Economia Politica
https://doi.org/10.1007/s40888-024-00337-y

ORIGINAL PAPER

Monetary-fiscal policies design and financial shocks in currency unions

Salvatore Capasso[1] · **Pasquale Foresti**[2]

Received: 2 November 2022 / Accepted: 22 May 2024

Abstract
This paper analyzes the design of monetary and fiscal policies in a currency union by focusing on the capacity to react to symmetric and asymmetric financial shocks. The model is constructed in order to mimic the institutional design adopted for the policy making in the EMU. The paper shows how a currency union set-up like the one adopted by the EMU can easily cope with symmetric financial shocks. However, it shows how in the face of asymmetric shocks more space for fiscal interventions is crucial, especially in more peripheral member countries.

Keywords Monetary union · Monetary-fiscal policy, EMU · Financial shocks

JEL Classification E52 · E61 · F33 · F36

1 Introduction

The macroeconomic imbalances within the euro area, and the following sovereign debt crisis in some member countries, have been tackled with the introduction of several institutional reforms in both the EMU and the EU. Many of the proposed institutional reforms focus on the improvement of the capability to shield member countries from the instability coming from financial markets, a channel that was clearly overlooked in the initial design of the EMU. Furthermore, another substantial part of these reforms has been dedicated to the management of public finances and policy making in the EMU.

✉ Pasquale Foresti
pasquale.foresti@roehampton.ac.uk; p.foresti@lse.ac.uk

Salvatore Capasso
salvatore.capasso@uniparthenope.it

[1] University of Naples Parthenope and CNR, Naples, Italy

[2] University of Roehampton London and The London School of Economics, London, UK

Published online: 18 July 2024

This changing economic and institutional scenario has prompted a renewed academic interest in the management of national public deficits in a monetary union, as well as in the interaction between monetary and fiscal policies in such an institutional arrangement.

This article presents a monetary union model in which the interaction between monetary and fiscal policies is studied by taking into account also the presence of asymmetric financial shocks. The presented model falls in the literature studying the functioning of economic policy making in currency unions by means of game theory models (Beetsma & Debrun, 2004; Foresti, 2018). As its main peculiarity, the present paper extends this kind of analysis by studying also the impact of symmetric and asymmetric financial shocks.

Given the scarcity of contributions on this specific aspect, this study hopes to make a meaningful contribution to the contemporary debate on the policy response to financial shocks and to how we conceptualize 'well-designed' monetary unions.

One of the key features of the model is that the central bank conducts monetary policy on the basis of union-wide average data. This is in line with the official pronouncements of the ECB stating that, in order to find the optimal policy rule for the EMU as a whole, national macroeconomic data should first be aggregated into euro-wide averages. On the other side, each government fixes its fiscal policy on the basis of its national data. These features of the model, combined with the fact that it can account for the presence of asymmetric financial shocks, make it suited to explore some of the problems recently faced by the EMU member countries.

The main results of the model can be summarized as follows.

Financial shocks that increase (decrease) the average national interest rate in the union result in a reduction (increase) of the central bank's interest rate in the equilibrium.

Fiscal authorities have not a stabilization task in response to financial shocks as long as they are perfectly symmetric. This is due to the fact that in the case of a symmetric financial shock the central bank is able to stabilize it by reducing the official interest rate. Therefore, no national governments intervention is required.

However, when financial shocks occur asymmetrically across the union, governments recognize the need for national specific maneuvers and fiscal policy is necessary to stabilize the national macroeconomic effects of such shocks.

Specifically, in the equilibrium, national financial shocks do not reverberate on national output-gap and interest rate only when perfectly symmetric. Therefore, idiosyncratic financial shocks can generate increases in the national interest rate (increasing the spread between member countries) and contractions in the national output. This reflects the national governments' limited capability to affect the interest rate and the fact that the central bank reacts on the basis of average data in the union.

If a credibility shock hits asymmetrically some member countries (a sudden increase in the national interest rate), conventional monetary policy cannot stabilize it and the interest rate and output-gap in this country are then affected by this kind of shocks. The impact of asymmetric financial shocks on the output-gap will be weaker: (1) the stronger the fiscal multiplier; (2) the less governments are constrained by their fiscal target.

Finally, the model allows to show that such problems are more severe for peripheral countries in the union.

Therefore, the model shows how, in the face of severe idiosyncratic financial turbulences, policy makers in monetary unions are very constrained and that the way to minimize the real effects of such shocks is to reduce the tightening of fiscal rules (and then reducing the focus on budget targets) and maximize the fiscal multiplier.

The remainder of the paper is the following. Section 2 provides some backgrounds to the research presented in this article. Section 3 describes the model, while Sect. 4 reports the results of the model in its equilibrium. Section 5 concludes the study.

2 Backgrounds and relevant literature

Following the birth of the EMU, a vast literature has adapted macroeconomic tools to analyze policy design issues in multi-country frameworks. For obvious reasons, one of the most relevant is the study of the interaction between a centralized monetary policy and many decentralized fiscal policies. Although this literature had its most flourishing period in the beginning of the 2000s, the global financial crisis and the consequent macroeconomic imbalances in some EMU member countries have raised questions concerning the targets of the ECB, the degree of policy coordination within the EMU, the enforcement of fiscal rules and the commitment of policy makers to their assigned objectives.

This has prompted a renewed interest in the theoretical literature studying monetary and fiscal policies interactions in a monetary union, as it provides possible answers to such questions and permits to evaluate the ongoing process of redesigning the institutional structure underlying the formation of the policy mix in the EMU.

Given the large amount of contributions on the topic, this section cannot extensively review such literature. Hence, it is intended to recall the main methodological pillars of the relevant literature and to stress its most relevant results.[1]

2.1 Methodological background

The cornerstone of such literature can be related to a series of articles by Dixit and Lambertini (2001, 2003a, b), where the interaction of monetary and fiscal policies is analyzed via a simple and flexible general game theory framework. In this framework, a monetary union involves n member countries indexed by $i = 1, 2 \ldots, n$, each of them with its fiscal policymaker (often indicated also as the national government). Monetary policy is conducted by a single supranational

[1] For extensive reviews focusing on different aspects of this literature, see Beetsma and Debrun (2004), Beetsma and Giuliodori (2010) and Foresti (2018).

central bank. Therefore, the set of players (X) is formed by $n+1$ policy-makers x_j, with $j = 1, 2, \ldots, n+1$.

The action of the fiscal authorities (b_i) can be assumed to be public expenditure, taxation or primary deficit maneuvers. Monetary policy action (a) can be intended to be manipulating the interest rate, the level of inflation or the quantity of money. Then, a profile of actions of all players is given by $C = (c_j)$, with $c_j = (a, b_1, b_2, \ldots b_n)$. Each of the $n+1$ players has a payoff that is commonly represented by a loss function $L_j = L_j(D)$. Where D includes the policy instruments (b and c) as well as other variables that can potentially enter the authorities' loss functions (d). It is worth noting that large part of the literature strictly focuses on the interaction between fiscal and monetary authorities, but some contributions extends this framework by adding also private agents (see for instance Chari & Kehoe, 2008; Kempf & von Thadden, 2013).

Concerning the structure of the interaction game, in the literature it is assumed that all fiscal policymakers act at the same stage. This implies that there are three relevant set-ups: (1) Simultaneity; (2) Fiscal Leadership; and (3) Monetary Leadership.

Furthermore, players that are located to play at the same stage can cooperate by forming coalitions in which they jointly decide their actions. Formally, the players involved in a coalition decide by minimizing a weighted average common loss function.

The most common way of modeling the fiscal-monetary interactions is a linear-quadratic specification of the outlined framework. The economy is represented with a linear model and there is a $Px1$ vector summarizing the state of the economy. This vector depends on the $jx1$ vector of actions of the players (denoted as x):

$$y = \overline{y} + Bx \tag{1}$$

with $\overline{y}$ is a vector of constants, while B denotes a Pxj matrix. The p-th element of y, y_p, characterizes the aggregate variable p, with $p = 1, 2, \ldots, P$. The most common formalization of Eq. (1) in the literature relies on two equations representing: (1) The demand side; and (2) the supply side of the economy.

Let y^{*j} denote a $px1$ vector target of values of these variables for the j-th player, with p-th element y_p^{*j}. Target values are not necessarily shared by all players. The payoff function for the j-th player is a weighted sum of squared deviations of the elements of y from their target values, i.e.:

$$L_j = \frac{1}{2}\left[\omega_1^j (y_1 - y_1^{*j})^2 + \cdots + \omega_p^j (y_p - y_p^{*j})^2\right] \tag{2}$$

where individual payoffs depend on the actions of other players through the model itself (i.e. the B-matrix) and player-specific weights ω^j in the payoff functions. To avoid degenerate cases, the matrix B is assumed to be invertible whenever $p = X$. Moreover, for every variable p there exist a pair of values $\omega_p^j > 0$ and $b_{pj} \neq 0$. The entry $b_{pj} \in B$ denotes the marginal effect of the action of the j-th player on the variable p for at least the j-th player.

2.2 Relevant literature

When the loss functions of all the authorities contain exactly the same variables and the same target levels, a phenomenon called symbiosis emerges (see Dixit & Lambertini, 2003b). Symbiosis implies that if the authorities share the same preferences, the targets can always be attained independently of the details of the institutions. The most important feature of symbiosis is that the social optimum is obtained despite disagreements about the weights of the objectives, despite the order of moves, without coordination and irrespective of commitment to policy rules as the analysis of all other equilibria follows the same lines and all yield the common ideal outcome (see Dixit & Lambertini, 2003b). Therefore, according to symbiosis, the only relevant aspect is the concordance on the targets between the authorities. Once the concordance is achieved, these targets will be naturally attained irrespectively of any other institutional structure. Kempf and von Thadden (2013) show that this result holds also including the private agents' payoff function. Overall, symbiosis offers very appealing theoretical elements for the institutional architecture of a monetary union, and it suggests that most of the main concerns for the EMU may be irrelevant. The Maastricht Treaty and the Stability and Growth Pact (and further reforms) restrain fiscal policies in order to impose a certain level of coordination and minimize the impact of externalities, while the ECB is designed to be a strictly committed central bank. However, symbiosis suggests that these restrictions may be unnecessary.

Obviously, this conclusion would be relevant for the EMU only if symbiosis between national governments and the ECB holds. Unfortunately, symbiosis holds only under some essential features of the model. The authorities must share the same variables in their loss functions and they should agree on the most desirable level of output in each country and on the most desirable level of inflation. Moreover, this result is obtained assuming that all the shocks are observed and that authorities do not face any type of uncertainty. Therefore, other contributions in the literature have relaxed these assumptions in order to elucidate their role.

The assumption of the lack of uncertainty is very important in order to obtain a symbiosis between fiscal and monetary policy. It is worth noting that, due to the linear-quadratic nature of the game, the introduction of unobserved additive shocks into Eq. (1) does not affect the optimal policies set under average outcomes. Nevertheless, multiplicative (or parameter) uncertainty can affect the symbiosis in the strategic interaction between fiscal and monetary authorities. Multiplicative (or parameter) uncertainty imposes a stochastic nature on one or more of the parameters in the model (see Holly & Hughes Hallett, 1989). Di Bartolomeo and Giuli (2011) and Di Bartolomeo et al. (2009) introduce multiplicative uncertainty in the model by assuming that unobserved shocks can affect fiscal and monetary policy effectiveness. They show that under multiplicative uncertainty the achievement of ideal output and inflation is not guaranteed anymore. Specifically, an increasing level of uncertainty raises inflation and reduces output. The explanation for this result is that when outcomes are random, a conflict between policy makers emerges because their targets on average are no longer a common objective.

Other two circumstances in which symbiosis does not occur are the following. When fiscal and monetary authorities consider different variables in their loss functions. This is shown in Lambertini (2004) and Lambertini et al. (2007), where the fiscal authorities also consider their fiscal stance in their loss function. The last assumption that can be removed is the one of common target values for the central bank and the governments. In the case of conflicting objectives between the monetary and fiscal authorities, Dixit and Lambertini (2000, 2001) show that the equilibrium outcomes do not coincide with the bliss points and that they depend on the details of the institution, such as the commitment to a rule and the order of moves. The importance of the difference in the targets of the authorities is also analyzed by Demertzis et al. (2004) who stress that the conflict arising when authorities pursue their goals independently becomes stronger when preferences diverge (see also Hughes Hallet & Viegi, 2002).

Hence, although symbiosis provides very appealing results for the institutional building of a monetary union, one must admit that the assumptions on which it is based are very unlikely to happen all together in reality. For instance, the institutional architecture in the EMU separates the targets of the ECB and the objectives of national governments. The ECB is supposed to be concerned about inflation as its first objective, while fiscal discipline is a direct concern of single governments. A natural representation of this framework would not lead to a coincidence between the variables in the loss functions of the monetary and fiscal authorities. Second, economic policy uncertainty is difficult to measure, but there is a large consensus on the fact that such circumstance can occur (see, for instance, Bachmann et al., 2013; Baker et al., 2013; Bloom, 2009). Moreover, in multi-country arrangements the effects of monetary policy are less predictable by the central bank, as the reaction to monetary shocks can differ between countries (see, for instance, Clausen, 2001; Clausen & Hayo, 2006). Third, economic and political heterogeneity across member countries also makes it very difficult to have fully concordant targets in practice. Thus, the most relevant implication for these evidences is that symbiosis does not apply in reality and that the degree of commitment to a rule and discretion, the level of coordination, the order of moves and other characteristics of the interaction game, they all matter and require attention when the interaction between monetary and fiscal policies in a monetary union is analyzed.

Based on this conclusion, another branch of the literature has investigated the implications of commitment versus discretion in a monetary union. The case of full discretion results in a too high output and a too low inflation due to a non-cooperative race in which fiscal authorities try to achieve output beyond the central bank's ideal, while the monetary authority aims at an inflation rate that is below the fiscal authorities' ideal (Foresti, 2018). Furthermore, the more the priorities of the central bank and of the governments differ, the more their policies will be conflicting and the larger the policy mix bias (Demertzis et al., 2004). Dixit and Lambertini (2001) study monetary leadership as a possible solution to the problem of the policy-mix bias. They conclude that although under full discretion monetary leadership can perform better than the Nash equilibrium, it is not allow to achieve the target values yet.

Another possible solution to the policy-mix bias is the commitment of policy authorities to specific rules. Specifically, the interaction between fiscal and monetary policies allows for three different possible solutions. The first option is the one of full commitment, in which all the authorities commit to policy rules. Alternatively two partial commitment solutions are possible, one in which only the monetary authority commits to a rule and another where only the fiscal authorities are committed. In case of partial commitment in which only the monetary authority follows a policy rule, it is like the central bank announces its policy function before expectations are formed. Under this specification, Dixit and Lambertini (2001) show that this arrangement provides the same outcome as the discretionary monetary leadership. This is due to the fact that the beneficial effects of the monetary commitment are totally nullified by the discretionary fiscal policies in the union, as the latter act as a constraint for the monetary rule. Then, fiscal policy regulation can improve the performance of monetary commitment. Furthermore, countries in a monetary union should also have incentives to adhere to a fiscal rule as it allows governments to internalize the long-run benefits of reducing the debt in terms of lower future inflation. This has been one of the arguments supporting the Stability and Growth Pact. Therefore, the equilibrium that is potentially able to avoid the policy mix bias is the one of full commitment to policy rules in which also fiscal authorities adhere to a rule. Intuitively, when the authorities fix their targets according to policy rules, agree on them, and are concerned about the same variables, the outcome of full commitment provides the attainment of these targets. In such a case, the coalition consisting of all authorities is able to reproduce the situation in which symbiosis occurs and the social optimum (or bliss point) is achieved (Beetsma & Uhlig, 1999). Provided that full commitment allows avoiding any policy mix bias, a relevant question concerns the optimal level of commitment. Hughes Hallett and Weymark (2007) agree with the conventional wisdom on the fact that full commitment is the most desirable arrangement, but they enrich this conclusion analyzing the required degree of commitment. They find that a certain degree of commitment is required in order to uniquely obtain the desired outcome for each authority. This minimum degree is a positive function of other authorities' degree of commitment, level of impatience of the authorities and the structure of the economy. Moreover, the optimal level of commitment is not necessarily the same for all the authorities. They show that undesirable scenarios can be avoided when monetary commitment is sufficiently stronger than fiscal commitment. Although additive shocks have not been formally considered so far, it is worth noting that they play an important role in the commitment to a rule by policy makers. As highlighted by Beetsma and Uhlig (1999) and Dixit (2000), large and asymmetric shocks make it difficult to sustain a commitment rule. Therefore, the authors suggest that some degrees of flexibility are required in order to make the rules sustainable under severe asymmetric shocks. The degree of flexibility, however, is a very sensitive aspect especially for fiscal policy rules, as according to the degree of freedom fiscal policy can reduce both the central bank's commitment and conservativeness (see Andersen, 2008; Dixit, 2001).

The results highlighted in this section have some important institutional implications for the setting up of a monetary union. Provided that the assumptions that trigger symbiosis are very unlikely to occur in reality, the lack of rules and full discretionary policies should provide a policy mix bias in which the final outcome diverges from the initial targets. To avoid the results of this non-cooperative interaction, the formulation of policy rules is extremely needed. In the institutional framework of the EMU it is clearly stated, through a hierarchical mandate, that the ECB is intended to be a conservative monetary authority and fiscal rules, like the ones in the Stability and Growth Pact, have been considered as a necessary requirement. Nevertheless, the constraints on the conduct of fiscal policy and the convergence criteria have shown to be insufficient to implement a proper rule mechanism on the fiscal authorities' choices. According to the models presented in this section, this scenario can undermine the beneficial effects of the central bank's conservativeness and harm national economies in the long run. The implementation of mechanisms able to enforce a fiscal rule is then crucial in order to achieve the targets and to avoid divergent macroeconomic dynamics in a monetary union. Therefore, the reform of the Stability and Growth Pact should be pointing in this direction. Still, the flexibility of fiscal rules is also a necessary element in order to facilitate the management of asymmetric shocks and potential financial turbulence by national governments (see also De Grauwe & Foresti, 2016).

The aim of the present paper is to contribute to this literature by studying the interaction of a centralized monetary policy with many decentralized fiscal policies by considering also the role of financial markets shocks. To this aim, the analysis is conducted with a model based on (1) and (2), in which symbiosis does not occur, by extending the set of equations forming (1) with some relations linking the interest rates across the union.

3 The model

The interaction between monetary and fiscal authorities relies on the framework represented in (1) and (2). The model assumes the presence of n member countries and one central bank. As main particularity, the presented model extends the set of equations forming (1) by adding equations linking the interest rates in member countries with each other and with the official interest rate fixed by the monetary authority. This allows to study the effects of symmetric and asymmetric financial markets shocks. No coalitions between players are formed and all authorities take simultaneous decisions.

3.1 Fiscal authorities

In a monetary union, the conduct of fiscal policy is fractionated among national governments and each of them relies on its national macroeconomic data in the setting of the fiscal stance. It is assumed that each government is directly concerned about its national output-gap and primary deficit. Therefore, in a monetary union formed by n member countries, under the assumption that the fiscal authorities share the same preferences, the loss function of government i can be written as follows:

$$L_{G,i} = \frac{1}{2}\left[(y_i - y_i^T)^2 + \gamma(f_i - f_i^T)^2\right] \tag{3}$$

where the output-gap is represented by y_i and primary deficit by f_i, while y_i^T and f_i^T are the targeted output-gap and primary deficit by each government. For notational simplicity, and with no loss of generality, both the output-gap and fiscal targets are set to zero for each government. The preference parameter γ represents the relative weight that the fiscal authorities assign to the stabilization of deficit, and it is assumed to be symmetric across member countries. The governments' policy instrument is the fiscal stance variable (f_i), by which they minimize their loss function according to the surrounding economic scenario.

Each government considers the following national demand equation:

$$y_i = a - b\rho_i + kf_i + \varepsilon_{1,i} \tag{4}$$

where $\rho_i = r_i - \pi$ and a are the real interest rate and the potential output-gap in country i, respectively; while $\varepsilon_{1,i}$ represents idiosyncratic demand shocks. Equation (4) assumes the absence of fiscal policies spillover effects and the symmetry of the demand parameters across member countries.

As anticipated by the real interest rate equation, the model is developed assuming that inflation is the same across the union and that the law of one price holds.[2] It can be modeled with the following supply equation:

$$\pi = \pi^e + \alpha \frac{1}{n} \sum_{i=1}^{n} y_i + \varepsilon_2 \tag{5}$$

where $\frac{1}{n} \sum_{i=1}^{n} y_i$ is the average output-gap in the union, π^e is the expected inflation and ε_2 represents supply shocks.

One of the principal predicaments of the optimal currency areas (OCAs) theory is that a well designed monetary union should be characterized by free capital mobility and perfectly integrated financial markets. Therefore, by assuming perfect capital mobility and perfect monetary transmission mechanism, financial markets can be included in the model by means of the following stochastic parity condition:

$$r_i = r_{cb} + \varepsilon_{3,i}. \tag{6}$$

Equation (6) links the nominal interest rate controlled by monetary policy, r_{cb}, with the nominal interest rate in country i, r_i. Deviations from this parity can occur due to events linked to relations not formally accounted in the model and are then modeled with financial markets shocks ($\varepsilon_{3,i}$). These can manifest, for instance, in the form of a credibility shock.

Equation (6) can be rewritten as:

$$r_i + \varepsilon_{3,-i} = r_{-i} + \varepsilon_{3,i} \tag{7}$$

where r_{-i} represents the average interest rate in the rest of the union apart from country i. Then, Eq. (7) can be interpreted as a stochastic uncovered interest parity between countries in a monetary union (an irrevocable fixed exchange rate with no expected exchange rate variations).

2 For the rationale of this assumption see De Grauwe (2000) and Honohan and Lane (2003).

Demand ($\varepsilon_{1,i}$), supply (ε_2) and financial ($\varepsilon_{3,i}$) shocks are assumed to be i.i.d with zero means and constant variances.

3.2 Central bank

The central bank takes its decisions on the basis of the union-wide average data, and its preferences are represented by the following loss function:

$$L_M = \frac{1}{2}\left\{(\pi - \pi^T)^2 + \beta\left[\frac{1}{n}\sum_{i=1}^{n}(y_i - y_i^T)\right]^2\right\}. \tag{8}$$

This specification implies that the central bank takes its decisions considering the deviations of inflation (π) and union-average output-gap ($\frac{1}{n}\sum_{i=1}^{n} y_i$) from the target values. Also for the central bank, the output-gap target is set to zero, while the inflation target is π^T. The preference parameter β represents the relative importance that the monetary authority assigns to the output-gap stabilization.

The central bank's monetary instrument is the nominal interest rate (r_{cb}). It is chosen in order to minimize the loss function, considering the equations that represent the structure of the economy.

The average output-gap is determined by the following demand equation:

$$y = \frac{1}{n}\sum_{i=1}^{n} y_i = a - b\frac{1}{n}\sum_{i=1}^{n}\rho_i + k\frac{1}{n}\sum_{i=1}^{n} f_i + \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{1,i} \tag{9}$$

where a represents the average potential output-gap, while $\frac{1}{n}\sum_{i=1}^{n}\rho_i = \rho = r - \pi$ is the average real interest rate in the union. The average nominal interest rate in the union (r) is obtained as:

$$r = \frac{1}{n}\sum_{i=1}^{n} r_i = \frac{1}{n}\sum_{i=1}^{n}(nr_{cb} + \varepsilon_{3,i}) = r_{cb} + \varepsilon_3. \tag{10}$$

Inflation is still modeled by adopting Eq. (5).[3]

Concerning the micro-foundations of the model, Woodford (2003) shows that the central bank's objective function can be obtained as a result of an expected utility maximization problem of a household in a New Keynesian Model thanks to a quadratic approximation. Dixit and Lambertini (2003b) show how Eq. (3) can be derived with a log-linearization around the steady state of a micro-founded model. Moreover, Lambertini and Rovelli (2004) provide an eclectic derivation of Eq. (4), while Bofinger and Mayer (2007) show that Eq. (5) can be obtained from a bargaining interaction between monopolistic competitive firms and workers, under the assumptions of a zero mark-up factor.

[3] In what follows it will be assumed that monetary policy is credible ($\pi^e = \pi^T$).

4 Monetary-fiscal policies interactions and equilibrium

As any game theory analysis with multiple agents, the interaction between fiscal and monetary policy in a monetary union can be modeled under different sequential arrangements. The present article follows Hughes Hallett and Weymark (2007) arguing that the best representation of the interaction in a monetary union like the EMU is a simultaneous game. Then, in what follows the model is solved in a simultaneous game framework.

In the Nash equilibrium, all the authorities take their policy decisions simultaneously and this requires deriving their respective best reaction functions.

The best response function of each government is obtained by minimizing (3) subject to (4), (5) and (6):

$$f_i(r_{cb}) = \frac{-ak}{k^2+\gamma} + \frac{bk}{k^2+\gamma}(r_{cb}-\pi) - \frac{k}{k^2+\gamma}\varepsilon_{1,i} + \frac{bk}{k^2+\gamma}\varepsilon_{3,i}. \tag{11}$$

Equation (11) shows how each fiscal authority in the union fixes its fiscal stance as a function of the monetary policy instrument.

Given that $\frac{\delta f_i}{\delta r_{cb}} = \frac{bk}{k^2+\gamma}$, when the central bank performs restrictive monetary policies (an increase in r_{cb}), governments implement expansionary fiscal policies (an increase in f_i) because they consider the restrictive effects of the monetary maneuver on the output-gap. The magnitude of such reaction depends negatively on the weight for the primary deficit stabilization in the governments' preferences (γ) and positively on the impact of the reaction of the output-gap to monetary policy (b).

The central bank minimizes (8) subject to (5), (9) and (10). The optimization problem can be solved following the two step procedure proposed in Bofinger et al. (2009). By solving for y, the following first order condition for the average output-gap is retrieved:

$$y = -\frac{\alpha}{\alpha^2+\beta}\varepsilon_2. \tag{12}$$

By substituting Eq. (12) into (5), it is possible to obtain the following reduced form expression for the inflation:

$$\pi = \pi^T + \frac{\beta}{\alpha^2+\beta}\varepsilon_2. \tag{13}$$

Then, by employing Eqs. (9), (10), (12) and (13) it is possible to obtain the best response function of the central bank:

$$r_{cb}(f) = \frac{a}{b} + \pi^T + \frac{b\beta+\alpha}{b(\alpha^2+\beta)}\varepsilon_2 + \frac{k}{b}f + \frac{1}{b}\varepsilon_1 - \varepsilon_3. \tag{14}$$

Equation (14) represents how the central bank fixes the nominal interest rate as a function of the average fiscal stance in the union ($f = \frac{1}{n}\sum_{i=1}^{n} f_i$). The same applies to the shocks as $\varepsilon_1 = \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{1,i}$, $\varepsilon_2 = \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{2,i}$ and $\varepsilon_3 = \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{3,i}$.

According to Eq. (14), when the fiscal authorities perform expansionary fiscal policies, the central bank reacts with a restrictive maneuver increasing the nominal interest rate. This is totally consistent with the central bank's preferences and the structure of the economy as represented in the model. Expansionary fiscal policies increase the output-gap and the level of inflation in the union. Both variations increase the loss of the monetary authority, that reacts increasing the interest rate in order to minimize the increase in the output-gap and in the inflation caused by fiscal policies. Moreover, the central bank reacts to positive demand and supply shocks with a restrictive monetary policy. The central bank also aims at eliminating the effects of financial markets shocks, as the official interest rate is reduced following a positive financial markets shock. Then, as long as financial shocks occur symmetrically across the union, the central bank reacts aiming at fully stabilize them although there is no precise target assigned to financial stability by the monetary authority. Equations (12)–(14) also show that in the absence of shocks ($\varepsilon_1 = \varepsilon_2 = \varepsilon_3 = 0$), and with a passive fiscal policy ($f = 0$), the central bank is able to reach its targets ($r = \frac{a}{b} + \pi^T$, which implies $y = 0$ and $\pi = \pi^T$).

Given the central bank's reaction function and the n reaction functions of the governments, the equilibrium of the game can be easily obtained as there are $n + 1$ linear equations and $n + 1$ unknowns. The system is solved using Eqs. (11), (13) and (14). The equilibrium nominal interest rate controlled by the central bank is:

$$r^*_{cb} = \frac{a}{b} + \pi^T + \frac{1}{b}\varepsilon_1 + \frac{\gamma b\beta + \alpha(k^2 + \gamma)}{\gamma b(\alpha^2 + \beta)}\varepsilon_2 - \varepsilon_3. \tag{15}$$

Both supply and demand shocks have a positive effect on the official nominal interest rate. Furthermore, it is easy to show that financial shocks that increase the average national interest rate in the union result in a reduction of the central bank's interest rate in the equilibrium. Hence, symmetric financial shocks are entirely smoothed by the monetary authority that is then able to preserve financial stability in the union. This provides evidence that national governments should not worry about symmetric financial shocks, but does not necessarily imply the same if the shock is asymmetric.

This is evidenced by the equation representing the fiscal stance in the equilibrium for country i:

$$f^*_i = \frac{k}{(k^2 + \gamma)}(\varepsilon_1 - \varepsilon_{1,i}) + \frac{bk}{k^2 + \gamma}(\varepsilon_{3,i} - \varepsilon_3) + \frac{\alpha k}{(\alpha^2 + \beta)\gamma}\varepsilon_2. \tag{16}$$

Fiscal authorities have not a stabilization task in response to demand and financial shocks as long as these are perfectly symmetric. In the case of a symmetric financial shock ($\Delta\varepsilon_3 = \Delta\varepsilon_{3,i}$), the central bank is able to stabilize this by modifying the interest rate. Therefore, no national governments' intervention is required. When financial shocks occur asymmetrically across the union ($\Delta\varepsilon_3 \neq \Delta\varepsilon_{3,i}$), governments recognize the need for national specific maneuvers and fiscal policy is necessary to stabilize the national effects of such shocks. Then, according to the solution of the model, fiscal policy flexibility is necessary in order to smooth such asymmetric shocks. To better understand the motivations and implications for such interventions, it is worth analyzing the national output-gap and interest rate for country i in the equilibrium. These can be obtained by employing Eqs. (4), (6), (13), (15) and (16):

$$y_i^* = \frac{\gamma}{(k^2+\gamma)}(\varepsilon_{1,i} - \varepsilon_1) + \frac{b\gamma}{k^2+\gamma}(\varepsilon_3 - \varepsilon_{3,i}) - \frac{\alpha}{\alpha^2+\beta}\varepsilon_2 \tag{17}$$

$$r_i^* = \frac{a}{b} + \pi^T + \frac{1}{b}\varepsilon_1 + \frac{\gamma b\beta + \alpha(k^2+\gamma)}{\gamma b(\alpha^2+\beta)}\varepsilon_2 + \varepsilon_{3,i} - \varepsilon_3. \tag{18}$$

Equations (17) and (18) show that, despite the policy reactions to financial shocks, national financial shocks do not reverberate on national output-gap and interest rate only when perfectly symmetric. Therefore, a positive idiosyncratic financial shock determines an increase in the national interest rate (increasing the spread between member countries) and generates a contraction in the national output.

This implies that such shocks are not fully smoothed in the equilibrium, reflecting the impossibility for national governments to fully affect the interest rate and the fact that the central bank reacts on the basis of average data in the union. Moreover, according to Eqs. (17) and (18) also an imposed reduction in primary deficit won't have any beneficial effect to smooth the shock. Furthermore, as evidenced in Eq. (11), the reaction of fiscal policy to an asymmetric shock depends on the fiscal multiplier (k) and on the governments' preference for the stabilization of primary budget (γ). Then, the real effects of asymmetric financial shocks depend on such parameters as $\frac{\delta y_i^*}{\delta(\varepsilon_3 - \varepsilon_{3,i})} = \frac{b\gamma}{k^2+\gamma}$.

If we define $\frac{b\gamma}{k^2+\gamma} = Z$ (by recalling that b, γ and k are all positive numbers) we can then verify that: $\frac{\delta Z}{\delta \gamma} = \frac{bk^2}{(k^2+\gamma)^2} > 0$; $\frac{\delta Z}{\delta b} = \frac{\gamma}{k^2+\gamma} > 0$; $\frac{\delta Z}{\delta k} = -\frac{2bk\gamma}{(k^2+\gamma)^2} < 0$. Therefore, we can conclude that the impact of asymmetric financial shocks on output will be stronger: (1) the weaker the reaction of the output-gap to fiscal policies (k); (2) the more governments are concerned about their fiscal target (γ); (3) the stronger the reaction of the output to variations in the real interest rate (b). Therefore, the model shows how in the face of severe idiosyncratic financial turbulences, policy makers in monetary unions are very constrained. The way to minimize the real effects of such shocks is to reduce the tightening of fiscal rules (and then reducing the focus on budget targets) and stimulate the fiscal multiplier.

So far it has been assumed that in the calculation of the union-wide average data, the central bank assigned the same weight to each member country. If this is not the case, such problems become more severe for countries that receive a lower weight by the monetary authority. Assume for instance that:

$$\varepsilon_3 = \psi\varepsilon_{3,-i} + (1-\psi)\varepsilon_{3,i} \tag{19}$$

where $1-\psi$ is the relative weight assigned by the central bank to financial shocks in country i, while ψ is the weight for the shocks in the rest the union. By assuming that a shock occurs only in country i, we can rewrite Eq. (19) as $\varepsilon_3 = (1-\psi)\varepsilon_{3,i}$. Then, Eqs. (17) and (18) in country i and in the rest of the union can be written as:

$$y_i^* = -\frac{b\gamma}{k^2+\gamma}\psi\varepsilon_{3,i}, \quad y_{-i}^* = \frac{b\gamma}{k^2+\gamma}(1-\psi)\varepsilon_{3,i} \tag{20}$$

$$r_i^* = \psi\varepsilon_{3,i}, \quad r_{-i}^* = -(1-\psi)\varepsilon_{3,i}. \tag{21}$$

These results confirm that the country from which the shock originates experiences a contraction, whereas the rest of the union experiences an expansion, but they also add the evidence that the magnitude of such asymmetry is determined by the weight assigned by the central bank to the country hit by the shock. The lower the weight for country i, the stronger is the effect of the shock in such country in the equilibrium. This occurs because the stabilization effort of the central bank will be low. Therefore, it can be concluded that asymmetric financial shocks are a major problem for small (or peripheral) countries participating in a union, as the interest rate set by the monetary authority will not be designed for a country with a low GDP weight unless the correlation of shocks is high. In the limit, when the GDP share of an individual member country tends to zero, the shock will be passed through completely if fiscal policy remains passive ($\gamma \to \infty$). Therefore, fiscal stabilization policy is particularly needed in small countries to smooth out the impact of financial shocks.

Thus, it can be concluded that a monetary union is easier to manage if shocks are highly correlated and fiscal policy actively engages into stabilizing business cycles. Most importantly, the solution of the model provides a rationale for fiscal intervention in the presence of asymmetric financial shocks.[4]

5 Conclusion

In this paper, the design of monetary and fiscal policies in a currency union has been analyzed. Specifically, the paper has focused on the capacity to react to symmetric and asymmetric financial shocks. The game theory model employed has been constructed in order to mimic the institutional design adopted for the policy making in the EMU.

From the policy and institutional point of view, the main results highlighted in the paper are the following.

Symmetric financial shocks can be stabilized by the intervention of the central bank even without a specific task assigned to the monetary authority. For instance, financial shocks that increase the average national interest rate in the union can be stabilized by the monetary authority by reducing the official interest rate. Under this circumstance, fiscal authorities have not a stabilization task in response to such shocks as no national governments intervention is required.

Things are very different when financial shocks occur asymmetrically across the monetary union. Under asymmetric financial shocks, the central bank alone is

[4] Similar conclusions can be drawn also for asymmetric demand shocks.

not capable to stabilize such shocks. Hence, governments recognize the need for national specific maneuvers and fiscal policy is necessary to stabilize the national effects of such shocks. As a result, despite the fiscal and monetary intervention, an idiosyncratic financial shock can generate an increase in the national interest rate (increasing the spread between member countries) and a contraction in the national output. This reflects the impossibility for national governments to fully control the national interest rate and the fact that the central bank reacts on the basis of average data in the union.

Finally, the model has also allowed to show that peripheral countries in the union are more exposed to such problems. Financial shocks are a major problem for small (or peripheral) countries participating in a union, as the interest rate set by the monetary authority will not be designed for a country with a low weight unless the correlation of shocks is high. In the limit, when the share of an individual member country is almost zero, the shock will be passed through completely if fiscal policy remains passive.

Therefore, the model shows how in the face of severe idiosyncratic financial turbulences, policy makers in monetary unions are very constrained and that the way to minimize the real effects of such shocks is to reduce the tightening of fiscal rules (and then reducing the focus on budget targets) and maximize the fiscal multiplier.

Overall, these results can be related to the situation experienced by some EMU member countries during the financial and sovereign debt crises and the policy implications deriving from the employed model can provide insights on how to improve the capacity of reacting to financial shocks. According to the results provided by the theoretical model, in the face of asymmetric financial shocks in the EMU some adjustments in the institutional and policy framework can be beneficial. In this regard, in order to allow member countries to smooth the negative shocks, a relaxation of the fiscal rules is needed so to provide national policy makers with the necessary fiscal space. Hence, the presence of some degree of flexibility in the EMU fiscal rules is paramount.

The model presented in this paper is based on a static game-theory framework. Therefore, among the possible extensions of the presented framework, one would like to consider the replication of this analysis in a dynamic setting. This would allow, among other possibilities, to consider also the impact of the dynamics implied by the level of public debt and by the presence of the zero lower bound on the interest rate. This is left for future research.

Data availability No data was used for this paper.

References

Andersen, T. M. (2008). The macroeconomic policy mix in a monetary union with flexible inflation targeting. *Journal of International Money and Finance, 27*(3), 411–437.

Bachmann, R., Elstner, S., & Sims, E. R. (2013). Uncertainty and economic activity: Evidence from business survey data. *American Economic Journal: Macroeconomics, 5*(2), 217–249.

Baker, S. R., Bloom, N., & Davis, S. J. (2013). *Measuring economic and policy uncertainty*. Chicago Booth Papers Working Paper No. 83.

Beetsma, R., & Debrun, X. (2004). The interaction between monetary and fiscal policies in a monetary union: A review of recent literature. In R. Beetsma, C. Favero, A. Missale, A. Muscatelli, P. Natale, & P. Tirelli (Eds.), *Monetary policy, fiscal policies and labour markets: Macroeconomic policymaking in the EMU*. Cambridge University Press.

Beetsma, R., & Giuliodori, M. (2010). The macroeconomic costs and benefits of the EMU and other monetary unions: An overview of recent research. *Journal of Economic Literature, 48*(3), 603–641.

Beetsma, R., & Uhlig, H. (1999). An analysis of stability and growth pact. *The Economic Journal, 109*, 546–571.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica, 77*(3), 623–685.

Bofinger, P., & Mayer, E. (2007). Monetary and Fiscal policy interaction in the Euro area with different assumptions on the Phillips curve. *Open Economies Review, 18*(3), 291–305.

Bofinger, P., Mayer, E., & Wollmershauser, T. (2009). Teaching new Keynesian open economy macroeconomics at the intermediate level. *Journal of Economic Education, 40*(1), 80–102.

Chari, V., & Kehoe, P. (2008). Time inconsistency and free-riding in a monetary union. *Journal of Money, Credit, and Banking, 40*(7), 1329–1355.

Clausen, V. (2001). *Asymmetric monetary transmission in Europe*. Springer.

Clausen, V., & Hayo, B. (2006). Asymmetric monetary policy effects in the EMU. *Applied Economics, 38*(10), 1123–1134.

De Grauwe, P. (2000). Monetary policies in the presence of asymmetries. *Journal of Common Market Studies, 38*(4), 593–612.

De Grauwe, P., & Foresti, P. (2016). Fiscal rules, financial stability and optimal currency areas. *Economics Letters, 145*(C), 278–281.

Demertzis, M., Hughes Hallett, A. J., & Viegi, N. (2004). An independent central bank faced with elected governments. *European Journal of Political Economy, 20*(4), 907–922.

Di Bartolomeo, G., & Giuli, F. (2011). Fiscal and monetary interaction under monetary policy uncertainty. *European Journal of Political Economy, 27*(2), 369–375.

Di Bartolomeo, G., Giuli, F., & Manzo, M. (2009). Policy uncertainty, symbiosis, and the optimal fiscal and monetary conservativeness. *Empirica, 36*(4), 461–476.

Dixit, A. (2000). A repeated game model of monetary union. *The Economic Journal, 110*(466), 759–780.

Dixit, A. (2001). Games of monetary and fiscal interactions in the EMU. *European Economic Review, 45*(4–6), 589–613.

Dixit, A., & Lambertini, L. (2000). *Fiscal discretion destroys monetary commitment*. Mimeo, Princeton University and UCLA.

Dixit, A., & Lambertini, L. (2001). Monetary-fiscal policy interactions and commitment versus discretion in a monetary union. *European Economic Review, 45*, 977–987.

Dixit, A., & Lambertini, L. (2003). Interactions of commitment and discretion in monetary and fiscal policies. *American Economic Review, 93*(5), 1522–1542.

Dixit, A., & Lambertini, L. (2003). Symbiosis of monetary and fiscal policies in a monetary union. *Journal of International Economics, 60*(2), 235–247.

Foresti, P. (2018). Monetary and fiscal policies interaction in monetary unions. *Journal of Economic Surveys, 32*(1), 226–248.

Holly, S., & Hughes Hallett, A. (1989). *Optimal control, expectations and uncertainty*. Cambridge University Press.

Honohan, P., & Lane, P. R. (2003). Divergent inflation rates in EMU. *Economic Policy, 18*(37), 357–394.

Hughes Hallett, A., & Weymark, D. (2007). Fiscal leadership and central bank design. *Canadian Journal of Economics, 40*(2), 607–627.

Hughes Hallet, A., & Viegi, N. (2002). Central bank independence, political uncertainty and the assignment of instruments to targets. In M. Buti, J. von Hagen, & C. Martinez-Mongay (Eds.), *The behaviour of fiscal authorities: Stabilization, growth and institutions* (pp. 268–286). Palgrave.

Kempf, H., & von Thadden, L. (2013). When do cooperation and commitment matter in a monetary union? *Journal of International Economics, 91*(2), 252–262.
Lambertini, L. (2004). *Fiscal cooperation in a monetary union*. Mimeo, Boston College.
Lambertini, L., Levine, P. & Pearlman, J. (2007). *Fiscal policy in a monetary union: Can fiscal cooperation be counterproductive?* School of Economics Discussion Papers 1707 School of Economics, University of Surrey.
Lambertini, L., & Rovelli, R. (2004). Independent or coordinated? Monetary and fiscal policy in EMU. In R. Beetsma, C. Favero, A. Missale, A. Muscatelli, P. Natale, & P. Tirelli (Eds.), *Monetary policy, fiscal policies and labour markets: Macroeconomic policymaking in the EMU.* Cambridge University Press.
Woodford, M. (2003). *Interest and prices: Foundations of a theory of monetary policy. Chapter 6*. Princeton University Press.