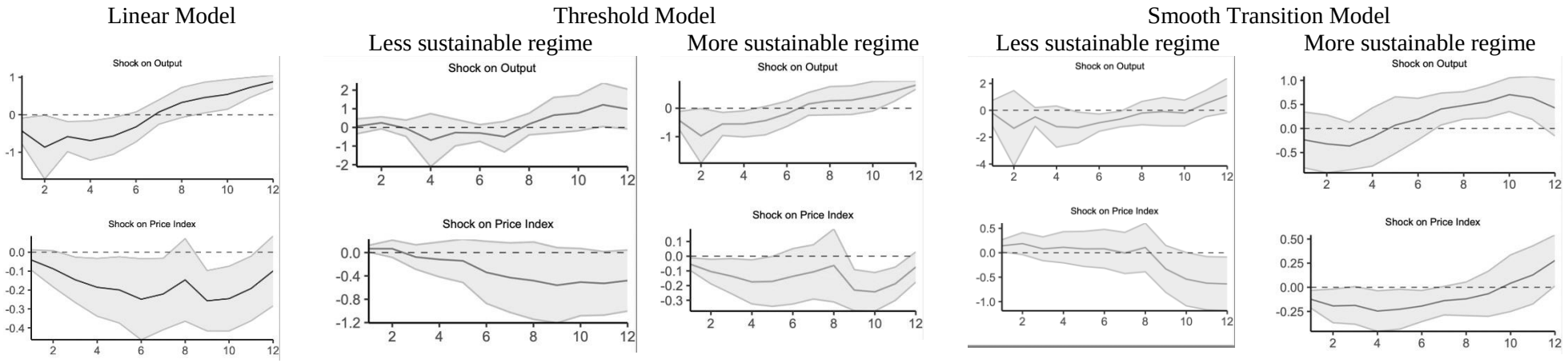
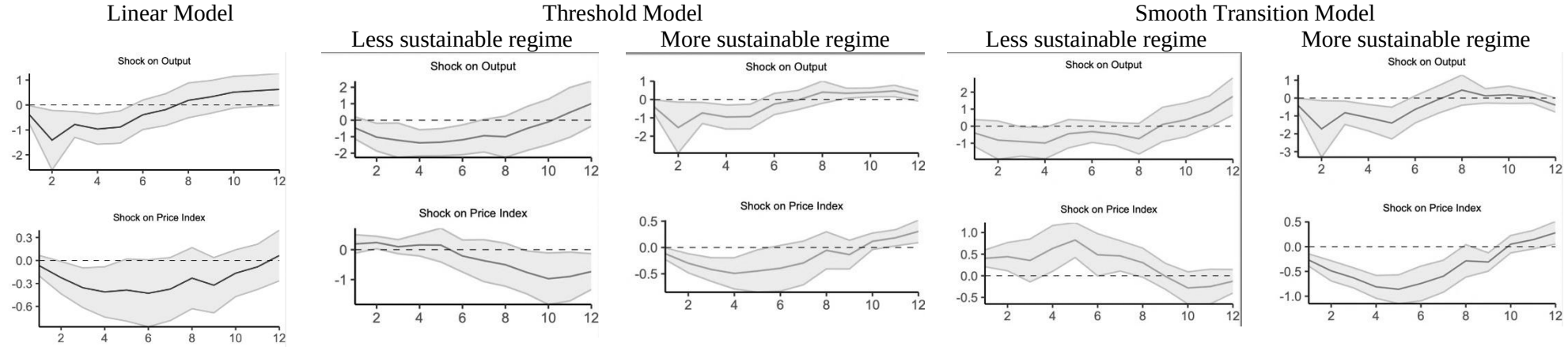


Figure 10: Monetary contraction, Portugal Results (2001Q4-2021Q4). Bohn's Rule. Only Positive Surprises



The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively.

4.2. Robustness Analysis with Cointegration Rule

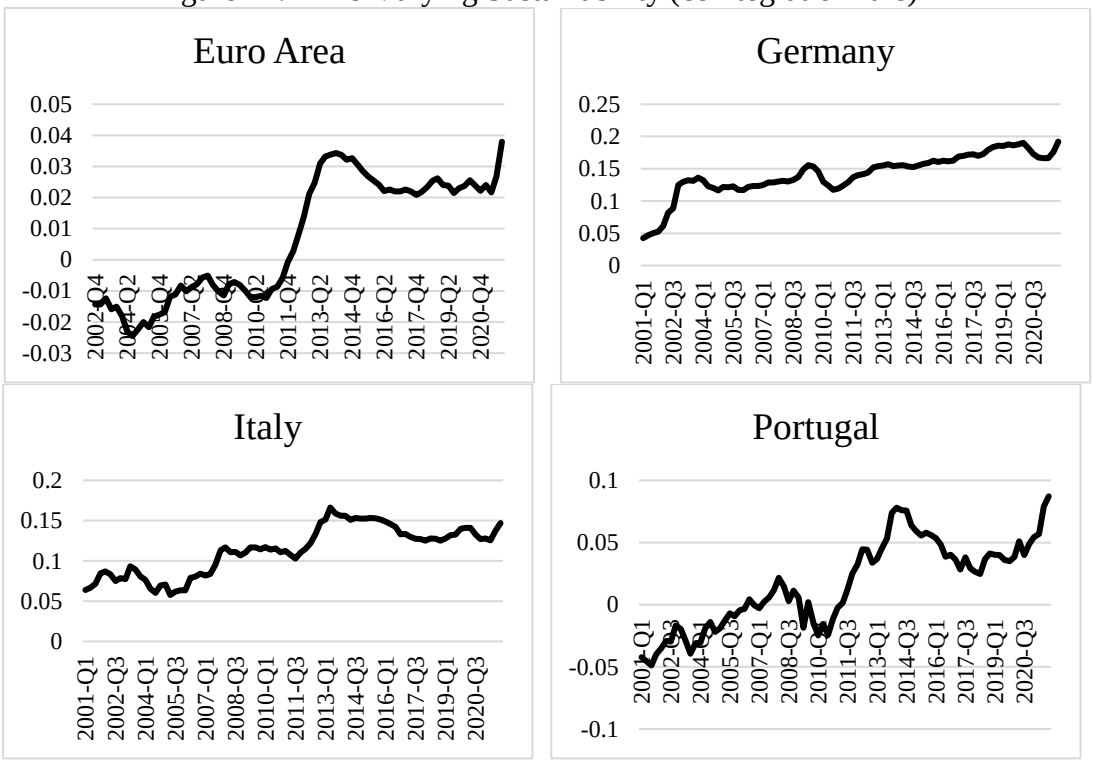
To further test our theoretical link between monetary surprises and fiscal stability, we conducted a robustness analysis by estimating an alternative fiscal rule to discriminate between low and high sustainability regimes. We analyze the cointegration relationship between government revenues and expenditures (Hakkio and Rush, 1991; Afonso, 2005) and we estimate the following time-varying equation:

$$R_t = \alpha + \delta G_t + \varepsilon_t \qquad (5)$$

where R_t corresponds to total government revenue as a percentage of GDP and G_t corresponds to government expenditure as a percentage of GDP. The sample studied now is from 2002Q3 to 2021Q4 for the Euro Area and from 2001Q1 to 2021-Q4 for the other countries, thanks to the contemporary relationship in fact we do not lose observations as in the first model. Figure 11 shows the new TVCs estimated by Schlicht (2003)'s method.

The coefficients of the cointegration rule appear to be less variable than those of Bohn's rule, although Portugal continues to show greater variability. In addition, compared to the previous TVC. Figure 11 shows an overall improvement in sustainability along the sample; a slight deterioration after the last two crises, although less pronounced than in the previous model; a more evident structural break for the Euro Area, Italy, and for Portugal after the sovereign debt crisis, especially for the Euro Area, 2011 represented a real "leap" towards stability.

Figure 11: Time-Varying Sustainability (cointegration rule)



Schlicht (2003)'s Time-Varying coefficients of regression of government revenues on the government expenditures (Afonso, 2005)

When comparing the results between Bohn's discrimination and the so-called cointegration rule, it is important to emphasize that the two rules are two different ways of looking at sustainability and are not perfect substitutes for each other. While the former looks at fiscal reaction functions, i.e., the response of the primary surplus to increases in inherited debt, the latter deals with a simultaneous relationship between the assets (revenues) and liabilities (expenditures) of the government balance. In fact, according to Afonso et al. (2023), there is a negative relationship between the fiscal sustainability coefficients of the two different rules: if revenues are more in line with expenditures, the government is under a lower pressure to make fiscal adjustments. Similarly, if the primary surplus is more responsive to the lagged debt-to-GDP ratio, fiscal sustainability is improved and there is less urgency for revenues to adjust more immediately to government expenditures.

With these considerations in mind, Figures 12, 13, 14, and 15 show the results of our LP model discriminating fiscal regimes on each country's new average coefficient.

Figure 12: Monetary contraction, Euro-Area Results (2002Q4-2021Q4). Cointegration Rule.

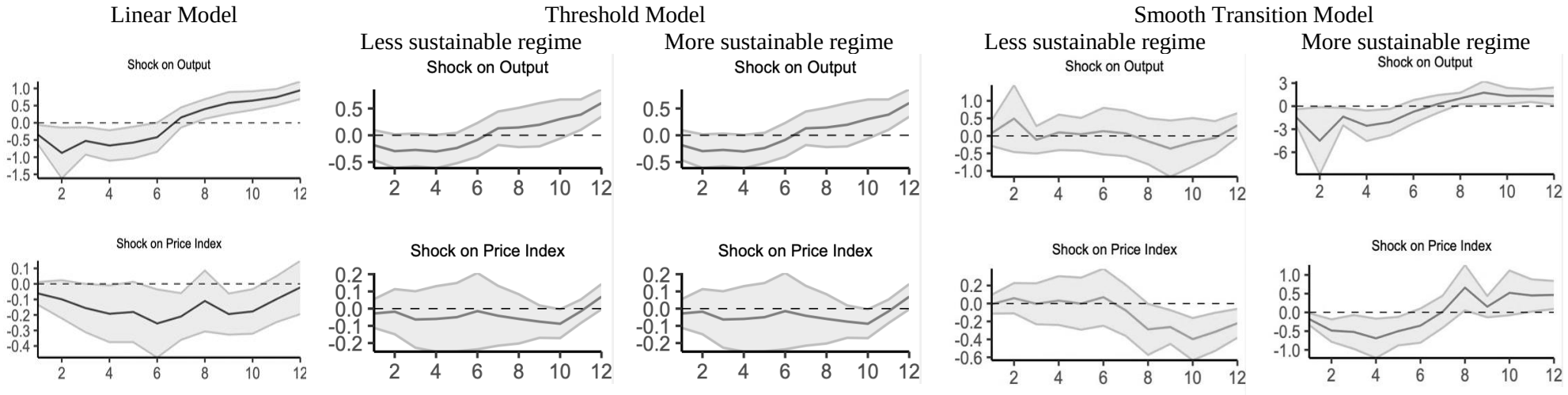


Figure 13: Monetary contraction, Germany Results (2001Q1-2021Q4). Cointegration Rule.

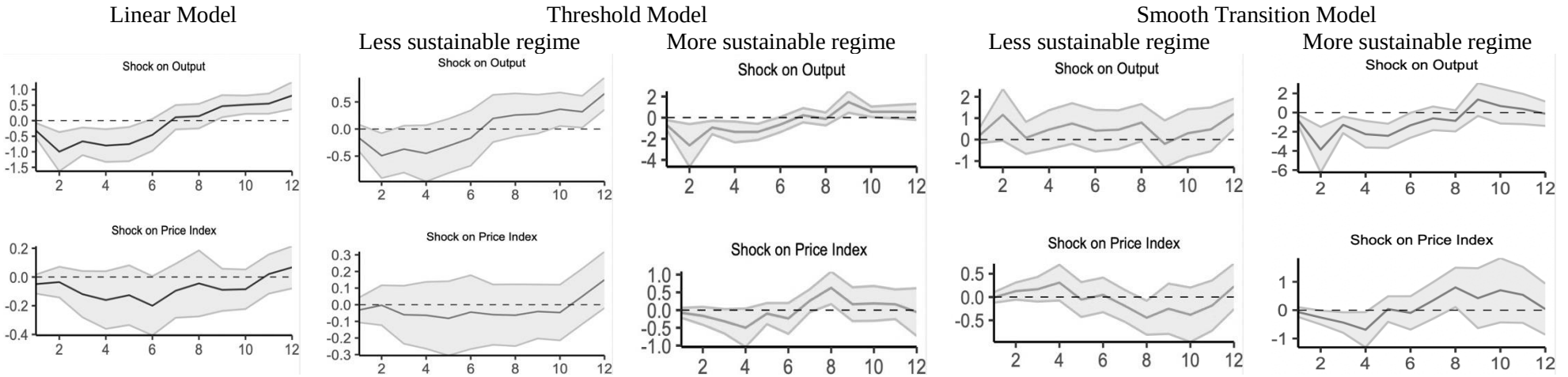


Figure 14: Monetary contraction, Italy Results (2001Q1-2021Q4). Cointegration Rule.

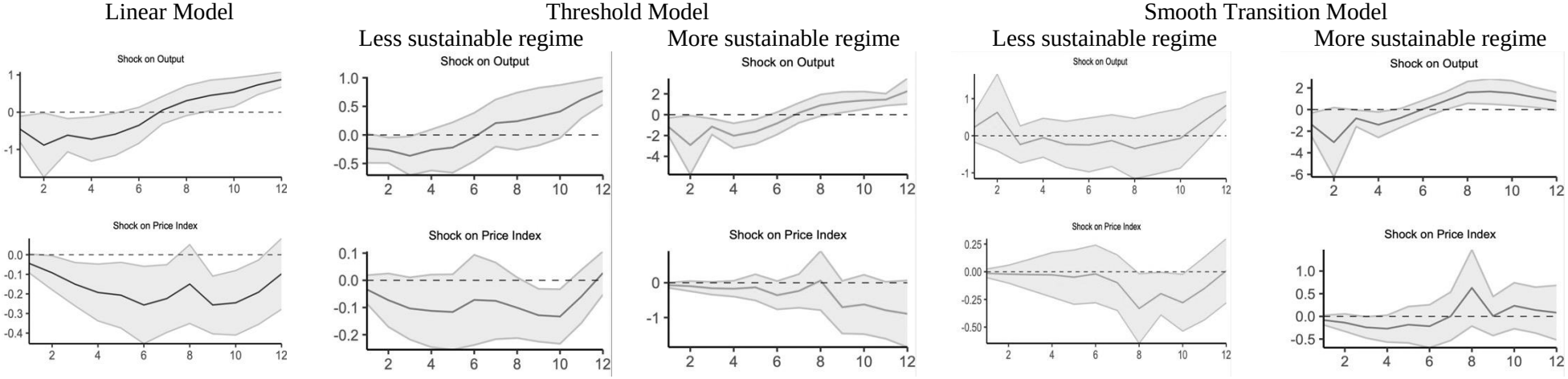
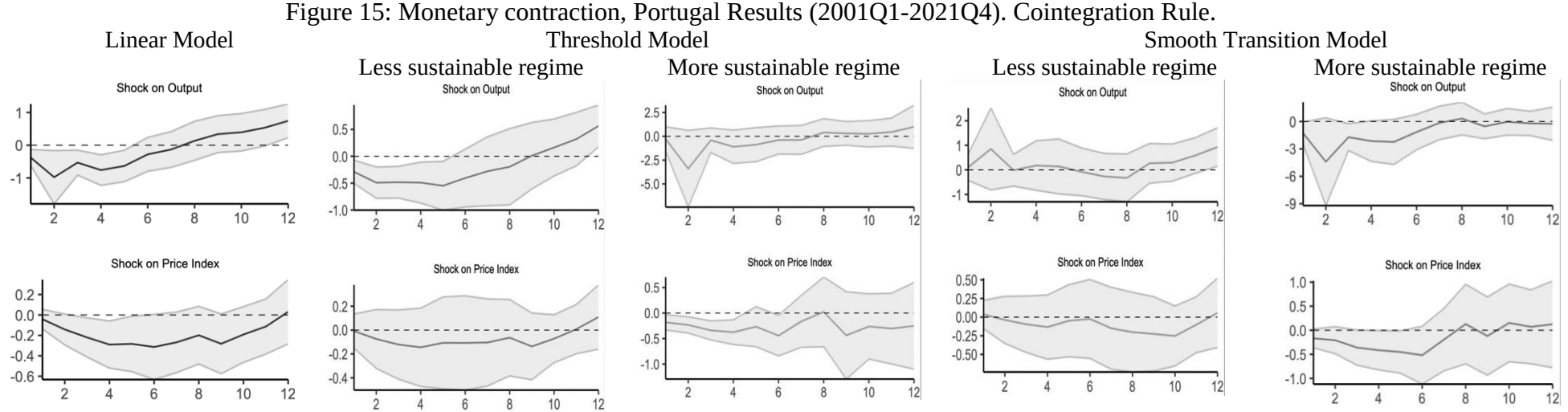


Figure 15: Monetary contraction, Portugal Results (2001Q1-2021Q4). Cointegration Rule.



The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively.

When we discriminate by the cointegration rule, our results are similar to those already mentioned above, demonstrating the robustness of the analysis. In particular, with the exception of Italy, where the price level response decreases but not significantly in both models, we find that a contractionary monetary policy shock in the second (high sustainability) regime is followed by a contraction in both output and prices, in contrast to the first (low sustainability) regime. This result is largely confirmed by both the threshold and smooth transition models. Although, as noted above, the rules we use to determine our fiscal sustainability measure are not perfectly substitutable, we believe that this specification can strengthen our analysis.

In the latter model, we do not find an increase in prices, that is, the so-called fiscal inflation motive that we previously found for Italy and Germany. This is not so surprising if we consider that pressures from fiscal developments are associated with the intertemporal budget constraint that most closely approximates Bohn's rule rather than a contemporaneous relationship between government revenues and expenditures (Bohn, 2007).

Finally, further robustness analyses were performed: first, we checked for 4 lags instead of 2; second, we included only the positive shocks for the Afonso's rule;[14]third, we made the same estimates using output and prices in growth rates. The results don't change and are available upon request.

To sum up, our findings show a strong policy interdependence for all countries and for different specifications of the fiscal stance: higher fiscal passivity (as defined by Leeper 1991) is associated with higher monetary effectiveness.

6. Conclusions and Policy Implications

In recent decades, the study of the interactions between monetary policy and fiscal policy has become increasingly important. The literature shows the existence of a dependence between the two policies for their relative effectiveness. Accordingly, we investigate the effect of Jarociński and Karadi (2020) monetary policy surprises on output and price levels under different degrees of fiscal sustainability for the Euro Area (aggregate data), Germany, Italy, and Portugal. We use quarterly data from 2002Q4 to 2021Q4 for the Euro Area and from 2001Q4 to 2021Q4 for the other countries.

Our study consists of two parts. First, we estimate a time-varying fiscal reaction function (Bohn, 1998), namely the responses of the primary fiscal balance to lagged debt. We do this

[14] We show the results of this estimation in the Appendix from Figure A1 to Figure A4.

using the method of Schlicht (2003). Next, we estimate three models: (1) a linear model, (2) a threshold model conditional on our fiscal stance (Jordà, 2005), and (3) a smooth transition model (Auerbach and Gorodnichenko, 2012). Our fiscal stance represents periods of "low" and "high" sustainability, based on the average of time-varying coefficients indicating the magnitude of fiscal solvency.

According to our knowledge, this relationship between surprises and time-varying sustainability has never been investigated before.

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 price level; (ii) when we insert the fiscal stance, the monetary effect depends on the regime in place; specifically, in the "higher" sustainable regime output and prices tend to respond more strongly to monetary tightening, in contrast to the "lower" sustainable regime (this result is even more pronounced when we take only the positive shocks); (iii) in the most Ricardian regime the output contraction is very pronounced compared to the unconditioned linear model; (iv) for all the countries in the unresponsible regime, we find an increase of the price level, in line with the FTPL; (v) when we discriminate the fiscal stance through the contemporaneous relationship between government revenues and expenditures (Afonso, 2005), the main results do not change and are robust, even if they don't manage to capture the fiscal inflation; (vi) the dependence of the effectiveness of monetary policy on fiscal solvency is valid for Euro-Area and all the study countries, therefore it does not depend on whether a country is "core" or "periphery", but only by the policy conduct over time.

Moreover, according to our estimation, the smooth transition model manages to fit better in terms of results and significance. This is due to the logistic function, which does not lose any observations and preserves the magnitude of the fiscal stance.

Our results have important policy implications. The most important one is related to the European Central Bank's ability to control inflation. According to our idea, the ECB's effectiveness depends strongly on the type of fiscal policy pursued by each member state, in particular, whether the single fiscal authority is pursuing a path of fiscal sustainability or not. The latter suggestion is in line with the FTPL, and with Cochrane (2022), who states "… *Monetary policy is important, as a simplistic reading of "fiscal theory" might not recognize, but fiscal policy also creates inflation that monetary policy cannot fully control, as a simplistic reading of the dictum "inflation is always and everywhere a monetary phenomenon" might deny…*".

References

1. Aastveit, K. A., Natvik, G. J., & Sola, S. (2017). Economic uncertainty and the influence of monetary policy. *Journal of International Money and Finance*, *76*, 50-67.
2. Adämmer, P. (2019). lpirfs: An R package to estimate impulse response functions by local projections. *The R Journal (2019)*, *11*(2), 421-438.
3. Afonso, A. (2005). Fiscal sustainability: The unpleasant European case. *FinanzArchiv/Public Finance Analysis*, 19-44.
4. Afonso, A. (2008). Ricardian fiscal regimes in the European Union. *Empirica*, *35*(3), 313-334.
5. Afonso, A., & Toffano, P. (2013). Fiscal regimes in the EU. European Central Bank Working Paper 1529.
6. Afonso, A., & Jalles, J. T. (2017). Euro area time-varying fiscal sustainability. *International Journal of Finance & Economics*, *22*(3), 244-254.
7. Afonso, A., & Gonçalves, L. (2020). The policy mix in the US and EMU: Evidence from a SVAR analysis. *The North American Journal of Economics and Finance*, *51*, 100840.
8. Afonso, A., Alves, J., & Tovar Jalles, J. (2021). Fiscal Reaction Functions in the EU: A Tale of "r-g" and Whether it Matters. *Revue française d'économie*, *36*(3), 65-101.
9. Afonso, A., & Coelho, J. (2023). Twin Deficits through the Looking Glass: Time-Varying Analysis in the Euro Area. Economic Change and Restructuring, forthcoming.
10. Afonso, A., Alves, J., & Coelho, J. C. (2023). Determinants of the degree of fiscal sustainability. REM Working Paper 255-2023. CESifo Working Paper No. 10225.
11. Afonso, A., & Coelho, J. C. (2023). Public finances solvency in the Euro Area. *Economic Analysis and Policy*, *77*, 642-657
12. Auerbach, A. J., & Gorodnichenko, Y. (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy*, *4*(2), 1-27.
13. Bianchi, F., & Ilut, C. (2017). Monetary/fiscal policy mix and agents' beliefs. *Review of Economic Dynamics*, *26*, 113-139.
14. Bianchi, F., & Melosi, L. (2017). Escaping the great recession. *American Economic Review*, *107*(4), 1030-1058.
15. Bianchi, F., & Melosi, L. (2022). Inflation as a fiscal limit. FRB of Chicago Working Paper No. 2022-37.
16. Blanchard, O. J., & Quah, D. (1988). The dynamic effects of aggregate demand and supply disturbances. NBER WORKING PAPER n. 2737.

17. Bohn, H. (1998). The behavior of US public debt and deficits. *the Quarterly Journal of economics*, *113*(3), 949-963.

18. Bohn, H. (2007). Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint?. *Journal of monetary Economics*, *54*(7), 1837-1847.

19. Buti, M., & Giudice, G. (2002). Maastricht's fiscal rules at ten: an assessment. *JCMS: Journal of Common Market Studies*, *40*(5), 823-848.

20. Canzoneri, M. B., Cumby, R. E., & Diba, B. T. (2001). Is the price level determined by the needs of fiscal solvency?. *American Economic Review*, *91*(5), 1221-1238.

21. Cochrane, J. H. (1998). A frictionless view of US inflation. *NBER macroeconomics annual*, *13*, 323-384

22. Cochrane, J. H. (2001). Long-term debt and optimal policy in the fiscal theory of the price level. *Econometrica*, *69*(1), 69-116.

23. Cochrane, J. H. (2022a). Fiscal inflation. *Forthcoming in Populism and the Fed, James Dorn Ed., Cato Institute*

24. Cochrane, J. H. (2022b). Fiscal Histories. *Journal of Economic Perspectives*, *36*(4), 125-46.

25. Cochrane, J. H. (2023). *The fiscal theory of the price level*. Princeton University Press.

26. Creel, J., & Le Bihan, H. (2006). Using structural balance data to test the fiscal theory of the price level: Some international evidence. *Journal of Macroeconomics*, *28*(2), 338-360.

27. De Luigi, C., & Huber, F. (2018). Debt regimes and the effectiveness of monetary policy. *Journal of Economic Dynamics and Control*, *93*, 218-238.

28. Davig, T., Leeper, E. M., Galí, J., & Sims, C. (2006). Fluctuating macro policies and the fiscal theory [with comments and discussion]. *NBER macroeconomics annual*, *21*, 247-315

29. Davig, T., Leeper, E. M., & Walker, T. B. (2010). "Unfunded liabilities" and uncertain fiscal financing. *Journal of Monetary Economics*, 57(5), 600-619.

30. Favero, C. A. (2002). How do European monetary and fiscal authorities behave?. CEPR Discussion Papers 3426.

31. Galí, J., & Perotti, R. (2003). Fiscal policy and monetary integration in Europe. *Economic policy*, *18*(37), 533-572.

32. Hakkio, C. S., & Rush, M. (1991). Is the budget deficit "too large?". *Economic Inquiry*, *29*(3), 429-445.

33. Hülsewig, O., & Rottmann, H. (2022). Euro area periphery countries' fiscal policy and monetary policy surprises. *Oxford Bulletin of Economics and Statistics*, *84*(3), 544-568.

34. Jarociński, M., & Karadi, P. (2020). Deconstructing monetary policy surprises—the role of information shocks. *American Economic Journal: Macroeconomics*, *12*(2), 1-43.

35. Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American economic review*, *95*(1), 161-182.

36. Kilian, L., & Kim, Y. J. (2011). How reliable are local projection estimators of impulse responses?. *Review of Economics and Statistics*, *93*(4), 1460-1466.

37. Kliem, M., Kriwoluzky, A., & Sarferaz, S. (2016a). On the low-frequency relationship between public deficits and inflation. *Journal of applied econometrics*, *31*(3), 566-583.

38. Kliem, M., Kriwoluzky, A., & Sarferaz, S. (2016b). Monetary–fiscal policy interaction and fiscal inflation: A tale of three countries. *European Economic Review*, *88*, 158-184.

39. Kloosterman, R., Bonam, D., & van der Veer, K. (2022). The effects of monetary policy across fiscal regimes. DNB Working Paper, NO 755.

40. Leeper, E. M. (1991). Equilibria under 'active' and 'passive' monetary and fiscal policies. *Journal of Monetary Economics,* 27(1), 129-147.

41. Leeper, E. M., & Leith, C. (2016). Understanding inflation as a joint monetary–fiscal phenomenon. In *Handbook of Macroeconomics* (Vol. 2, pp. 2305-2415). Elsevier.

42. Lucas, R. E. (1980). Two illustrations of the quantity theory of money. *The American Economic Review*, *70*(5), 1005-1014.

43. Melitz, J. (2000). *Some cross-country evidence about fiscal policy behavior and consequences for EMU*. Department of Economics, Fraser of Allander Institute.

44. Muscatelli, V. A., Tirelli, P., & Trecroci, C. (2004). 10 Monetary and fiscal policy interactions over the cycle: some empirical evidence. *Monetary Policy, Fiscal Policies and Labour Markets*, 256.

45. Newey, W. K., & West, K. D. (1986). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*

46. Panjer, N., de Haan, L., & Jacobs, J. P. (2020). Is fiscal policy in the euro area Ricardian?. *Empirica*, *47*, 411-429.

47. Paredes, J., Pedregal, D. J., & Pérez, J. J. (2014). Fiscal policy analysis in the euro area: Expanding the toolkit. *Journal of Policy Modeling*, *36*(5), 800-823.

48. Ramey, V. A. (2016). Macroeconomic shocks and their propagation. *Handbook of macroeconomics*, *2*, 71-162.

49. Ramey, V. A., & Zubairy, S. (2018). Government spending multipliers in good times and in bad: evidence from US historical data. *Journal of political economy*, *126*(2), 850-901.

50. Reichlin, L., Ricco, G., & Tarbé, M. (2023). Monetary–fiscal crosswinds in the European Monetary Union. *European Economic Review*, *151*, 104328.

51. Sargent, T. J. Wallace, N. (1981). Some unpleasant monetarist arithmetic. *Federal reserve bank of Minneapolis quarterly review*, 5(3), 1-17.

52. Sargent, T. J., & Surico, P. (2011). Two illustrations of the quantity theory of money: Breakdowns and revivals. *American Economic Review*, *101*(1), 109-128

53. Schlicht, E. (2003). *Estimating time-varying coefficients with the VC program* (No. 2003-6). Munich Discussion Paper.

54. Sims, C. A. (1994). A simple model for the study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic theory*, *4*, 381-399.

55. Sims, C. A. (2011). Stepping on a rake: The role of fiscal policy in the inflation of the 1970s. *European Economic Review*, *55*(1), 48-56.

56. Semmler, W., & Zhang, W. (2004). Monetary and fiscal policy interactions in the euro area. *Empirica*, *31*, 205-227

57. Smets, F., & Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of the European economic association*, *1*(5), 1123-1175.

58. Tenreyro, S., & Thwaites, G. (2016). Pushing on a string: US monetary policy is less powerful in recessions. *American Economic Journal: Macroeconomics*, *8*(4), 43-74.

59. Quintos, C. E. (1995). Sustainability of the deficit process with structural shifts. *Journal of Business & Economic Statistics*, *13*(4), 409-417.

60. Woodford, M. (1994). Monetary policy and price level determinacy in a cash-in-advance economy. *Economic theory*, *4*, 345-380.

61. Woodford, M. (1995). Price-level determinacy without control of a monetary aggregate. *In Carnegie-Rochester conference series on public policy* (Vol. 43, pp. 1-46). North-Holland.

Appendix

Table A1: Variables, definition, and data source

Countries: Euro Area 20; Germany; Italy; Portugal.		
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**
R_t	Total General Government Revenue on GDP. Constructed Variable. Quarterly Data. The Ratio of Total General Government Revenue (Annualized) over Nominal GDP Year.	**Eurostat**
G_t	Total General Government Revenue on GDP. Constructed Variable. Quarterly Data. The Ratio of Total General Government Revenue (Annualized) 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

Variable	Obs.	Mean	Std. Dev.	Maximum	Minimum
Euro Area					
s_t	77 (2002q4-2021q4)	-0,388	1,954	2,221	-6,574
d_t	77 (2002q4-2021q4)	83,853	10,293	99,538	65,917
R_t	77 (2002q4-2021q4)	45,567	1,674	47,395	33,923
G_t	77 (2002q4-2021q4)	48,586	2,594	54,628	35,877
PI_t	77 (2002q4-2021q4)	4,554	0,086	4,699	4,382
$RGDP_t$	77 (2002q4-2021q4)	14,706	0,056	14,809	14,6
Germany					
s_t	84 (2001q1-2021q4)	0,472	2,303	3,11	-5,052
d_t	84 (2001q1-2021q4)	68,621	6,822	81,995	57,750
R_t	84 (2001q1-2021q4)	44,526	1,530	47,922	40
G_t	84 (2001q1-2021q4)	46,053	2,092	52,403	43,390
PI_t	84 (2001q1-2021q4)	4,543	0,092	4,708	4,379
$RGDP_t$	84 (2001q1-2021q4)	13,404	0,079	13,527	13,289
Italy					
s_t	84 (2001q1-2021q4)	1,028	1,959	3,531	-6,583
d_t	84 (2001q1-2021q4)	123,7	15,238	159,338	103,9
R_t	84 (2001q1-2021q4)	45,786	1,658	48,623	42,86
G_t	84 (2001q1-2021q4)	49,250	2,467	57,628	46,663
PI_t	84 (2001q1-2021q4)	4,529	0,101	4,674	4,379
$RGDP_t$	84 (2001q1-2021q4)	12,899	0,033	12,964	4,321

Portugal					
s_t	84 (2001q1-2021q4)	-1,531	2,737	3,418	-8,457
d_t	84 (2001q1-2021q4)	100,55	30,011	138,92	54,037
R_t	84 (2001q1-2021q4)	41,905	1,677	45,319	38,941
G_t	84 (2001q1-2021q4)	46,853	2,857	52,64	42,451
PI_t	84 (2001q1-2021q4)	4,54	0,095	4,663	4,323
$RGDP_t$	84 (2001q1-2021q4)	10,7	0,04	10,789	10,580

Figure A1: Monetary contraction, Euro-Area Results (2002Q4-2021Q4). Cointegration Rule. Only Positive Surprises

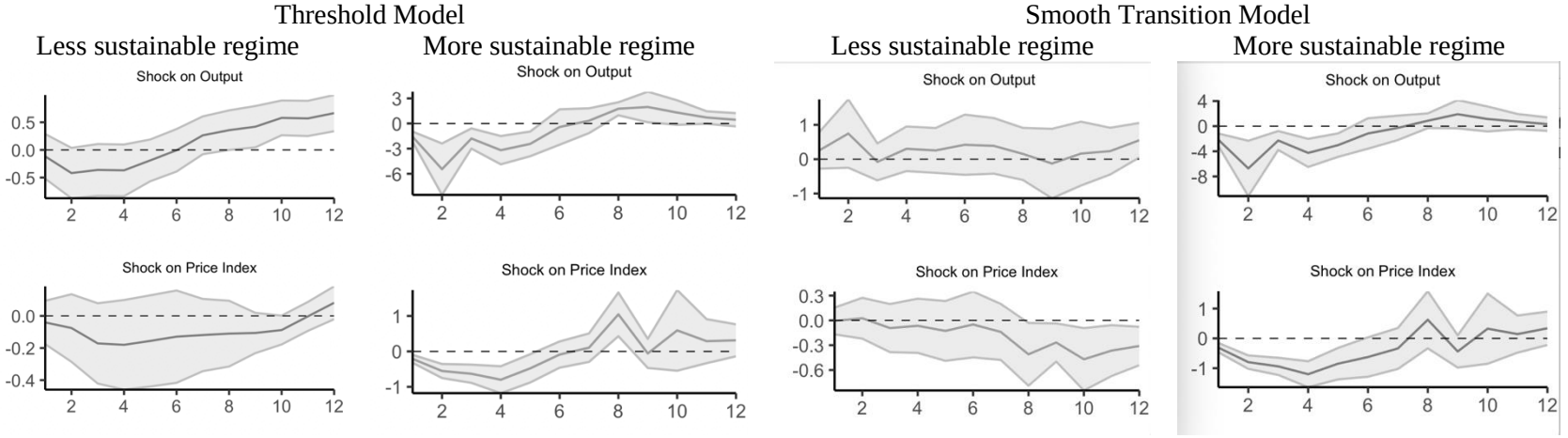


Figure A2: Monetary contraction, Germany Results (2001Q1-2021Q4). Cointegration Rule. Only Positive Surprises.

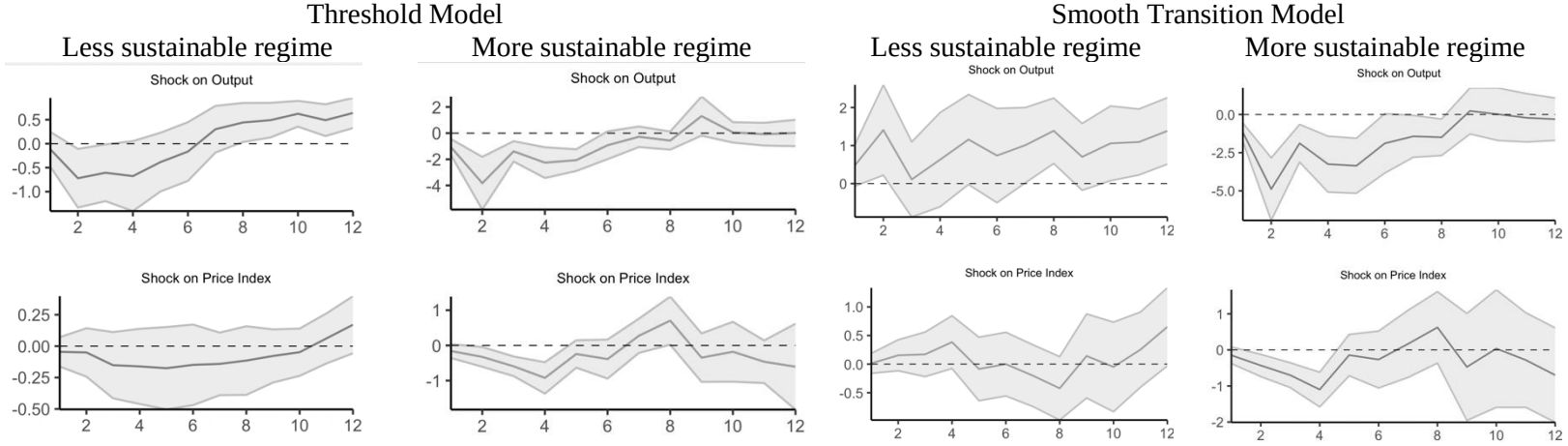


Figure A3: Monetary contraction, Italy Results (2001Q1-2021Q4). Cointegration Rule. Only Positive Surprises.

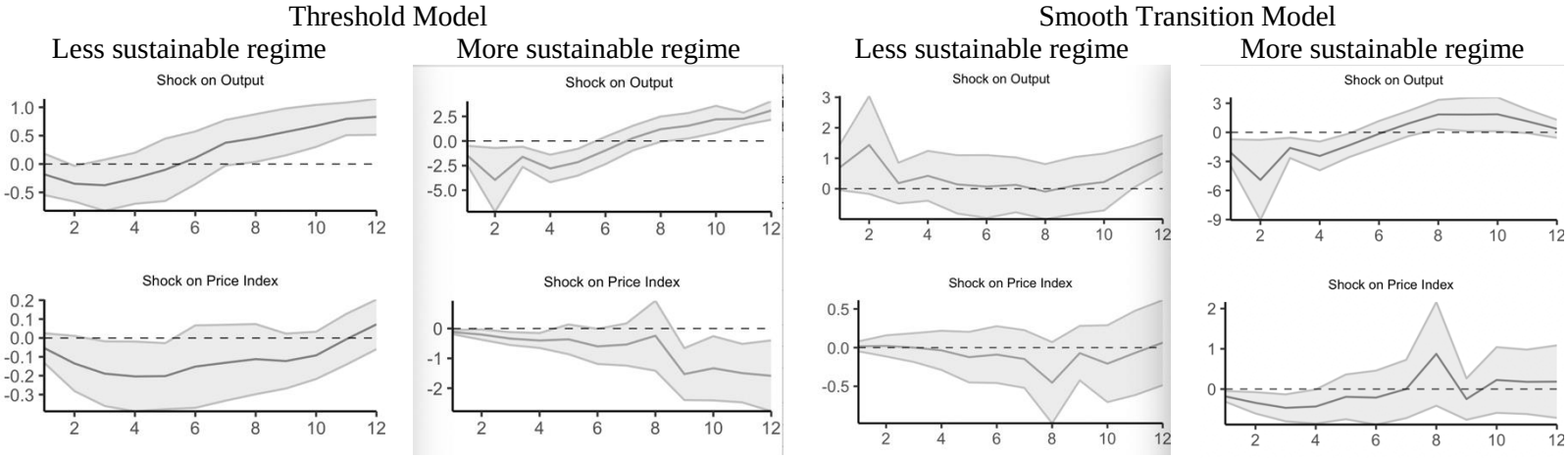
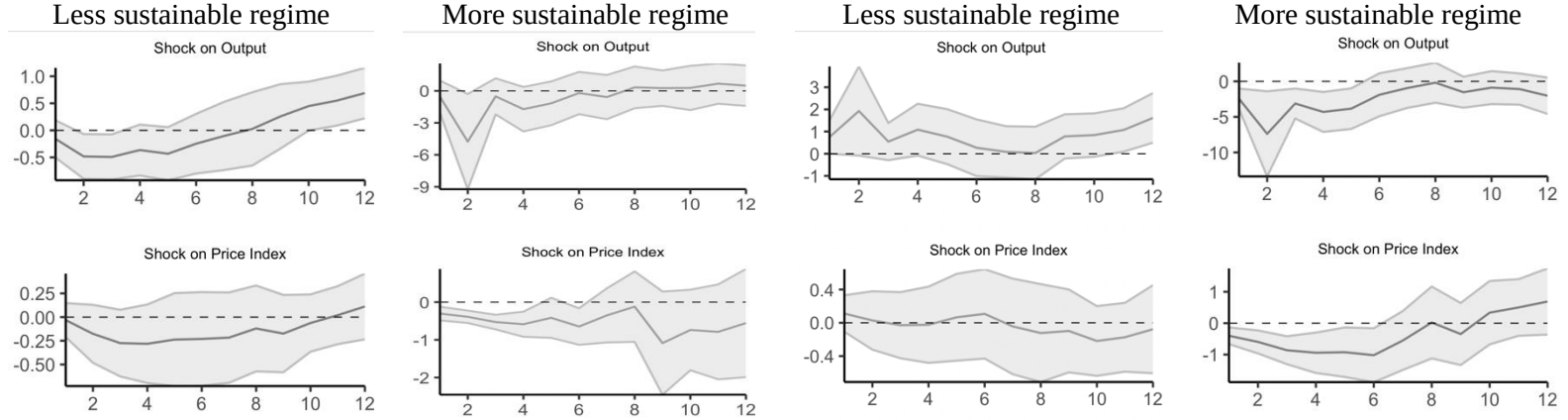


Figure A4: Monetary contraction, Portugal Results (2001Q1-2021Q4). Cointegration Rule. Only Positive Surprises



The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The impulse responses can be interpreted as percentage deviations from their original values. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively.