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Does monetary policy influence euro area fiscal sustainability?*

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António Afonso [$], Francisco Gomes-Pereira [#]

Abstract

This paper studies the impact of monetary policy on fiscal sustainability in the euro area. Our sample includes 12 euro area countries and covers the period from 2003:Q1 to 2022:Q4. We extend a fiscal reaction function (Bohn's rule) by including the monetary policy stance as an interaction term. Our findings are as follows: First, a contractionary (expansionary) monetary stance tends to lead to an increase (decrease) in the primary balance. Second, the ECB's monetary policy stance significantly influences the fiscal reaction function coefficient. In other words, contractionary monetary policy induces a larger increase in primary balances in response to an increase in the debt-to-GDP ratio than if monetary policy was neutral or expansionary. Our findings suggest that expansionary monetary policy has the potential to help fiscal sustainability, and potentially mitigate fiscal fatigue. Conversely, contractionary monetary policy can exacerbate the fiscal effort required to satisfy the government intertemporal budget constraint.

JEL: E52, E58, E63
Keywords: Monetary Policy Stance, Fiscal Sustainability, Debt Sustainability.

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1 Introduction

How did ECB's monetary policy influence fiscal sustainability in the euro area? While The ECB's mandate is price stability, fiscal policy reacts to shifts in monetary policy, which subsequently affects fiscal sustainability. In this paper, we contribute to the literature by exploring empirically how the ECB's monetary policy influenced debt sustainability. Specifically, we extend a fiscal reaction function (Bohn's rule) with a monetary policy stance interaction moderator term. When monetary policy is expansionary, it might allow governments to maintain a lower primary balance and potentially reduce fiscal fatigue. On the other hand, if monetary policy is contractionary, primary balances need to increase to maintain the debt trajectory sustainable.

The aftermath of the 2008-2009 Global Financial Crisis (GFC) and the sovereign debt crisis left euro area countries with large public debt relative to GDP from a historical perspective. This situation raised concerns about the fiscal sustainability of several member countries, particularly those with the highest levels of sovereign indebtedness. These concerns were further amplified by the relatively subdued economic growth in several euro area countries compared to other developed nations. Arguably, the difficulty in addressing the large debt levels stems from the European economic and monetary union (EMU) framework of common monetary policy and decentralized fiscal policy. This provides a significant challenge for achieving policy coordination. This issue is relevant because fiscal and monetary policies play a pivotal role in managing fluctuations inherent in the business cycle as they are the main tools of macroeconomic stabilization (Musgrave, 1973). Hence, fiscal sustainability becomes of particular importance under this framework. The occurrence of self-fulfilling debt crisis and adverse feedback loops underscores the necessity of maintaining coordinated policies.

Under the analysis of debt sustainability by Bohn (1998), a sustainable government will increase the primary balance to satisfy the intertemporal government budget constraint (IGBC). Specifically, an increase in the governments' debt-to-GDP ratio should be matched with future increases in the primary balance. Although the original fiscal reaction function model proposed by Bohn does not include monetary policy, we argue that it is an important component for these dynamics. The rate at which the debt is discounted could significantly influence the present value of the primary balance. Similarly to government debt, if the central bank's policy rate increases, a fiscally sustainable government will increase the primary balance to remain solvent. Under this scenario, and assuming fiscal policy acts "responsibly", monetary policy can exert a disciplinary effect on fiscal policy. Alternatively, expansionary monetary policy can increase the sustainable level of debt and ease the pressure on fiscal policy authorities. However, in the later situation, there could be questions regarding debt monetization and potentially place doubt on the price stability mandate.[1] There is a clear moral hazard issue if monetary policy is complacent with governments' increase in debt. However, monetary policy that is too restrictive can place unnecessary difficulty for governments repaying debt (De Grauwe, 2011).

The results obtained in this study, for 12 euro area countries, in the period frequency from 2003:Q1 to 2022:Q4, indicate that contractionary (expansionary) ECB's monetary policy stance tends to lead to an increase (decrease) in the primary balance of member countries. Furthermore, the interaction between the debt-to-GDP ratio and the monetary policy stance in the extended fiscal reaction function exhibits statistical significant coefficients. That is, when monetary policy is contractionary, primary balances increased more following an increase in the debt-to-GDP ratio than when monetary policy is neutral or expansionary. Conversely, when monetary policy is expansionary, the increase in the primary balances is not as pronounced following an increase in the debt-to-GDP ratio. These results suggest that contractionary monetary policy exerts a disciplinary effect on fiscal policy, while expansionary monetary policy goes together with more relaxed fiscal constraints. Overall, these results suggest that euro area countries conducted fiscal policy in a "responsible" manner, and are indicative of a Ricardian fiscal regime, or a monetary dominant regime. However, regarding the magnitude and significance of the coefficients obtained, our results show that expansionary monetary policy has larger and more significant results than contractionary monetary policy.

As a general understanding of these results, monetary policy that is more contractionary than necessary following an increase in the debt ratio could induce an unnecessary burden in public finances. On the other hand, expansionary monetary policy has the potential to increase the level of sustainable debt and decrease the risk of fiscal fatigue. As exposed in Willems and Zettelmeyer (2022), these dynamics are possible provided the central bank enjoys a certain degree of credibility. However, this power by the monetary authorities can give rise to conflicts of interest if the independent goals are not well defined or are perceived to have changed. If monetary policy is too

[1] This is linked to the possibility of non-Ricardian regimes, where money and prices would need to adjust to the level of government debt to guarantee the fulfilment of the government intertemporal budget constraint (passive monetary policy), see Buiter (2002).

expansionary, then public finances are allowed be less sustainable and could raise questions of goal independence.

This paper is organized as follows. Section 2 reviews the literature. Section 3 details the data used and the main econometric specifications. Section 4 reports the results. Lastly, section 5 concludes.

2 Related literature

This paper is related to the literature on fiscal sustainability, government debt sustainability, fiscal reaction functions, and fiscal-monetary policy interactions. In this strand of literature, governments are often characterized as following a Ricardian or a non-Ricardian fiscal regime (Aiyagari and Gertler, 1985; Woodford, 1995; Afonso, 2008 provide thorough descriptions). Under a Ricardian fiscal regime, the government guarantees the sustainability of its interest-bearing obligations by increasing the primary balance through increased tax revenue or reduced spending. In other words, government finances satisfy the intertemporal government budget constraint (IGBC). On the other hand, under a non-Ricardian fiscal regime, the level of government debt will have no influence in fiscal policy decisions. Another interpretation of this concept is classifying regimes as monetary dominant and fiscal passive, or vice versa (see for instance Sargent and Wallace, 1981; Leeper, 1991; Sims, 1994). Simply put, under a dominant monetary and passive fiscal regime, monetary policy is set to maintain inflation at a pre-determined level, independent of fiscal policy decisions and government debt levels. Consequently, fiscal policy adjusts to the constraints of monetary policy. Under a fiscal dominant regime, fiscal policy is determined irrespective of monetary policy. Under this regime, monetary policy and the price level will have to adjust to sustain higher levels of government debt and fiscal deficits. This situation is not desirable as it often leads to inflation and, eventually, to default.

Fiscal reaction functions are a common method for assessing government debt sustainability. Under this framework, it is a common empirical exercise to regress primary balances on government debt as percentage of GDP (See for instance Bohn, 1998; Canzoneri et al., 2001; Afonso, 2008). This method is usually referred to as the Bonh’s rule. This methodology allows for the evaluation of fiscal sustainability from the perspective of debt accumulation. It explains how governments react to the accumulation of debt and asks whether governments take corrective measures and act “responsibly”. In this paper, we extend this analysis by including the monetary policy stance variable as an interaction term. In this line of literature, another important detail is the difference between the interest rate on public debt (r) and the real growth of the economy (g). Blanchard (2019) suggests that the fact that $r<g$ signifies that governments can run primary deficits indefinitely and still maintain debt sustainability. The sustainability of debt is guaranteed by GDP growth.

Many researchers have proposed that expansionary monetary policy can be used to maintain fiscal sustainability and avoid self-fulfilling debt crisis. Bacchetta et al. (2018) discusses how monetary policy can impede self-fulfilling sovereign debt crisis through inflation surprises, output growth, and lower interest rates. Roch and Uhlig (2018) Proposes an actuarily bailout agency to restore sovereign yields back to fundamentals and avoid sunspot driven defaults. Alberola et al., (2022) argues that unconventional monetary policy, in particular the Pandemic Emergency Purchasing Programme (PEPP), substantially improved debt sustainability in the euro area for the countries with higher debt stock. For the case of Japan, Alberola et al. (2023) shows that unconventional monetary policy lowered sovereign funding costs, which, in turn, help improve debt sustainability. Cavalcanti et al., (2018), in a DSGE setting, argue that contractionary monetary policy increases public debt interest payment, therefore government need to have increasingly positive budget balances to guarantee debt sustainability. Afonso et al. (2023), using a fiscal reaction function for 35 OECD countries, in the period 1980-2021, report that higher inflation rates contribute positively to fiscal sustainability.

Interestingly, in the literature there are not many extensions of the Bohn's rule including a monetary policy variable. One exception is the study by Dascher-Preising and Greiner (2023), in which the authors estimate a fiscal reaction function incorporating a monetary policy variable to investigate its impacts on primary balances. Their findings indicate that monetary policy exerts a "disciplining effect" on fiscal policy. Willems and Zettelmeyer (2022) explore the link between government debt sustainability and central bank credibility and provide a comprehensive summary of this literature. The authors highlight that credible central banks have the ability to expand the boundary of sustainable debt and fiscal deficits and avoid self-fulfilling debt crisis. A credible central bank can influence macroeconomic variables such as the public debt interest rate and promote sustainability at higher levels of debt-to-GDP ratios. If a central bank has enough credibility, it can alleviate debt vulnerabilities when needed. Indeed, this assumption is a precondition for the hypothesis posed in this paper.

3 Empirical Strategy

3.1 Data

The data for this study was retrieved from the Eurostat and the ECB databases. We retrieved data for 12 euro area countries[2] at quarterly frequency from 2003:Q1 to 2022:Q4. We selected these 12 countries because most of them introduced the euro in January 2001 (except Greece that introduced the euro in January 2002). Therefore, this selection of countries will allow us to extend the period of our analysis. For the series available at monthly and daily frequency, we transform it to quarterly frequency by averaging the values that belong to each specific quarter. Government expenditure, total government revenues, and the primary balance, exhibit significant seasonality. To deal with this issue, we employ the same methodology as in Afonso and Coelho (2023) and average the variables in a 4-quarter rolling window. The rolling windows approach is calculated as follows $Y_{t,rw} = \frac{1}{4}\sum_{i=0}^{3} X_{t-i}$. To maintain consistency with this transformation, we employ the rolling windows approach to all variables. We use output gap as a control variable calculated using the Hendrick-Prescott filter with the smoothing parameter set to 1600. For the monetary policy stance, we use Krippner's shadow rate (Krippner, 2013) and the MRO rate. We considered the Krippner's shadow rate as an appropriate measure of monetary policy stance, as it includes the zero lower bound (ZLB) period and accounts for unconventional monetary policies. The list of variables, their source, and their transformations are reported in Table A1 in the Appendix. The primary balance as % of GDP (PB) is obtained by using the following calculation: PB = TR – TE + IE. Where the primary balance as % of GDP (PB) is equal to total government revenues as % of GDP (TR) minus total government expenses as % of GDP (TE) plus and total government interest expense as % of GDP (IE).

3.2 **Specifications**

To undertake our analysis, we extend the Bohn's rule by incorporating a monetary policy stance variable. With this approach, we study the influence of monetary policy on the primary balance and on the debt sustainability coefficient. We use a panel with 12 euro area countries and

[2] The countries included are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain.

estimate a fixed effects model with country fixed effects. To ensure the stationarity of the variables, we use the first differences of the primary balance, debt-to-GDP, and the monetary policy stance. Furthermore, using growth rates addresses potential baseline differences among countries. We estimate the following fiscal reaction function:

$$\Delta PB_{it} = \beta_1 \Delta GD_{it-4} + \beta_2 \Delta MPS_{t-s} + \beta_3 outgap_{it} + c_i + \varepsilon_{it} \qquad (1)$$

where *i* represents the country and *t* represents quarters. PB represents the primary balance as % of GDP, *outgap* represents the output gap. *GD* represents the debt-to-GDP ratio. C_i represents country fixed effects. *MP*S represents the monetary policy stance. As discussed, we consider two variables to capture the monetary policy stance, MPS. For conventional monetary policy, we use the MRO rate for the period from 2003:Q1 to 2015:Q4. We decided to end the period in 2015:Q4 because the MRO reached the ZLB in the beginning of 2016. For unconventional monetary policies we use Krippner's shadow rate for the period from 2003:Q1 to 2022:Q4. In the regression equations we include monetary policy at t=0 (s=0), at t-2 (s=2), at t-4 (s=4), and the average monetary policy stance from the change in the debt level to the current period, calculated as $\Delta MPS_{t,average} = \frac{1}{4}(\sum_{t=0}^{3} \Delta MPS_{t-i})$. These different approaches were used because the timing of changes in monetary policy can influence the response of the primary balance.

To understand how monetary policy interacted with the government debt, we estimate the following model:

$$\Delta PB_{it} = \beta_1 \Delta GD_{it-4} + \beta_2 \Delta MPS_{t-s} + \beta_3 outgap_{it} + \beta_4 (\Delta GD_{it-4} \times \Delta MPS_{t-s}) + c_i + \varepsilon_{it}. \qquad (2)$$

In Equation 2, we are mostly interested in the coefficients β_2 and β_4, which we expect to be positive. In other words, if monetary policy is contractionary and fiscal policy is "responsible", then we expect the primary balance to increase in larger magnitude following an increase in the debt-to-GDP ratio than if monetary policy is neutral or expansionary.

To provide further evidence of this mechanism, we define dummy variables for expansionary and contractionary monetary policy events. This approach enables us to distinguish the behavior of primary balances following an expansionary and a contractionary policy event as the impacts may be different. In other words, the response to monetary policy may not be symmetric. Given these hypotheses, we estimate the following equation:

$$\Delta PB_{it} = \beta_1 \Delta GD_{t-4} + \beta_2 MPS_t^e + \beta_3 MPS_t^c + \beta_4(\Delta GD_{t-4} \times MPS_t^e) + \beta_5(\Delta GD_{t-4} \times MPS_t^c) + \beta_6 outgap_t + C_i + \varepsilon_{it} \quad (3)$$

where MPS_t^e represents expansionary monetary policy events and MPS_t^c represents the contractionary monetary policy events. As before, the $MPS_t^{e,c}$ variables will take the form of the shadow rate ($SR\_av4_t^{e,c}$) for unconventional monetary policy and the marginal refinancing operations rate ($MRO\_av4_t^{e,c}$) for conventional monetary policy. For reasons of parsimony, we will only consider the average monetary policy stance since the change in debt to the current period as defined above ($\Delta MPS_{t,average}$).[3] These variables will be equal to one if the monetary policy stance crosses a defined threshold. We define two thresholds for our analysis. The first threshold is defined as a scenario where the change in the monetary policy stance is less than 0%. Using this threshold, we introduce an expansionary dummy variable as follows:

$$\Delta MPS_t^{E,<0\%} = \begin{cases} 1, if \ \frac{1}{4}(\sum_{t=0}^{3} \Delta MPS_{t-i}) < 0 \\ 0 \ Otherwise \end{cases}.$$

With this approach, we wish to test whether expansionary monetary policy events are related with lower primary balances compared to neutral and contractionary monetary policy.

To further explore the effects of monetary policy on the primary balance, we define a second threshold where a contractionary monetary policy event is defined as when the average quarterly change in the monetary policy stance changes are greater than or equal to 0.10%. Further, we define an expansionary monetary policy event if the monetary policy stance changes by less than or equal to -0.10%. These dummy variables will be compared to neutral monetary policy which is defined as when ΔMPS is smaller than 0.10% or larger than -0.10%. Specifically, we define a contractionary monetary policy event as follows:

$$\Delta MPS_t^{C,\geq 0.10\%} = \begin{cases} 1, if \ \frac{1}{4}(\sum_{t=0}^{3} \Delta MPS_{t-i}) \geq 0.10\% \\ 0 \ Otherwise \end{cases},$$

and we define an expansionary monetary policy event as follows:

$$\Delta MPS_t^{E,\leq -0.10\%} = \begin{cases} 1, if \ \frac{1}{4}(\sum_{t=0}^{3} \Delta MPS_{t-i}) \leq -0.10\% \\ 0 \ Otherwise \end{cases}.$$

[3] The variable is computed as follows $\Delta MPS_{t,average} = \frac{1}{4}(\sum_{t=0}^{3} \Delta MPS_{t-i})$.

With these dummy variables, we wish to test whether the changes in primary balances differ in periods following expansionary and contractionary monetary policy events compared to neutral monetary policy.

4 Results

In our analysis, Pesaran CD tests confirmed the presence of cross-sectional dependence in the estimated models. Additionally, the Breusch-Godfrey test confirmed the presence of serial correlation. Consequently, we used Driscoll Kray robust standard errors (Driscoll & Kraay, 1998).

Table 1, column 1, reports the fiscal reaction function with the debt ratio only, without the inclusion of a monetary stance variable. The results suggest that the euro area countries followed a Ricardian fiscal regime. That is, as the debt ratio increased, the primary balance also increased to guarantee debt sustainability. Columns 2-6 report the results with the inclusion of the monetary policy stance, in this case the shadow rate. The monetary policy stance exhibits a positive coefficient. In other words, the primary balance exhibits a positive (negative) reaction to a contractionary (expansionary) monetary policy. These results suggest that fiscal policy behaved in a "responsible" manner with respect to monetary policy. The contemporaneous shadow rate (ΔSR_t) is the only coefficient that is not statistically significant, which suggests that monetary policy influences fiscal policy with a lag. The output gap exhibits a positive coefficient which is aligned with the ex-ante expectations that governments would be collecting more taxes and paying less in social transfers and expenditures during growth periods.

Table 1 – The influence of the monetary policy stance, measured by the shadow rate, on the primary balance. The dependent variable is the primary balance (ΔPB_t).

Model: Fixed Effects **Period:** 2003:Q1-2022:Q4 **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4	5
ΔGD_{it-4}	0.223404***	0.219867***	0.227408***	0.234819***	0.2241***
	(0.041605)	(0.043273)	(0.040827)	(0.040224)	(0.041261)
ΔSR_t		0.214093			
		(0.174198)			
ΔSR_{t-2}			0.461138***		
			(0.155006)		
ΔSR_{t-4}				0.391552***	
				(0.14151)	
ΔSR_av4_t					0.511949**
					(0.211237)
$outgap_t$	0.213991***	0.202645***	0.190852***	0.198878***	0.187794***
	(0.034283)	(0.04157)	(0.035531)	(0.032327)	(0.038408)
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	960	960	960	960	960
Countries	12	12	12	12	12
Quarters	80	80	80	80	80
rsq	0.28634	0.28977	0.29948	0.29461	0.29835
adjrsq	0.27653	0.27924	0.2891	0.28416	0.28795

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

Table 2 – The impact of the monetary policy stance on the primary balance, including the interaction between the debt ratio and the monetary policy stance. The dependent variable is the primary balance (ΔPB_t).

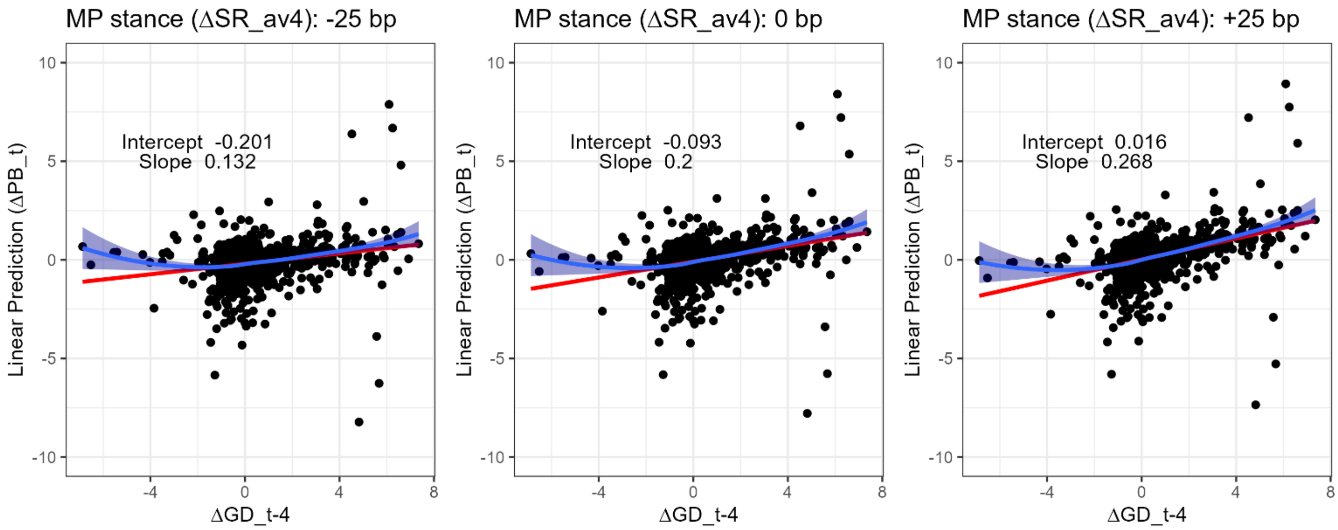
Model: Fixed Effects **Period:** 2003:Q1-2022:Q4 **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4
ΔGD_{it-4}	0.221785***	0.251669***	0.2352172***	0.241446***
	(0.044161)	(0.039508)	(0.0412638)	(0.042813)
ΔSR_t	0.200558			
	(0.164984)			
ΔSR_{t-2}		0.347234**		
		(0.156086)		
ΔSR_{t-4}			0.3881797**	
			(0.1673495)	
ΔSR_av4				0.435029**
				(0.18158)
$\Delta GD_{it-4} \times \Delta SR_t$	0.109152			
	(0.087974)			
$\Delta GD_{it-4} \times \Delta SR_{t-2}$		0.287263**		
		(0.116745)		
$\Delta GD_{it-4} \times \Delta SR_{t-4}$			0.0040723	
			(0.0862277)	
$\Delta GD_{it-4} \times$ ΔSR_av4				0.270617**
				(0.135963)
$outgap_t$	0.221785***	0.251669***	0.2352172***	0.241446***
	(0.044161)	(0.039508)	(0.0412638)	(0.042813)
Country FE	Yes	Yes	Yes	Yes
Observations	960	960	960	960
Countries	12	12	12	12
Quarters	80	80	80	80
rsq	0.29421	0.31752	0.29698	0.31201
adjrsq	0.28299	0.30668	0.28581	0.30108

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

Table 2 reports the results of Equation 2, that is the fiscal reaction function including the interaction between the government debt ratio and the shadow rate. Similar to Table 1, the results from Table 2 indicate that an increase in the debt ratio with a lag of 4 quarters (ΔGD_{it-4}) leads to an increase in primary balances, suggestive of a Ricardian regime. Generally, an increase in the monetary policy stance will also lead to an increase in the primary balance. Furthermore, if the monetary policy stance is expansionary (contractionary), the debt sustainability coefficient

($\Delta \mathrm{GD}_{\mathrm{it}-4}$) is smaller (larger). These results suggest that during periods of debt accumulation, accommodative monetary policy can significantly reduce the necessity of governments to increase primary balances to maintain debt sustainability and thus reduce the risk of fiscal fatigue. Conversely, if monetary policy is contractionary during periods of debt accumulation, it could place a greater strain on fiscal policy.

Figure 1 – Linear prediction of the primary balance given different monetary policy stances of the shadow rate.



Notes: *This figure plots the interaction between the debt ratio and the monetary policy stance (Krippner's shadow rate) from Equation 2. The red line represents a linear regression between the debt ratio at t-4 and the linear prediction of the primary balance. The blue line represents a loess curve with span parameter set to 0.9.*

Figure 1 helps to understand the effects of monetary policy on the growth of the primary balance following an increase in the deb-to-GDP ratio. Figure 1 shows the interaction between the debt ratio and the monetary policy stance, and their combined effect on the primary balance. When the monetary policy stance, in this case the shadow rate, [4] is -25 basis points, then the slope of regression line is 0.13. That is, when the government debt increases by 1%, primary balance increases by 0.13%. The slope increases as the monetary policy becomes contractionary. When monetary policy is +25 basis points, the primary balance increases by 0.27% following an increase of the debt ratio of 1%. Another interesting observation is that the linear relationship appears to break down when there is a significant reduction in the debt ratio. The loess curves (in blue in Figure 1) exhibit nonlinearity when the change in the debt ratio is very negative. This suggests that

[4] Calculated as $SR\_av4_t = \frac{1}{4}(\sum_{t=0}^{3} \Delta SR_{t-i})$.

the primary balance does not become negative when there is significant decrease in the debt ratio, instead it remains balanced.

Table 3 – Influence of the monetary policy stance, measured by the MRO rate, on the primary balance. The dependent variable is the primary balance (ΔPB_t).

Model: Fixed Effects **Period:** 2003:Q1-2015:Q4 **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4
ΔGD_{it-4}	0.224408***	0.256561***	0.258864***	0.252239***
	(0.051508)	(0.04958)	(0.05283)	(0.04796)
ΔMRO_t	0.922184***			
	(0.205163)			
ΔMRO_{t-2}		0.683186***		
		(0.203734)		
ΔMRO_{t-4}			0.329115**	
			(0.166169)	
ΔMRO_av4				0.950438***
				(0.238014)
$outgap_t$	0.131619***	0.157133***	0.181434***	0.14342***
	(0.035092)	(0.036407)	(0.039823)	(0.034402)
Country FE	Yes	Yes	Yes	Yes
Observations	624	624	624	624
Countries	12	12	12	12
Quarters	52	52	52	52
rsq	0.2225	0.21157	0.19841	0.21936
adjrsq	0.20462	0.19344	0.17998	0.20142

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

Table 3 reports the results with the MRO rate to account for conventional monetary policy. These results are similar to the results including the shadow rate as the monetary policy stance. However, the estimated MRO coefficients are larger, which suggests that the MRO rate influenced primary balances in a more substantial manner than the shadow rate. Monetary policy either induces the government to generate larger primary balances or allows governments to maintain lower primary balances in the case of expansionary monetary policy. The positive and statistically significant coefficients for the debt ratio and the MRO rate suggest that during this period, fiscal policy also acted in a "responsible" manner.

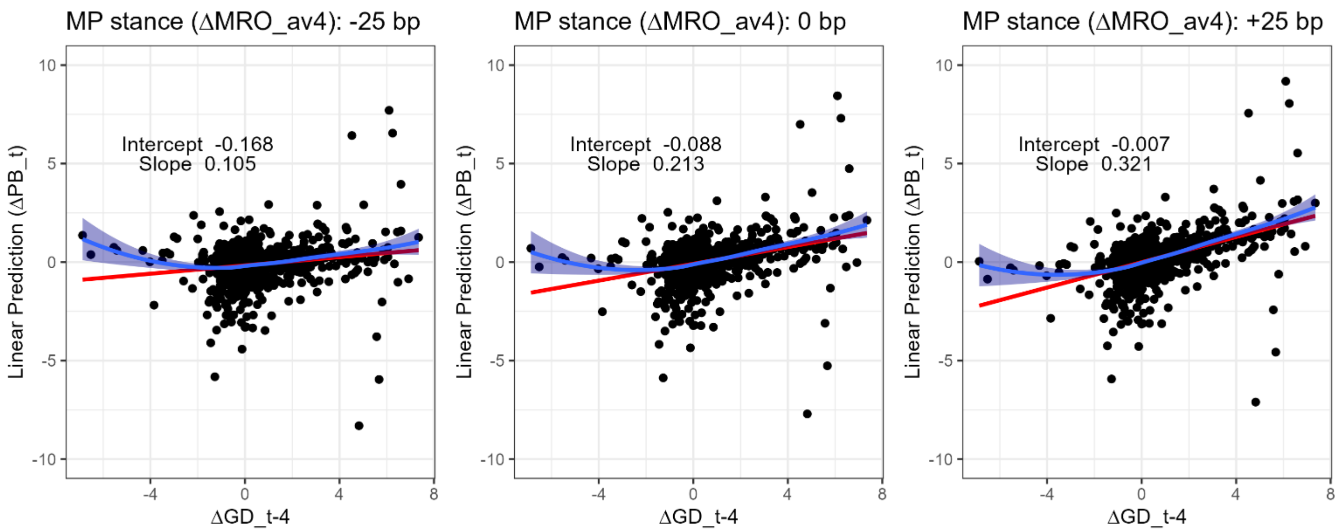
Table 4 – Influence of the monetary policy stance, measured by the MRO rate, on the primary balance and interacts the debt ratio with the monetary policy stance. The dependent variable is the primary balance (ΔPB_t).

Model: Fixed Effects **Period:** 2003:Q1-2015:Q4 **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4
ΔGD_{it-4}	0.253325***	0.287738***	0.283816***	0.297684***
	(0.055776)	(0.050674)	(0.053609)	(0.048178)
ΔMRO_t	0.864995***			
	(0.197906)			
ΔMRO_{t-2}		0.358394		
		(0.241356)		
ΔMRO_{t-4}			-0.012199	
			(0.223036)	
ΔMRO_av4				0.644152**
				(0.251805)
ΔGD_{it-4} x ΔMRO_t	0.456484*			
	(0.23967)			
ΔGD_{it-4} x ΔMRO_{t-2}		0.354871**		
		(0.163045)		
ΔGD_{it-4} x ΔMRO_{t-4}			0.266781**	
			(0.106442)	
ΔGD_{it-4} x ΔMRO_av4				0.506696***
				(0.19089)
$outgap_t$	0.1298***	0.152623***	0.17162***	0.138048***
	(0.456484)	(0.037542)	(0.041429)	(0.03548)
Country FE	Yes	Yes	Yes	Yes
Observations	624	624	624	624
Countries	12	12	12	12
Quarters	52	52	52	52
rsq	0.23451	0.22597	0.20918	0.23916
adjrsq	0.21562	0.20687	0.18967	0.22039

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

Table 4 reports the results of Equation 2, that is the fiscal reaction function including the interaction between the debt-to-GDP ratio and the MRO rate, accounting for conventional monetary policy. The results obtained in this table are similar to the results obtained including the shadow rate as the monetary policy stance. However, one notable difference is that the estimated coefficients have larger magnitude. This suggests that changes in the MRO rate were more effective as either a disciplinary tool for fiscal policy, or it provided greater relief for fiscal policy during the period under analysis (2003:Q1 to 2015:Q4).

Figure 2 – Linear prediction of the primary balance given different monetary policy stances of the MRO rate.



Notes: *This figure plots the interaction between the debt ratio and the monetary policy stance (MRO rate) from Equation 2. The red line represents a linear regression between the debt ratio at t-4 and the linear prediction of the primary balance. The blue line represents a loess curve with span parameter set to 0.9.*

Figure 2 plots the interaction between the debt ratio and the MRO rate. When the monetary policy stance variable[5] is -25 basis points, then the regression line is 0.10. As monetary policy becomes increasingly contractionary, the slope increases and primary balances become increasingly positive. When the monetary policy is +25 basis points, the slope becomes 0.32, which predicts that the primary balance as percentage of GDP would increase by 0.32% following an increase of 1% of debt-to-GDP ratio. Similar to the results with the shadow rate in Figure 1, this linear relationship appears to break down when there is a significant reduction in the debt ratio. The loess curves (in blue in Figure 2) exhibits nonlinearity when the change in the debt ratio is very negative.

[5] Calculated as $MRO\_av4_t = \frac{1}{4}(\sum_{t=0}^{3} \Delta MRO_{t-i})$

Table 5 - Influence of the shadow rate expansionary and contractionary dummy variable events, on the primary balance. The dependent variable is the primary balance (ΔPB_t).

Model: Fixed Effects **Period:** 2003:Q1-2022:Q4 **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4
ΔGD_{it-4}	0.224501***	0.339756***	0.220842***	0.261199***
	(0.040332)	(0.077)	(0.039798)	(0.060106)
$\Delta SR\_av4_t^{E,<0\%}$	-0.296345***	-0.217301***		
	(0.089268)	(0.076035)		
$\Delta SR\_av4_t^{E,\leq -0.10\%}$			-0.211782**	-0.155871
			(0.097101)	(0.098352)
$\Delta SR\_av4_t^{C,\geq 0.10\%}$			0.149682*	0.131065*
			(0.087788)	(0.076847)
$\Delta GD_{it-4} \times \Delta SR\_av4_t^{E,<0\%}$		-0.192114**		
		(0.088814)		
$\Delta GD_{it-4} \times \Delta SR\_av4_t^{E,\leq -0.10\%}$				-0.129014*
				(0.076862)
$\Delta GD_{it-4} \times \Delta SR\_av4_t^{C,\geq 0.10\%}$				0.052181
				(0.100389)
$outgap_t$	0.198719***	0.193525***	0.195475***	0.188972***
	(0.034988)	(0.036077)	(0.034743)	(0.034885)
Country FE	Yes	Yes	Yes	Yes
Observations	960	960	960	960
Countries	12	12	12	12
Quarters	80	80	80	80
rsq	0.3063	0.32792	0.30708	0.32255
adjrsq	0.29602	0.31725	0.29606	0.31032

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

The analyses thus far, though useful, were not able to inform whether the primary balance is more responsive to contractionary or expansionary monetary policy. We argue that this distinction is important in this context to understand whether monetary policy exerts a disciplinary effect or a relief effect on fiscal policy. It could be the case that primary balances are more reactive to expansionary monetary policy than contractionary monetary policy, or vice versa.

From Table 5, column 1, we can conclude that when the change in monetary policy is less than zero, on average, the change in the primary balance is significantly lower than when the shadow rate is greater than or equal to zero. From column 2, we see that the interaction term between the debt ratio and the shadow rate is negative and statistically significant. These results confirm the prior findings that expansionary monetary policy can ease fiscal constraints and allows governments to maintain lower primary balances given increases in the debt-to-GDP ratio. When monetary policy is expansionary, an increase in the government debt results in lower growth of the primary balance compared to when monetary policy is neutral or contractionary. In columns 3 and 4, we only consider expansionary or contractionary events if the monetary policy stance variable is greater than or equal to 10 basis points or less than or equal to -10 basis points respectively. In column 3, the coefficient for expansionary monetary policy is negative while it is positive for contractionary monetary policy, consistent with the prior results. However, the coefficients exhibit larger magnitude and significance for expansionary monetary policy. Altogether, this suggests that expansionary monetary policy was more effective at alleviating fiscal constraints than contractionary monetary policy at "disciplining" fiscal policy. In column 4, only the contractionary dummy variable and the interaction between the expansionary dummy variable and the debt-to-GDP ratio exhibit statistical significance. From this, we can conclude that expansionary monetary policy only affected the growth in primary balance when there is an interaction with the debt-to-GDP ratio and not independently. These results suggest that expansionary monetary policy can improve fiscal sustainability and eventually decrease the risk of fiscal fatigue. The contractionary dummy variable is also statistically significant, which suggests that primary balances increase following contractionary monetary policy events. However, using less restrictive standard errors, such as Newey-West standard errors for instance, provides statisticaly significant for most coefficients.

Table 6 - Influence of the MRO rate expansionary and contractionary dummy variable events, on the primary balance. The dependent variable is the primary balance (ΔPB_t).

Model: Fixed Effects **Period: 2003:Q1-2015:Q4** **Dep. Variable:** Change in Primary Balance (ΔPB_t)	1	2	3	4
ΔGD_{it-4}	0.255555***	0.344205***	0.2330383***	0.278527***
	(0.046402)	(0.078745)	(0.0486399)	(0.066714)
$\Delta MRO\_av4_t^{E,<0\%}$	-0.298887***	-0.236336***		
	(0.080266)	(0.084073)		
$\Delta MRO\_av4_t^{E,\leq -0.10\%}$			-0.3507685***	-0.247685*
			(0.1119139)	(0.131627)
$\Delta MRO\_av4_t^{C,\geq 0.10\%}$			0.0029082	0.035497
			(0.0857471)	(0.089493)
$\Delta GD_{it-4} \times \Delta MRO\_av4_t^{E,<0\%}$		-0.122978		
		(0.093889)		
$\Delta GD_{it-4} \times \Delta MRO\_av4_t^{E,\leq -0.10\%}$				-0.123479
				(0.103322)
$\Delta GD_{it-4} \times \Delta MRO\_av4_t^{C,\geq 0.10\%}$				-0.089792
				(0.122904)
outgap_t	0.176698***	0.178357***	0.1528577***	0.15446***
	(0.033595)	(0.034713)	(0.0369754)	(0.03574)
Country FE	Yes	Yes	Yes	Yes
Observations	624	624	624	624
Countries	12	12	12	12
Quarters	52	52	52	52
rsq	0.21264	0.21964	0.21534	0.22262
adjrsq	0.19454	0.20039	0.19598	0.20081

Note: *, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Driscoll Kray standard errors in parentheses.

Table 6 uses the MRO rate to account for conventional monetary policy. From column 1 and 2, we can conclude that monetary policy events that are lower than 0 basis points generate statistically significant lower primary balances, similar to the results reported in Table 5. However, when this variable is interacted with government debt (column 2) the coefficient is negative but not statistically significant. This could indicate that monetary policy did not significantly explain changes in primary balances following changes in government debt during this shorter period. Possibly, this result could be explained by the fact that prior to the sovereign debt crisis, sovereign debt risk was possibly less correlated with fiscal and debt sustainability and therefore did not exert a large influence on fiscal policy. Only the expansionary monetary policy dummy variable by itself exhibits statistical significance. The remaining dummy variables in columns 4 are not statistically significant coefficient. The interaction between the debt ratio and contractionary monetary policy events even suggests a negative value, very close to zero. Likewise, this could indicate that contractionary monetary policy did not exert much pressure on fiscal policy solvency during this period.

5 Conclusion

In this paper we have assessed how monetary policy influenced debt sustainability in the euro area, through the estimation of a fiscal reaction function (Bohn's rule) with the inclusion of a monetary policy stance variable. For conventional monetary policy, we use the MRO policy rate and considered the period from 2003:Q1 to 2015:Q4. For unconventional monetary policy we used the shadow rate (Krippner, 2013) and considered the period from 2003:Q1 to 2022:Q4.

Our results suggest that contractionary (expansionary) monetary policy induces an increase (decrease) in the growth of primary balances. Under the classic analysis of debt sustainability, this first result is intuitive as the sustainability of public finances is affected by the rate at which primary balances are discounted. Given this backdrop, monetary policy can exacerbate the fiscal effort required to satisfy the government intertemporal budget constraint. Secondly, we find that the ECB's monetary policy stance significantly influences the fiscal reaction function coefficient. When we interact the change in the debt-to-GDP ratio with the change in the monetary policy stance, our findings indicate that contractionary monetary policy induces a larger increase in primary balances in response to an increase in the debt-to-GDP ratio than if monetary policy was neutral or expansionary. This underscores the potential of monetary policy to reduce the fiscal effort needed to promote fiscal sustainability and decrease the risk of fiscal fatigue, particularly during periods of debt accumulation. Thirdly, our results seem to suggest that the impact on the primary balance is more significant for expansionary than for contractionary monetary policy. In other words, the primary balances decrease by a greater magnitude and significance following an expansionary monetary policy change than increase following a contractionary monetary policy change. This result is noteworthy as it suggests that in the euro area, monetary policy exerted a disciplining effect on fiscal policy, but its influence was greater in providing relief for fiscal policy. With regards to policy implications, the results obtained suggest that monetary policy has the potential to reduce the fiscal effort needed to guarantee debt sustainability, and therefore reduce rollover risk and avoid self-fulfilling debt crisis. Conversely, if monetary policy is more contractionary than necessary, it might place undue burdens on fiscal policy and increase these risks.

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Appendix

Data

Variables	Source	Source Code	Transformations/Own calculations
Krippner's Shadow Rate	https://www.ljkmfa.com/	N/A	Monthly data transformed to quarterly by averaging the values for the months that belong to each specific quarter. After that, a rolling windows approach was used.
Main Refinancing Operations (MRO) rate	ECB	FM.D.U2.EUR.4F.KR.MRR_RT.LEV	Daily data transformed to quarterly by averaging the values of each day that belong to each specific quarter. After that, a rolling windows approach was used.
Government debt (% of GDP)	Eurostat	Data code - gov_10q_ggdebt Sector - S13 Unit - PC_GDP na_item - GD	Rolling windows approach
Output gap	Eurostat	Data code - namq_10_gdp s_adj - SCA na_item - B1GQ Unit - CLV15_MEUR	Output gap calculated as the rolling windows of the log of output minus the rolling windows of the log of the output trend. Output trend is calculated with the Hodrick-Prescott filter with the smoothing parameter set to 1600.
Total Revenues (% of GDP)	Eurostat	Data code - gov_10q_ggnfa s_adj - NSA Sector - S13 Unit - PC_GDP na_item - TR	Rolling windows approach
Total Expenditures (% of GDP)	Eurostat	Data code - gov_10q_ggnfa s_adj - NSA Sector - S13 Unit - PC_GDP na_item - TE	Rolling windows approach
Interest Expenditures (% of GDP)	Eurostat	Data code - gov_10q_ggnfa s_adj - NSA Sector - S13 Unit - PC_GDP na_item - D41PAY	Rolling windows approach
Primary Balance (% of GDP)	Eurostat	N/A	Total Revenue - Total Expenditure + Interest Expenditure.

Notes: The rolling windows approach is calculated as follows: $Y_{t,rw} = \frac{1}{4}\sum_{i=0}^{3} X_{t-i}$