



Every Country for Itself and the Central Bank for Us All?

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Published online: 12 October 2020
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Abstract This paper used a small stylized nonlinear three-country macroeconomic model of a monetary union to analyse the interactions between fiscal (governments) and monetary (common central bank) policymakers. The three fiscal players were divided into a financially stable core and a less stable periphery. The periphery itself consisted of two players with different perceptions of the trade-off between fiscal stability and output growth. Using the OPTGAME algorithm, solutions were calculated for two game strategies: one cooperative (Pareto optimal) and one non-cooperative game type (the Nash game for the feedback information pattern). Introducing a negative demand shock, the performance of different coalition options between players were analysed. A higher level of cooperation leads in general to a better overall outcome of the game, however, with highly varying burdens to be borne by the players.

Keywords Dynamic game · Nash equilibrium · Pareto solution · Monetary union · Coalitions · Macroeconomics · Public debt

JEL Classification C54 · C61 · E27 · E61 · E63

Introduction

The European Sovereign Debt crisis, which was triggered by the financial and economic crisis of 2007–2010, hit several countries, mainly in southern Europe. Greece is the most well-known example of this crisis as it experienced several bailout programs and is still struggling with high public debt and unprecedentedly high unemployment. In the financial crisis, fiscal policymakers generally agreed on a set of actions and reacted to this shock with expansionary policies, both through discretionary measures and automatic stabilizers

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supported by an expansionary course for monetary policy. In contrast to this coordinated response to the financial crisis, in the case of the debt crisis, there was no such general agreement on how to resolve the financial stability issues accompanied by declining output. One reason for this can be seen in the heterogeneity of the Euro Area's state of economic development, combined with the unfavorable effects of the one-size-fits-all monetary union. Monetary policy, and exchange rate policy, in particular, are no longer available to national policymakers in the Euro Area as an instrument, and internal depreciation in an economically weak country, like Greece, does not seem to be a viable option. This led to pressure on the European Central Bank from different forces, with some governments asking for a more relaxed monetary policy to accommodate their expansionary budgetary policies and others pressing for more austerity in terms of sovereign debt and monetary policy directed at price stability. Thus, the European Central Bank is a decision maker in a strategic interaction with different governments that are competing to exert influence on their common monetary policy.

The macroeconomic policy literature so far has mostly treated problems of fiscal and monetary policy in a currency union using dynamic stochastic general equilibrium (DSGE) models. For example, Farhi et al. (2014) investigated the use of fiscal instruments as substitutes for exchange rate policies in a monetary union. Optimal policies in a currency union were studied by Benigno (2004) and Gali and Monacelli (2008) for monetary policy and by Beetsma and Jensen (2005) and Ferrero (2009) for the fiscal-monetary policy mix using models of this type. While the latter authors found that fiscal policy coordination was required to maximize social welfare in a monetary union, Okano (2014) claimed that fiscal policy cooperation is irrelevant in a monetary union. In the context of a debt crisis, such as the one that occurred in the Euro Area, free-riding on government debt may turn out to be beneficial for the highly indebted country (Aguilar et al., 2015). In a framework of dynamic policy games, Plasmans et al. (2006a) and Plasmans et al. (2006b) showed that the advantages of coordination in a monetary union depend on the nature of the shock to which the union is exposed. They may also depend on the degree of commitment (Hughes Hallett et al., 2014). Given these conflicting results, there is a need to investigate the effects of non-coordinated versus coordinated fiscal and monetary policy in a monetary union like the Euro Area under alternative assumptions. Herein, a game-theoretic approach was followed, assuming that fiscal (governments) and monetary (central bank) policy decision makers interact strategically to achieve their goals, while households and firms do not act strategically but take policy actions as given. Non-coordinated policies are modelled as non-cooperative dynamic games using the feedback Nash equilibrium solution. For coordinated policies, it is assumed that the coordinated players act like one player, i.e. they enter binding agreements among themselves that hold over the time horizon under consideration. Coordination may occur between different governments or between one or more governments and the central bank.

Determining coordinated optimal policies in a model with several decision makers amounts to determining Pareto-optimal policies. Pareto-optimality means that none of the cooperating players can improve his or her outcome without diminishing the outcome of another cooperating player. It is a property naturally required of any coordinated solution. As there are many Pareto-optimal solutions of the games, a decision of which one to take must be made. The so-called collusive solution was chosen, where each player gets the same (fixed) weight in the joint objective function of the coordinated players to be maximized jointly. Alternatives would be various bargaining solutions, which are subjects of further research.

If one is worried about divergent interests in such a context, this approach should be complemented by an examination of the strategic interactions of these policymakers, taking into account the possibilities of non-cooperative behavior over time. Only a few authors so far have used such a game-theoretic approach to macroeconomic policy design, and because of analytical difficulties, mostly very simple models were used (e.g. Andersen 2005). In previous papers, a small macroeconomic model was developed for a monetary union with some features of the Euro Area. The interaction between monetary and fiscal policy was investigated using dynamic game theory (Blueschke and Neck, 2011; Neck and Blueschke, 2014). Using the macroeconomic model MUMOD1 for a monetary union with a joint central bank and two governments (one with high and one with low preferences for balanced budgets versus output, called core and periphery), cooperative and non-cooperative fiscal and monetary policies were identified showing that cooperative policies outperform non-cooperative ones.

A recent paper (Blueschke and Neck, 2018) extended this analysis to the case of three governments. The presence of three governments allows for a more sophisticated study of coalitions among players. The current paper follows this line of research and concentrates on coalitions between fiscal players. The fiscal players are asymmetric regarding the initial set-up of the financial stability indicators and their preferences in the output-public debt trade-off. The three fiscal players are divided into a financially stable core and a less stable periphery. The periphery itself consists of two players with different perceptions of the trade-off between fiscal stability and output growth. The core and periphery oriented towards financial stability were denoted as thrifty. The periphery oriented towards output growth was denoted as thrifless. The position of the thrifty periphery is of main interest as it can join both sides, the core and the thrifless periphery. Moreover, the situation of a fiscal union playing against an independent central bank is taken into account. In addition, a common central bank, which is formally independent but accountable to the public in the area of the monetary union, can intensify coordination in the monetary union in order to mitigate the negative effects of the crisis, which would lead to a fully cooperative solution.

Given the complexity of a dynamic game with a nonlinear dynamic system, one cannot hope for general analytical solutions but must resort to numerical ones. For this purpose, the OPTGAME algorithm is used (Blueschke et al., 2013). The macroeconomic developments in the Euro Area during the financial and sovereign debt crises were replicated, as they have dominated development since 2008 and were better to replicate it in the model. The results for the effects of a supply shock on the MUMOD1 model (with two governments) were presented in Neck and Blueschke (2016). Similar results are shown to hold for the advantages of cooperation, but fiscal policies must be designed in a completely different way.

Problem Description

The analysis considers nonlinear dynamic games in discrete time given in tracking form. The players aim to minimize quadratic deviations of the equilibrium values from given desired values. Each player determines his or her control variables (policy instruments) to minimize an objective function (loss function), J^i :

$$\min_{u_1^i, \dots, u_T^i} J^i = \min_{u_1^i, \dots, u_T^i} \sum_{t=1}^T L_t^i(x_t, u_t^1, \dots, u_t^N), i = 1, \dots, N, \quad (1)$$

with

$$L_t^i(x_t, u_t^1, \dots, u_t^N) = \frac{1}{2}[X_t - \tilde{X}_t^i]'\Omega_t^i[X_t - \tilde{X}_t^i]. \quad (2)$$

The parameter N denotes the number of players (decision makers). T is the terminal period of the planning horizon. X_t is an aggregated vector

$$X_t = [x_t \ u_t^1 \ u_t^2 \ \dots \ u_t^N]', \quad (3)$$

consisting of a $(n_x \times 1)$ vector of state variables x_t and N $(n_i \times 1)$ vectors of control variables u_t^1, \dots, u_t^N . The desired levels of the state and the control variables enter Equation (1) and Equation (2) via the terms

$$\tilde{X}_t^i = [\tilde{x}_t^i \ \tilde{u}_t^{i1} \ \tilde{u}_t^{i2} \ \dots \ \tilde{u}_t^{iN}]'. \quad (4)$$

Finally, Equation (2) contains a penalty matrix Ω_t^i weighting the deviations of states and controls from their desired levels in any period t .

The dynamic system constraining the choices of the decision makers is given in state-space form by a first-order system of nonlinear difference equations:

$$x_t = f(x_{t-1}, x_t, u_t^1, \dots, u_t^N, z_t), \quad x_0 = \bar{x}_0. \quad (5)$$

\bar{x}_0 contains the initial values of the states and z_t contains non-controlled exogenous variables. The latter may be global variables, for example; the paper will consider exogenous (global or politically determined) shocks to the economy of the monetary union.

For the strategy spaces of the players, it was assumed that the dynamic system (5), the objective functions, (Eq. (1) with Eq. (2)) and the mood of the game (whether non-cooperative or cooperative and the particular solution concept) are common knowledge. For the Pareto-optimal solution, which is obtained by solving an optimal control problem, open-loop and closed-loop solutions coincide for the deterministic model studied, hence one does not have to specify the information pattern. For the non-cooperative solution, the feedback information pattern was assumed (Basar and Olsder (1995) for the terminology), i.e. each player knows the current state of the dynamic system in each period. These strategy spaces and Equation (1), Equation (2) and Equation (5) define a nonlinear dynamic tracking game problem. This paper considers non-cooperative and cooperative games. For non-cooperative games, the feedback Nash equilibrium solution was determined, with strong time-consistent or Markov perfect equilibrium strategies (e.g. Basar 1989). Partial cooperation (coalitions of subsets of the players) was modelled as a non-cooperative game among players which act as a single player, i.e. they act according to the Pareto-optimality solution concept among themselves and according to the feedback Nash solution concept *vis-à-vis* the other players (if there are any). In order to solve this game, the OPTGAME algorithm was used, as described in Blueschke et al. (2013).

The MUMOD2 Model

MUMOD2 is a small macroeconomic model of an asymmetric monetary union. It is formulated in terms of deviations from a long-run growth path and includes four decision makers. The common central bank decides on the prime rate R_{Et} , a nominal rate of interest under its direct control. The national governments decide on fiscal policy. g_{it} denotes country i 's ($i = 1, 2, 3$) real fiscal surplus (or, if negative, its fiscal deficit), measured in relation to real gross domestic product (GDP).

The model consists of the following equations:

$$y_{it} = \delta_i \left(\frac{\pi_{jt} + \pi_{kt}}{2} - \pi_{it} \right) - \gamma_i (r_{it} - \theta) + \rho_{ij} y_{jt} + \rho_{ik} y_{kt} - \beta_i \pi_{it} + \kappa_i y_{i,t-1} - \eta_i g_{it} + z d_{it}, \quad (6)$$

$$r_{it} = I_{it} - \pi_{it}^e, \quad (7)$$

$$I_{it} = R_{Et} - \lambda_i g_{it} + \chi_i D_{it} + z h p_{it}, \quad (8)$$

$$\pi_{it} = \pi_{it}^e + \xi_i y_{it} + z s_{it}, \quad (9)$$

$$\pi_{it}^e = \varepsilon_i \pi_{i,t-1} + (1 - \varepsilon_i) \pi_{i,t-1}^e, \quad \varepsilon \in [0, 1], \quad (10)$$

$$y_{Et} = \sum_{i=1}^3 \omega_i y_{it}, \quad \sum_{i=1}^3 \omega_i = 1, \quad (11)$$

$$\pi_{Et} = \sum_{i=1}^3 \omega_i \pi_{it}, \quad \sum_{i=1}^3 \omega_i = 1, \quad (12)$$

$$D_{it} = (1 + B I_{i,t-1} - \pi_{i,t-1}^e) D_{i,t-1} - g_{it} + z h_{it}, \quad (13)$$

$$B I_{it} = \frac{1}{6} \sum_{\tau=t-5}^t I_{it}. \quad (14)$$

The goods markets are modelled for each country i by the short-run income-expenditure equilibrium relation (IS curve) Equation (6) for real output y_{it} at time t ($t = 1, \dots, T$). The natural real rate of output growth, $\theta \in [0, 1]$, is assumed to be equal to the natural real rate of interest. δ_i expresses the relative price effect on output, γ_i the interest rate effect, ρ_{ij} the international spillover, β_i the Pigou effect, η_i the fiscal-policy multiplier and κ_i an autoregressive (hysteresis) effect.

The current real rate of interest, r_{it} , is given by the familiar Fisher equation (Eq. (7)). The nominal rate of interest, I_{it} , is given by Equation (8), where $-\lambda_i$ and χ_i (assumed to be positive) are risk premiums for country i 's fiscal deficit and public debt level. This allows for different nominal rates of interest in the union despite a common monetary policy.

The inflation rates for each country π_{it} are determined in Equation (9) according to an expectations-augmented Phillips curve. π_{it}^e denotes the rate of inflation expected to prevail during time period t , which is formed according to the hypothesis of adaptive expectations at (the end of) time period $t - 1$ (Eq. (10)). $\varepsilon_i \in [0, 1]$ are positive parameters determining the speed of adjustment of expected to actual inflation.

The average values of output and inflation in the monetary union are given by Equation (11) and Equation (12), where parameter ω_i expresses the weight of country i in the economy of the monetary union as a whole defined by its output level. The same weight, ω_i , is used for calculating union-wide inflation.

The government budget constraint is given as an equation for real government debt, D_{it} , (measured in relation to GDP) and is defined in Equation (13). The interest rate on public debt (on bonds) is denoted by $B I_{it}$, which assumes an average government bond maturity of six years, as estimated in Krause and Moyen (2016).

Here an attempt has been made to calibrate the model parameters to fit the Euro Area. The data used for calibration include average economic indicators for the 17 Euro Area

Table 1 Initial values of the three-country monetary union

y_i	π_i	π_i^e	I_i	D_1	D_2, D_3	R_E	g_1	g_2, g_3
0	2.5	2.5	3	60	80	3	-2	-4

countries from EUROSTAT (2019) up to the year 2007 (pre-crisis state). Mainly based on the public finance situation, the Euro Area is divided into three blocs: a core (country or bloc 1) and a periphery bloc, which is itself divided into two subblobs (or countries 2 and 3). The first bloc includes 12 Euro Area countries (Austria, Belgium, Estonia, Finland, France, Germany, Latvia, Lithuania, Luxembourg, Malta, Netherlands and Slovakia) with a more solid fiscal situation and inflation performance. This bloc has a weight of 60% in the entire economy of the monetary union.¹ The second bloc has a weight of 40% in the economy of the union. The Euro Area consists of seven countries with higher public debt and/or deficits and higher interest and inflation rates on average (Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain). This periphery bloc is separated into two halves assuming different preferences for the fiscal stability targets. Country 2 attaches the same importance to the public debt target as country 1. In contrast, country 3 attaches much less importance to the public debt target and can be considered as a less fiscal stability-oriented country or even as more thrifless. The reason for breaking down the periphery into two blocs is the goal of making the analysis more realistic in terms of the situation of the Euro Area. Governments of countries with less favorable conditions (periphery countries) need not reveal the same preferences with respect to the output/employment vs. public debt trade-off. If the recent path of the Euro Area economies is considered, e.g. Ireland seems to pursue the public debt target more vigorously than some other countries, this may be explained by different preferences.

Table 1 shows the initial values of the three countries (blobs) of the monetary union. For the numerical values of the parameters of the model, values were used in accordance with econometric studies and plausibility considerations (Table 2).

Using the MUMOD2 model, an intertemporal nonlinear game was considered, which is given in tracking form. The players aim at minimizing quadratic deviations of the objective (state) variables from given ideal (desired) values. The individual objective functions of the national governments ($i = 1, 2, 3$) and common central bank (E) are given by

$$J_i = \frac{1}{2} \sum_{t=1}^T \left(\frac{1}{1 + \frac{\theta}{100}} \right)^t \{ \alpha_{\pi_i} (\pi_{it} - \tilde{\pi}_{it})^2 + \alpha_{y_i} (y_{it} - \tilde{y}_{it})^2 + \alpha_{D_i} (D_{it} - \tilde{D}_{it})^2 + \alpha_{g_i} g_{it}^2 \} \quad (15)$$

$$J_E = \frac{1}{2} \sum_{t=1}^T \left(\frac{1}{1 + \frac{\theta}{100}} \right)^t \{ \alpha_{\pi_E} (\pi_{Et} - \tilde{\pi}_{Et})^2 + \alpha_{y_E} (y_{Et} - \tilde{y}_{Et})^2 + \alpha_E (R_{Et} - \tilde{R}_{Et})^2 \} \quad (16)$$

where all α are weights of state variables representing their relative importance to the policymaker concerned (Table 3). A tilde denotes the desired (ideal) values of the particular variable (Table 4).

The joint objective function for calculating the cooperative Pareto-optimal solution is given by the weighted sum of the four objective functions:

$$J = \mu_1 J_1 + \mu_2 J_2 + \mu_3 J_3 + \mu_E J_E, \quad (\mu_1 + \mu_2 + \mu_3 + \mu_E = 1). \quad (17)$$

¹The weights correspond to the respective shares in Euro Area real GDP (in 2007).

Table 2 Parameter values for the asymmetric monetary union, $i = 1, 2, 3$

T	θ	ω_1	ω_2, ω_3	$\delta_i, \eta_i, \varepsilon_i$	ρ_{21}, ρ_{31}	$\rho_{23}, \rho_{32}, \beta_t, \gamma_i, \kappa_i, \lambda_i$	ρ_{12}, ρ_{13}	ξ_i	χ_i
30	3	0.6	0.2	0.5	0.375	0.25	0.125	0.1	0.0125

Table 3 Weights of the variables in the objective functions

$\alpha_{y_i}, \alpha_{g_i}$	$\alpha_{\pi E}$	$\alpha_{yE}, \alpha_{\pi i}$	α_{D1}, α_{D2}	α_{D3}	α_{RE}	μ_i, μ_E
1	2	0.5	0.01	0.0002	8	0.25

Table 4 Target values for the asymmetric monetary union

\tilde{D}_{1t}	$\tilde{D}_{2t}, \tilde{D}_{3t}$	$\tilde{\pi}_{it}$	$\tilde{\pi}_{Et}$	\tilde{y}_{it}	\tilde{y}_{Et}	\tilde{g}_{it}	\tilde{R}_{Et}
60	80 \setminus 60	2	2	0	0	0	3

Table 5 Negative demand shocks in the asymmetric monetary union

t	1	2	3	4	5	6	7	8	9	...
zd_{1t}	-1	-6	-1	0	0	0	0	0	0	0
zd_{2t}	-1	-6	-1	-3	-4	-3	-1	0	0	0
zd_{3t}	-1	-6	-1	-3	-4	-3	-1	0	0	0

The dynamic system, which constrains the choices of the decision makers, is given in state-space form by the MUMOD2 model as presented in Equation (6) through Equation (14). Equation (15) and Equation (16) and the dynamic system (Equation (6) through Equation (14)) define the key ingredients of a nonlinear dynamic tracking game problem. Non-cooperative and cooperative games were analysed, with solution concepts as explained before (feedback Nash equilibrium and Pareto, respectively), as models for non-coordination and (partial or total) coordination between fiscal and monetary policies in the monetary union. Using the OPTGAME3 algorithm (Blueschke et al., 2013) these dynamic tracking games were solved for and the effects of different shocks acting on the system were analysed. This study considered demand-side shocks in the goods markets as represented by the variables zd_{it} . These demand shocks represent both the negative effects of the economic crisis in 2007-2010 acting similarly on the whole monetary union and the European Sovereign Debt crisis acting on the second bloc only. The details of the shocks are shown in Table 5.

Table 6 Different coalition strategies

	Scenario	Game strategy
1	every country for itself	Nash FB with 4 players: CB, C1, C2, C3
2	core vs. periphery:	Nash FB with 3 players: CB, C1, C2 + C3
3	coalition of periphery countries thrifty vs. thriftless:	Nash FB with 3 players: CB, C1 + C2, C3
4	coalition of countries 1 & 2 fiscal union:	Nash FB with 2 players: CB, C1 + C2 + C3
5	coalition of 3 countries fiscal and monetary union	Pareto solution

Results

This study investigated the effects of creating different coalitions. The main focus is on the coalitions between fiscal players and the role of country 2, which is between the fiscally stable country 1 oriented towards fiscal stability and the fiscally unstable country 3 not oriented towards fiscal stability. To this end, the performance of the players was compared based on five scenarios (as summarized in Table 6): *sc1* (the non-cooperative Nash game with four independent players), *sc2* (a coalition of periphery sublocs which results in a Nash game with three players: central bank vs. core vs. periphery), *sc3* (a coalition of countries oriented

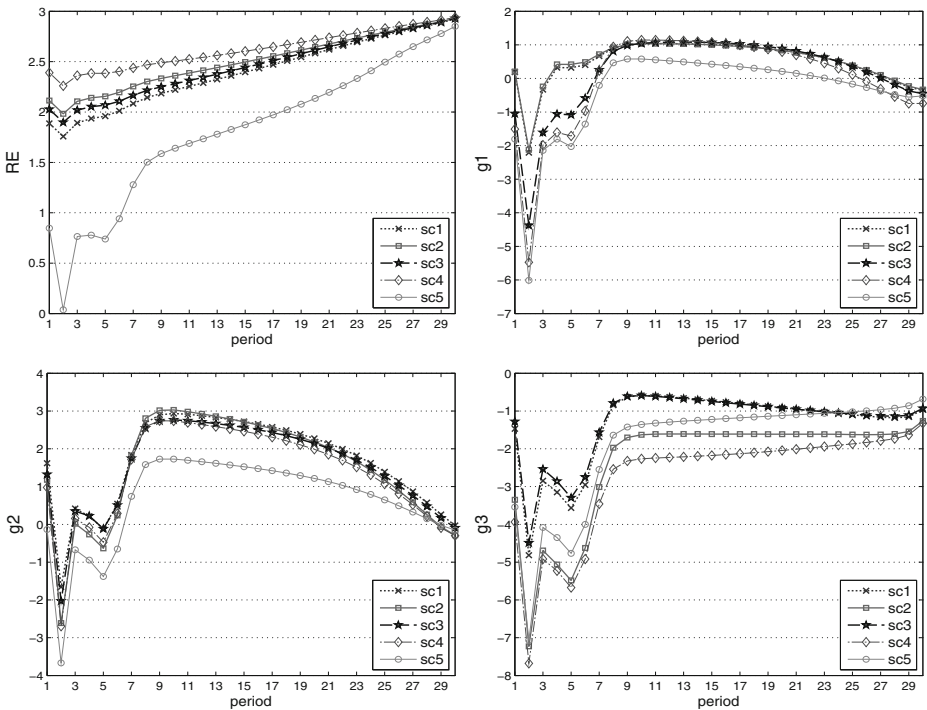


Fig. 1 Time paths of control variables during and after the shock: prime rate (R_{E_t}) and fiscal surplus of core (g_1) and periphery (g_2, g_3)

towards fiscal stability, namely countries 1 and 2, which results in a Nash game with three players: central bank vs. core + country 2 vs. country 3), *sc4* (a coalition of all fiscal players, which results in a Nash game with two players: central bank vs. countries) and *sc5* (the cooperative Pareto solution where all players act in a coordinated fashion as one player).

Figure 1 shows the results of the control variables in this experiment. Figure 2 and Figure 3 show the results for the key state variables (output and public debt). Regarding the control variables, it can be seen that in all of the scenarios an active use of policy instruments is required during the occurrence of the crisis shock. Monetary policy is required to be expansionary during the whole optimization period. The situation is quite different with the optimal use of fiscal policy instruments. The design of the optimal policy depends on both the strategy played and the initial situation of the economy under consideration. However, a clear tendency to use expansionary fiscal policy during the immediate negative impact of an external shock is observable for all scenarios. It is quite obvious that by doing so the countries try to mitigate the negative effects of the shock on output (Figure 2) but they still have to pay attention to the inflation and public debt target (Figure 3). As country 3 accords less importance to the public debt, as a consequence it runs a more expansionary fiscal policy with the budget deficit reaching 8% of GDP in period 2.

Comparing scenarios 1 and 2, one can observe the effects of a periphery coalition. In this case, countries 2 and 3 coordinate their fiscal policies in order to achieve their individual targets simultaneously. The effects of such a coalition can be seen very clearly on the public debt target. As an agreement of this cooperation, country 2 is now allowed to accumulate more public debt (e.g. in period 30, 125% of GDP as compared to 119% in scenario 1).

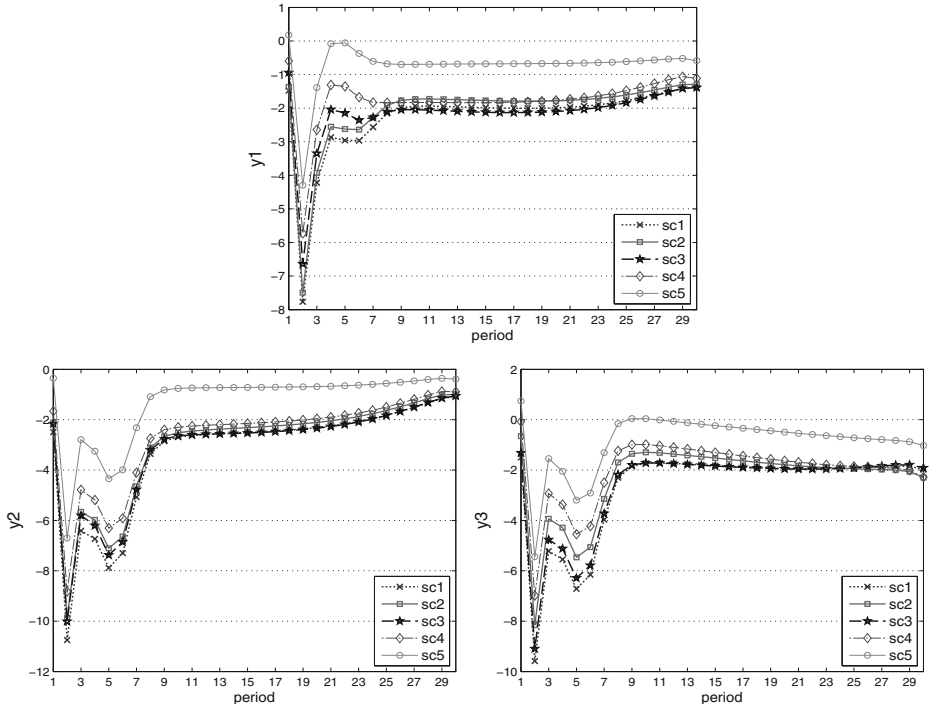


Fig. 2 Time paths of state variable output of core (y_1) and periphery (y_2, y_3) during and after the shock

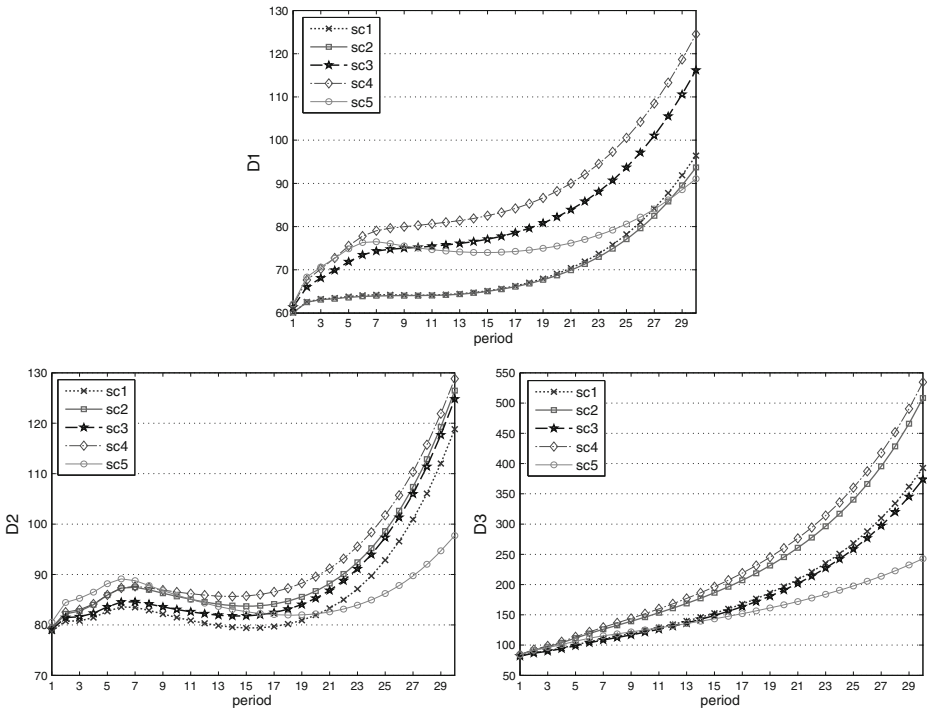


Fig. 3 Time paths of state variable public debt of core (D_1) and periphery (D_2, D_3) during and after the shock

In contrast, country 3 is forced to be more responsible regarding the public debt target (e.g. in period 30, 400% of GDP as compared to 500% in scenario 1).² Regarding the control variables it can be observed that scenario 2 has a stronger effect on country 3, which is required to cut its deficit by more than 2 percentage points during the occurrence of the negative demand shock. This indicates that the fiscal policy instrument is extremely expensive in terms of public debt and the trade-off of output and fiscal stability-oriented policy at the current stage of the Euro Area is dominated by the public debt target.

Scenario 3 describes the results for a coalition of fiscal stability-oriented countries, namely countries 1 and 2. In this case, country 1 is confronted with the higher initial public debt of its coalition partner and is required to run a more expansive fiscal policy. By doing so it supports economic growth in country 2. As a result, slightly better performance can be observed in regards to output and inflation for both countries but it is accompanied by higher debt levels (for country 1 it increases from 95% of GDP in scenario 1 to 115% in scenario 3). Such an active fiscal policy and increasing public debt creates a welfare loss for country 1, as can be seen in Table 7, which summarizes the objective function values (loss functions which are to be minimized) for all scenarios.

Scenario 4 describes a coalition of all fiscal players and can be regarded as a fiscal union scenario. In such a case, the core has to care about the higher public debt in both subblocks

²This study does not include the possibility of a haircut or default (e.g., Neck and Blueschke, 2014), which would be a necessity if the public debt attained such values in reality. This study analyses the effects of a coalition. Thus it is important to look at the dynamics of the variables without any breaks.

Table 7 Objective function values

sc	CB	C1	C2	C3
sc1	183.42	113.20	319.46	233.02
sc2	136.47	97.14	293.55	267.20
sc3	153.66	143.14	298.85	207.96
sc4	87.32	153.31	252.23	263.67
sc5	203.03	66.96	102.64	120.17
sc	C1+C2	C2+C3	C1+C2+C3	CB+C1+C2+C3
sc1	432.66	552.48	665.68	849.10
sc2	390.70	560.75	657.89	794.36
sc3	441.99	506.81	649.96	803.62
sc4	405.54	515.90	669.20	756.52
sc5	169.60	222.82	289.78	492.81

of the periphery, namely countries 2 and 3. It leads to an even more active fiscal policy for country 1 and, as a result, increasing public debt even though the country itself is more fiscal stability-oriented. As a result, the public debt of country 1 increases to 125% of GDP at the end of the planning horizon. In such a situation, the optimal strategy for the fiscal instrument of country 3 is to create more deficits even at the cost of an ever more increasing public debt. The welfare loss for country 3 is nevertheless smaller compared to scenario 1. Country 2 can also benefit from this coalition by improving its output and inflation (and the aggregated welfare losses). For the central bank, such active use of the fiscal policy instrument, of the fiscal players (or rather the fiscal union) allows it to cut its efforts in mitigating the effects of a negative demand shock, which results in a significantly lower welfare loss (87.32 in scenario 4 as compared to 183.42 in scenario 1).

Finally, scenario 5 describes a cooperative solution and can be regarded as a creation of a monetary and fiscal union. The major burden of mitigating the effects of a negative demand shock in such a situation is borne by the central bank, which is required to drastically reduce its interest rate. This expansionary monetary policy is supported by active use of fiscal policy and the classical policy mix produces the optimal strategy mix for the fiscal and monetary union confronted with an exogenous negative demand shock. The economic performance of the countries improves in terms of output and inflation. Regarding public debt, it can be observed that it also improves the situation, at least at the end of the planning horizon. However, during the presence of the shock, or rather during the active use of the fiscal instruments the public debt in countries 1 and 2 increases significantly. This is also the only scenario in which the public debt of country 3 stays within a somehow acceptable level without immediate threat of bankruptcy.

Conclusions and Outlook

This paper analyzed the effects of fiscal coalitions in a monetary union using a game-theoretic approach. The coalitions are built in a stylized three-country macroeconomic model faced by two crises representing the financial crisis and the European sovereign debt crisis. Using the OPTGAME algorithm, solutions were calculated for several games, such as a non-cooperative solution where each government and the central bank play against each other (a feedback Nash equilibrium solution), a fully cooperative solution with all

players following a joint course of action (a Pareto-optimal solution) and three solutions where various coalitions (subsets of the players) play against coalitions of the other players in a non-cooperative way. As usual in this kind of framework, it turns out that the fully cooperative solution yields the best results. However, the main burden of mitigating the negative effects of the crisis is taken by the central bank, which would strongly contradict its well-defined aims. The non-cooperative solution fares worst and the coalition games lie in between. A somehow striking result can be seen by comparing scenarios 2 and 3. The difference is between the coalition partners of the periphery oriented towards fiscal stability (country 2). The results show that a coalition of periphery countries (2 and 3) is more preferable to a coalition of countries 1 and 2 in terms of the total values of the objective function. It should be mentioned that when entering a coalition, the players retain the same behavior regarding the target values and the importance of the variables. An adjustment of these parameters due to the coalition negotiations is likely to be possible. These are topics for further research. Nevertheless, these results have some relevance for the current policy conflicts in the Euro, Area such as the budget discussions in Italy.

Funding Open access funding provided by Alpen-Adria-Universitat Klagenfurt.

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