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The Interplay between Monetary and Fiscal Policies in the EU [*]

António Afonso [$] Alexandre Sousa [#]

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Abstract

We study the interactions between monetary and fiscal policies in the EU countries, for the period 1995-2019. Our results show notably that: i) the inflation rate has a relevant impact over the central banks' decision making; ii) the cyclically adjusted primary balance reacts positively to increases in the level of government debt; iii) monetary policy reaction functions do not seem to take into consideration the cyclically adjusted primary balance; iv) fiscal policy, via the cyclically adjusted primary balance, seem to be affected by the short-term interest rate in a negative way. The global economic and financial crisis impacted negatively both the short-term nominal interest rates and the cyclically adjusted primary balance, however with a higher degree in the euro area.

KEYWORDS: Monetary Policy, Fiscal Policy; Reaction Functions; Great Recession.
JEL CODES: E52; E62; E63; E65; H62.

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"We need to reflect on is **interactions between monetary and fiscal policies**. When central banks have to use balance sheet policies extensively, there is an inevitable strengthening of the interplay between monetary and fiscal policies. This interaction works both ways." Lagarde (2020).

1. INTRODUCTION

Monetary policy relates to all the actions and measures that central banks devise and implement in their aim to fulfil their mandate and mission of notably price stability. In their pursuit to achieve their goal, central banks rely on open market operations, reserve requirements and discount rates. By contrast, governments decided and implement fiscal policy. via changes in the composition of a country's government expenditure and revenues, with the objective of influencing macroeconomic conditions and fostering economic activity.

Over time, the historical effectiveness of monetary policy as a means to overcome crises or boost activity in the financial sector (hence transmitting its effects to the real economy) relegated fiscal policy to a second place. Monetary policy does not have an implementation lag as big as that of fiscal policy, influencing economic conditions quickly and effectively.

However, it would be amiss to dissociate the study of these two policies: the success of monetary policy depends on fiscal sustainability and the value of government's liabilities can be influenced by the price level. For that reason, studying the effects that each of these policies have on one another becomes important, in order to understand how each of the authorities (monetary and fiscal) affects the economy separately and jointly.

The economic and financial crisis of 2007-2009 put a spotlight on the interactions between monetary and fiscal policies. In their attempts to counter the effects of the crisis, central banks around the world eased monetary conditions, lowering interest rates, and supplying abundant liquidity to the banking sector. The constraints imposed by the zero lower bound led central banks to the implementation of so-called unconventional monetary policy. Despite all the efforts, these measures did not yield sufficient results, and governments were required to step in and play a more significant role. Several countries adopted expansionary packages, with the intention of avoiding even worse macroeconomic consequences and helping economic activity to recover. These decisions led governments to face historically high budget deficits and debt levels in the aftermath of the crisis.

The European Union (EU) is an interesting case study when it comes to the effects of the policy mix: the twenty-eight Member States represent a highly heterogeneous pool due to their levels of indebtedness, growth and inflation rates, among others. In addition, we can identify two sub-groups: one whose members are those countries that adopted the euro as their currency (euro-area countries), and another one for those countries which decided to maintain their national currency (non-euro area countries). In non-euro area countries, the corresponding national central bank operates as ultimate monetary authority, implementing their policy based on national objectives. Fiscal policy is also the national government's prerogative. In the case of the euro area, the European Central Bank (ECB) is the authority in the design and implementation of monetary policy (being part of the Eurosystem), while each country is responsible for its fiscal decisions. This leads to a situation where, in the countries that use the euro as their currency, there is a one-size-fits-all monetary policy. Studying how this common policy interacts with the country-specific fiscal policies is of great interest.

In this paper, we use an empirical approach to analyse monetary and fiscal policies interactions in the EU. For that, we perform a panel data analysis with data from the twenty-eight countries that belong to the EU. Our data covers the period between 1995 and 2019, and also look at potential differences in the way monetary and fiscal policies were pursued prior and after the 2007-2009 crisis.

Our results suggest that monetary policy strongly reacts to the inflation rate, while not taking into consideration the cyclically adjusted primary balance. On the other hand, fiscal authorities seem to be concerned with the public finances, since the cyclically adjusted primary balance reacts positively to the debt level, a rather Ricardian result. Moreover, there is evidence that the relation between monetary and fiscal policies is of substitutability, as the monetary authority seems to be dominant when the cyclically adjusted primary balance is more pronounced.

This paper is organised as follows. Section 2 provides a review of the related literature. Section 3 describes the data used in this study and the adopted econometric approach. Section 4 provides an empirical assessment to monetary policy, fiscal policy and the policy mix, including the functions used and the discussion of the results. Section 5 concludes.

2. LITERATURE REVIEW

2.1. Theoretical Background

There has been a sustained belief in economics that inflation is solely a monetary phenomenon. This convention stems from the quantity theory of money, according to which

price stability is achieved through the commitment of the central bank to such objective. Through the intertemporal government budget constraint, we can understand both this explanation as well as a disputing one. The constraint is expressed as follows:

$$\frac{B_t}{P_t} = \sum_{s=0}^{\infty} \frac{s_{t+s}}{(1+r)^{s+1}} \quad (1)$$

where B_t is the outstanding nominal government debt in period t, P_t is the price level in period t, s_t is the real primary budged balance at period t and r is the real interest rate. Taking into consideration Equation (1), the monetarist doctrine defends that the constraint should restrict the expenditure and revenue policies implemented by the government. This said, those policies must be adjusted, so that for any P_t, Equation (1) holds. Hence, when the relation is not in equilibrium, the government is the one that must adjust its policies, through revenues or expenses, in order to restore the equality. Authors such as Friedman and Schwartz (1963) perpetuated this theory.

However, toward the end of the twentieth century, the belief that both monetary and fiscal policy play an important role in the determination of the price level increased. Sargent and Wallace (1981) were the first authors to explore the idea of a policy mix, concluding that, in a situation where the fiscal authority establishes its policies without taking into consideration the decisions made by the central bank, the monetary authority may be forced later on to accept a price level higher than desired.

After Sargent and Wallace's work, some other authors, notably Leeper (1991), Sims (1994), and Woodford (1995) went a step further and defended a less orthodox view, which was encapsulated in the so-called Fiscal Theory of the Price Level (FTPL), that contradicted the quantity theory of money. According to this theory, Equation (1) does not constrain the government policy making, since there is nothing obliging it to do so. Instead, when the equality in (1) is disturbed, the consequence is a change in the price P, so that the equilibrium is restored.

According to Leeper (1991), monetary and fiscal policies may have active or passive roles. The author presented two scenarios: one in which there is an active monetary policy and a passive fiscal policy (and hence the government decision making takes into consideration debt shocks). On the other hand, in another scenario, the shocks in the debt level affect money creation, meaning that monetary policy has a passive role, while fiscal policy is not constrained by the debt evolution, displaying an active behaviour.

Sims (1994) defended that monetary policy, by itself, is not sufficient to determine the equilibrium price level, since fiscal policy also plays an important role. The author stated that the value of fiat money depends on how the public sees the soundness of fiscal policy. This said, the decision making of the government has a direct effect over the price level, which depends on the perception that agents have over the fiscal policies being implemented.

In turn, Woodford (1995) criticised the quantity theory of money arguing that this view is incomplete, since it does not consider the effect of fiscal policy over the price level. Contrarily, the price level is relevant in the government decision making because it changes the real value of net government liabilities. Hence, Woodford established two policy regimes regarding the determination of the price level: the Ricardian and the non-Ricardian regimes. On the one hand, in the Ricardian regime, in which the quantity theory of money stands correct, the government has no effect over the determination of the price level. Regarding this regime, the author stated, "such regimes represent a highly special case, for there is no reason why a well-formulated policy rule must force to hold, regardless of the path of the price level." On the other hand, the non-Ricardian regime is characterised by a government that is not constrained by the evolution of the public debt, and hence is not following a Ricardian policy. In this situation, the central bank must adjust its monetary policy, so that the intertemporal budget constraint is met.

The topic of the interactions between monetary and fiscal policies gained renewed importance with the Great Recession. As Blanchard et al. (2010) stated, during the financial crisis, because of the zero-lower bound, conventional monetary policy became ineffective and most central banks in developed countries turned into unconventional policies, that went from quantitative easing to target easing and new forms of liquidity provision. However, monetary policy was reaching its limits and the need to rely on fiscal policy rose. Moreover, since the crisis was expected to last, fiscal policies would be beneficial, even with the lags associated with it.

Furthermore, Blanchard et al. (2013) suggested new solutions for the after-crisis. For central banks' decision making it is proposed that they should also target financial stability and economic activity, while performing forward guidance, so that they are able to influence market expectations. In fact, the authors stated that there is evidence that forward guidance announcements have an economic impact, and that, while other unconventional monetary policy tools may end up being unnecessary, forward guidance is here to stay. Regarding fiscal policy, Blanchard et al. (2013) highlighted the important aspect of the risk of fiscal dominance. This risk is caused by the need for difficult fiscal adjustments, leading the government to put

pressure on the central banks to help limiting borrowing costs, hence jeopardising the central bank independence.

2.2. Empirical Research

The existing literature on the topic focuses especially on the individual reaction functions of monetary and fiscal policies. Nevertheless, some authors also studied the interaction between these policies, besides the single effects.

Regarding the monetary policy reaction function, most of the literature takes interest rates as the main variable. Taylor (1993) proposed a monetary policy rule in order to control the inflation rate, which is known as the Taylor rule. According to this rule, central banks should increase interest rates when inflation is high or when there is a positive output gap. Several central banks around the world used the logic of the Taylor rule and its effectiveness has been assessed several times.

Gerlach and Schnabel (2000) showed that, between 1990 and 1998, for the countries that afterwards adhered to the euro area, the monetary policy reaction function proposed by Taylor (1993) is a good fit. The authors state that the ECB could use the Taylor rule to conduct its monetary policy. Gerdesmeier and Roffia (2003) corroborated these results, but found that when adding M3, the broadest monetary aggregate, and the fluctuations of stock prices, the accuracy of the model increases. Furthermore, Ruth (2007) estimated an interest rate reaction function, for the euro area, using panel data, finding that the ECB only deviated from the interest rate path when there was area-wide inflation.

Taking fiscal policy, and its long-run stability, into consideration, studies focus, essentially, on two indicators: the debt stock level and the primary balance flow. To assess fiscal policy feedback rules in the United States of America (USA), Favero and Monacelli (2003) estimated Markov-switching regression methods, for the period between 1960 and 2002. The authors found that the regimes are not fixed throughout time, changing from a non-Ricardian regime, from the 1960s throughout the 1980s, to a Ricardian regime afterwards. Sala (2004) made an analysis, also for the USA, and for the same period as Favero and Monacelli (2003) and by performing a Vector Autoregressive (VAR) analysis observed that between 1960 and 1979 there is evidence of a non-Ricardian regime and that from 1990 onwards there seems to exist a Ricardian regime. Moreover, Sala (2004) stated that between 1982 and 1990 there is no fiscal regime defined. During this period, the central bank was implementing measures to reduce inflation, but the government was not responding to those policies.

Afonso (2008) tested whether regimes in the EU-fifteen countries are Ricardian or non-Ricardian by using panel data, for the period between 1970 and 2003. The results showed that, during that period, there is evidence of the presence of Ricardian fiscal regimes, since the budget balance reacts to the debt level. The author also found evidence that the higher the indebtedness of the country, the higher the fiscal policy effort to deliver a surplus. To study the fiscal policy behaviour in Japan, the USA and the United Kingdom (UK), Ito et al. (2011) estimated a Markov-switching model by the Bayesian method, spanning more than a century for all the countries. The authors observed that, while in Japan there is a stochastic switch between Ricardian and non-Ricardian regimes, for the USA and the UK there is evidence that the fiscal policy presented a Ricardian Regime.

Concerning the interactions between monetary and fiscal policies, Semmler and Zhang (2004) implemented a State-Space model with Markov-switching for France and Germany and found that, for those countries, the interactions between the two policies were not strong, contrariwise they were countercyclical for the period under analysis. Cevik et al. (2014) achieved similar results, when performing a joint transition matrix for the two policies, for some emerging European economies, between 1995 and 2010.

Davig and Leeper (2011) performed Markov-switching monetary and fiscal policy rules, for the USA, concluding that the regimes fluctuate throughout time, between active and passive, but that the periods with a passive monetary policy tend to last more. Also for the USA, Bianchi and Ilut (2017) used a Markov-switching Dynamic Stochastic General Equilibrium (DSGE) model to understand the policy mix, concluding that the fiscal regimes change from passive to active throughout time. Moreover, the authors found that when fiscal policy is active, a fiscal imbalance leads to a lasting increase in the price level, while the monetary authority has no power over inflation. Hence, the decision making of the central bank is only going to be effective, and have influence over the price level, when the fiscal authority takes those decisions in consideration.

Afonso and Toffano (2013) assess the existence of fiscal regime shifts in the U.K., Germany, and Italy, using Markov switching fiscal rules, respectively for the periods, 1970:4-2010:4, 1979:4-2010:3, and 1983:3-2010:4. They report that While in the UK “active” and “passive” (Leeper, 1991) fiscal regimes are somewhat clearer cut, in Germany fiscal regimes have been overall less active, supporting more fiscal sustainability. For Italy, a more passive fiscal behaviour is uncovered in the run-up to EMU.

To evaluate the policies interactions, Afonso et al. (2019) estimated a monetary authority function with fiscal variables and a fiscal authority function with monetary variables. The authors used a panel data set, with a time span from 1970 to 2015, of the twenty-eight EU countries. The authors concluded that central banks do not react to fiscal policy, acting passively, and that the primary balance reacts positively to government debt, however with a lower impact than the one that exists when considering the fiscal individual reaction functions.

Regarding the effect that de Great Recession had over monetary and fiscal policies, Mitreska et al. (2010) concluded that with the financial crisis there were a lot of tools that were implemented by central banks and governments and that the policy mix might have been affected by those stimuli. The authors find that this change is stronger in developed countries, in which the fiscal policy had a larger impact during the crisis.

Alcidi and Thirion (2016) studied the policy mix for the euro area, the USA and the UK, in the periods before and after the financial crisis. Their main conclusions were that from 2000 to 2015, the interaction between monetary and fiscal policies appeared to be different in the euro area relative to the USA. For instance, because of unconventional monetary policy measures, the inverse relationship between interest rates and inflation is not so relevant in the after-crisis period since the interest rate stopped being a good proxy for monetary policy. Concerning fiscal policy, the euro area had a more conservative procedure because of fiscal rules, the shock of sovereign crisis and the fiscal cost that most governments had after the support given to financial institutions.

Silva and Vieira (2017) used panel data for advanced and developing economies and estimated a Generalized Method of Moments (GMM) model for two periods: before the financial crisis (from 2001 to 2008) and after (from 2009 to 2012). For the monetary policy reaction function, the authors concluded that when there is a change in inflation, the central bank policy is going to have the same sign, and that this relation did not change with the financial crisis. However, for most advanced economies, this policy is not pursued through a change in the nominal interest rate, because of the zero lower bound, but through unconventional monetary instruments. For the fiscal policy reaction function, Silva and Vieira (2017) concluded that prior to the crisis, the higher the budget balance in one period, the lower the government expenditure in the following period. However, this relation ceased to exist after the financial crisis, in the case of advanced economies, where the use of fiscal policy gained a major role as a macroeconomic policy tool.

3. DATA AND ECONOMETRIC APPROACH

In our analysis we use annual data from 1995 to 2019, for the 28 countries that belong to the European Union. We can split these countries into two groups, the ones that belong to the euro area – Austria, Belgium, Cyprus, Estonia, France, Finland, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain, and the ones that did not adopt the common currency – Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, and the United Kingdom.

The data used in this study is from the European Commission AMECO database. The dataset includes the following variables: cyclically adjusted primary balance (*capb*); debt ratio (*debt*); short-term nominal interest rate (*i*); long-term nominal interest rate (*il*); real effective exchange rate (*reer*); inflation rate (π), measured as the instantaneous growth rate of the Harmonized Consumer Price Index (HCPI).

Moreover, to assess the impact of the financial crisis on the implementation of monetary and fiscal policies, and the interaction between them, a dummy variable for the after-crisis period (from 2009 to 2019) was created.

Table 1 reports the descriptive statistics of the variables used in the analysis. The description of the data being used is presented in the Appendix.

Table 1 –Descriptive Statistics for the full sample: 1995-2019

	Obs.	Mean	Std. Dev.	Min.	Max.
capb	700	0.064	3.240	-29.233	9.565
debt	693	56.656	33.440	3.766	181.212
i	663	4.037	7.305	-0.500	80.750
il	614	4.367	2.654	-0.250	22.500
reer	700	98.672	15.480	29.986	170.322
inf	676	1.327	2.332	-0.741	40.643

The analysis estimate unbalanced panel data specifications, with cross-sectional and a times series dimensions.

The methodologies being applied are the Ordinary Least Squares (OLS), the Two-stage Least Square (2SLS) and the GMM models. Using OLS with panel data may lead to heterogeneity bias, if the unique errors are correlated with the independent variables. Therefore, we also resort to 2SLS, which allows us to deal with endogeneity, the problem of omitted variables bias, and hence unobserved heterogeneity, by using instrumental variables. Two

conditions must be satisfied, so that we have a relevant instrument: it must not have partial effects over the dependent variable and needs to be uncorrelated with the omitted variables (Wooldridge, 2016). In this work, one-period lag independent variables are used as instruments. In order to decide between fixed and random effects, we run a Hausman (1978) test. This allows us to test whether the unique errors are correlated with the regressors, being the null hypothesis that they are not. Hence, if we reject the null hypothesis (that the preferred model is random effects), we use fixed effects.

Moreover, we also estimated a two-step system GMM. Besides taking into consideration the time series dimension of the data, this method also treats the explanatory variables as being endogenous and deals with non-observable effects (Verbeek, 2014). In order to test the validation of the instruments being used, we resort to the Hansen (1982) statistic. We also test for the presence of second order autocorrelation of the error term, by looking at the AR(2). Because of the mentioned characteristics, we give priority to the GMM method for the EU and to the 2SLS[1] method when considering the euro area and non-euro area sub-groups.

4. EMPIRICAL ANALYSIS

The empirical analysis of is divided into 4 different parts. Firstly, we estimate, separately, the individual reaction functions for monetary policy and for fiscal policy. Afterwards, in order to observe the interactions between the two policies, we estimate the same regressions as for the individual authorities, but with a difference: while the monetary policy reaction function includes a fiscal variable, the fiscal policy reaction function will feature monetary variables.

4.1. Monetary Policy Reaction Function

Most of the existent literature on the analysis of monetary policy follows the Taylor rule, where the interest rate is the monetary instrument. We follow the same strategy, and we will focus our analysis in the conventional monetary instruments. Hence, the monetary policy regression is given by the following expression:

$$i_{jt} = a + \beta_j + \beta_1 i_{jt-1} + \beta_2 \pi_{jt} + \beta_3 reer_{jt} + \beta_4 aftcri_{jt} + \mu_{it} \qquad (2)$$

[1] The GMM is not useful when considering the sub-groups, since the instruments largely outnumber the number of groups.

where the index j (j = 1,2,...,J) represents the country, the index t (t = 1,…,T) denotes the period, i is the short-term nominal interest rate, π is the inflation rate, *reer* is the real effective exchange rate and *aftcri* a dummy variable that takes the value 1 when t is between 2009 and 2019 and 0 otherwise. Moreover, $\beta_{j,}$ stands for the country fixed effects μ_{jt} are the independent disturbances across countries.

In Table 2 the estimated results for regression (2) are presented. Regarding the EU, all the variables, besides the real effective exchange rate, are statistically significant at a 1% level. Both the one-period lagged nominal interest rate and the inflation rate have a positive impact over the nominal interest rate however with different magnitudes.

Table 1 - Monetary Policy Reaction Function

Method Group	OLS-FE EU	OLS-RE Euro Area	OLS-RE Non-Euro Area	2SLS-RE EU	2SLS-RE Euro Area	2SLS-RE Non-Euro Area	GMM EU
Constant	1.478**	1.329***	-0.693	-1.112*	0.355	-3.823	1.520
	(0.713)	(0.484)	(1.353)	(0.620)	(0.587)	(2.752)	(1.533)
i_{jt-1}	0.566***	0.632***	0.543***	0.578***	0.547***	0.560***	0.595***
	(0.018)	(0.024)	(0.0289)	(0.044)	(0.035)	(0.139)	(0.023)
inf_{jt}	1.163***	0.636***	1.296***	1.144***	1.006***	1.235**	1.066***
	(0.052)	(0.078)	(0.087)	(0.166)	(0.146)	(0.530)	(0.075)
$reer_{jt}$	-0.012	-0.007	0.012	0.014**	0.002	0.043	-0.012
	(0.007)	(0.004)	(0.014)	(0.006)	(0.005)	(0.028)	(0.016)
$aftcri_{jt}$	-0.950***	-1.181***	-0.940**	-1.042***	-1.266***	-1.017**	-0.924***
	(0.160)	(0.144)	(0.400)	(0.154)	(0.160)	(0.430)	(0.174)
N	633	437	196	605	418	187	633
R^2	0.917	0.840	0.936	0.917	0.814	0.939	-
countries	28	19	9	28	19	9	28
Hausman prob.	0.013	0.410	0.650	0.521	0.928	0.999	-
AR(2)	-	-	-	-	-	-	0.513
Hansen stat.	-	-	-	-	-	-	0.245

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.

While an increase of 1% in the lagged interest rate leads to a rise of 0.595% in the interest rate, rising the inflation rate by 1% soars the dependent variable by 1.066%. When looking at the after-crisis period, the interest rates are, on average, 0.924% lower than in the period between 1995 and 2008. This outcome was predictable since most countries have been dealing with low inflation rates, leading to central banks responding with low interest rates.

Comparing the results for the euro area and the non-euro area countries, it is possible to observe that the real effective exchange rate is still the only variable that it is not statistically significant. Regarding the one-period lagged nominal interest rate, the effect on both zones is

similar. However, when looking at the inflation rate, there seems to exist evidence that when it changes, it has a higher impact on the interest rates of non-euro area countries than in euro area ones. Concerning the after-crisis period, the coefficients are negative, and higher for the countries that use the euro, suggesting that the ECB lowered the interest rates more aggressively than the other national central banks. In fact, while in the euro countries the nominal interest rates decreased, on average, 1.266% in the postcrisis, in the other EU countries they only decreased by 1.017%, on average. Notably, the R^2 lowers when analysing only the euro area countries, suggesting that the interest rate in that area was more affected by variables that are not captured in the model.

Our results regarding the implementation of monetary policy are coherent with those found by Wolters (2012) and Silva and Vieira (2017).

4.2. Fiscal Policy Reaction Function

Regarding the fiscal policy reaction function, the dependent variable is normally the primary budget balance. It looks logical that, if countries want to reduce their public debt stock, there is the need to deliver, at least, primary surpluses. In this study, the fiscal policy reaction function suggested by (Afonso, 2008) is followed and adapted as follows:

$$capb_{jt} = a + \beta_j + \beta_1 capb_{jt-1} + \beta_2 debt_{jt-1} + \beta_3 aftcri_{jt} + \mu_{it} \quad (3)$$

where the index j (j = 1,2,...,J) represents the country, the index t (t = 1,0,...,T) denotes the period, *capb* is the cyclically adjusted primary balance, *debt* is the percentage given by the ratio of government debt over potential output and *aftcri* a dummy variable that takes the value 1 when t is between 2009 and 2019 and 0 otherwise. Moreover, β_j, stands for the individual effects for each country j and $\mu_{j,t}$ are the independent disturbances across countries.

Besides analysing the effect of the level of public debt over the cyclically adjusted primary balance, we also want to assess how a variation of the public debt affects that same dependent variable. That said, we use Equation (3), substituting the debt level by the variation of the public debt. The new equation is given by:

$$capb_{jt} = a + \beta_j + \beta_1 capb_{jt-1} + \beta_2 \Delta debt_{jt-1} + \beta_3 aftcri_{jt} + \mu_{it}. \quad (4)$$

The results from the estimation of regression (3) are presented in Table 3 (and of Equation (4) are in Table A2 in the Appendix). Firstly, starting with the results for Equation (3) and looking at the EU, we can observe that all variables are statistically significant at a 1% level. The cyclically adjusted primary balance seems to be positively impacted by its one-period lag, rising by 0.666% when the lagged one increases by 1%. Regarding the one-period lagged debt level, we can state that when it rises by 1%, the cyclically adjusted primary balance increases by 0.0016%. Since a rise in the debt level leads to an increase in the cyclically adjusted primary balance, we can assume that the EU, as a whole, follows a Ricardian fiscal regime, maintaining a stable financial situation. According to the results, the years after the Great Recession had a negative impact over the cyclically adjusted primary balance, lowering it by 0.966% on average.

Table 2 - Fiscal Policy Reaction Function

Method Group	OLS-FE EU	OLS-FE Euro Area	OLS-FE Non-Euro Area	2SLS-FE EU	2SLS-FE Euro Area	2SLS-FE Non-Euro Area	GMM EU
Constant	-2.168***	-2.895***	-1.171***	-2.591***	-3.254***	-1.689***	-0.378
	(0.295)	(0.417)	(0.360)	(0.317)	(0.446)	(0.392)	(0.252)
$capb_{jt-1}$	0.605***	0.611***	0.593***	0.629***	0.664***	0.548***	0.666***
	(0.029)	(0.035)	(0.049)	(0.045)	(0.054)	(0.077)	(0.032)
$debt_{jt-1}$	0.051***	0.062***	0.035***	0.059***	0.068***	0.047***	0.016***
	(0.006)	(0.008)	(0.008)	(0.006)	(0.008)	(0.010)	(0.004)
$aftcri_{jt}$	-1.433***	-1.859***	-0.829***	-1.499***	-1.870***	-0.941***	-0.966***
	(0.195)	(0.268)	(0.254)	(0.220)	(0.301)	(0.286)	(0.202)
N	665	456	209	637	437	200	665
R^2	0.501	0.500	0.536	0.520	0.512	0.565	-
Countries	28	19	9	28	19	9	28
Hausman prob.	0.000	0.000	0.000	0.000	0.000	0.000	-
AR(2)	-	-	-	-	-	-	0.809
Hansen stat.	-	-	-	-	-	-	0.252

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.

Now looking at the Equation (4), it is possible to observe that the variation of public debt is the only statistically significant at a 1% level[2]. If we compare the results above stated, for regression (3), with the ones estimated for this specification we can state that the Great Recession seems to have no effect this time. However, governments react to both the cyclically adjusted primary balance from the previous year and the variation of the debt level. In fact, a

[2] In this situation we will resort to the 2SLS method, since the Hansen statistics for the GMM is too high to be considered accurate (Roodman, 2009).

positive variation of public debt of 1% leads to a decrease of 0.467% on the cyclically adjusted primary balance.

Regarding regression (3) and observing the two sub-groups, the euro area and the noneuro area countries, all variables continue to be statistically significant at a 1% level, with some differences arising between the two areas. There seems to exist evidence that the cyclically adjusted primary balance is positively affected by its lag with a higher impact in the euro area than in the non-euro area countries. Concerning the lagged debt level, its coefficient is slightly higher in the euro area: when it rises by 1%, it leads to an increase of 0.068% in the cyclically adjusted primary balance, comparing with an increase of 0.047% for the non-euro area countries.

Concerning the post-crisis period, it is clear that its negative impact was substantially higher in the countries that adopted the euro. In fact, that decrease in euro area countries was on average of 1.870%, almost double than in countries that did not adopt the euro, that suffered a decrease of 0.941%, on average. This information fits together with the countries that had sovereign debt crisis (e.g. Portugal, Ireland and Greece) that were mostly members of the euro area.

Looking again at Equation (4), it is possible to observe that, for both euro and noneuro countries, the only variable that is statistically significant at a 5% level is the variation of public debt. Comparing these estimations with those of regression (3) we can state right ahead that the financial crisis had no impact over the relations presented in this regression, for both sub-groups. Governments of both sub-groups seem to only respond to the variation of the debt level, however with a higher magnitude in the euro area countries than in the non-euro area ones. In fact, while for the euro countries a positive variation of the public debt of 1% leads to a decrease of 0.525% on the cyclically adjusted primary balance, for non-euro countries, the reduction is only of 0.492%.

The results for fiscal regimes are consistent with the ones reported by Afonso (2008), Bajo-Rubio et al. (2009) and Afonso and Jalles (2017).

4.3. Monetary Policy Reaction Function and Fiscal Determinants

In order to observe if there is some evidence that the central bank's decision making takes into consideration the behaviour of the government, Equation (2) is again computed, but with a little twist: the addition of the cyclically adjusted primary balance with one period lag. The new equation is the following:

$$i_{jt} = a + \beta_j + \beta_1 i_{jt-1} + \beta_2 \pi_{jt} + \beta_3 reer_{jt} + \beta_4 aftcri_{jt} + \beta_5 capb_{jt-1} + \mu_{it}. \quad (5)$$

In Table 4 the estimated results for regression (5) are presented. Regarding the EU, all the variables, besides the real effective exchange rate and the one-period lagged cyclically adjusted primary balance, are statistically significant at a 1% level. The first aspect that stands out is that central banks are not reacting to fiscal policy, since the cyclically adjusted primary balance is not statistically significant. Hence, there is evidence that the monetary authorities are following an active policy regime, not taking the fiscal policy results into its decision making.

Regarding the other explanatory variables, the results are similar to the ones found when estimating Equation (2). The one-period lagged nominal interest rate and the inflation rate have a positive impact over the nominal interest rate, and when each one increases by 1%, the dependent variable rises by 0.595% and 1.064%, respectively. Concerning the after-crisis period, it seems to have a bigger impact on the monetary policy reaction function than in the estimation of Equation (2). The interest rates are, on average, 0.940% lower than in the period before the financial crisis.

Table 3 – Monetary Policy Reaction Function with Fiscal determinants

Method Group	OLS-FE EU	OLS-FE Euro Area	OLS-FE Non-Euro Area	2SLS-RE EU	2SLS-RE Euro Area	2SLS-RE Non-Euro Area	GMM EU
Constant	1.492**	1.429***	-0.647	-0.977	0.653	-3.703	1.540
	(0.715)	(0.492)	(1.366)	(0.625)	(0.617)	(2.777)	1.540
i_{jt-1}	0.586***	0.627***	0.542***	0.572***	0.532***	0.552***	0.595***
	(0.018)	(0.025)	(0.029)	(0.044)	(0.037)	(0.139)	(0.023)
inf_{jt}	1.163***	0.630***	1.295***	1.156***	0.981***	1.257**	1.064***
	(0.052)	(0.079)	(0.088)	(0.166)	(0.147)	(0.532)	(0.075)
$reer_{jt}$	-0.012	-0.007	0.011	0.014**	0.001	0.043	-0.012
	(0.007)	(0.004)	(0.014)	(0.006)	(0.005)	(0.028)	(0.016)
$aftcri^{jt}$	-0.964***	-1.241***	-0.969**	-1.131***	-1.401***	-1.136**	-0.940***
	(0.166)	(0.153)	(0.414)	(0.168)	(0.188)	(0.455)	(0.194)
$capb_{jt-1}$	-0.008	-0.020	-0.018	-0.042	-0.038	-0.065	-0.009
	(0.025)	(0.018)	(0.064)	(0.031)	(0.027)	(0.083)	(1.529)
N	633	437	196	605	418	187	633
R^2	0.917	0.840	0.936	0.917	0.815	0.939	-
Countries	28	19	9	28	19	9	28
Hausman prob.	0.030	0.645	0.741	0.521	0.928	0.999	-
AR(2)	-	-	-	-	-	-	0.508
Hansen stat.	-	-	-	-	-	-	0.267

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.

Looking at the euro area and the non-euro area countries, it is possible to observe that the real effective exchange rate and the cyclically adjusted primary balance are still the only variables that are not statistically significant. Therefore, we make the same conclusion as for the EU: the central banks do not take into consideration the government's action. An increase of 1% in the one-period lagged nominal interest rate increases the nominal interest rate by 0.0532% in the euro area and by 0.552% in countries that did not adopt the euro. When looking at the inflation rate, as in Equation (2), it has a higher impact on the dependent variable if we consider non-euro area countries. When it increases by 1%, the nominal interest rate rises by 1.257% in those countries and only by 0.981% in the euro area. Regarding the 2009-2019 period, we conclude the same as for the EU: the coefficients are higher in this situation, when compared to the monetary authority alone. While in the euro area the interest rates dropped, on average, 1.401% in the post-crisis, in the non-euro area countries they only decreased by 1.136%, on average.

4.4. Fiscal Policy Reaction Function and Monetary Determinants

To assess whether monetary policy has some influence over the fiscal policy developments, we take into consideration Equations (3) and (4) and change them, by adding the lagged short-term nominal interest rate and the lagged long-term nominal interest rate (*il*). We include the latter one, in order to try to capture forward guidance developed by central banks. Then, the new regressions are given by:

$$capb_{jt} = a + \beta_j + \beta_1 capb_{jt-1} + \beta_2 debt_{jt-1} + \beta_3 aftcri_{jt} + \beta_4 i_{jt-1} + \beta_5 il_{jt-1} + \mu_{it} \quad (6)$$

$$capb_{jt} = a + \beta_j + \beta_1 capb_{jt-1} + \beta_2 \Delta debt_{jt-1} + \beta_3 aftcri_{jt} + \beta_4 i_{jt-1} + \beta_5 il_{jt-1} + \mu_{it.} \quad (7)$$

The results from the estimation of regressions (6) and (7) are presented respectively in Table 5 and in Table A3 in the Appendix. Firstly, considering regression (6) looking at the EU, we can observe that, when dealing with endogeneity, all variables are statistically significant at a 1% level[3], besides the long-term nominal interest rate. This may indicate that the forward guidance developed by central banks does not influence governments' decision making. Contrarily, one aspect that stands out is that fiscal policy is affected by the monetary authorities'

[3] In this situation we will resort to the 2SLS method, since the Hansen statistics for the GMM is too high to be considered accurate (Roodman, 2009).

decision making, at least for the short-term nominal interest rates. In fact, an increase of 1% in that independent variable leads to a decrease of 0.66% on the cyclically adjusted primary balance. This suggests a relationship of substitutability between the monetary and fiscal policies.

With respect to the lagged cyclically adjusted primary balance and the lagged debt level, the results are similar to those estimated in Equation (3). When these variables increase by 1%, the interest rate rises by 0.629% and 0.059%, respectively. As determined when estimating Equation (3), the cyclically adjusted primary balance reacts positively to the debt level, allowing us to assume that in the EU a Ricardian fiscal regime is followed. Notably, in the after-crisis period, the effect over the dependent variable is much higher for the fiscal policy reaction function than the one estimated for the fiscal policy alone. In this situation the Great Recession lowered the cyclically adjusted primary balance by 2.450%, on average.

Table 5 - Fiscal Policy Reaction Function with Monetary Determinants

Method Group	OLS-FE EU	OLS-RE Euro Area	OLS-RE Non-Euro Area	2SLS-RE EU	2SLS-RE Euro Area	2SLS-RE Non-Euro Area	GMM EU
Constant	-1.395***	-2.052***	-0.927	-0.822	-1.353*	-0.176	1.036**
	(0.444)	(0.575)	(0.712)	(0.531)	(0.708)	(0.569)	(0.404)
i_{jt-1}	0.605***	0.585***	0.666***	0.627***	0.647***	0.688***	0.680***
	(0.032)	(0.038)	(0.055)	(0.054)	(0.069)	(0.060)	(0.041)
inf_{jt}	0.056***	0.064***	0.038***	0.048***	0.052***	0.013*	0.011***
	(0.007)	(0.009)	(0.012)	(0.009)	(0.011)	(0.007)	(0.004)
$reer_{jt}$	-2.194***	-2.584***	-1.160***	-2.450***	-2.721***	-1.256***	-1.708***
	(0.248)	(0.320)	(0.354)	(0.309)	(0.406)	(0.342)	(0.301)
$aftcri_{jt}$	-0.107*	-0.061	-0.266***	-0.366***	-0.357***	-0.583***	0.276***
	(0.058)	(0.077)	(0.096)	(0.089)	(0.122)	(0.119)	(0.104)
$capb_{jt-1}$	-0.088	-0.132*	0.191	0.075	0.051	0.447	0.023
	(0.060)	(0.069)	(0.143)	(0.099)	(0.119)	(0.170)	(0.133)
N	571	408	163	543	389	154	571
R^2	0.552	0.549	0.606	0.550	0.546	0.597	-
Countries	28	19	9	28	19	9	28
Hausman prob.	0.000	0.000	0.030	0.000	0.000	0.080	-
AR(2)	-	-	-	-	-	-	0.388
Hansen stat.	-	-	-	-	-	-	0.661

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.

Now considering Equation (7), it is possible to observe that for the Euro area all variables are statistically significant at a 1% level,[4] besides the dummy for the after crisis period and the cyclically adjusted primary balance. Juxtaposing these estimations with those found for the specification (6), the differences that stand out are that, in this case, the period after the financial crisis seems to have no impact over the dependent variables, while the long-term nominal interest has. In fact, there is evidence that an increase of 1% in the long-term nominal interest rate leads the cyclically adjusted primary balance to soar by 0.442%. Regarding the variation in public debt, when it increases by 1%, it leads to a decrease of 0.512% in the cyclically adjusted primary balance.

Looking at the two sub-groups, euro area and non-euro area countries, all variables, besides the long-term nominal interest rate and the lagged debt level of the non-euro area countries, continue to be statistically significant at a 1% level. For the countries that did not adopt the euro, the lagged debt level is only statistically significant at a 10% level. There is evidence that the cyclically adjusted primary balance is positively affected by its lag. However, considering the government's reaction function, the impact is higher in the non-euro area countries than in the euro area, while when performing the analysis solely for the fiscal policy, the results were the opposite. Regarding the lagged debt level, its coefficient is slightly higher in the euro area, leading to an increase in the cyclically adjusted primary balance of 0.052% when rising 1%, comparing with an increase of 0.013% for the non-euro area countries.

For the post-crisis period, it is clear that the crisis' negative impact was significantly higher in the countries that adopted the euro. The decrease of the cyclically adjusted primary balance, in the euro area countries was on average of 2.721%, more than double than that in the countries that did not adopt the euro, where it suffered a decrease of 1.256%, on average. Regarding the one-period lagged short-term nominal interest rate, it has a negative coefficient on both areas, indicating a substitution effect between the twopolicies. However, there is evidence that the governments of countries that did not adopt the euro are more affected by changes in the lagged short-term nominal interest rate. In fact, a change of 1% on that variable leads to a variation, on the cyclically adjusted primary balance, of -0.357% in the euro area and -.583% in the non-euro area countries.

[4] In this situation we will resort to the 2SLS method, since the Hansen statistics for the GMM is too high to be considered accurate (Roodman, 2009).

Observing again Equation (7), we can state that for the euro area all variables are statistically significant at a 1% level, besides the dummy for the after crisis period and the cyclically adjusted primary balance, while for non-euro area countries only the variation of the debt level is not statistically significant at a 5% level. Comparing the results presented above with the ones estimated for this regression, it is curious to observe that on the one hand, the lagged cyclically adjusted primary seems to have no influence over the dependent variable in the euro area and have for the other countries, while on the other hand the opposite happens with the variation of public debt. Another aspect that stands out is that the period after the Great Recession only as an impact on the countries that do not belong to the euro area. As for the EU, the long-term nominal interest rate impacts the dependent variables in both sub-groups, however with a higher magnitude for non-euro area countries. In fact, an increase of 1% in the long-term nominal interest rate leads to a soar of 0.539% in the cyclically adjusted primary balance in non-euro countries and of only 0.421% for the euro area ones.

In sum, the results that we find for the estimation of the reaction function of monetary policy to fiscal variables, and the other way around, are in line with the studies done by Alcidi and Thirion (2016), Silva and Vieira (2017), and Afonso et al. (2019).

5. CONCLUSION

During the last years, the interactions between monetary and fiscal policies gained renewed importance due to the Great Recession. In the EU, this discussion acquires even more importance, since the countries that belong to the euro area have centralized monetary policy, but the government of each country is responsible for the fiscal policy. The adoption of extraordinary policies, from both monetary and fiscal authorities, may have led to a change on the policy mix. On the monetary policy side, the zero lower bound and the implementation of unconventional monetary policy, and for the fiscal policy the especial packages implemented, led to a combination of measures that had never been seen before.

By using panel data, our objective was to understand how each policy behaved in the European Union, between 1995 and 2019, and how their interactions might have been affected. Furthermore, we did the same analysis for two sub-regions, the euro area and the non-euro area countries, in order to assess if there are any differences between the countries that adopted the euro and the ones that did not.

Regarding the monetary policy reaction function, we find that the inflation rate has a big impact over the central banks' decision making and that this effect is higher in those countries

that do not belong to the euro area. Having inflation has a crucial variable for the determination of interest rates was expected, since most central banks define price stability as their mandate. Another aspect, that is not surprising, is that in the post-crisis period the interest rates declined, with a higher impact on the euro area. The real effective exchange rate seems to have no effect over the interest rate.

Concerning fiscal policy, the cyclically adjusted primary balance reacts positively to increases in the level of government debt. This idea reveals a Ricardian fiscal regime, disclosing that fiscal authorities are concerned with the health of public finances. Furthermore, after the Great Recession the cyclically adjusted primary balance decreased and, when comparing the two sub-regions, the euro area was more affected. This last effect was expected, since it reflects the sovereign crisis that some countries went through. We also found evidence that there is a negative relation between the variation of the cyclically adjusted primary balance and the variable that represents the variation of the public debt that occurred in the previous year.

We also estimated the reaction functions for monetary policy, considering a fiscal variable, and for fiscal policy, considering monetary determinants. Our estimation showed that monetary policy reaction functions do not seem to take into consideration the cyclically adjusted primary balance, hence presenting an active monetary policy behaviour. On the other hand, fiscal policy, via the cycally adjusted primary balance, seem to be affected by the short-term interest rate in a negative way. This hints that the relation between those policies is of substitution. Moreover, there is evidence that this substitutability is of a higher degree for the countries that do not use the euro.

Summing up, the conception that monetary policy independently controls the stability of the price level, while governments try to keep a good health for the public finances ends up being confirmed. Nevertheless, the monetary authority presents an active role, taking action when the cyclically adjusted primary balance gets out of hand. Going along with the existing literature, this suggests a relation of substitutability between monetary and fiscal policies. Moreover, the euro area states were more affected by the 2007-2009 financial crisis than the other countries of the EU.

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Appendix

Table A1 – Data Description and Transformations

Variable	Definition	Unit	Source
capb	Cyclically adjusted primary balance	Percentage of GDP at current prices	AMECO
debt	Debt ratio	Percentage of GDP at current prices	AMECO
i	Nominal short-term interest rate	%	AMECO
il	Nominal long-term interest rate	%	AMECO
reer	Real effective exchange rate	Index (2015 = 100)	AMECO
hcpi	Harmonized consumer price index	Index (2015 = 100)	AMECO
π	Inflation	%	π=ln(hcpi_t)-ln(hcpi_{t-1})

Table A2 - Fiscal Policy Reaction Function to Monetary Variables with the variation of public debt as independent variable

Method Group	OLS-FE EU	OLS-FE Euro Area	OLS-FE Non-Euro Area	2SLS-RE EU	2SLS-RE Euro Area	2SLS-RE Non-Euro Area	GMM EU
Constant	0.233*	0.341**	0.024	0.189	0.415*	-0.254	0.316**
	(0.121)	(0.159)	(0.166)	(0.313)	(0.158)	(0.243)	(0.124)
$capb_{jt-1}$	0.558***	0.526***	0.665***	0.220*	0.112	0.323	0.781***
	(0.040)	(0.050)	(0.065)	(0.0.121)	(0.163)	(0.214)	(0.061)
$\Delta debt_{jt-1}$	-0.081***	-0.094***	-0.041	-0.467***	-0.525***	-0.492**	0.056
	(0.023)	(0.029)	(0.036)	(0.102)	(0.129)	(0.222)	(0.037)
$aftcri_{jt}$	-0.340*	-0.421*	-0.153	0.0.211	0.159	0.478	-0.677***
	(0.179)	(0.235)	(0.246)	(0.159)	(0.341)	(0.396)	(0.155)
N	637	437	200	609	418	191	637
R^2	0.467	0.452	0.536	0.360	0.326	0.396	-
Countries	28	19	9	28	19	9	28
Hausman prob.	0.000	0.000	0.025	0.094	0.064	0.339	-
AR(2)	-	-	-	-	-	-	0.949
Hansen stat.	-	-	-	-	-	-	0.404

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.

Table A3 - Fiscal Policy Reaction Function to Monetary Variables with the variation of public debt as independent variable

Method Group	OLS-FE EU	OLS-FE Euro Area	OLS-RE Non-Euro Area	2SLS-RE EU	2SLS-RE Euro Area	2SLS-RE Non-Euro Area	GMM EU
Constant	1.370***	1.555***	0.383	0.232	0.661	0.425	1.737***
	(0.314)	(0.380)	(0.466)	(0.526)	(0.754)	(0.589)	(0.404)
$capb_{jt-1}$	0.571***	0.560***	0.721***	0.221*	0.192	0.604***	0.786***
	(0.043)	(0.051)	(0.061)	(0.120)	(0.175)	(0.116)	(0.066)
$\Delta debt_{jt-1}$	-0.067***	-0.063**	-0.050	-0.512***	-0.513***	-0.103	0.083*
	(0.026)	(0.030)	(0.045)	(0.113)	(0.160)	(0.120)	(0.045)
$aftcri_{jt}$	-1.1383**	-1.618***	-0.691**	-0.562	-0.923	-0.984**	-1.696***
	(0.252)	(0.326)	(0.312)	((0.406)	(0.642)	(0.404)	(0.295)
i_{jt-1}	-0.342***	-0.094***	-0.389***	-0.522***	-0.599***	-0.607***	-0.338***
	(0.055)	(0.074)	(0.083)	0.081)	(0.129)	(0.123)	(0.087)
il_{jt-1}	0.107*	0.087	0.336***	0.442***	0.421***	0.539***	0.034
	(0.061)	(0.070)	(0.466)	(0.110)	(0.134)	(0.177)	(0.108)
N	557	397	160	529	378	151	557
R^2	0.516	0.503	0.593	0.385	0.361	0.601	-
countries	28	19	9	28	19	9	28
Hausman prob.	0.000	0.027	0.151	0.250	0.649	0.199	
AR(2)	-	-	-	-	-	-	0.451
Hansen stat.	-	-	-	-	-	-	0.621

Standard errors in parentheses. Significance: *, 10%; **, 5% ; *** 1%.