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Interactions between monetary and fiscal policies

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ABSTRACT

Using a panel data set of the 28 EU countries from 1970 to 2015, we study the nature of monetary and fiscal policies of both respective authorities and assess how economic and institutional events influence each authority's reaction functions. Our results show that, for the all period under analysis and controlling for institutional variables, inflation has a significant impact on monetary policy, and that governments raise their primary balances when facing increases in government debt. We also find a substitution relationship between both policies, whereby the central bank assumes an active role, especially in cases of higher levels of debt. Furthermore, the introduction of a common currency shared by 19 out of 28 EU countries had a structural impact on the response and the interaction between the two policies.

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Monetary policy; fiscal policy; reaction functions

1. Introduction

The Maastricht Treaty signature was the first step towards a common currency among the European Union (EU) member states, establishing convergence criteria based on budget deficit and debt levels rules and low inflation and interest rates close to the EU average. This set of rules intended to achieve the price stability and fiscal sustainability required for the development of an Economic and Monetary Union (EMU). In 1997, to complement the Maastricht provisions, the EU members agreed to a Stability and Growth Pact (SGP), setting a budget deficit limit of 3% of GDP and one of 60% of GDP for government debt. Finally, the third and last stage of the EMU took place on the first of January 1999, with the launch of a common single currency, the Euro, which was to be used as the monetary unit for all transactions by January 2002. Despite all the advantages that these three economic milestones brought about, they restricted the use of fiscal policy, especially when countries joined the Eurozone. The inability of the Eurozone member countries to resort to monetary policy requires a reflection regarding the relationship between the fiscal and monetary policies of each country.

The interactions between fiscal policy and monetary policy are a complex topic, as the role of each respective authority has a different impact on the economy. Therefore,

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the type of relationship established by both authorities is important to determine how their policies will influence the levels of inflation, debt, and economic growth. The purpose of this paper is to analyse, on one hand, the impact of several economic variables on these policies, and, on the other hand, to assess the evidence of Ricardian fiscal regimes for the 28 EU countries during the 1970–2015 period. Furthermore, our aim is to analyse how institutional features of the creation of the Economic and Monetary Union has influenced the coordination between the monetary and fiscal authorities. The impact of introducing the Euro is also an important event for understanding changes in the type of interaction between countries which share the same currency, and those which do not. For this reason, to study potentially different responses between the two policies, we split our analysis into two additional periods, one from 1970 until 1999, and the other between 2000 and 2015. In addition, from each authority's reaction functions, we are able to define their main goals and the type of interaction that exists between national governments and central banks. Finally, we assess how certain institutional events and crises have influenced monetary and fiscal policies.

Our results show that inflation is far relevant for monetary policy and that the primary balance reacts positively to increases in government debt. Furthermore, there is a substitution relationship between both authorities, resulting in a stricter monetary policy when countries face high budget deficit levels. On the other hand, the introduction of the Euro has a greater negative effect on fiscal policy, together with that of a rise in countries' budget deficits. As we expected, crises influence monetary and fiscal policies negatively, although this effect is smoothed out when countries belong to the Eurozone.

The paper is structured as follows: [Section 2](#) provides a literature review of closely related theoretical and empirical studies; [Section 3](#) presents the data and the methodology employed; [Section 4](#) presents our results; and, lastly, [Section 5](#) provides the conclusions.

2. Literature review

Since the beginning of the 1980s, the discussion regarding the roles of central banks and governments, as well as the relationship between monetary and fiscal authorities, started to gain more relevance. Although central banks focus on inflation, whereas governments are concerned with cyclical conditions and the level of government indebtedness, the control of both variables depends on policy coordination, whereby monetary and fiscal policies depend on each other (Wyplosz, 1999). However, this coordination does not always lead to the most desirable results, which are consequently dependent on the role assumed by each authority. Sargent and Wallace (1981) argued that both authorities could be relevant in a “dominant” way. When monetary policy dominates fiscal policy, it is the monetary authority that permanently controls inflation, as it is free to set the base level for money. However, if fiscal policy dominates monetary policy, then the latter authority loses some of its influence in controlling inflation phenomenon.

Aiyagari and Gertler (1985) introduced the distinction between Ricardian and non-Ricardian regimes, which characterises the behaviour of a government. In a non-

Ricardian regime, primary budget balances are freely set by the government and prices are endogenously determined from the government's budget constraints. Consequently, the fiscal authority does not commit to completely financing debt through future taxes, which thus leads to monetary financing. In a Ricardian regime, the monetary authority determines the stock of money and the price level, and the government has to achieve a certain degree of primary budget surplus to ensure that the budget constraint is consistent with the repayment of the initial stock of debt and to guarantee fiscal solvency. According to Leeper (1991), fiscal policy can be "active" or "passive", depending on the effect it has in the face of a government debt shock. An active authority avoids the state of government debt and independently establishes a decision rule that depends on past, current, and future variables, whereas, on the other hand, a passive authority's decision rule depends on the current state of government debt after it has been constrained by the active authority's actions and by private optimisation.

Taylor (1993) further addressed the estimation of policy reaction function by initially proposing a monetary policy rule to control inflation in the U.S. during the early 1990s, which is known as the Taylor rule. As Ghatak and Moore (2011) state, although this rule describes the changes in the instruments that accompany an increase in inflation or in real GDP, its primary aim is to allow central banks to be successful in stabilising inflation and output gap. Later on, after the establishment of the EMU, many authors concluded that the Taylor rule is a useful tool for conducting monetary policy in the Union and that it provides a similar level of macroeconomic stabilisation when compared with the optimal rule (Gerlach & Schnabel, 2000).

With regards to the empirical studies on fiscal policy and its sustainability, these essentially analysed two main indicators: debt and primary balance. In Bohn (1998), the U.S. primary budget surplus turned out to be an increasing function which responded positively to the debt-to-GDP ratio, showing that U.S. fiscal policy satisfies an inter-temporal budget constraint, in a Ricardian fashion. Galí and Perotti (2003) study how the Maastricht Treaty and the SGP changed the fiscal policy in EMU countries by making them more pro-cyclical, and they also find a decrease in cyclical primary deficits in the face of increase in government debt. On the other hand, Afonso (2005) uses causality tests between the primary balance and government debt ratios. The results of the various tests show that the 15 EU governments raised their primary budget surpluses following increases in the outstanding stock of government debt and that they appear to use primary budget surpluses to reduce the debt-to-GDP ratio. We can therefore acknowledge the evidence of Ricardian fiscal regime in these papers.

Finally, Brzozowski and Siwiska-Gorzela (2010) evaluate the impact of fiscal rules on fiscal policy volatility. More specifically, these authors find that budget balance and debt constraints impact fiscal volatility differently. In fact, a budget balance constraint rule tends to increase volatility, whereas debt constraints rules help decrease it. These results show that fiscal policies need to be implemented in order to achieve more efficient fiscal policy stabilisation.

Regarding monetary policy, it can be observed that reaction functions are usually based on interest rates. Altavilla (2003) estimates several reaction functions in order to assess how the European Central Bank (ECB) should control interest rates when facing a change in real output, inflation, or the exchange rate. The conclusions are

that central bank behaviour is better explained by adding a lagged interest rate and future inflation movements; Ruth (2007) develops a panel reaction function based on the Taylor rule for analysing the European monetary policy. With regards to the interest rate path, in the short term, the author only finds deviation by the ECB in cases of area-wide inflation. Clausen and Hayo (2002) also study the effects of asymmetric monetary policy over the short- and medium-term for Germany, Italy, and France. Furthermore, Huchet's (2003) study concludes that a common monetary policy change, applied to the eight major EMU countries under analysis in his research, could have led to asymmetric reactions due to different national economic structures. On the other hand, Andrade and Pires (2011) study the effectiveness of the Brazilian monetary policy during the Real Plan, providing a new insight on how monetary policy can act in the case of indexed bonds. The results of the authors suggest that wealth effect acts as a significant monetary policy transmission channel, although a high proportion of indexed bonds can offset this role.

To study the interactions between monetary and fiscal policies, Beetsma and Jensen (2005) analyse the interaction between both policies, assuming a monetary union with a sticky prices hypothesis, whilst assessing the effects of several fiscal rules. Furthermore, Leith and von Thadden (2008) study the interaction between these policies in a non-Ricardian hypothesis. Due to the admission of this hypothesis, the authors conclude that public debt has an important role, although, without an explicit level for this variable, it is impossible to determine the efficiency of both fiscal and monetary policy rules in ensuring an equilibrium. In addition, Lagoa (2016) evaluates the causes of inflation differences among Eurozone countries during the 1998--2008 period, and reveals that exchange rates are a central determinant in inflation dynamics, rather than output gap and real labour costs measures. Furthermore, based on the results of his study, this author also provides an interesting discussion regarding the interaction between monetary and fiscal policy and their degree of effectiveness during the financial crisis and subsequent periods.

Leeper and Davig (2009) estimate Markov-switching policy rules for the United States. Their paper's results highlight the fact that the impacts of a fiscal stimulus cannot be understood without studying monetary and fiscal policies jointly, as they fluctuate between active and passive behaviour. A similar approach is provided by Afonso and Toffano (2013), who report clearly established "active" and "passive" fiscal regimes in the UK, whereas in Germany, fiscal regimes have been less active overall, supporting more fiscal sustainability. For Italy, a more passive fiscal behaviour is uncovered during the run-up to EMU. Furthermore, by providing new insights regarding a highly relevant topic regarding the interaction between monetary and fiscal policies, Haga (2015) finds an inverse relationship between central banks' independence and the magnitude of political budget cycles through the study of the degree of independence and the coordination between these policies. That is to say, a non-independent central bank plays a passive monetary role in the face of an expansionary fiscal policy. In addition, Bianchi and Ilut (2017) also estimate a Markov-switching DSGE model to study the US economy as a means of assessing monetary and fiscal policy mix changes, highlighting passive monetary policy during the 1960s-1970s, reflecting a behaviour that was reversed in the 1980s.

3. Data and methodology

For the period between 1970 and 2015, our dataset is based on the 28 EU countries – Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE) Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), the Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), and the United Kingdom (UK).

The variables used in the analysis are from several sources: 1) from the AMECO database we gathered data regarding cyclically adjusted primary balance (*capb*), debt-to-GDP ratio (*debt*), nominal short-term interest rate (*interest*), the output gap between actual, potential gross domestic product (*outputgap*), and real effective exchange rates (*REER*); 2) from the World Development Indicators (WDI) we obtained inflation (*inflation*) and current account balance (*current*) data, and; 3) from the World Bank's Financial Development and Structure dataset we collected M3 data, also referred to as liquid liabilities (*m3*). Table 1 presents the descriptive statistics for the full sample.

In addition, in order to assess the impact of certain events on authorities' policies, we added three dummy variables: a *dmt* dummy for the Maastricht Treaty¹; a *dsdp* dummy for the adoption of the SGP framework, and; a *dez* dummy for countries in the Euro area. Furthermore, we also intend to study the effect that a crisis can have on monetary and fiscal policies. Accordingly, we collected data regarding the total number of crises a country experienced in each year (*crisis*) from the database of Reinhart and Rogoff (2009).²

We use a panel data approach for our analysis, as this notably provides the possibility of obtaining a larger sample. In addition, we resort to OLS-FE and 2SLS to deal with possible unobserved effects and endogeneity problems,³ respectively. The 2SLS analysis allows the use of instrumental variables – exogenous variables, totally uncorrelated with the error term and partially correlated with the explanatory variables. Therefore, it solves the endogeneity

Table 1. Descriptive statistics (full sample): 1970–2015.

	Mean	Std. Dev	Min.	Max.	Obs.
<i>Capb</i> (% of GDP)	0.159	3.203	−27.264 (IE, 2010)	9.224 (FI, 1976)	612
<i>Debt</i> (% of GDP)	51.02	30.743	3.664 (EE, 2007)	178.962 (GR, 2014)	940
<i>Interest rate</i> (%)	7.026	7.26	−0.2 (SE, 2015)	80.75 (RO, 1997)	874
<i>Outputgap</i> (% of potential GDP)	−0.198	2.994	−15.025 (GR, 2013)	14.259 (EE, 2007)	941
<i>Inflation</i> (annual %)	11.874	64.212	−4.48 (IE, 2009)	1494.684 (HR, 1993)	1044
<i>M3</i> (% of GDP)	74.386	49.307	6.866 (IE, 1981)	399.114 (LU, 2008)	1037
<i>Current</i> (% of GDP)	−1.431	5.035	−25.549 (BG, 2007)	12.485 (MT, 1975)	878
<i>Reer</i> (Index)	94.023	12.493	41.707 (BU, 1996)	127.711 (LV, 2008)	560

¹The dates of the Maastricht referendum approval are different for each country: 1992 for Belgium, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain; 1993 for Denmark, Germany and the United Kingdom, and; 1994 for Austria, Finland and Sweden.

²Available at: <http://www.reinhartandrogoff.com/data/browse-by-topic/>.

³We use one-period lag independent variables for the instrumental variables.

problem and leads to a consistent estimator when there are omitted variables. The advantage is that, if those instrumental variables are not weak, they may very well satisfy the two properties mentioned above, and 2SLS clearly becomes a more suitable method than OLS. Hence, we give priority to the 2SLS estimations. Furthermore, we apply the White diagonal covariance matrix to assume residual heteroscedasticity in all the econometric techniques mentioned. Moreover, we also provide additional results on panel data results regarding both monetary and fiscal policies and reaction functions between those policies.

Additionally, to achieve a more complete analysis through studying the impact that monetary and fiscal authorities have on each country, we decided to apply a SUR estimation. The use of SUR estimation, in the context of EU, is useful, as it provides country-specific results and also allows for cross-equation correlations between the error terms. Indeed, the possibility of common factors across EU member states that contribute towards creating the errors cannot be discarded, for instance, problems arising from European integration, the single currency, and a common fiscal overarching fiscal framework. Furthermore, we run the equations for two sub-periods – one for the 1970–1999 period and the other for the 2000–2015 period, in order to disentangle the possible effect of the introduction of the Euro currency.⁴ For reasons of parsimony, we only discuss the results without presenting the tables of the SUR estimations, which are available in the online appendix.

4. Empirical analysis

4.1. Policies of the authorities

4.1.1. Monetary policy

In our study, as well as in most the literature that follows the Taylor rule, interest rate is the instrument used for monetary policy. Regarding the explanatory variables, for instance, Huchet (2003) uses lagged short-term interest rate, inflation gap and the M3 growth gap compared to its 2% target and a 4.5% reference value, respectively, and the output gap. Altavilla (2003) creates instrument rules which vary between inflation, output gap, and interest rate, as well as their lagged values and an autoregressive term. In addition, some literature highlights the importance of considering external variables as the current account balance and real effective exchange rates to achieve a better assessment of monetary policy dynamics (see, for instance, Kara & Nelson, 2003; Monacelli, 2005; Corsetti & Pesenti, 2005; Kirsanova, Leith, & Wren-Lewis, 2006, and; Leith & Wren-Lewis, 2007).

We have therefore set up our monetary policy regression for country i ($i = 1, \dots, N$) at time t ($t = 1, \dots, T$) in the following form:

$$\text{interest}_{i,t} = \beta_i + \delta \text{interest}_{i,t-1} + \phi \text{inflation}_{i,t-1} + \varphi \text{outputgap}_{i,t-1} + \lambda m3_{i,t-1} + \eta \text{current}_{i,t-1} + \zeta \text{REER}_{i,t-1} + u_{i,t} \quad (1)$$

where *interest* is the nominal short-term interest rate, *inflation* represents inflation, *outputgap* is the output gap, *m3* is the monetary aggregate M3, *current* is the current account

⁴For these regressions, and due to reasons of parsimony, the results are available on request. Furthermore, the estimations for Tables 3 and 5 do not make use of both Stability and Growth Pact and Euro dummy variables, as few observations exist for each sub-period. The use of these variables could lead to econometric problems, such as near-singular matrix errors.

balance, and *REER* is the real effective exchange rate, β_i represents the estimated individual effects for each country and u_{it} are the independent disturbances across countries. In addition, we expect to uncover positive estimated coefficients related to inflation and output gap, with negative coefficient for the other variables, i.e., $\phi, \varphi > 0$ and $\delta, \lambda, \eta, \zeta < 0$.

In Table 2 we present the estimated results for regression (1). When we analyse the effect of each variable, one-at-a-time, we can conclude that short-term interest rate is positively sensitive to inflation only when we correct for endogeneity problems through the application of 2SLS technique. Furthermore, in the case of a positive output gap, i.e., when actual GDP is higher than the potential GDP, interest rates tend to increase by about 0.2 p.p. per 1% increase in output gap. On the other hand, an increase in money supply, current account balance, and real exchange rates has a negative impact on interest rate dynamics. In addition, and when we analyse the variables altogether and analyse both OLS and OLS-FE results, we can state that the output gap is the only variable that accounts for interest rates dynamics.

Furthermore, when we run equation (1) for the 1970–1999 period, we can conclude that inflation is also important to determine interest rates movements. In fact, we observe a negative impact of approximately -0.3% in interest rates per unit per cent positive change in inflation, while output gap has almost five times more effect than the result obtained for the entire period. Furthermore, for the period between 2000 and 2015, the results for inflation seem to lose explaining power for the interest rates dynamics. Lastly, current account balance appears to have a detrimental effect on monetary policy response, i.e., when the current account balance improves, there is a trend of a relief of interest rates.

Applying the SUR estimation to Equation (1), we find that interest rates are sensitive to inflation changes, with the exception of some countries such as Croatia, Cyprus, and Ireland. Furthermore, while we conclude that a rise in inflation leads to a rise in interest rates for Bulgaria, Estonia, and Hungary, we verify the opposite relationship in other countries, whereby a rise in inflation seems to reduce interest rates, such as in the case of Austria and Germany. In conclusion, when comparing the panel and the SUR estimation results, the inflation effects on interest rates point to evidence of some persistent differences between old and new EU member states.

In addition, the majority of the results achieved for the interest rates-output gap connection evidence an expected positive correlation between these variables. This result is also true for the real exchange rates results, whose results show that with a positive increase in this index, interest rates tend to be lower. Lastly, our results lead us to conclude that, in general, an improvement in international trade, as well as monetary supply growth tend to reduce interest rates. In general, our results achieved for monetary policy function are in line with those reached in Wolters (2012) and in Lee and Crowley (2008).

In addition, those countries belonging to the Eurozone evidence a decline in interest rates of 0.584% and 1.491% for OLS-FE and 2SLS econometric specifications. The other institutional events, namely the signature of the Maastricht Treaty and the Stability and Growth Pact, do not significantly influence interest rates dynamics. Furthermore, the estimated results for the periods of crisis also highlight a negative impact on interest rate movements.

Nevertheless, M3 turned out to gain more relevance with the introduction of the Euro, as the monetary aggregates reference values became secondary goals for central banks. In addition, when we individually observe the results for the 1970–1999 and 2000–2015 periods, it seems that institutional events do not have an impact on monetary policy responses.

Table 2. Monetary policy with $interest_{it-1}$ as dependent variable: 1970–2015, 1970–1999 and 2000–2015.

	OLS			OLS-FE			2SLS		
	1970–2015 (1)	1970–1999 (2)	2000–2015 (3)	1970–2015 (4)	1970–1999 (5)	2000–2015 (6)	1970–2015 (7)	1970–1999 (8)	2000–2015 (9)
$interest_{it-1}$	0.847*** (0.157)	1.506*** (0.163)	0.650*** (0.053)	0.851*** (0.181)	1.515*** (0.157)	0.556*** (0.060)	0.967*** (0.249)	1.228*** (0.349)	0.768*** (0.096)
$inflation_{it-1}$	0.035 (0.083)	−0.302*** (0.079)	0.097 (0.064)	0.035 (0.098)	−0.320*** (0.073)	0.154** (0.073)	−0.154 (0.258)	−0.073 (0.211)	−0.159 (0.158)
$outputgap_{it-1}$	0.148*** (0.049)	0.877 (0.559)	0.118*** (0.024)	0.170** (0.083)	0.957* (0.566)	0.070** (0.028)	0.078 (0.062)	−1.412 (0.960)	0.074*** (0.027)
$m3_{it-1}$	−0.000 (0.002)	0.032 (0.024)	−0.001 (0.001)	0.000 (0.002)	0.029 (0.025)	−0.023*** (0.007)	0.000 (0.002)	0.063 (0.048)	−0.001 (0.001)
$current_{it-1}$	−0.015 (0.018)	0.267 (0.182)	−0.029** (0.014)	−0.022 (0.017)	0.270 (0.184)	−0.074*** (0.023)	−0.014 (0.024)	0.502 (0.388)	−0.048*** (0.018)
$REER_{it-1}$	−0.009 (0.017)	−0.042 (0.064)	−0.001 (0.010)	−0.005 (0.023)	−0.051 (0.069)	−0.002 (0.013)	−0.017 (0.021)	0.097 (0.099)	−0.022 (0.021)
Obs.	454	47	388	454	47	388	423	27	360
R^2	0.889	0.965	0.867	0.889	0.958	0.882	0.888	0.968	0.781

*, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets. Additional results on the effects of each variable one at a time on the dependent variable are available on request.

Table 3. Estimation of institutional variables' effect on monetary policy with $interest_t$ as dependent variable: 1970–2015.

	OLS			OLS-FE			2SLS		
	1970–2015	1970–1999	2000–2015	1970–2015	1970–1999	2000–2015	1970–2015	1970–1999	2000–2015
$interest_{t-1}$	0.941*** (0.272)	1.507*** (0.170)	0.594*** (0.086)	0.576*** (0.090)	1.589*** (0.211)	0.543*** (0.101)	1.621*** (0.501)	1.435*** (0.165)	2.067 (2.589)
$inflation_{t-1}$	0.001 (0.136)	-0.347*** (0.064)	0.252** (0.106)	0.071 (0.051)	-0.357*** (0.068)	0.290** (0.130)	1.018*** (0.343)	-0.287*** (0.041)	-1.129 (2.336)
$outputgap_{t-1}$	0.248 (0.169)	0.519 (0.496)	0.073 (0.05)	0.091 (0.058)	0.712 (0.538)	0.060 (0.053)	-0.106 (1.022)	-0.699 (0.420)	0.034 (0.213)
$m3_{t-1}$	0.010 (0.012)	0.005 (0.029)	-0.005 (0.006)	-0.037*** (0.013)	0.015 (0.033)	-0.017* (0.009)	-0.008 (0.046)	-0.010 (0.028)	0.048 (0.096)
$current_{t-1}$	0.017 (0.034)	0.323* (0.183)	0.005 (0.022)	-0.063 (0.054)	0.374* (0.188)	0.012 (0.066)	0.117 (0.246)	-0.042 (0.162)	-0.016 (0.067)
$REER_{t-1}$	-0.020 (0.051)	-0.098** (0.045)	0.034 (0.021)	-0.046** (0.019)	-0.055 (0.061)	0.027 (0.030)	0.055** (0.022)	-0.067 (0.047)	-0.136 (0.321)
dmt_{it}	0.310 (2.737)	6.386 (4.782)	0.932 (1.443)	-2.378 (1.770)	7.973 (5.706)	1.110 (1.483)	-0.895 (1.822)	5.011 (5.642)	9.764 (16.505)
$dsgp_{it}$	1.232 (5.800)	- (5.800)	- (5.800)	0.190 (0.383)	- (0.383)	- (0.383)	-1.461 (1.213)	- (1.213)	- (1.213)
dez_{it}	-0.025 (0.521)	- (0.521)	- (0.521)	-0.584** (0.252)	- (0.252)	- (0.252)	-1.491*** (0.445)	- (0.445)	- (0.445)
$crisis_{t-1}$	-0.872*** (0.324)	2.991 (2.985)	-1.042*** (0.167)	-0.412** (0.188)	2.925 (2.958)	-1.005*** (0.164)	0.419 (2.449)	-0.386 (4.117)	-3.853 (4.406)
Obs.	211	36	164	211	36	164	206	23	148
R^2	0.894	0.979	0.917	0.830	0.979	0.920	0.663	0.994	0.170

*, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets.

4.1.2. Fiscal policy

The assessment for fiscal policy is usually based on the primary budget balance, whereby governments aim to achieve a certain level of primary surplus to diminish their outstanding stock of public debt. Therefore, the primary balance is commonly used as the dependent variable for the regressions for fiscal rules (or fiscal reaction functions). However, the explanatory variables included in the regressions also differ from author to author. For example, while Galí and Perotti (2003) use expected output gap, debt at the time of budget decision (relative to potential output), and the last year cyclically unadjusted total budget deficit (as a percentage of GDP), Bohn (1998) includes the ratio of debt to aggregate income, the level of temporary government spending, and a business cycle indicator.

Regarding fiscal policy reaction function, we follow Afonso (2005), using Equation (2):

$$capb_{i,t} = \beta_i + \alpha capb_{i,t-1} + \sigma debt_{i,t-1} + u_{i,t} \quad (2)$$

where *capb* is the cyclically adjusted primary balance and *debt* represents the debt-to-GDP ratio; u_{it} are the independent disturbances across countries.

The results of Equation (2) are presented in Table 4. We obtain an expected positive signal of $\sigma > 0$, meaning that there is a positive reaction of primary balances to government debt changes. This result means that the 28 EU governments raise primary budget surplus when they face increases in levels of government debt stock. The enacting of this stabilising behaviour by governments translates into a Ricardian fiscal regime, especially when adjusting the inter-temporal budget constraint.

Subsequently, we estimated the fiscal policy reaction functions for each country separately, using the SUR model. For some countries, such as Austria, Denmark, and the Netherlands, we found that those governments follow Ricardian fiscal regimes – whenever debt increases, primary budget surplus is raised to stabilise the fiscal position. The other countries in our sample represent the exceptions to this fiscal behaviour, as the debt effect on cyclically adjusted primary balance seems to have a negative, or no impact at all. Lastly, the results obtained for the subsamples of the two periods depict the same pattern as the results for the entire period. Overall, our results for the Panel and for the SUR estimations regarding the existence of Ricardian fiscal regimes are in accordance with those of Bohn (1998), Favero (2002), Afonso (2005), Afonso (2008), Díaz-Roldán and Esteve (2009), and Afonso and Jalles (2011). In addition, when we analyse the SUR results, and contrary to the German case, our results are in line with those achieved for the French case in Semmler and Zhang (2004).

The implementation of the Euro as a common currency was the major event to have had a negative impact on fiscal policy, whereby cyclically adjusted primary balance decreased by 0.738% on average (Table 5). Previously, there was already monetary union and free mobility of capital, which allowed for banks from the countries of the south of Europe to ask for loans from the banks of the north in the interbank money market – where interest rates charged for credit to companies and households were extremely high in these southern countries, and much lower in the northern European ones. However, this did not occur on account of exchange risk, for when the Euro emerged, this risk disappeared, and southern European countries started to request

Table 4. Estimation of fiscal policy with $capb_{i,t}$ as dependent variable: 1970–2015, 1970–1999 and 2000–2015.

	OLS			OLS-FE			2SLS		
	1970–2015 (3)	1970–1999 (10)	2000–2015 (13)	1970–2015 (6)	1970–1999 (11)	2000–2015 (14)	1970–2015 (9)	1970–1999 (12)	2000–2015 (15)
$capb_{i,t-1}$	0.730*** (0.066)	0.740*** (0.067)	0.673*** (0.083)	0.606*** (0.078)	0.422*** (0.093)	0.543*** (0.087)	0.648*** (0.077)	0.805*** (0.061)	0.691*** (0.070)
$debt_{i,t-1}$	0.009*** (0.003)	0.010** (0.004)	0.011*** (0.004)	0.029*** (0.006)	−0.013 (0.014)	0.045*** (0.008)	0.032*** (0.006)	0.009** (0.004)	0.010*** (0.004)
Obs.	582	136	419	582	136	419	554	109	391
R^2	0.577	0.690	0.505	0.625	0.816	0.58	0.625	0.765	0.491

*, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets. Additional results on the effects of each variable one at a time on the dependent variable are available on request.

Table 5. Estimation of institutional variables' effect on fiscal policy with $capb_{i,t}$ as dependent variable: 1970–2015.

	OLS				OLS-FE				2SLS			
	1970–2015	1970–1999	2000–2015	1970–2015	1970–1999	2000–2015	1970–2015	1970–1999	2000–2015	1970–1999	2000–2015	2000–2015
$capb_{i,t-1}$	0.779*** (0.116)	0.784*** (0.070)	0.744*** (0.152)	0.677*** (0.147)	0.457*** (0.112)	0.627*** (0.16)	0.718*** (0.177)	0.879*** (0.059)	0.772*** (0.112)			
$debt_{i,t-1}$	0.016*** (0.005)	0.009 (0.007)	0.013* (0.007)	0.045*** (0.012)	–0.008 (0.025)	0.047 (0.037)	0.054*** (0.014)	0.001 (0.010)	0.014 (0.01)			
$dmt_{i,t}$	–0.408 (0.390)	–0.128 (0.388)	–0.453 (0.536)	–1.194* (0.670)	–0.085 (0.728)	–1.389 (0.924)	–1.275 (1.125)	0.545 (0.614)	–0.125 (0.909)			
$dsgp_{i,t}$	–0.351 (0.322)	– (0.322)	– (0.322)	0.037 (0.446)	– (0.446)	– (0.446)	–0.108 (1.520)	– (0.581)	– (0.581)			
$dez_{i,t}$	–0.622*** (0.241)	– (0.241)	– (0.241)	–0.853*** (0.293)	– (0.293)	– (0.293)	–0.798 (0.798)	– (0.798)	– (0.798)			
$crisis_{i,t-1}$	–0.408*** (0.145)	–0.200 (0.211)	–0.447** (0.207)	–0.374** (0.146)	–0.369 (0.277)	–0.459** (0.188)	–0.704 (0.535)	0.247 (0.307)	–1.049 (1.644)			
Obs.	302	110	176	302	110	176	286	94	160			
R^2	0.625	0.699	0.591	0.689	0.776	0.641	0.684	0.743	0.563			

*, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets.

more loans from the northern countries, which led to a further decrease in interest rates and to an increase in public debt.

Therefore, it became more than necessary for Euro area countries to achieve a higher primary balance to meet the above-mentioned increases in outstanding government debt. These results are in line with those of Baskaran (2009), who finds that the Maastricht Treaty's provisions did not have the expected positive effect on economic growth and fiscal outcomes, especially after the introduction of the Euro. Galí and Perotti (2003) also mention that fiscal policy did not become less counter-cyclical after the Maastricht treaty. Furthermore, beyond the fact that an economic crisis provokes detriment growth by about 0.4%, the results show that the Maastricht Treaty was the most detrimental institutional event for the improvement of public finances. Lastly, and similar to monetary policy behaviour and its relationship with institutional variables, we also conclude that institutional variables do not impact on fiscal policy behaviour in the case of each of the two sub-periods.

4.2. Interactions between monetary and fiscal authorities

Besides estimating the policies of each authority, we also decided to include fiscal (monetary) variables in the monetary (fiscal) regression, in order to highlight, in a different way, the real concerns of national governments and central banks, along the lines of Wyplosz (1999). Therefore, we can thus identify the interactions between monetary policy and fiscal policy, which is one of the objectives of our study.

4.2.1. Reaction function of the central banks

To estimate the reaction function results of the monetary authority, we compute Equation (3) by adding a change in the cyclically adjusted primary balance term ($\Delta capb_{it-1}$):

$$interest_{i,t} = \beta_i + \delta interest_{i,t-1} + \phi inflation_{i,t-1} + \varphi outputgap_{i,t-1} + \lambda m3_{i,t-1} + \theta \Delta capb_{i,t-1} + \eta current_{i,t-1} + \zeta REER_{i,t-1} u_{i,t} \quad (3)$$

The estimation for central banks' reaction function is presented in Table 6. Whilst estimating Regression (3), the expected results are $\phi, \varphi > 0$ and $\lambda, \theta, \eta, \zeta < 0$. From the results, we conclude that central banks do not react to fiscal policy. Therefore, the obtained results evidence a passive behaviour by monetary authorities. In addition, in fact, we only obtain statistical significance coefficients for current account balance and output gap. Therefore, we can say that central banks are not only concerned with external balances, but also with inflation through output deviations from their potential values. In fact, positive output gaps between the actual GDP and its potential leads to possible inflationary pressures.

On the other hand, and before the introduction of the Euro, inflation seems to be quite significant in explaining the dynamics in interest rates, in line with the results for Equation (1). However, we found the opposite effect for the current account on interest rates. In fact, while current account balance improvement seems to reduce interest rates, we obtained a different result for the results obtained for the 1970–1999 period. More specifically, on average, a 1% increase in the current account balance increases interest rates by 0.3%. During the twenty-first century, the results follow the pattern reported in Table 6.

Table 6. Estimation of central banks' reaction function with $interest_{i,t}$ as dependent variable: 1970–2015, 1970–1999 and 2000–2015.

	OLS			OLS-FE			2SLS		
	(1) 1970–2015	(2) 1970–1999	(3) 2000–2015	(4) 1970–2015	(5) 1970–1999	(6) 2000–2015	(7) 1970–2015	(8) 1970–1999	(9) 2000–2015
$interest_{i,t-1}$	0.848*** (0.160)	1.555*** (0.157)	0.617*** (0.057)	0.826*** (0.191)	1.556*** (0.150)	0.494*** (0.06)	0.936*** (0.281)	1.373*** (0.189)	0.862*** (0.124)
$inflation_{i,t-1}$	0.034 (0.084)	-0.325*** (0.080)	0.054 (0.071)	0.040 (0.102)	-0.342*** (0.072)	0.099 (0.077)	-0.120 (0.215)	-0.238** (0.103)	-0.294 (0.243)
$outputgap_{i,t-1}$	0.148*** (0.047)	0.884 (0.591)	0.133*** (0.023)	0.123* (0.070)	1.029* (0.603)	0.094*** (0.026)	0.057 (0.057)	-1.056 (0.974)	0.088** (0.038)
$m3_{i,t-1}$	-0.000 (0.002)	0.046* (0.024)	-0.001 (0.001)	-0.005 (0.020)	0.041* (0.024)	-0.025*** (0.007)	0.004 (0.027)	-0.006 (0.065)	-0.001 (0.001)
$\Delta capb_{i,t-1}$	0.001 (0.029)	0.073 (0.283)	0.003 (0.024)	0.003 (0.030)	0.004 (0.280)	0.006 (0.026)	0.056 (0.083)	-2.988 (3.582)	0.073 (0.163)
$current_{i,t-1}$	-0.015 (0.018)	0.325* (0.182)	-0.038*** (0.014)	-0.057* (0.034)	0.322* (0.178)	-0.082*** (0.023)	-0.086** (0.037)	0.288 (0.604)	-0.063** (0.025)
$RERR_{i,t-1}$	-0.007 (0.018)	-0.051 (0.078)	0.001 (0.012)	-0.018 (0.029)	-0.056 (0.086)	0.001 (0.015)	-0.030 (0.031)	-0.070 (0.100)	-0.03 (0.027)
<i>obs</i>	450	43	366	450	43	366	419	25	338
R^2	0.888	0.969	0.807	0.889	0.957	0.837	0.899	0.974	0.693

*, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets. Additional results on the effects of each variable one at a time on the dependent variable are available on request.

Regarding the results of the SUR analysis, and according to Wyplosz (1999), a positive sign for the estimated primary balance coefficient implies a complementary relation between both authorities. In fact, our results evidence that a complementary relationship exists for the primary balance of some countries, such as Cyprus, Finland, France, Italy, and Portugal. However, improvement in public finances does not reveal a similar reduction in price level through the increasing of interest rates, as in the case of Denmark and Hungary and some other countries.

4.2.2. Reaction function of national governments

For the fiscal reaction function, we follow the same approach as Wyplosz (1999), regarding the choice of explanatory variables, but without relative unit labour costs. We decided to introduce the first-differences of the short-term interest rate, in order to attain most of the expected results. Hence, the regression is presented as follows:

$$capb_{it} = \beta_i + \alpha capb_{i,t-1} + \delta \Delta interest_{i,t-1} + \phi inflation_{i,t-1} + \phi outputgap_{i,t-1} + \sigma debt_{i,t-1} + u_{i,t} \quad (4)$$

The estimated results are summarised in Table 7. The results show that primary balance still reacts positively to government debt ($\sigma > 0$), although its impact is smaller than in the case when we consider the simple fiscal policy reaction Function (2). The results regarding the output gap indicate that fiscal policy is not conditioned by the business cycle. When we run the OLS-FE test, the significance of inflation also provides quite an interesting result, whereby the fiscal authority has to achieve the necessary levels of primary budgetary surpluses to ensure that its budget constraint is consistent with the price level determined by the monetary authority.

In addition, changes in interest rates only slightly improve fiscal stance when we look at the results obtained using the OLS approach. In fact, cyclically, the budget improves less than 0.1% for a 1% increase in interest rates, which highlights a lower degree of active behaviour by a government. In addition, it seems that, contrary to the post-2000 period, governments were not sensitive to either public debt changes or interest rates variations. Furthermore, between the year of 1970 and the end of the XX century, it seems that government finances did not react to business cycles, as the output gap coefficient for that period appears to be insignificant. One last factor is related to the relationship between public finances and the external side of the economy, where it seems that current account balance and real effective exchange rates have a more serious impact after 2000, than before this date.

Once again, the results of the SUR model show that for some countries, such as Austria, Bulgaria, Cyprus, Finland, and Sweden, governments have followed a Ricardian fiscal regime. Regarding monetary variables, none of the above-mentioned variables had an impact in Cyprus, however, in some countries, such as Italy and Poland, while only one monetary variable appears to be relevant in determining the necessary primary budget surplus, for the majority of countries, such as Belgium, Denmark, and Sweden, the primary balance suffers the impact of all monetary variables.

Comparing the SUR estimation with that carried out for the central banks' reaction function, the results lead us to conclude that the relationship between a national government and its central bank does not change for both estimations

Table 7. Estimation of national governments' reaction function with $capb_{i,t}$ as dependent variable: 1970–2015, 1970–1999 and 2000–2015.

	OLS			OLS-FE			2SLS		
	(1) 1970–2015	(2) 1970–1999	(3) 2000–2015	(4) 1970–2015	(5) 1970–1999	(6) 2000–2015	(7) 1970–2015	(8) 1970–1999	(9) 2000–2015
$capb_{i,t-1}$	0.598*** (0.081)	0.511*** (0.173)	0.54*** (0.081)	0.439*** (0.078)	–0.296 (0.198)	0.401*** (0.079)	0.257 (0.37)	0.837*** (0.252)	0.55*** (0.079)
$debt_{i,t-1}$	0.01*** (0.004)	0.013 (0.011)	0.009** (0.004)	0.049*** (0.011)	–0.036 (0.067)	0.047*** (0.013)	0.082 (0.113)	–0.018 (0.017)	0.007 (0.004)
$\Delta interest_{i,t-1}$	0.051* (0.029)	0.008 (0.075)	0.23** (0.089)	0.031 (0.029)	–0.166 (0.112)	0.189** (0.086)	–0.631 (2.587)	–0.035 (0.142)	0.611 (0.583)
$\Delta inflation_{i,t-1}$	0.011 (0.009)	0.017 (0.017)	0.099 (0.064)	0.024* (0.013)	0.05 (0.032)	0.111* (0.067)	–0.003 (0.193)	0.002 (0.041)	0.205 (0.303)
$\Delta outputgap_{i,t-1}$	–0.032 (0.044)	0.035 (0.146)	–0.087* (0.046)	0.007 (0.055)	0.218 (0.326)	–0.03 (0.058)	0.208 (0.7)	0.191 (0.408)	–0.148 (0.157)
$\Delta m3_{i,t-1}$	–0.003 (0.002)	–0.01 (0.014)	–0.002 (0.002)	–0.033*** (0.009)	0.162** (0.062)	–0.022** (0.011)	–0.038 (0.032)	–0.006 (0.021)	–0.002 (0.002)
$\Delta current_{i,t-1}$	0.123*** (0.026)	0.214** (0.093)	0.134*** (0.027)	0.118*** (0.033)	–0.03 (0.14)	0.139*** (0.044)	0.126 (0.297)	0.111 (0.229)	0.170*** (0.059)
$\Delta REER_{i,t-1}$	–0.02* (0.01)	0.005 (0.011)	–0.035** (0.014)	–0.007 (0.011)	–0.026 (0.044)	–0.019 (0.014)	–0.002 (0.054)	–0.014 (0.025)	–0.060** (0.029)
Obs.	448	44	365	448	44	365	417	27	337
ΔR^2	0.582	0.835	0.547	0.648	0.960	0.613	0.288	0.840	0.513

*, ** and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. The robust standard errors are in brackets. Additional results on the effects of each variable one at a time on the dependent variable are available on request.

when the interest rate is relevant. For example, the short-term interest rates of both France and Luxembourg positively influence the primary balance, which suggests a complementary relationship, whereas the negative sign for the interest rates of Austria and Finland suggests a substitution relationship. However, in cases when the interest rate is not significant, the relationship between both authorities' changes in the SUR estimations of central banks and national governments' reaction functions.

In conclusion, our results for the interaction between the two policies are consistent with those presented in Semmler and Zhang (2004), Cevik, Dibooglu, and Kutan (2014), Silva and Vieira (2017).

5. Conclusions

Over the last decades, the study of the interactions between monetary policy and fiscal policy has gained more relevance, especially after the creation of the EMU, which led to a more distant, less cooperative, relationship. Accordingly, our study focused on the 28 EU countries, and also on the well-known major goals of both policies, which are dependent on certain economic variables, as well as trying to determine what type of interactions were established.

Regarding monetary policy, we find that inflation has a great impact on monetary authority response, which is not a surprising result, as price stability is the main central banks' objective. Furthermore, we also find that this policy reaction function tends to be pro-cyclical and is influenced by external demand. In fiscal terms, primary balance followed the expected behaviour, whereby it reacts positively to increases in government debt, which is in accordance with Ricardian fiscal regimes – the reaction function for national governments evidenced being a major concern for public debt levels, as was the case, albeit less so, for the levels of inflation and output gap. These conclusions can be related to Ricardian fiscal regimes.

However, we also achieved results for both authorities' responses, separated into two sub-periods, i.e., before and after the introduction of the Euro. In fact, we find that the introduction of the euro was the institutional event that had more relevance in both monetary and fiscal authorities' responses. Specifically, the introduction of the euro had the biggest effect on fiscal policy, a negative one, by leading to a decrease of the primary balance.

Furthermore, the impact of the Maastricht Treaty is the only event that appears to have an effect on fiscal policy, whereby monetary authorities do not suffer any impact from these events. In addition, when faced by various crises over the entire period, these events all had a negative impact on both policies. The results of each policy reaction function give new insights regarding how institutional arrangements decisively influence the coordination within a monetary union. In fact, the analysis of the impact of these institutional variables, despite carrying out an in-depth study of the impact of other macroeconomic variables which can influence the coordination between fiscal and monetary policies, could lead to an improved design of European institutions, and, consequently, provide to guarantee for successful monetary union, such as in the case of the Eurozone, as suggested in Smaghi and Casini (2000), Godbillon and Sidiropoulos (2001), and Panico and Purificato (2013).

In summary, the overall consensus that monetary authority controls inflation and fiscal policy controls government debt became clear. However, when governments attain high levels of public debt or budget deficits, then the central bank assumes a somewhat more dominant position to confront the fiscal problem. Similar to the literature, these results evidence a substitution relationship between both authorities. In the individual country analysis, this relationship was not present in the whole sample, as most of the countries belong to the EMU, i.e., monetary policy is the same, whereas fiscal policy is completely different, which thus creates a variety of interactions across countries, as well as some other results. In addition, this paper shows that the type of relationship adopted by each country between its two authorities is of extreme relevance for sustainable economic performance – beyond the major impact that the introduction of the Euro common currency had on the coordination and individual behaviour of both fiscal and monetary authorities.

Disclosure statement

No potential conflict of interest was reported by the authors.

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