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Abstract

This paper argues that the key issue for defining and solving the Eurozone's (EZ) difficulties lies in readjusting the relationship between the centre and the periphery of the EZ. Our argument proceeds in two steps. Firstly, the basic finance problem of a centre-periphery system is captured by a threat game with perfect but incomplete information. To get close to the essence of today's crisis we analyze to what extent a 'troubled' periphery EZ member can negotiate a bailout from the center due to the existence of a negative externality arising from its potential default. Secondly, we analyze how establishing 'exit rules', which have recently also been advocated by Jacques Delors, would shift the centre-periphery relationship in a way that safeguard the stability of the EZ. We demonstrate that such rules may help limiting the scope for brinkmanship whereby fiscal problems in one member create a negative externality for the rest of the EZ. We show that such rules will strengthen the EZ through at least four channels.

JEL-Code: E620, F330, H770, C700.

Keywords: sovereign debt crisis, Eurozone, Euro, exit rules, bail-out, political economics, game theory.

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1 Introduction

With the spread of the European sovereign debt crisis suggestions abound as to how to save the Eurozone (EZ). Some commentators focus on the long-term challenges (see, e.g., Cooley and Marimon (2011) who are advocates for debt rules) while others address short-term stabilization issues (see, e.g., De Grauwe (2010) on the role of the European Central Bank (ECB) in stabilizing government debt markets or Delpla and von Weizsäcker (2010) who opt for the creation of so-called Eurobonds as a way to enlarging the EZ's financial fire power).

What brings many of the proposals together is the fact that they focus (predominantly) on economic factors and/or treat the EZ as a monolithic political organism. This paper argues, however, that the key issue for defining and solving the EZ's difficulties lies in readjusting the relationship between the centre and the periphery of the European Economic and Monetary Union (EMU). The challenge is to create institutions that shift the EZ's centre-periphery relationship in a way that fosters stability. Our argument proceeds in two steps. Firstly, the basic financial problem of a centre-periphery system is captured by a threat game. To get close to the essence of today's crisis, we analyse to what extent a 'troubled' peripheral Eurozone member can negotiate a bail-out due to the existence of a negative externality arising from its potential default. Following an exogenous shock, the periphery will make a decision whether to pursue politically costly austerity or resort to a brinkmanship strategy in order to pass some of the fiscal costs on to the centre, given that the long-term stability of the EMU is a joint public good. Secondly, we analyse how establishing 'exit rules', which have recently also been advocated by Jacques Delors (2011), would shift the centre-periphery relationship within the EZ.

The remainder of the paper can be outlined as follows. In section 2, we present a short overview of the literature and show how the paper adds to it. In section 3, we establish a theoretical threat game, which comprises a brinkmanship strategy (section 3.1), a Rubinstein bargaining model (section 3.2), and 'exit rules' that reshape the centre-periphery relationship within the EZ (section 3.3). In section 4 we discuss some of the policy and empirical implications. In section 5, we present the main conclusions of the study.

2 Literature

The EZ is a unique common currency area in that it is a monetary union among sovereign states, and not a federal state with a common fiscal policy, like the US. Early on, it was recognized that the absence of coordinated fiscal policies might be a potential 'hazard area' in the construction of the EZ because of the interactions between the member states' domestic policies (Bordo and Jonung, 1999). In particular, it has been argued that member governments might be tempted to engage in moral hazard behaviour. This is to say that such governments may generate unsustainable debts and push the ECB to inflate them away or run up high levels of debt that would create negative spillovers for others (Baldwin et al., 2010).

The nature of such interactions among members in multi-tiered systems (including the internal incentives and macroeconomic consequences) has first been systematically studied in the context of federations and later applied to the problem of monetary unions. For example, Rodden (2004) presents a game to study the role of central government commitment to a no-bail-out clause in the event of the sovereign debt crisis of sub-national officials. In the game, sub-national officials decide whether to purse fiscal adjustment based on their beliefs about the credibility of the central government's commitment. When the commitment is credible, fiscal discipline is enforced by the voters and credit markets. But, if the central government's commitment is not fully credible, sub-national officials have incentives to pursue unsustainable borrowing. In this framework, intergovernmental grants are at the heart of the commitment problem. If sub-national governments were financed purely by local taxes, the voters and creditors would view the local government's obligations as being autonomous. If, on the other hand, the central government's tax capacity is high and sub-units rely on direct intergovernmental grants, one can expect a greater willingness by the sub-national units to avoid or delay adjustment, resulting in larger and more persistent deficits.

After an empirical investigation into the tax capacity of the central units of the European Union (EU), the paper concludes that there is little risk of fiscal indiscipline in the EMU. However, this paper is based on a model that is not the model of a monetary union, but rather that of a fiscal federation. Therefore, it does not allow for an analysis of the specific effects that a common currency area could have on the fiscal outcomes in member states. Similar bail-out problems have also been modelled as a sequential game driven by the central government's incentives by Wildasin (1997), who

focuses on the structure of jurisdictions and by Inman (2003) who considers a range of other factors. However, in these cases too, the models do not include monetary factors that are pertinent to monetary unions.

The recent sovereign debt crisis in Europe has sparked new attempts to apply game theory in the specific context of monetary unions. For example, Blueschke and Neck (2011) use a dynamic game model of a two-country monetary union to study the impacts of an exogenous fall in aggregate demand, the resulting increase in public debt, and the consequences of a sovereign debt haircut for a member country or bloc of the union. In their currency area, the governments of participating members pursue national goals when deciding on fiscal policies, whereas the common central bank's monetary policy aims at union-wide objective variables. The union consists of a 'core' with lower initial public debt, and a 'periphery' with higher initial public debt. The 'periphery' may experience a haircut due to the high level of its sovereign debt. The authors not only show that a haircut is disadvantageous for both the 'core' and 'periphery' of the monetary union, but they also provide an argument for coordinated fiscal policies in a monetary union.

While the above line sheds light on whether a particular strategy is more preferable to other strategies in terms of macroeconomic outcomes, such as 'debt restructuring' or 'no-debt-restructuring', it does not address the issue of the institutional design of a monetary union, in the context of the current sovereign debt crisis. This issue has, however, been taken up in a recent paper by Suzuki and Tsuranuki (2011). They use a game-theoretic framework to analyse the mechanisms of EZ financial governance, with a focus on centralization vs. decentralization and incentive structures in the EU. Specifically, they construct a Stackelberg game with n ministries of finance within the EZ as the first movers, and the ECB as the second mover. They then show that such set-up creates an incentive to increase public debt (i.e. free-riding on other members). In particular, they show that an increase in the number n of ministries of finance or the number n of members will lead to a more severe free-rider problem. Within this framework, they analyse the solution to the free-rider problem through the penalty scheme in the Stability and Growth Pact (SGP). According to their analysis 'limited sovereignty' should be optimally imposed on the high marginal cost member.

While our paper also addresses the issue of the EZ's institutional set up, our approach is somewhat different. Firstly, we consider the case of a monetary union and assume that the stability of the EZ is a joint public good for which players are willing

to pay, irrespective of the nature of the fiscal institutions. Secondly, we specifically focus on a negative externality problem which is central to the current EZ sovereign debt crisis, in which the refinancing difficulties of a small economy, for example Greece, which accounts for only 2% of the EZ's GDP, can endanger the whole monetary union. The key question is to what extent can such a 'troubled' EZ member successfully negotiate a bail-out due to the existence of a negative externality ensuing from its potential default. Thirdly, we analyse how establishing some sort of 'exit rules' could influence the ability of a single EZ member to pursue such a credible threat strategy within the EZ.

3 The game

We shall consider a game between the centre (CEN) of the EZ, which is characterized by current account surpluses and a sustainable public debt (think of Germany, Finland, Luxembourg, and the Netherlands) and the EZ's periphery (PER) which suffers from twin deficits (think of Greece, Ireland, Italy, Portugal, and Spain).[1] Both players are concerned about the expected electoral consequences of their policy decisions and they are concerned with preserving the smooth functioning of the EZ – i.e., 'EZ stability' as a joint public good. Both players will accrue the long-term benefits of EZ membership in terms of efficiency gains stemming from the lower transaction costs in cross-border trade, increased specialization, competition and so on Beetsma and Guiliodori (see, e.g., 2010, for a survey of the issues).

The game starts with an exogenous shock to the periphery and shows to what extent a single PER can pass some of the 'fiscal adjustment costs' on to CEN. Given that PER's potential default would create a negative externality for the rest of the EZ (i.e., contagion in the form of spreading defaults to other PER countries), this particular PER player could resort to a brinkmanship strategy. Such negative externality represents a bargaining chip in the negotiations over redistributing PER's 'fiscal adjustment costs'. Hence, within the scope and limits of such brinkmanship strategy, CEN might be threatened to reveal its willingness-to-pay for 'EZ stability' and thus PER may effectively elicit financial assistance. The structure of the game is shown in detail in figure 1.

[1] In doing so, we rely on Fahrholz (2007); further, e.g., Fahrholz and Wójcik (2012) and Arghyrou and Tsoukalas (2010) deal particularly with the Greek sovereign debt crisis.

Specifically, a single PER_i (denoted as player $j = 1$, whereas $i = 1, ..., n$) has complete but imperfect information about a representative CEN's (player $j = 2$) willingness-to-pay for 'EZ stability'. The point of departure is that PER_i faces an

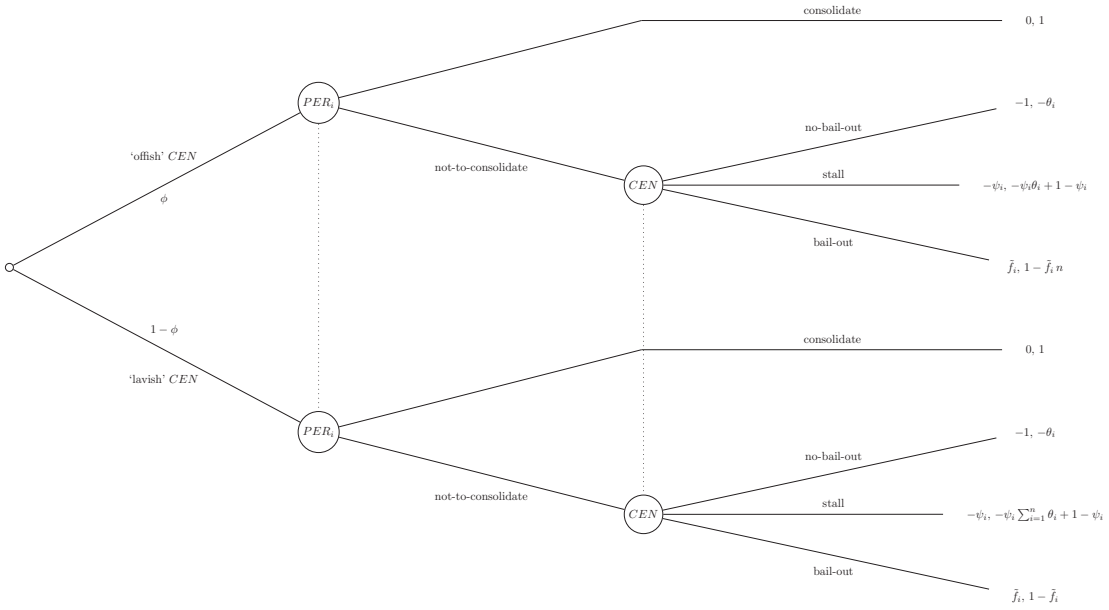

Figure 1: Extensive Form of the Game

adverse fiscal shock and the imminent risk of default. The game involves the haggling between the PER_i and CEN over sharing the 'fiscal adjustment costs' needed to safeguard 'EZ stability'. These costs are denoted as $F_i = (f_i, f_{-i})$ in the case of a specific PER_i, whereas the benefits derived from EZ membership for PER_i and CEN are denoted as $B_i = (b_i, b_{-i})$. The benefits b_i stand for preserving EZ membership. At the same time, from the perspective of CEN, the corresponding b_{-i} represents the benefits of EZ membership (see above).[2] The deterioration in the public good 'EZ stability' is also costly. The latter costs pertain primarily to defaulting within the EZ and are, henceforth, denoted as 'default costs' $D_i = (d_i, d_{-i})$. In this regard, CEN

[2] We assume that the benefits are the same for both players as it makes the game simpler to solve. One can rightly argue that the benefits can differ for, say, a large economy like Germany or France and, say, a small one such as Greece or Portugal. However, assuming the benefits are not symmetric it would not change the general tone of our results.

has a subsidiary role: While PER_i will not accept costs that are higher than its 'fiscal adjustment costs' f_i in exchange for contributing to 'EZ stability', CEN will administer fiscal assistance within the limits of their maximum willingness to pay. Accordingly, CEN will have limited liability, amounting to a share θ_i in the 'fiscal adjustment costs' with $0 < \theta_i \leq 1$. In other words, CEN will, at the most, transfer funds to PER_i amounting to f_{-i}. The reason is that beyond that point CEN's willingness to pay for preserving 'EZ stability' would be exhausted. By the same token, PER_i could, at a maximum, pass all 'fiscal adjustment costs' on to the CEN, though never more than the amount currently required for averting an immediate default. It thus follows that whatever the 'default costs' $D_i = (d_i, d_{-i})$, there is never more to redistribute between the centre and the periphery than the incipient 'fiscal adjustment costs' $F_i = (f_i, f_{-i})$. The following proposition can be derived from these considerations:

$$\theta_i = \begin{cases} 0 & \text{if } f_{-i} \geq d_{-i} \\ 0 \leq \theta_i < 1 & \text{if } f_{-i} < d_{-i} < f_{-i} \\ 1 & \text{else} \end{cases} . \tag{1}$$

The entire F_i reflects each player's maximum willingness to pay for preserving 'EZ stability' (i.e., each player's cost tolerance in the escalation processes of brinkmanship).

When the brinkmanship strategy adopted is credible, then during negotiations neither player will maximize their piece of the pie, but minimize their respective share in the 'fiscal adjustment costs' F_i. The inherent bargaining problem is thus characterized by the tuple (F_i, D_i) where $F_i \subset \mathbb{R}_+^{*2}$ is a vector combination of the feasible (dis)utility allocations. A particular 'disagreement' is the bargaining outcome if both parties' negotiations break down. If PER_i and CEN cannot agree on an appropriate policy solution for PER_i, i.e. providing fiscal assistance to safeguard 'EZ stability', it will trigger a default. In this regard, the 'disagreement' is congruent with the occurrence of 'default costs' D_i.

To summarize, in this game the following costs arise $G(F_i, D_i \,|\, \theta_i)$: There are 'fiscal adjustment costs' F_i, around which the bargaining revolves; if the corresponding haggling on distributing F_i were to break down, then a default would occur and both players would be stuck with a 'disagreement' outcome equivalent to the 'default costs' D_i contingent on the 'limited liability' θ_i.

There are some caveats to the basic structure of this threat game. On the one hand, there is the question of whether PERs should form a cartel to strengthen their brinkmanship vis-à-vis other EZ members. On the other hand, the EZ centre could announce in

advance that they will punish the first member that dares to practice brinkmanship. In other words, CEN might pursue an enter-deterrence game.[3] We exclude both corner solutions, as coordination problems and competition among all EZ members render both scenarios unlikely. If PERs try to coordinate their brinkmanship, then this could lead financial markets to discriminate more between both group of countries, PERs and CENs. Also, since only PER is facing the risk of imminent default, other PERs will not be willing to join as it could be a signal to the financial markets that they are also on the brink of a default. By the same token, a coordination problem within CEN arises because of uncertainty regarding their future potential need for financial assistance.

In such set-up, successful brinkmanship is dependent on two probabilities, ϕ and ψ_i that are independent of each other and are endogenously determined. From the perspective of PER_i, ϕ denotes the probability of encountering an 'offish' CEN or a 'lavish' one with a probability of $1 - \phi$. The more 'offish' the CEN, the lesser the probability of executing successful brinkmanship. Given that PER_i is a member of the EZ, economically connected with the rest of the EMU, we assume $\phi < 1$. At the same time $\phi > 0$, because 'EZ stability' is a joint public good and CEN has at least some willingness to pay for it as encompassed in the benefits b_{-i}. Hence, we reject the corresponding corner solutions of ϕ, so that $0 < \phi < 1$.

Moreover, both players are concerned about the expected electoral consequences of their policy decisions. Thus, the probability ψ_i describes the likelihood of negative externalities (i.e. spreading defaults within the EZ) triggered by voter alienation towards fiscal consolidation processes within PER_i (i.e. when burdening the electorate with 'fiscal adjustment costs'). Uncertainty regarding the constituency's reaction to the stipulated fiscal retrenchment processes may buttress PER_i's bargaining position in negotiations vis-à-vis CEN. If the electorate were completely 'Europhile', then there would be no room for the government to burden other EZ members with 'fiscal adjustment costs', as the imposed fiscal austerity would not cause any political upheaval and subsequently negative externalities within the EZ. In fact, the probability ψ_i would be zero in such circumstances. At the same time, we expect that voters as well as their delegated governments must also rate the benefits b_i as valuable. Otherwise, any efforts towards fiscal consolidation within PER_i would be unacceptable and a government would be unable to

[3] The scope for an enter-deterrence game is also limited by the fact that due to problems of effective monitoring, assessing fiscal policy and identifying any deliberate infringement of the fiscal rules within the EZ is a complicated issue. For example, Jaeger and Schuknecht (2007) discuss this issue in the context of pro-cyclical fiscal positions and boom-bust phases. With regards to boom-bust cycles within the EZ, please also refer to Backé and Wójcik (2008).

achieve consensus over its contribution to safeguarding 'EZ stability'. Hence, we exclude corner solutions, so that $0 < \psi_i < 1$. In other words, some political resources exist on the national level which a government in PER_i can play off against CEN in intergovernmental negotiations on the European level. If the conditions for successful brinkmanship are met, then CEN will oblige and dance to PER_i's tune and share some of the 'fiscal adjustment costs' F_i in terms of providing financial assistance. In the following section, we determine the Nash strategies, i.e. the mutually best responses which will eventually constitute a sub-game perfect Nash equilibrium of the brinkmanship game $G(F_i, D_i \,|\, \theta_i)$.

3.1 Brinkmanship

Given that each players' maximum willingness to pay for 'EZ stability' corresponds each time to the total of F_i, we can normalize $f_{ij} = b_{ij} = 1$. Hence, we can transform the threat game $G(F_i, D_i \,|\, \theta_i)$ into the form of $\tilde{G}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)$ with $0 \leq \tilde{f}_{ij} \leq 1$, $\tilde{f}_{ij} \in \tilde{F}_i$, $\tilde{F}_i \subset \mathbb{R}^2$. The standard assumption holds that $\tilde{f}_{ij} = (\tilde{f}_{i1}, \tilde{f}_{i2})$ is a non-empty, convex and compact set. In this game $\tilde{G}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)$ a single PER_i quasi maximizes the counterparty CEN's share of 'fiscal adjustment costs' for safeguarding 'EZ stability'. The subsequent bargaining (see section 3.2) could lead to an outcome, in which PER_i elicits fiscal assistance amounting to $\tilde{f}_i$ and, in turn, saddles CEN with the share $\tilde{f_{-i}} = 1 - \tilde{f}_i$. Accordingly, the players' continuous utility functions $u_{(i)j}(\tilde{f_{(i)j}})$ are $u_{i1}(\tilde{f}_{i1}) = \tilde{f}_{i1} = \tilde{f}_i$ and $u_2(\tilde{f}_{i2}) = \tilde{f}_{i2} = (1 - \tilde{f}_i)$. The following paragraphs deal with the structure of the players' strategies and pay-offs.

When considering a brinkmanship strategy, PER_i is faced with two different sub-games of $\tilde{G}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)$ due to having complete but imperfect information. First, PER_i does not know whether it will encounter an 'offish' (ϕ) or a 'lavish' ($1-\phi$) CEN. In this context, negative externalities have to be considered: On the one hand, a single sovereign debt crisis has the potential to trigger further defaults by all $n\,PER_i$ via contagion. Overall, this would be the worst pay-off from the vantage point of CEN. Fearing such exorbitant costs, the primary goal of CEN would be to sustain the support in each PER_i to safeguard 'EZ stability'. From this perspective, it could be more beneficial to be 'lavish'. Second, CEN could display a rather reluctant attitude towards providing bail-outs because any obvious generosity would intensify moral hazard behaviour which possibly requires transferring n-times $\tilde{f}_i$. Due to CEN's ambiguous attitude towards providing extra funding, PER_i's pay-offs have to be weighted with a probability ϕ of encountering an 'offish' and $1 - \phi$ for a 'lavish' CEN, i.e. two different sub-games.

PER_i's feasible set of strategies consists of two choices: 'consolidate' or 'not-to-

consolidate'. The latter strategy consists of practising brinkmanship based on the premise that its constituency would possibly not accept fiscal retrenchment. If, for instance, PER_i is very confident about controlling the risk that a fiscal consolidation process will trigger voter resistance to some extent, the government may resort to such strategy.[4] When exploring the scope of its brinkmanship strategy, the government might achieve consensus among the constituency that favours a departure from the EZ, which would credibly put the entire 'EZ stability' at risk. Thus, choosing 'not-to-consolidate' could, eventually, help to elicit financial assistance from CEN, i.e. redistribute the 'fiscal adjustment costs'. If PER_i chooses to 'consolidate' (i.e., practise no brinkmanship), it forgoes the opportunity of passing a share $\tilde{f}_i$ of the 'fiscal adjustment costs' on to CEN. This would be the best choice from the viewpoint of CEN. When PER_i adopts a strategy of choosing 'not-to-consolidate', the outcome ultimately depends on the reaction of CEN. The latter player could choose a strategy of 'bail-out', 'stall' or 'no-bail-out'. In other words, CEN's may provide fiscal assistance. However, CEN could also attempt to withhold funding by adopting a strategy of 'stall' (i.e., negotiating 'fiscal adjustment costs' with PER_i). Moreover, CEN could also choose a 'no-bail-out' strategy which would imply cutting PER_i out of the EZ. This outcome is congruent with the breaking off of negotiations and the immediate default of PER_i, as depicted by the 'disagreement' point comprising the 'default costs' D_i.

The pay-offs are as follows: If PER_i chooses to 'consolidate', then it receives zero benefits, whereas CEN receives all the benefits of the secured 'EZ stability' amounting to 1. If PER_i chooses 'not-to-consolidate' and CEN reins in PER_i's prospective default, then PER_i receives the aspired fiscal assistance in the amount of $\tilde{f}_i$. In this case, CEN receives a pay-off $(1 - \tilde{f}_i)$, although it may also possibly have to deal with transferring payments to all PER_i amounting to n-times the size of $\tilde{f}_i$ – for instance, via some kind of special purpose vehicle (think of all the EZ bail-out facilities currently in place). If CEN chooses to 'stall', PER_i may be stuck with 'default costs' amounting to $-\psi_i$. This pay-off hinges upon PER_i's likelihood of losing public support for fiscal retrenchment and consequently defaulting. Simultaneously, CEN receives the pay-off $(-\psi_i\theta_i + 1 - \psi_i)$ or $(-\psi_i \sum_{i=1}^{n} \theta_i + 1 - \psi_i)$ in the event of spreading defaults via contagion among all the PERs. If CEN is able to confine the case of a 'troubled' PER_i and, hence, chooses 'no-bail-out' then both players would encounter a country-specific default scenario and forgo the corresponding mutual benefits of 'EZ stability'. In this respect, both players

[4] For the sake of argument, we do not distinguish between 'deliberate' and 'accidental' brinkmanship. Whether it is fiscal negligence or 'blackmailing', it does not affect the results of our analysis.

would suffer from the realization of 'default costs' $\tilde{D}_i$, where the pay-off is $(-1, -\theta_i)$ in line with the aforementioned proposition (see equation 1).

A brinkmanship strategy has to meet some conditions. Successful brinkmanship has to be effective and acceptable. Its effectiveness rests on the extent of PER_i's default: As CEN is increasingly affected by negative externality costs, a PER_i's threat gains more credibility. Whether PER_i is able to force CEN into providing funding is subject to a critical threshold: If the respective probability is too small, PER_i will not be able elicit fiscal assistance. By the same token, the credibility of the brinkmanship strategy is also dependent on whether the prospective outcome is acceptable to PER_i. If the probability of triggering its own default is too high and, hence, the acceptability condition cannot be accomplished, then PER_i will have to 'consolidate'. In turn, this player will incur the 'fiscal adjustment costs' for sustaining 'EZ stability' in their entirety.

PER_i's brinkmanship will be successful, which means eliciting the extra funds desired amounting to $\tilde{f}_i$, if it constitutes a credible threat strategy. In this regard, PER_i's brinkmanship could be effective if at least the expected pay-off of CEN for providing the funds is higher than from the decision to 'stall', and the associated risk of triggering spreading defaults within the EZ.[5] Therefore, it has to be valid that

$$(1 - \tilde{f}_i) > -\psi_i \sum_{i=1}^{n} \theta_i + 1 - \psi_i.$$

Correspondingly, the minimum probability for effective brinkmanship $\psi_{i,min}$ has to be

$$\psi_{i,min} > \frac{\tilde{f}_i}{\sum_{i=1}^{n} \theta_i + 1}. \tag{2}$$

The probability $\psi_{i,min}$ is the minimum threshold of the brinkmanship for PER_i. Below this level CEN would choose a 'no-bail-out' strategy, even if it were 'lavish'. However, with a probability of ϕ PER_i may feel that the strategy 'not-to-consolidate' is too risky with regard to encountering an 'offish' CEN. At the same time, PER_i will encounter a 'lavish' CEN with a probability of $(1 - \phi)$, which could indulge in the provision of pecuniary assistance contingent on the effectiveness condition (2). Contingent on

[5] Please note that fiscal assistance amounting to $\tilde{f}_i$ for a single PER_i is always better than n-times $\tilde{f}_i$ as is, for instance, the case with the currently existing EZ bail-out schemes, i.e. the European Financial Stability Facility (EFSF) and the European Financial Stabilisation Mechanism (EFSM), as well as the envisioned European Stability Mechanism (ESM). The reader will realize that according to our modelling framework, it is not the so-called 'firewall' but the probability of triggering negative externalities that affects players' calculus and the occurrence of bail-outs.

$0 < \psi_i < 1$ PER_i will pose a probabilistic threat, if its expected pay-off is higher than a zero pay-off from choosing to 'consolidate', so that

$$-\psi_i p + \tilde{f}_i(1-\phi) > 0,$$

the resolving of which results in

$$\psi_{i,max} < \tilde{f}_i \frac{1-\phi}{\phi}. \tag{3}$$

Correspondingly, the acceptability hinges on the values for ϕ. Therefore, the values for ϕ have to be below a critical threshold. Otherwise, $\psi_{i,max}$ in inequation (3) would have to be even smaller than $\psi_{i,min}$ in inequation (2) for some high values of ϕ. That would render any brinkmanship fruitless as it does indeed become effective but is not acceptable. From the proposition $\psi_{i,min} < \psi_{i,max}$ it follows that the maximum probability ϕ_{max} has to be

$$\phi_{max} < \frac{\sum_{i=1}^{n} \theta_i + 1}{\sum_{i=1}^{n} \theta_i + 2} < 1. \tag{4}$$

Besides, this acceptability condition exhibits another interesting feature: If the probability ϕ of encountering an 'offish' CEN is very small, PER_i will always find the brinkmanship acceptable.[6] This holds when

$$\tilde{f}_i \frac{1-\phi}{\phi} \geq 1.$$

Hence, 'not-to-consolidate' is always acceptable for critical values

$$\phi_i^0 \leq \frac{\tilde{f}_i}{\tilde{f}_i + 1}.$$

If the probability ϕ for an 'offish' CEN satisfies the acceptability condition, then the following proposition must be valid:

$$\phi^* \in \Phi^*, \qquad \Phi^* := \{\phi^* \,|\, \phi^* \leq \phi_{max} < 1,\, \phi^* \in \mathbb{R}_+^*\} \tag{5}$$

[6] If, for the sake of the argument, we think of the probability ϕ for encountering, for instance, 'offish' EZ members being inversely related to the economic size of a particular member inclined to fiscal profligacy, then the large economies would be the first to bend the fiscal rules of such a multi-tiered system. Whether the infringement of the SGP by Germany and France in 2003 really fits into this line of reasoning is a subject for future research.

Regarding $\psi_{i,min}$, the probability ψ_i in a brinkmanship strategy has to remain below the critical threshold $\psi_{i,max}$. Above that value PER_i will refrain from a 'not-to-consolidate' strategy because it fears the mutual detrimental effects. Therefore, for every given probability $0 < \phi < 1$ the probabilistic threat is credible when a country-specific ψ_i^* is an element of the finite set Ψ_i^*. The corresponding proposition is:

$$\psi_i^* \in \Psi_i^*, \qquad \Psi_i^* := \{\psi_i^* \,|\, \psi_{i,min} \leq \psi_i^* \leq \psi_{i,max},\, \psi_i^* \in \mathbb{R}_+^*\} \tag{6}$$

When the endogenous effectiveness and acceptability conditions for the parameters ϕ and ψ_i are satisfied, PER_i will resort to brinkmanship. CEN's response to PER_i's brinkmanship is to immediately transfer the 'fiscal adjustment costs' amounting to the share $\tilde{f}_i$. This is equivalent to PER_i passing the respective portion of the 'fiscal adjustment costs' on to CEN, i.e. a bail-out in the face of negative externalities.

After setting out the Nash strategies, we now focus on the non-cooperative Rubinstein bargaining solution (RBS) for distributing PER_i's 'fiscal adjustment costs' $\tilde{F}_i$. That is to say that we ascertain each player's portion of the 'fiscal adjustment costs', which are a prerequisite for safeguarding 'EZ stability'.

3.2 Bargaining

The longer the negotiations on a bail-out take, the more it becomes obvious from the perspective of the financial markets that both parties are unable to agree on an appropriate policy response. By the same token, both players are aware that the markets may finally sanction their fierce bargaining and that time, therefore, is not on their side. This modelling part particularly refers to Rubinstein (1982). However, contrary to the general association of the RBS as a 'shrinking pie' (i.e. utility) over time, here the 'pie of costs' inflates over time and will leave its mark on both parties upon their collapse – i.e. both are burdened with 'default costs'. In this regard, the RBS makes use of players' 'patience', so that despite an infinite time horizon, the impeding risk of a breakdown makes both parties agree on the distribution of the 'fiscal adjustment costs' in finite time. The settlement of the bargaining is particularly dependent on each player's negotiating skills in terms of 'patience'. The latter are inversely proportional to the players' bargaining power coefficients μ_i and ν_{-i}, i.e. both camps talent for negotiating (Nash, 1953). In this respect, a player who can for longer convincingly conceal his fear of being faced with the 'default costs' in the case of a negotiation breakdown is better off. In line with this rationale, the obvious see-sawing in the run-up to a bail-out within the EZ - in terms

of stipulating fiscal retrenchment on the 'tumbling' economies within the periphery and deliberating upon financial assistance by the centre - represents a preparatory stage. This portion of the game-theoretic analysis still pertains to the game $\tilde{G}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)$ and only calls for the RBS to shed light on the relevance of negotiating a redistribution of the 'fiscal adjustment costs'. In this respect, the game $\tilde{G}$ is completed by a bargaining on the non-empty, convex, and compact set comprising any convex combination of the aforementioned vector $\tilde{F}_i \in \mathbb{R}^{*2}_{+}$. In order to craft a RBS we have to assume that the players are well-informed, i.e. the assumptions of complete information and common knowledge apply to the RBS.

The negotiations proceed as follows: At the outset of its brinkmanship strategy, PER_i makes a particular offer k in $t = 0$. Such offer consists of demanding the 'fiscal adjustment costs' $\tilde{f}_{i2}$ sufficient to keep it from further brinkmanship. The CEN can accept or refuse. When CEN rejects the offer, it can make a counter-offer l in $t = \tau$, where $\tau > 0$ denotes the length of the interval between two successive offers. In turn, PER_i can refuse or accept. As no player refuses once and for all – in that case the outcome would be a 'disagreement' comprising of the 'default costs' $\tilde{D}_i$ – but makes counter-offers, the bargaining is infinite. In line with previous considerations $u_{(i)j}(0, t) = 0$, $u_{(i)j}(1, 0) = 0$, and $\lim_{t\to\infty} u_{(i)j}(\tilde{f}_{ij}, t) = 0$ when the game would go on forever. Moreover, the RBS concept requires amending the original players' utility functions $u_{(i)j}(\tilde{f}_{ij})$ to $v_{(i)j}(\tilde{f}_{ij}, t) = u_{(i)j}(\tilde{f}_{ij})\delta^t_{(i)j}$ where $\delta_{(i)j}$ is a player's time-preference. In this respect, stationary strategies are of particular interest. Strategies are stationary when a player's history is of no interest. That is every player j always plans to make the same offer – which here is a specific share $\tilde{f}_{ij}$ of the 'fiscal adjustment costs' – every second round regardless of any previously rejected offers and counter-offers. Only an equilibrium offer makes the responding player indifferent between refusing and accepting. In accordance, CEN always accepts an offer k (or anything better) and rejects anything worse, whereas the same goes for PER_i as regards the offer l. The offers are represented by the vectors $a = u_{(i)j}(k, t)$ and $b = u_{(i)j}(l, t)$. Since the RBS assumes common knowledge and perfect foresight, backward induction is allowed. Hence, both players anticipate the final bargaining outcome in the first round. Generally, in equilibrium the players are indifferent between accepting and rejecting, so that for every arbitrary interval τ between alternating offers

$$a_2 = \delta^{\tau}_2 b_2 \quad \text{and} \tag{7}$$

$$b_1 = \delta^{\tau}_{i1} a_1. \tag{8}$$

We can replace the discount rates by $\delta_{(i)j} = e^{-\rho_{(i)j}}$, with $\rho_{(i)j}$ as the players' time-preferences rates, so that we can also write $\mu_i = \frac{1}{\rho_i 1}$ and $\nu_2 = \frac{1}{\rho_{-i}}$. From the equations (7) and (8) it then follows

$$\left(\frac{a_2}{b_2}\right)^{\beta_{-i}} = \left(\frac{b_1}{a_1}\right)^{\alpha_i} = e^{-\tau},$$

which implies that

$$a_1^{\mu_i} a_2^{\beta_{-i}} = b_1^{\mu_i} b_2^{\nu_{-i}}$$

coincide.

We are particularly concerned with the impact of the negotiation time on the financial market reactions possibly triggering a default, as a result of which the outcome $\tilde{D}_i$ occurs. Hence, the case of $\tau \to 0$ is of particular interest to our game $\tilde{g}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)$. This implies for $\lim_{\tau \to 0} e^{-\tau} = 1$ it holds true that

$$a_2 = b_2 \quad \text{and} \quad a_1 = b_1.$$

This is to say that both players' offers really correspond to each other for $\tau \to 0$. At the same time, the particular shares $\tilde{f_{i1}} = \tilde{f}_i$ of the 'fiscal adjustment costs' that PER_i can pass on to CEN, such that the latter player carries the share $\tilde{f_{i2}} = 1 - \tilde{f}_i$, represent the bargaining outcome.

The RBS is subject to the following maximization problem:

$$\max_{\tilde{f_{ij}}} (\tilde{g}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i)) = (u_{i1}(\tilde{f_{i1}}) - u_{i1}(\tilde{d_{i1}}))^{\mu_i} (u_2(\tilde{f_{i2}}) - u_2(\tilde{d_{i2}}))^{\nu_{-i}}. \tag{9}$$

Given the players' utility functions, the maximization problem in the light of $\tilde{D}_i = (-1, -\theta_i)$ is

$$\max_{\tilde{f_{i1}}, \tilde{f_{i2}}} \tilde{g}(\tilde{F}_i, \tilde{D}_i \,|\, \theta_i) = (\tilde{f}_i + 1)^{\mu_i} ((1 - \tilde{f}_i) + \theta_i)^{\nu_{-i}}.$$

Given that $\mu_i + \nu_{-1} = 1$, the subsequent first-order condition implies that in equilibrium

$$\tilde{f}_i^{\,*} = \begin{cases} \text{not defined} & \text{if } (1+\theta_i)\mu_i - \nu_{-i} \leq 0 \\ 0 < \tilde{f}_i < 1 & \text{if } (1+\theta_i)\mu_i - \nu_{-i} \leq 1 \\ 1 & \text{else} \end{cases}. \tag{10}$$

With respect to the completed (transformed) threat game $\tilde{G}$, the RBS comprises the

equilibrium outcome tuple

$$\tilde{F_i}^* = (\tilde{f_i}^*, (1 - \tilde{f_i}^*)). \tag{11}$$

for successful brinkmanship. The 'not defined' outcomes represent corner solutions, at which the 'default costs' exceed the sum of the players' willingness-to-pay for safeguarding 'EZ stability'. The interpretation is obvious: 'too-big-to-be-bailed-out' would result in a de facto default, turning the incipient sovereign debt crisis into a case of public insolvency. By definition, this would annul the joint public good of 'EZ stability' and, hence, result in an alteration of the underlying political-economic configuration of the EZ. However, we are still confining ourselves to a discussion concerning an incipient sovereign debt crisis, allowing for a successful brinkmanship strategy.

The equilibrium solution (equation (11)) constitutes the unique sub-game perfect Nash equilibrium, incorporating a specific RBS of the transformed threat game $\tilde{G}(\tilde{F_i}, \tilde{D_i} \,|\, \theta_i)$ and contingent on valid conditions for successful brinkmanship (see the propositions in the inequations (5) and (6)). That is to say that CEN's response to PER_i's credible brinkmanship strategy is to burden itself with 'fiscal adjustment costs' amounting to the share of $(1 - \tilde{f_i})$. PER_i thus passes the respective 'fiscal adjustment costs' on to other EZ members. When obtaining a share $\tilde{f_i}$ of the 'fiscal adjustment costs', PER_i will abstain from further attempts to promote a hazardous fiscal policy stance. The reason is that CEN's willingness to pay to secure the joint public good 'EZ stability' is exhausted at that point.[7]

3.3 Exit rules

The preceding game $\tilde{G}(\tilde{F_i}, \tilde{D_i} \,|\, \theta_i)$ demonstrates that in the current set-up of the EZ, a 'troubled' peripheral member could successfully negotiate a bail-out from the centre due to the existence of a negative externality arising from its potential default. We shall now analyse how enacting 'exit rules' would shift the centre-periphery relationship in the EZ in a way that mitigates brinkmanship behaviour within the EZ and safeguards EZ stability. The key question is whether such 'exit rules' would alter the key parameters of the game in a way that would limit the scope of successful brinkmanship.

[7] In this respect, another caveat might be in order: Since our modelling framework calculates a single PER_i's brinkmanship vis-à-vis CEN, such threat may only represent one particular round in a 'boxing match' of a series of incipient sovereign debt crises. Furthermore, one can expect the newly incipient but random sovereign debt crisis within the EZ to mark the starting point for another round of the outlined threat game. In this regard, the institutional set-up of the EZ prepares the ground for brinkmanship. In this paper, we have confined ourselves to analysing the occurrence of a bail-out and how the 'exit rules' would reshape the centre-periphery relationship of the EZ.

Technically, this would be the case when establishing 'exit rules' endogenously increases the critical threshold for the effectiveness condition (inequation (2)) and decreases the critical threshold for the acceptability condition (inequation (4)). This is because both thresholds constitute critical limits to successful brinkmanship.

The analysis in the sections 3 concerns an EZ set-up without 'exit rules'. The latter situation is now compared with an EZ set-up that incorporates 'exit rules'. Therefore, there is now an explicit non-zero probability that an EZ member such as PER_i would leave. In such case, the (new) EZ would consist of fewer members, M, where $M < N$. Given that exiting the EZ is now possible, both PER_i and CEN would attach some non-zero probability to such a scenario. Even if such probability is very small, the resulting change in the expected pay-off structure would lead to an endogenous change in the critical thresholds (see inequations (2) and (4)). Indeed, the threshold for the 'adjusted' effectiveness condition (denoted by a superscript $exit$) increases, so that

$$0 < \psi_{i,min} < \frac{\tilde{f}_i}{\sum_{i=1}^{n} \theta_i + 1} < \psi_{i,min}^{exit} < \frac{\tilde{f}_i}{\sum_{i=1}^{m} \theta_i + 1} < 1 \qquad \forall\, n > m \geq 1. \tag{12}$$

The effectiveness condition for successful brinkmanship shifts upward when enacting 'exit rules'. By the same token, the threshold for the 'adjusted' acceptability condition in conjunction with inequation (3) decreases to

$$0 < \phi_{max}^{exit} < \frac{\sum_{i=1}^{m} \theta_i + 1}{\sum_{i=1}^{m} \theta_i + 2} < \phi_{max} < \frac{\sum_{i=1}^{n} \theta_i + 1}{\sum_{i=1}^{n} \theta_i + 2} < 1 \qquad \forall\, n > m \geq 1. \tag{13}$$

Hence, the critical threshold for acceptable brinkmanship shifts downwards. In sum, the scope of successful brinkmanship decreases in a monetary union with 'exit rules'.

4 Exit rules: Policy and empirical implications

In the preceding section we have shown that enacting 'exit rules' limits the scope of successful brinkmanship in a monetary union. The credibility of the enforcement mechanism and the stability of the monetary union could increase. We now outline some policy and empirical implications.

How formulate the optimal exit rules? Jacques Delors has proposed that "(...) the new treaty should make it possible to kick a country out of the Eurozone if a majority of 75% are in favour" (2011). However, the range of possible solutions is far wider: from voluntary to obligatory and from automatic and discretionary rules (see a tentative

typology in figure 2). Importantly, apart from the decision mechanism, it would also be advisable that such rules stipulate what could be the legal procedure for leaving, what the costs would be, and how they would be distributed.

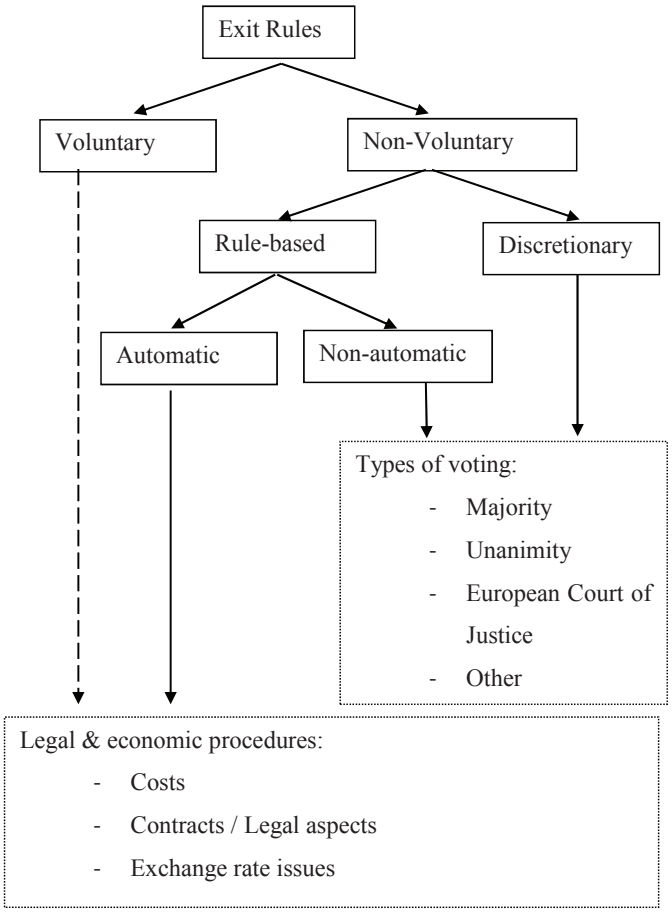

Figure 2: Typology of Exit Rules

However, while how the rules are drawn up is likely to shape the magnitude of the outcomes and should clearly be subject to further research but, for now, we are simply interested in the general direction of how allowing for an exit would change the rules of the game within the EZ.

Currently, the EU provisions stipulate that an exit is not possible. Even though a sovereign state can always decide to leave, such a strong institutional commitment have constituted the legal equivalent of an implicit guarantee that the member states will support one another to prevent an exit whatever the circumstances.[8] It is widely

[8] See, for example, Arghyrou and Tsoukalas (2010) who present a model for an EZ exit under shifting

assumed that such guarantee has given rise to a moral hazard, both for the markets and member states, and has allowed a small country like Greece to hold the entire EZ hostage. First, from the economic viewpoint, because of the guarantee, for many years the markets have been taking far too many risks by essentially treating, for instance, Greek and German bonds in the same way. This has led to a reduction in market discipline, lower interest rates and has provided easy access to capital, which in turn has led some members to indulge in excessive fiscal spending. The resulting imbalances have been threatening the stability of the EZ. Second, from the political perspective, the guarantee has shifted the political bargaining power to the profligate countries and given them leeway to pass part of their political and economic adjustment costs on to the rest of the Eurozone. Since the problems in Greece generate a negative externality for the other members, the Eurozone has little choice but to provide a bailout. Clearly, one of the distortions characterizing the EZ set-up is the problem of enforcement in a monetary union among sovereign members.

Through which channels could 'exit rules' decrease the range of successful brinkmanship and thus increase the credibility of the enforcement problem in the EZ? While the above analysis concerned the endogenous changes resulting from enacting 'exit rules', a look at the key exogenous parameters of the game could offer some additional insights into how they could work.

First, 'exit rules' could influence the perceived parameter ϕ, the probability of encountering an 'offish' CEN or a 'lavish' one with a probability of $1-\phi$. When ϕ increases, the threshold of acceptable brinkmanship decreases. Given that the effectiveness condition does not change in this case, the range of successful brinkmanship decreases. Thus, the more 'offish' CEN, the lower the probability of carrying out successful brinkmanship. In other words, 'exit rules' could decrease the amount of the perceived guarantee and thus reduce the possibility of moral hazard. If exiting the EZ were openly allowed, the markets would have no choice but to price non-zero probability into their risk assessment, and thus better differentiate – not only in times of crisis, but also in good times – the country risk among EZ sovereign bonds. External market discipline would thus be intensified.

Second, 'exit rules' could decrease the probability ψ_i that describes the likelihood of voter refusal for fiscal consolidation. We can see from the condition (2) that if ψ_i is sufficiently small, the PER_i cannot pose an effective threat. Brinkmanship will be effective only if, from the perspective of CEN, the payoff from stall (with contagion) is

membership expectations and the withdrawal of fiscal guarantees.

worse than the pay-off from possibly providing financial assistance for a single PER_i. The smaller the ψ_i, the more likely PER_i government is to opt for a 'consolidate' rather than 'not-consolidate' strategy. In other words, 'exit rules' could enhance domestic discipline because they would shift the internal political economy incentives. They would in essence increase the electorate's perceived costs of leaving (now largely hidden) in relation to the short-term 'fiscal adjustment costs'. Domestic discipline would thus be strengthened.

There are two additional channels (although they are outside our model) through which 'exit rules' could enhance 'EZ stability'. First, 'exit rules' could increase the political bargaining power of EZ members vis-à-vis the profligate countries. Their negotiating position and thus the power to enforce fiscal and structural reforms in the profligate countries could increase because the 'exit rules' would become a bargaining chip in their negotiations with these countries.

Second, 'exit rules' could also provide the added benefit of decreasing market uncertainty, which would support the political and economic adjustment process. Currently, nobody knows what the legal procedure could be for leaving, what the costs would be, and how they would be distributed. Clarifying this would limit the scope for disruptive speculation with all its detrimental effects on the real economy. Consequently, financial uncertainty could be mitigated.

A pertinent policy question also concerns the feasibility of establishing 'exit rules'. Some commentators may argue that there are no 'exit rules' in the US monetary union, the blueprint for the EZ. Although true, such view overlooks the unique nature of the Eurozone. It is a monetary union among sovereign states, and not a federal state with a common fiscal policy, like the US. While increasing European political integration might be a step in that direction, it is na ï ve to think that the Eurozone could make any substantial progress sufficiently quickly to avoid another blow somewhere in the near future. Europe is standing on the brink of a precipice between the undesirable now and the desirable future. It does not want to move backwards, but going forward is risky – which is when creativity is needed.

Some may also worry that the 'exit rules' could run counter to the political ideal of creating an irrevocable monetary union as the basis for a political union. We share this ideal, although the opposite is true. Paradoxically, 'exit rules' would decrease (and not increase!) the probability of an exit, or the breakup of the Eurozone. This is because, as suggested above, spelling out the 'exit rules' would give the EZ what it needs, i.e. enhanced market discipline, stronger enforcement power over the Eurozone,

more internal discipline in the profligate countries and reduce market uncertainty. The closest parallel to this positive feedback effect is the lender of last resort facility. A promise to provide unlimited funding to the banking sector decreases the probability of using public money because of the positive impact of such promise on the banking sector's stability. Evidence can also be found in political science and in the history of national states struggling with preserving their internal integration. Their experience suggests that when secession is not permitted, pressure for it rises. When secession is openly allowed many would-be secessionists cease to press so hard for it.

5 Conclusions

This paper argues that the key issue for defining and solving the Eurozone's difficulties lies in readjusting the relationship between the Eurozone's centre and periphery. We have presented a game that encapsulates the basic financial problem of a centre-periphery system. The model shows that in the current EZ set-up of a centre-periphery relationship, a 'troubled' periphery member can effectively negotiate a bail-out from the centre due to the existence of a negative externality arising from its potential default.

Against this backdrop, we have analysed how establishing 'exit rules' would shift the centre-periphery relationship in the Eurozone in a way that would foster stability. Based on the model we have shown that 'exit rules' would limit the scope of brinkmanship in the EZ and thus increase the credibility of the enforcement mechanism and EZ stability.

We have then discussed policy implications and posit that such rules could strengthen the Eurozone through several channels, including i) improved external market discipline, ii) strengthened internal macroeconomic discipline, iii) increased enforcement power of the Eurozone over profligate members, and iv) reduced uncertainty. We have also argued that establishing such 'exit rules' is politically and economically feasible. Therefore, 'exit rules' should be considered to be an option in future discussions regarding the reform of the institutional set-up of the Eurozone.

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