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Article — Published Version

Monetary policy surprises and fiscal sustainability: the case of the Euro Area

Economic Change and Restructuring

Provided in Cooperation with:

Springer Nature

Suggested Citation: Ionta, Serena; Afonso, António; Alves, José (2025) : Monetary policy surprises and fiscal sustainability: the case of the Euro Area, Economic Change and Restructuring, ISSN 1574-0277, Springer US, New York, NY, Vol. 58, Iss. 3, <https://doi.org/10.1007/s10644-025-09881-4>

This Version is available at:

<https://hdl.handle.net/10419/323354>

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Monetary policy surprises and fiscal sustainability: the case of the Euro Area

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Received: 10 October 2024 / Accepted: 8 April 2025 / Published online: 13 May 2025
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Abstract

We study the interaction between monetary and fiscal policies in the Euro Area, in particular the effect of monetary surprise shocks on real output and the price level under different fiscal sustainability regimes. We first estimate a time-varying Bohn (Q J Econ 113:949–963, 1998) rule using the Schlicht (2003) method. Then, we use a nonlinear local projection model for the Euro Area (aggregate data), Germany, Italy, and Portugal conditional on the fiscal regimes obtained in the first step. We find that the effect of monetary shocks depends on the degree of fiscal sustainability of each country. In the case of a more Ricardian regime, output and prices respond to monetary tightening by contracting. Instead, in the less Ricardian regime, the response is insignificant or even positive. Our results show that fiscal solvency is important for the effectiveness of monetary policy. The results are robust to different specifications and models.

Keywords Monetary surprises · Fiscal sustainability · Local projection models · Fiscal-monetary policy mix · Euro Area · Germany · Italy · Portugal

JEL C32 · E58 · E62 · E63

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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 2022a, 2022b). In particular, they see today's inflation as a consequence of the large pandemic fiscal packages, central banks' accommodative monetary policies, and agents' expectations about the future conduct of government policy. While this argument may hold in the USA, where fiscal stimuli have likely fueled inflationary pressures, the Euro Area presents a more complex case. In some instances, fiscal expansion has appeared to mitigate inflationary pressures, while in others, its effects have been less clear. This highlights the importance of studying the interaction between fiscal policies and the European Central Bank's monetary policy, especially within the Euro Area's unique institutional framework, characterized by a single monetary authority and multiple fiscal policymakers.

In this asymmetric setting, fiscal rules and treaties aim to maintain a clear separation between monetary and fiscal policies, based on the belief that macroeconomic stability relies on an independent central bank ensuring price stability and fiscal authorities maintaining sustainable debt levels. However, recent developments, such as 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 framework, necessitating stronger policy coordination.

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), alternates with the fiscal-dominant regime, in which 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. 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 objective 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. First, to distinguish between high and low fiscal sustainability regimes, we implement the time-varying fiscal reaction function (Bohn 1998) using Schlicht (2003)'s method. Second, we use the local projection

method (Jordà 2005) and compare the results of the linear, threshold and smooth transition models. We use quarterly data for Euro Area (aggregated), Germany, Italy, and Portugal. We choose these countries in order to cover countries with different fiscal characteristics.

The literature that has empirically estimated the FTPL has mostly looked only at fiscal rules or examined the conduct of monetary policy separately from fiscal policy. Our main contribution is to look directly at the effectiveness of monetary policy under different fiscal sustainability regimes. To the best of our knowledge, this is the first attempt in the literature that uses a time-varying fiscal reaction function (Bohn 1998) to distinguish between more and less Ricardian periods. Moreover, we run this test for the Euro Area, in order to examine the dependence of a European central bank's policy on the fiscal stance of each member country. 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. The findings are robust with different specifications and models.

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

2 Related literature

This paper refers to three strands of literature. The first is related 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 (notably when population growth is lower than the interest rate), 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 growth rate on money).

As defined by Leeper (1991), this scenario is also referred to as an active fiscal policy and a passive monetary policy regime,¹ 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

¹ Woodford (1995) also calls this regime a "Non-Ricardian" regime.

can be attributed to Sims (1994, 2011), Woodford (1994), and Cochrane (1998, 2001, 2023).²

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. 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, policy is Ricardian 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.³ 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 and Jalles 2017).⁴ Panjer et al. (2020) study the existence of Ricardian regimes in the Eurozone using the Area Wide Model fiscal database (Paredes et al. 2014), taking 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, and a Ricardian regime after the ECC until the Global Financial Crisis, when fiscal policy became active.

This latter idea of nonlinearity is also related to the broader emerging literature on MS 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.

² 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).

³ The author does cointegration tests for the annual sample period 1970–2003.

⁴ 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 Gali and Perotti (2003) among others.

Finally, the third strand of the literature relates to empirical studies of the interactions between monetary and fiscal policies. For the EMU countries, Melitz (2000) 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. (2004) estimate a VAR for G7 countries with both fiscal and monetary policy instruments and show that policy 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 USA, 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).⁵ 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 USA 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 us 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 time-varying fiscal rule à la Bohn (1998). We believe that dividing the sample into periods of more or less fiscal solvency is an appropriate method to best test the FTPL empirically.

⁵ 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 methodology (Jordà 2005). The LPs method offers several advantages over the traditional SVAR approach. First, it is a better estimator than the VAR when the latter is misspecified; second, it is much easier to implement because it is an OLS regression; and third, it is suitable for nonlinear estimation, which is the ultimate goal of this paper.⁶

We use quarterly data ranging from 2003Q4 to 2021Q4 for the aggregated Euro Area, and from 2001Q4 to 2021Q4 for Germany, Italy, and Portugal, and we estimate three models: (1) an unconditional linear model, (2) a nonlinear threshold model conditional on the fiscal stance (Jordà 2005), and (3) a conditional smooth transition model (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 represents a “core” country, especially from a fiscal and financial markets point of view; Italy is an example of a country in the “middle,” characterized by both high domestic product and some fiscal imbalances; and Portugal is to be considered as a “periphery” country.

To discriminate between different fiscal regimes and to perform time-varying fiscal regression, we follow Afonso and Jalles (2017) and Afonso et al. (2025), 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).

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

$$s_t = \alpha + \delta b_{t-4} + \psi \text{outputgap}_{t-4} + \varepsilon_t \quad (1)$$

where s_t is the primary budget balance, b_{t-4} is the lagged public debt, the outputgap_{t-4} is the output gap computed by the Hodrick-Prescott filter.⁷ We take the lagged value “-4” because the variables are quarterly but at the same time

⁶ For a discussion of the local projection method see Ramey (2016) or Kilian and Kim (2011).

⁷ We compute it choosing 1600 as the lambda for the HP filter. We divide the cyclical component on its trend, and we multiply by 100.

annualized. Fiscal variables are as ratio of GDP. We discriminate the periods based on the average of the δ coefficients, which indicate the magnitude of fiscal solvency. When the coefficient is greater than the average, we are in a more (high) Ricardian regime; when it is less, we are in a less (low) Ricardian regime. Second, we construct the impulse response functions (IRF), estimating our LP model.

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 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:

$$y_{t+h} = \alpha^h + \beta_h \text{shock}_t + \phi x_t + u_{t+h}^h, h = 0, 1, \dots, H-1 \quad (2)$$

where y_{t+h} is our variable of interest, real output and inflation, α^h denotes the constant, x_t is the vector of control variables that includes two lags of the LHS variable and one lag of the monetary policy shock, and shock_t is our monetary surprises shock.⁸ 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 (Eq. 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 to the shock.⁹ Hence, I_t is 0 when the sustainability coefficient is lower than the average and 1 when it is higher:

$$y_{t+h} = (1 - I_{t-1})[\alpha^{ah} + \beta_{ah} \text{shock}_t + \phi_a x_t] + (I_{t-1})[\alpha^{bh} + \beta_{bh} \text{shock}_t + \phi_b x_t] + u_{t+h}^h. \quad (3)$$

The third model (Eq. 4) is a smooth transition model, which computes state probabilities with a logistic function, preserving the magnitude of the fiscal stance:

$$y_{t+h} = F(z_{t-1})[\alpha^{ah} + \beta_{ah} \text{shock}_t + \phi_a x_t] + (1 - F(z_{t-1}))[\alpha^{bh} + \beta_{bh} \text{shock}_t + \phi_b x_t] + u_{t+h}^h \quad (4)$$

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 1.5.¹⁰ When fiscal sustainability

⁸ A further test was done by entering 4 lags instead of 2 as regards the control variables, and taking only positive monetary policy shocks (corresponding to monetary tightening); the results do not change.

⁹ 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 .

¹⁰ Robustness tests have been done changing γ , and it does not change the findings of the estimates. This results are available upon request.

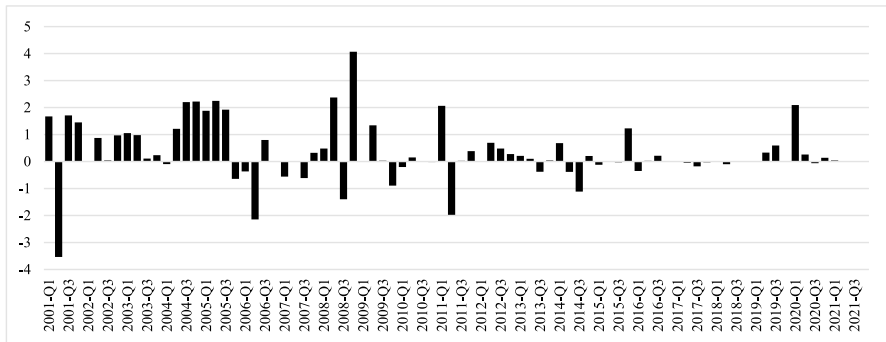


Fig. 1 ECB monetary surprises shocks. *Notes* Monetary surprises are taken from Jarociński and Karadi (2020), quarterly aggregated, and divided by the standard deviation

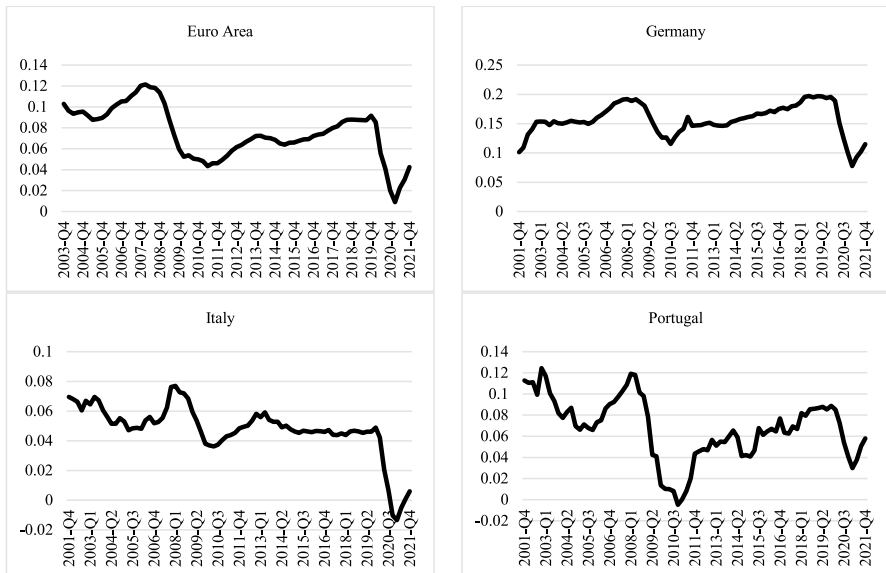


Fig. 2 Time-varying sustainability (Bohn's rule). *Note* Schlicht (2003)'s time-varying coefficients of regression of primary balance on the lagged debt-to-GDP ratio (Bohn 1998)

improves, our state variable z_t increases and causes $F(z_t)$ to go to 0. On the other case, $F(z_t)$ tends toward 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 site (Fig. 1). More information about the dataset is in Appendix.

Figure 2 illustrates the TVC-estimated magnitude of fiscal sustainability for the countries studied. The figure highlights several key points: (i) a common trend

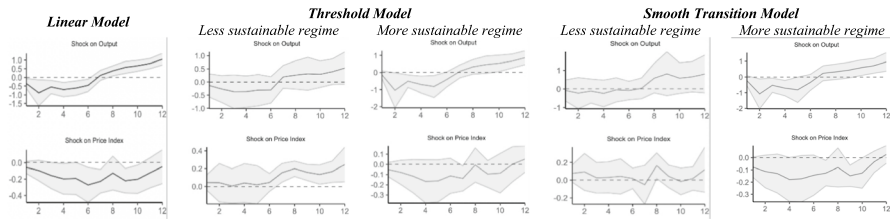


Fig. 3 Euro Area results (2003Q1–2021Q4), Bohn's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

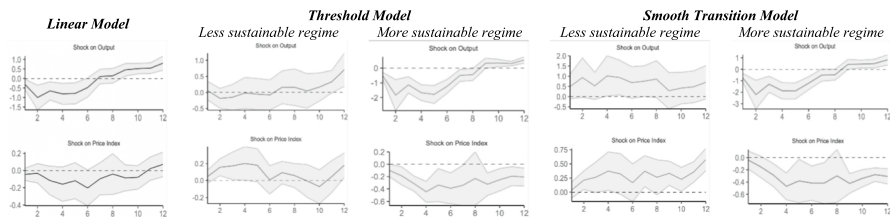


Fig. 4 Germany results (2001Q4–2021Q4), Bohn's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

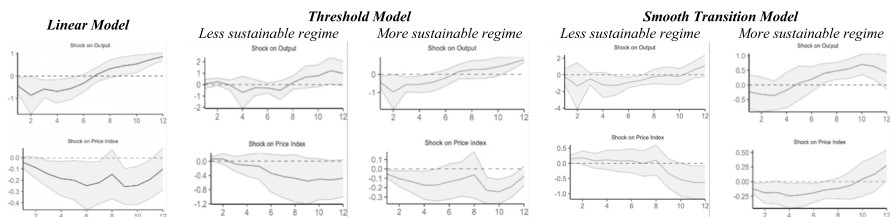


Fig. 5 Italy results (2001Q4–2021Q4), Bohn's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

observed across all countries; (ii) a notable decline in fiscal sustainability coefficients during the Great Recession (2008) and the Pandemic Recession (2020). This decrease reflects the significant fiscal responses deployed during these crises, as governments prioritized economic stabilization over fiscal discipline, leading to higher deficits and debt levels, which are captured by the Bohn's Rule; (iii) an improvement

in fiscal solvency following the 2011 sovereign debt crisis and related debt restructuring, particularly evident in Italy and Portugal, as these countries adopted strict fiscal consolidation measures; and (iv) greater variability in the coefficients for Portugal, likely due to the pronounced fiscal adjustments and reforms implemented over the period analyzed.

4 Results and discussion

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.

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.” 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 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

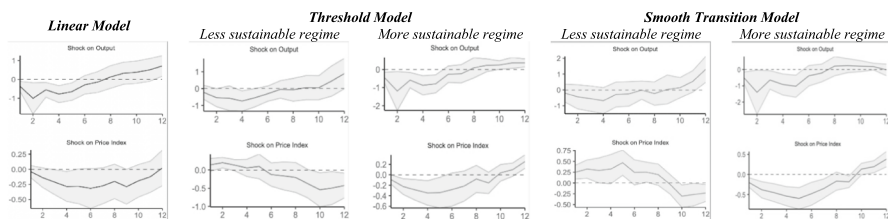


Fig. 6 Portugal results (2001Q4–2021Q4). Bohn's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

“less” Ricardian regime, as opposed to falling in the “more” Ricardian regime. This is very interesting and it 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” responsible regime, for the more responsible one, we find that output and prices are reduced.

As for the third model (third column), 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. Now, for Italy too, we find that in the unsustainable regime, the monetary shock leads to an increase in prices. Moreover, in Germany, the growth of output as a response stands for “a wealth effect” combined with the rise in the price level. Overall, while the results are not always significant at the 90% confidence level, there is consistently a difference in the response of prices and output. This highlights the substantial importance of the fiscal stance within the transmission mechanism.

Based on the literature reviewed in Sect. 2, our results are not surprising. They 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). This happens because monetary tightening leads to an increase in nominal debt in the hands of the public, causing a net wealth effect which 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). 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.

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, Fig. 2 shows the deterioration of the sustainability TVC in the last

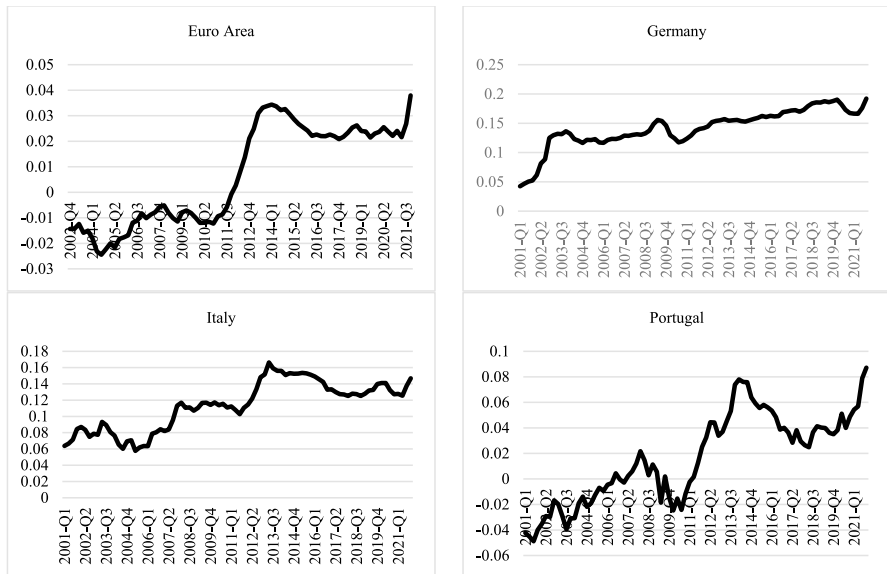


Fig. 7 Time-Varying Sustainability (Cointegration Rule). *Note* Schlicht (2003)’s time-varying coefficients of regression of government revenues on the government expenditures (Afonso 2005)

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 (Tenreiro 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 country in the middle (Italy), and for an aggregation of countries such as the Euro Area.

4.2 Robustness analysis: cointegration rule

To further test our theoretical link between monetary surprises and fiscal stability, we conduct 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:

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

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 2021Q4 for

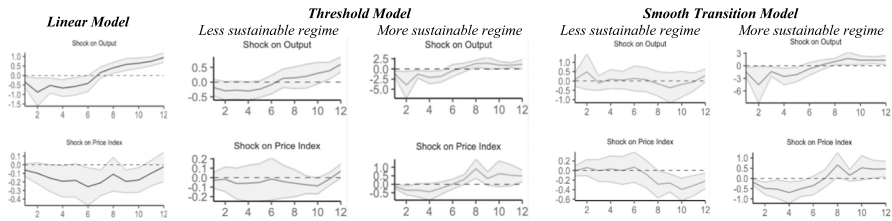


Fig. 8 Euro Area results (2002Q4–2021Q4), cointegration's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

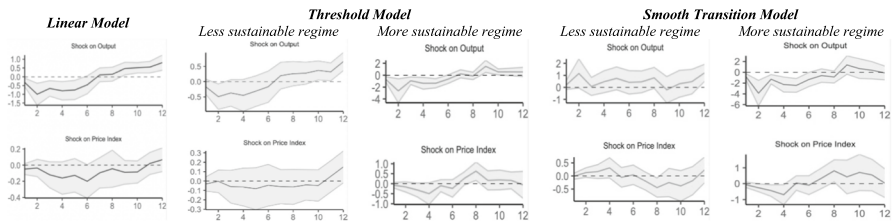


Fig. 9 Germany results (2001Q1–2021Q4), cointegration's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

the other countries, thanks to the contemporary relationship in fact we do not lose observations as in the first model. Figure 7 shows the new TVCs estimated by Schlicht (2003)'s method.

The coefficients of the cointegration's 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, Fig. 7 shows (i) an overall improvement in sustainability along the sample; (ii) a slight deterioration after the last two crises, although less pronounced than in the previous model; (iii) 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" toward stability.

When comparing the results between Bohn's discrimination and cointegrations, 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

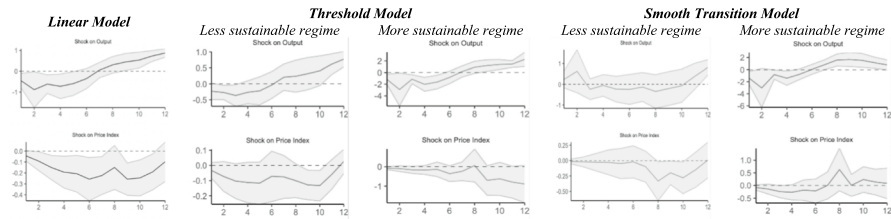


Fig. 10 Italy results (2001Q1–2021Q4), cointegration's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

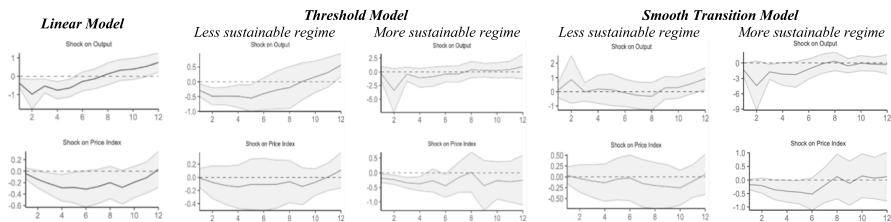


Fig. 11 Portugal results (2001Q1–2021Q4), cointegration's rule. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

are more in line with expenditures, the government is under less 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, Figs. 8, 9, 10, and 11 show the results of our LP model discriminating fiscal regimes on each country's new average coefficient.

When we discriminate by cointegration's rule, our results are similar to those 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 monetary 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 stance 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 that we previously found for Italy and Germany. This is not so surprising if we consider that fiscal inflation is associated with the intertemporal budget constraint that most closely approximates Bohn's rule with respect to 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 (those of the monetary contraction); third, we made the same estimates using output and prices in growth rates. The results are in Appendix.

5 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 2003Q4 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 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; (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 irresponsible regime, we find an increase in the price level, in line with the so-called “*Stepping on a rake*” effect (Sims 2011); (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 do not 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 (2022a, 2022b), 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..."

Appendix

Data source

Countries: Euro Area 20; Germany; Italy; Portugal

- 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. Data Source: EUROSTAT.
- Public Debt on GDP. Constructed Variable. Quarterly Data. The ratio of cumulative Debt Quarter over Nominal GDP Year. Data Source: EUROSTAT.
- Total General Government Revenue on GDP. Constructed Variable. Quarterly Data. The Ratio of Total General Government Revenue (Annualized) over Nominal GDP Year. Data Source: EUROSTAT.
- Total General Government Expenditure on GDP. Constructed Variable. Quarterly Data. The Ratio of Total General Government Expenditure (Annualized) over Nominal GDP Year. Data Source: EUROSTAT.
- Monetary Surprises. Jaronciski and Karadi (2020). Shock aggregated quarterly, through the sum of the monthly shocks. Divided by their Standard Deviation.
- 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. Data Source: FRED.
- Real Gross Domestic Product. Millions of Chained 2010 Euros, Quarterly, Seasonally Adjusted. Variable taken in natural logarithm. Data Source: FRED.
- HCPI Growth. All Items. Index 2015 = 100, Quarterly. Seasonally Adjusted by Census-X13 (R Software). Data Source: FRED.
- Real Output Growth. Millions of Chained 2010 Euros, Quarterly, Seasonally Adjusted. Data Source: FRED.

Only positive surprises shock (monetary tightening)

The next figures show 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. Moreover, in this specification, we are able to capture the dynamics of the wealth effect through the pattern of output which increases in the less sustainable regime for Italy and Germany (smooth transition model).

See Figs. 12, 13, 14 and 15

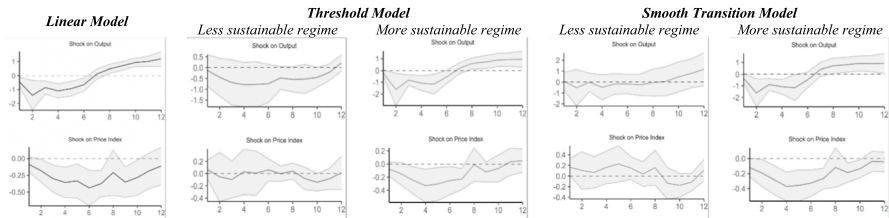


Fig. 12 Euro Area results (2003Q4–2021Q4), Bohn's rule. Only positive surprises. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

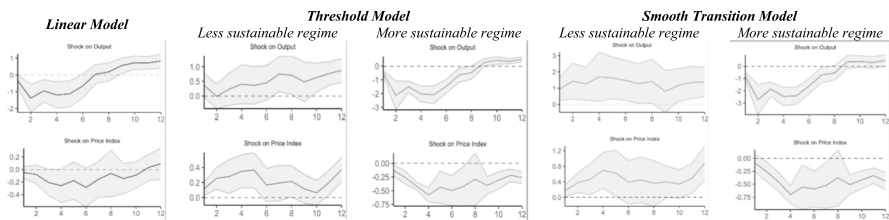


Fig. 13 Germany results (2001Q4–2021Q4), Bohn's rule. Only positive surprises. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

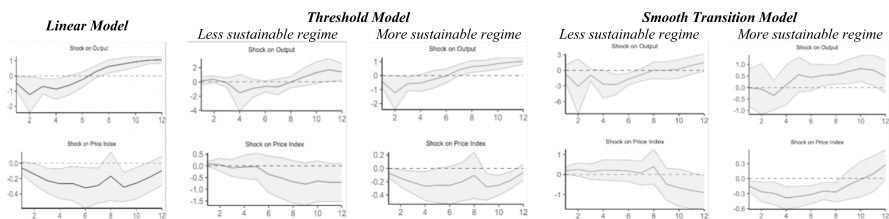


Fig. 14 Italy results (2001Q4–2021Q4), Bohn's rule. Only positive surprises. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

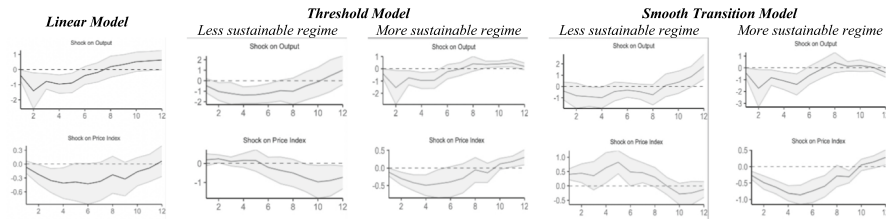


Fig. 15 Portugal results (2001Q4–2021Q4), Bohn's rule. Only positive surprises. *Note* The IRFs indicate the responses of real output and the price level to monetary policy surprises, for the 12-quarter forecast horizon. The gray bands indicate the 90 percent confidence interval. The linear model is not conditional on the new fiscal stance, while the second and third models represent the dummy/threshold approach and the smooth transition model, respectively

Acknowledgement We thank the editor and two anonymous referees for very useful suggestions. 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. The authors declare that they have no conflicts of interest, financial or otherwise, that could have influenced the research and findings presented in this paper. Any remaining errors or omissions are solely the responsibility of the authors.

Funding Open access funding provided by Università Commerciale Luigi Bocconi within the CRUI-CARE Agreement.

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