Sovereign Bail-Outs and Fiscal Rules in a Banking Union*

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Abstract

This paper studies optimal fiscal rules in a two-country economy in which cross-country linkages between sovereign debts and banking sectors motivate bail-outs among countries. The first-best sovereign borrowing, which is contingent on countries' output gap, cannot be achieved in the presence of asymmetric information on a country's potential output. Because bail-out induces overborrowing, fiscal rules can be implemented to prevent the ensuing inefficiency. A mechanism can be designed to induce a country with low potential output (i.e., a small negative output gap) to run an optimal budget deficit upon receiving a (ex-post) transfer from the other country. We characterize conditions under which this fiscal mechanism Pareto dominates a 'cyclically-*adjusted*' fiscal rule imposing a unique ceiling on a country's borrowing, independently of its potential output. We apply our setting to discuss implications for fiscal rules within the European Monetary Union.

Keywords: Sovereign Debt; Bail-out; Potential Output; Fiscal Rules.

JEL Classification Numbers: E62, F34, H63

*For helpful comments, we are grateful to Jan Auerbach, Alberto Bisin, Massimo Bordignon, Giacomo Calzolari, Paolo Manasse, Salvatore Nisticò, and Hrishikesh Singhania. For helpful comments and conversations, we also thank seminar and conference participants at Michigan State University, University of Bologna, University of Exeter, ESM (European Stability Mechanism) in Luxembourg, Macro, Banking and Finance Workshop (Pavia), Financial Economics Workshop at NYU, PET Conference in Luxembourg, XXVII Italian SIEP Conference in Ferrara, and the European Public Choice Society (EPCS) Annual Meeting in Freiburg. All remaining errors are ours.

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1 Introduction

At the beginning of the institutional building process of the European Monetary Union (EMU), fiscal rules on budget deficits were anchored solely to nominal constraints. Maastricht Treaty (1992) introduced the so-called '3%-rule', according to which member states must keep each year a ratio between nominal deficit and GDP not higher than 3%. One of the main rationales for imposing a cap on member states' deficit is represented by the possibility – perceived by financial markets – that less 'virtuous' member states benefit from more 'virtuous' members' financial help (*bail-out*) and, therefore, fail to internalize the negative externality they impose on other Union's members (see, for instance, Chari and Kehoe, 1998; Dixit and Lambertini, 2001; Dixit, 2001; Besfamille and Lockwood, 2008; and Tirole, 2015). This concern has grown with the increasing linkages produced by the integration of the EMU financial markets, such as the process of cross-border banking integration, and the increasing tendency of banks of core EMU countries to acquire significant holdings of sovereign bonds of other EMU members. During the 2010-2012 sovereign debt crisis, for example, the governments of core EMU countries came under pressure to relieve the sovereign debt burden of periphery countries due to the significant exposure of their own banking systems to those sovereigns. This was the case especially for French and German banks which had accumulated sizeable holdings of government bonds of Greece, Portugal and Italy (Breckenfelder and Schwaab, 2018; Altavilla et al., 2017; Guerrieri et al., 2013).

As a consequence of the 2010-2012 sovereign debt crisis, the Fiscal Compact Treaty (2013) has modified the set of fiscal constraints in the EMU by adding a new rule based on a 'cyclically-adjusted' deficit target. The first questioning of cyclically-adjusted budget deficit as the most appropriate fiscal policy indicator dates back to Blanchard (1990). More recently, several scholars have raised issues with the performance of cyclically-adjusted fiscal rules as compared to those based on nominal targets (see, e.g., Debrun et al., 2008; and Larch and Turrini, 2009).[1] At the EMU level, the European Central Bank acknowledges that the fiscal adjustment path dictated by the cyclically-adjusted set of rules is performing poorly (European Central Bank, 2015). And, as pointed out by Blanchard et al. (2021), after the COVID-19 crisis and the suspension of the Stability and Growth Pact, the need to revisit the EMU fiscal rules has become increasingly self-evident.

The main reason why the effectiveness of cyclically-adjusted fiscal rules might be questioned is that it ultimately relies on the computation of each country's potential output, from which – given the actual observable output level – it follows the size of the output gap.[2] However, pinning down countries' potential

[1]Other relevant studies include Petrova (2012), Carnot (2014), Corders et al. (2015), Kinda (2015), and Andrle et al. (2015).
[2]A country's potential output is defined as the highest real output level – compatible with a stable inflation rate – that the country can sustain in the long run.

output is hard, and gives rise to controversies between the European Commission and member states' governments. For instance, in April 2016, seven EMU governments asked the EU Commission for a revision of the potential output estimation procedures, stressing that the estimation of the output performed by international institutions such as the OECD and the IMF significantly differs from the EMU one.

In this paper, we argue that cyclically-adjusted fiscal rules (such as those in place in the EMU, although suspended until the end of 2022) can be suboptimal in the presence of intra-union bail-out incentives and asymmetric information over the member states' potential output. Inspired by the experience of the 2010-2012 sovereign debt crisis, and in line with a growing literature on sovereign-banks linkages (e.g., Auraya et al., 2018; Gennaioli et al., 2014; Lakdawala et al., 2018), we model the bail-out incentive as resulting from the exposure of the banks of a country in the union to the sovereign debt of other members of the union.

We construct a two-country model in which one country – the 'core' – has deep pockets and the other country – the 'periphery' – seeks to finance public expenditures by borrowing from banks located in the core. The periphery's government is privately informed about the country's potential output (and output gap), which can be either high or low. The government spending multiplier increases with the magnitude of the (negative) output gap. As it is standard in models of asymmetric information, absent bail-out, either a signalling or a pooling equilibrium would emerge in the game between the periphery and the outside creditors (see for instance Innes, 1991). In our setting, by diluting the difference in the probability of default between peripheries with different levels of potential output, bail-outs weaken the negative externality imposed by a periphery with a low potential output on a periphery with a high potential output.[3] A different inefficiency arises, however. Absent any intervention by a supranational authority, in a *laissez-faire* environment with bail-out the periphery overborrows from banks located in the core, thereby imposing an expected cost of bail-out on that country. We study the welfare implications of two possible types of intervention by a supranational authority (the union). Similar to the cyclically-adjusted scheme currently in place in the EMU, the union can prevent overborrowing by imposing a (*bunching*) constraint on the periphery's borrowing level based on its own estimates of the member state's cyclical position and output gap. Alternatively, it can design a (*separating*) mechanism in which a member state with a smaller (negative) output gap self-selects into its efficient level of borrowing upon receiving (ex post) a lump-sum transfer from the other country (the core). We characterize conditions under which the *separating* mechanism Pareto dominates the *bunching* fiscal rule. In particular, we show that, as the prior probability that the periphery is characterized by a high potential output increases, the relatively low bail-out costs and the efficiency gains generated by the *separating* mechanism make it Pareto-dominant with respect to the *bunching* rule. This result stems from

[3] An analysis of bail-outs at the international level can be found in Corsetti et al. (2006), Bolton and Jeanne (2011), and Tirole (2015).

the fact that, unlike the *separating* mechanism, the *bunching* constraint on borrowing becomes less stringent as the estimates on the periphery's output gap become more optimistic. This, in turn, implies an increasing cost of bail-out for the core were the periphery to default.

These results can yield insightful policy implications for the design of fiscal policies in federations. The framework can be broadly applied to federations characterized by limited information about the fiscal stance of their jurisdictions and by non-negligible financial linkages among the jurisdictions. Continuing with the application to the EMU case, provided the EMU aims at implementing a cyclically-adjusted mechanism while eliciting member states' private information, the mechanism proposed in this paper presents a major difference with respect to the current fiscal framework. To avoid overborrowing when a member state is not far from its potential, the (relatively) low deficit required from a member state characterized by a (relatively) low potential output must come with an ex-post transfer to be received from the other members of the Union. This mechanism has the crucial feature that it comes from the 'federal' level, thus implying a degree of fiscal risk sharing within the Union. Our analysis characterizes conditions under which, in the presence of asymmetric information and bail-out incentives, such a mechanism would Pareto dominate the current EMU fiscal framework and, hence, could be adopted under the unanimous voting scheme that is needed to reform EU treaties.

Our framework is based on two main premises. First, national governments have better information than union-level decision-making bodies about their country's fiscal and cyclical stance. Second, the size of the government spending multiplier increases in the (negative) output gap.

Concerning the first premise, the presence of an asymmetric information problem between government layers has been extensively investigated in the literature. Bordignon et al. (2001), Cornes and Silva (2002), and Besfamille (2003), among others, argue that local governments have a superior knowledge of macroeconomic conditions and/or structural parameters of the economy. Bottazzi and Manasse (2005) build a model in which the true state of the national business cycle is private information, and derive implications for the optimal (common) monetary policy in a monetary union. Following this strand of studies, we assume that member states are better informed about their potential output than the union decision-making body. For instance, member states' potential output can be thought as a function of the national government's past (structural) investments and reforms. The efficiency of past investments – e.g., the fraction of investments that is not spent in socially wasteful private perks – is private information of the national government. Further, a broad body of literature argues that national governments know the effectiveness of structural reforms within the national territory better than multilateral institutions such as the EU (Ehrmann and Smets, 2003; Borio, Disyatat and Juselius, 2014; Gruner, 2013; Marchesi, Sabani and Dreher, 2011).[4] In this

[4]Equivalently, given the assumption that spending multipliers are increasing functions of the capacity slack, the information

paper, we study the interaction between this type of information asymmetry and bail-out among members of a union, and derive implications for the optimal fiscal policy.

Concerning our second premise, it is supported by contributions on both the theoretical and the empirical sides. From the theoretical viewpoint, Christiano et al. (2009) and Woodford (2010) note that the spending multiplier is higher during recessions because the economy is most likely to reach the zero lower bound on the nominal interest rate.[5] In particular, the proportionality between slack capacity and output effects of the government spending stimulus stems from the fact that, because of the higher output gap, the government-spending-induced increase in output translates into a lower rise in inflation due to the flatter marginal cost curve which prevails under a great deal of excess capacity. This intuition is empirically confirmed and fairly robust to alternative estimation techniques. Auerbach and Gorodnichenko (2012a) estimate a quarterly data model (1947-2009) for the United States and find that the output effect of government spending is considerably larger during a recession than during an expansion. Auerbach and Gorodnichenko (2012b) and Batini et al. (2012) obtain similar results by looking at a larger sample of OECD countries. Baum et al. (2012) use output gap (rather than GDP growth) to better identify business cycle fluctuations (see also Harding and Pagan, 2002). They investigate six of the G7 economies from the 1970s to 2011 and find that in all the cases the magnitude of the multiplier is increasing with the negative output gap.

Finally, our paper is also related to the literature that studies the trade-off between commitment and flexibility in fiscal rules. Halac and Yared (2014) study optimal dynamic fiscal rules in a framework with persistent shocks (see also Amador et al., 2006). In their framework, a government is both privately informed about the realizations of shocks and suffers from a present-bias that may lead to excessive deficits. The presence of both private information and present-bias generates a desire for both flexibility of fiscal rules (to respond to shocks) and commitment (to not overspend and hurt future payoffs). Similar to Halac and Yared (2014), in our framework flexibility is desirable in order to respond to shocks. Also, a desire for commitment is generated by the presence of both the government's private information about the shock realization and its incentive to overborrow: while this latter incentive is generated by the government's present-bias in Halac and Yared (2014), in our static framework with a banking union this incentive stems from the presence of bail-out between countries. This reasoning also motivates our Pareto analysis.

Before we proceed, it is worth noting that, for the purpose of simplicity, in our main analysis we represent in reduced form two linkages of the model economy: the effects of government spending on output; and the impact that banks of the core country exposed to the (default of the) periphery's government have on the

asymmetry over the output gap can be easily reinterpreted as an information asymmetry over the magnitude of the government spending multiplier. Both these early reduced-form interpretations, as well as more recent ones based on deep structural parameters (e.g., Woodford, 2010), highlight that the ex-ante output effect of government spending is determined by parameters on which it is easy to think of an information advantage of the member state.

[5] See also Manasse (2007).

output of their own country. In the Online Appendix C, we present possible microfoundations for these linkages, drawing inspiration from a strand of recent studies (e.g., Farhi and Tirole, 2018; Arellano, Bai and Bocola, 2020). The remainder of the paper unfolds as follows. Section 2 lays out the model. We first solve the model under complete information and no bail-out (Section 3.1). We then introduce both features and characterize the equilibrium in a decentralized (unregulated) setting (Section 3.2). Section 4 analyzes the optimal properties of two alternative fiscal rules – a bunching and a separating mechanism – and provides a Pareto ranking of all the equilibria. Section 5 discusses assumptions, alternative specifications and applications of our framework. Section 6 concludes and offers additional policy implications. All the proofs and further microfoundations for the model are relegated to the Online Appendices. The Online Supplement briefly compares our model to the EMU current fiscal framework and discusses costs and benefits of targeting cyclically-adjusted variables.

2 The Model

We consider two countries S_i, for $i = 1, 2$. The government of each country finances public expenditures I_i possibly resorting to taxation and to borrowing from competitive domestic and foreign banks.[6] All players are risk neutral. We analyze a simplified setting in which the government of country 1, the 'core', has deep pockets – i.e., it does not need to turn to financial markets to finance its expenditures – whereas the government of country 2, the 'periphery', finances expenditures by resorting to (primary) deficit $B \in [0, +\infty)$. The government of country 2 can borrow from banks of country 1. Given the focus of this paper, to simplify the exposition, we disregard the presence of banks of country 2.[7] Banks of country 1 gather deposits from competitive home investors, hold government bonds and grant loans to home agents. For simplicity we abstract from foreign loans in our setting. Banks of country 1 are subject to a market or regulatory capital constraint which specifies that

$$E \geq \psi_L L \tag{1}$$

where E is the banks' equity capital, L are loans, and $\psi_L > 1$ captures the capital requirement on loans. In turn, from the definition of bank capital,

$$E = R + C^0 + L^0 - D^0, \tag{2}$$

[6] In what follows, we use S_i to refer to both country i and the government of country i, for $i = 1, 2$. A distinction between a country and its government is explicitly made when necessary.

[7] Adding banks of country 2 which hold a share of country 2's sovereign bonds would not qualitatively affect our main results.

where R is the repayment on outstanding government bonds held in country 2, C^0 is the amount of cash at the banks' disposal, L^0 is the outstanding loan stock, and D^0 is the outstanding deposit stock, and where we take the tri-ple $\{C^0, L^0, D^0\}$ as given (determined in an unmodelled past). As long as their capital constraint is not binding, core (country 1) banks are unrestricted in the amount of lending to agents in their own country. When the constraint (1) binds, instead, their loans are restricted to be equal to

$$L = \frac{R + C^0 + L^0 - D^0}{\psi_L}, \tag{3}$$

which is increasing in the repayment R of country 2's government.

As we intend to mimic a short-run macroeconomic framework, we assume that deficit spending B has real effects, i.e., it has a positive effect on income level Y_2 because of, for instance, nominal rigidities. Further, to capture a linkage between the banking sector and the real sector, we also allow the output of a country to depend on the amount of loans extended by banks. In particular, S_1 produces an end-of-period output $Y_1 = Y_1(L)$, which is increasing and concave in L. A broad literature endogenizes this linkage and, for simplicity, in our main setting we represent it in reduced form by positing that output is also a function of bank loans. In the Online Appendix C, we lay out possible microfoundations for these linkages of the model.[8]

Unlike Y_1, S_2's end-of-period output is stochastic, with $Y_2 = Y_2(\theta, B, \mu)$, where μ is a random variable, and where $\theta \in \{\underline{\theta}, \bar{\theta}\}$ represents S_2's position with respect to its potential output, with $\bar{\theta} > \underline{\theta}$.[9] More specifically, when $\theta = \bar{\theta}$ (respectively, $\theta = \underline{\theta}$), the absolute value of S_2's output gap is large (small). θ is S_2's private information. Government and banks of country 1 attach a probability α to $\theta = \bar{\theta}$ and $(1-\alpha)$ to $\theta = \underline{\theta}$. Because we analyze a short-run macroeconomic framework, we assume that potential output is exogenous and unaffected by investments.

As in Innes (1991), given (θ, B), the random variable μ generates a probability density function $f(Y_2 \mid \theta, B)$ and a distribution function $F(Y_2 \mid \theta, B)$ for Y_2. We assume $f(\cdot)$ is continuously differentiable on $[y(\theta), K(\theta, B)]$, where $K(\theta, B) > y(\theta)$ whenever $B > 0$, for $\theta \in \{\underline{\theta}, \bar{\theta}\}$. Also, following our discussion in Section 1, we assume that a larger output gap θ and a higher investment financed through deficit B generate better output distributions in the sense of first-order stochastic dominance. Specifically

[8] As discussed in the Online Appendix C, the microfoundations for these linkages build on prior studies (e.g., Farhi and Tirole, 2018).

[9] In the following, we make use of the framework developed in Innes (1991), and adapt it to the case of sovereign borrowing and bail-out.

$$F\left(Y_2 \mid \bar{\theta}, \cdot\right) < F\left(Y_2 \mid \underline{\theta}, \cdot\right), \quad F_B\left(Y_2 \mid \underline{\theta}, \cdot\right) < 0, \quad F_B\left(Y_2 \mid \bar{\theta}, \cdot\right) < 0, \quad \forall Y_2 \in \left[y\left(\theta\right), K\left(\theta, \cdot\right)\right], \quad \theta \in \left\{\underline{\theta}, \bar{\theta}\right\},$$

$$\text{and} \quad \int_{y(\bar{\theta})}^{K(\bar{\theta},B)} -F_B\left(Y_2 \mid \bar{\theta}, B\right) dY_2 > \int_{y(\underline{\theta})}^{K(\underline{\theta},B)} -F_B\left(Y_2 \mid \underline{\theta}, B\right) dY_2, \tag{4}$$

were subscripts denote partial derivatives. The last inequality in (4) implies that a larger output gap is associated with a higher multiplier of government spending.[10,11] We finally assume that the expected output $E\left[Y_2 \mid \theta, B\right]$ is increasing and concave in B, and that the Inada conditions hold.[12]

Financial Markets and Bail-out. The government of S_2 signs a contract with perfectly competitive and risk neutral banks of country 1. We take the return on a risk-free bond to be equal to zero. The contract consists of the amount B borrowed by the government of S_2 and a return for banks $R\left(Y_2, x\right)$ to be paid at the end of the period. This return depends on *i*) the realization of output Y_2, and *ii*) any 'bail-out' transfer $x \geq 0$ made by S_1 to S_2. More specifically, given a debt contract, we have

$$R\left(Y_2, x, \theta\right) = \min\left\{Y_2 + x,\ z(\theta)\right\}, \quad \text{for} \ \ \theta \in \{\underline{\theta}, \bar{\theta}\}, \tag{5}$$

where z is a promised loan repayment, possibly contingent on θ.

Foreign banks' holding of government bonds gives rise to cross-country spillovers and can generate an incentive for the government of a foreign country to bail the borrowing country out. In our framework, S_1's incentive to bail S_2 out stems from S_1's domestic banks holding B among their assets.[13] In the presence of capital requirements for banks, bail-out can prevent domestic banks from cutting credit to S_1's domestic agents (see (1) and (2)). As we formally show below, bail-out, however, generates further potential inefficiencies.[14]

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[10]In line with the discussion at the end of Section 1, this allows our model to be based equivalently either on the information asymmetry about the potential output level or on the information asymmetry about the size of the government spending multiplier.

[11]Innes (1991) assumes $F_B\left(Y_2 \mid \bar{\theta}, \cdot\right) < F_B\left(Y_2 \mid \underline{\theta}, \cdot\right)$, $\forall Y_2 \in \left[0, K\left(\cdot\right)\right]$. This inequality implies the last inequality in (4), whereas the reverse may not hold.

[12]As we disregard long-run considerations, the marginal utility of income is always increasing, so that national governments are not satiated with the closing of output gap because of political short-termism (see, e.g., Dixit and Lambertini, 2001).

[13]In principle, one could think that S_1 might also directly support its banks (e.g., through recapitalizations). There are however economic and political costs of such interventions. Further, our model may also capture a richer setting with multiple core countries in which one core country bails out the periphery to prevent banks in all core countries from contracting credit and triggering a downturn. These aspects are outside the focus of our analysis.

[14]Within the EMU, for instance, the attempt to overcome this issue by inserting an explicit 'no-bail-out clause' in the Maastricth Treaty (art. 125 of the Lisbon Treaty) has proved quite ineffective as the sovereign debt crisis in the eurozone displayed its effects. For a discussion of the free-rider problem within a monetary union – in which member states borrow in a common currency – see Buiter et al. (1993), Beetsma and Uhlig (1999), Von Hagen and Eichengreen (1996), and Lane (2012).

Ex-ante Contracting. We consider the presence of a central authority P whose objective is to maximize the (unweighted) joint utility of S_1 and S_2 (see below). S_1 and S_2 delegate P the authority to design and enforce a contract – possibly contingent on θ – consisting of the amount B borrowed by the government of S_2 and a (ex-post) transfer $t \in \mathbb{R}^+$ from S_1 to S_2. In particular, B is borrowed in the financial market and invested at the beginning of the period, whereas the transfer t is cleared at the end of the period, that is, after the realization of Y_2 is observed by all the players (see the timing below). By restricting t to take positive values, we effectively introduce a limited liability constraint for S_2. We take the amount B specified in the mechanism offered by P to be a an upper bound on S_2's borrowing level, and assume that P can enforce the limits imposed on B.

The mechanism $(t(\theta), B(\theta))$, for $\theta \in \{\underline{\theta}, \bar{\theta}\}$, proposed by P can be either a *bunching* mechanism – i.e., $t(\underline{\theta}) = t(\overline{\theta}) = 0$ and $B(\underline{\theta}) = B(\overline{\theta}) = B^B$ – or a *separating* mechanism – i.e., $\{(t(\underline{\theta}), B(\underline{\theta})), (t(\overline{\theta}), B(\overline{\theta}))\}$, with $t(\underline{\theta}) \neq t(\overline{\theta})$ and $B(\underline{\theta}) \neq B(\overline{\theta})$. We also define a 'decentralized' (*laissez-faire*) solution as one in which *i)* $t(\underline{\theta}) = t(\overline{\theta}) = 0$ and *ii)* S_2 is free to choose $B(\theta)$, subject to the constraints imposed by the lenders. Which of these solutions is implemented will ultimately depend on the agreement reached between S_1 and S_2.[15] In this paper, we remain agnostic about the exact process by which countries' preferences are aggregated, and we instead focus on the Pareto properties of the different solutions at countries' disposal. The Pareto criterion can be thought of, for example, as reflecting the unanimous voting rule that is needed to reform EU treaties (i.e., to choose among the different solutions in our model economy).

In the following, we denote $(t(\underline{\theta}), B(\underline{\theta}))$ and $(t(\overline{\theta}), B(\overline{\theta}))$ by $(\underline{t}, \underline{B})$ and $(\bar{t}, \overline{B})$, respectively. Similarly, we define $z(\underline{\theta})$ and $z(\overline{\theta})$ by $\underline{z}$ and $\overline{z}$, respectively.

Utility Functions. S_1's (ex-ante) utility function is:

$$U_1(L, B, \theta, x) = Y_1(L) + \tag{6}$$

$$-\alpha \left[\bar{t} + \int_{\min\{y(\overline{\theta}), \overline{z}\}}^{\overline{z}} \min\{(\overline{z} - Y_2), x\} f\left(Y_2 \mid \overline{\theta}, \overline{B}\right) dY_2 \right] - (1-\alpha) \left[\underline{t} + \int_{\min\{y(\underline{\theta}), \underline{z}\}}^{\underline{z}} \min\{(\underline{z} - Y_2), x\} f\left(Y_2 \mid \underline{\theta}, \underline{B}\right) dY_2 \right]$$

where the two integrals on the right-hand-side (RHS) of (6) represent the expected cost to S_1 of bailing S_2 out.

[15] As we clarify below, in our framework, P's role is to select the borrowing levels that maximize the (unweighted) sum of utilities of the two countries in both the *separating* and *bunching* mechanisms.

S_2's utility function is:

$$U_2(B,\theta) = t(\theta) + \int_{\max\{y(\theta),z(\theta)\}}^{K(\theta,B)} \left[(Y_2 - z(\theta)) f(Y_2 \mid \theta, B)\right] dY_2, \tag{7}$$

for $\theta \in \{\underline{\theta}, \bar{\theta}\}$.

P's utility function reads:

$$V(L,B,\theta) = U_1(L) + \left[\alpha U_2\left(\overline{B},\overline{\theta}\right) + (1-\alpha) U_2\left(\underline{B},\underline{\theta}\right)\right]. \tag{8}$$

Timing. We analyze a one-period game composed of six stages.

Stage 0: P designs a mechanism $\{t(\theta), B(\theta)\}$, for $\theta \in \{\underline{\theta}, \bar{\theta}\}$.

Stage 1: Nature draws θ, and this is revealed to S_2.

Stage 2: After observing the mechanism offered by P, S_2 announces an investment level B and a repayment z; lenders (country 1's banks) decide whether to accept S_2's offer.

Stage 3: Y_2 realizes and is publicly observed.

Stage 4: If $Y_2 < z$, S_1 decides whether to bail S_2 out by an amount x. S_2 repays lenders. The transfer t is also made.

Stage 5: Banks of country 1 extend loans L to country 1's private sector and $Y_1(L)$ realizes.

Our solution concept is Perfect Bayesian Equilibrium (PBE). Our goal is to study the Pareto properties of the different solutions – *bunching*, *separating* and *laissez-faire* – at S_1 and S_2's disposal. To this end, when we consider the *bunching* and *separating* solutions, P's role in Stage 0 consists of selecting the contract that maximizes the joint utility of S_1 and S_2 within any of these two mechanisms.

In what follows, we first characterize the optimal solution to S_2's investment problem absent any intervention by P (Section 3): Section 3.1 presents the analysis of S_2's investment choice in the absence of both asymmetric information and bail-out. In Section 3.2, we add both features and characterize a decentralized (*laissez-faire*) equilibrium. Section 4 studies the equilibria under an optimal *(i)* separating mechanism and *(ii)* bunching rule, and studies the Pareto ranking of all these equilibria.

3 Borrowing in a Laissez-faire Environment

In this section, we study the case in which P is absent. Formally, we drop Stage 0 from the timing of our game.

3.1 A Benchmark: Complete Information absent Bail-out

Suppose θ is perfectly observable by all the parties and bail-out is not allowed (i.e., $x = 0$). Because banks are competitive, we expect S_2 to appropriate the entire surplus generated by government spending. More specifically, S_2 solves:

$$\begin{aligned} &\max_{\{B\}} E\left[Y_2 - \min\{Y_2,\, z(\theta)\} \mid \theta, B\right], \\ &\text{s.t.}\quad E\left[\min\{Y_2,\, z(\theta)\} \mid \theta, B\right] = B, \end{aligned} \tag{9}$$

where the constraint represents banks' zero-profit condition. From (9), S_2 solves:

$$\max_{\{B\}} \int_{y(\theta)}^{K(\theta,B)} Y_2 f\left(Y_2 \mid \theta, B\right) dY_2 - B, \tag{10}$$

which gives us the symmetric information optimal borrowing level $B^*(\theta)$, for $\theta \in \{\underline{\theta}, \bar{\theta}\}$ (see also Figure 1). From (4), we have $B^*(\bar{\theta}) > B^*(\underline{\theta})$, where $B^*(\cdot)$ denotes the solution to (10). Absent any information asymmetry and bail-out mechanism, optimality requires the $\overline{\theta}-$type to borrow more than the $\underline{\theta}-$type, because the former has a higher spending multiplier.

3.2 Asymmetric Information and Bail-out

Consider now the case in which θ is S_2's private information. When banks of country 1 lend to S_2, we allow for S_1 to bail S_2 out in the event the realized output Y_2 falls short of the promised repayment.[16]

3.2.1 Bail-out Analysis

We proceed by backward induction. Suppose S_2 borrows B from banks and promises to repay z.[17] Suppose also that, in Stage 3 of our game, $Y_2 < z$ realizes, which implies $R < z$, unless S_1 bails out S_2 – and, *de facto*, its home banks – by contributing $x > 0$ in Stage 4. The following constrained maximization problem

[16]For an analysis of the model with asymmetric information and no bail-out, see Innes (1991).
[17]Banks can finance B by employing part of their cash C^0.

– solved by S_1 in Stage 4 – determines the optimal amount of x:

$$\max_{\{x\}} Y_1(L) - x \tag{11}$$

$$\text{s.t.} \quad L \leq \frac{R(x) + C^0 + L^0 - D^0}{\psi_L},$$

$$x \leq \max\{z - Y_2, 0\}.$$

The first constraint in (11) anticipates that the level of loans granted by banks does not violate banks' capital constraint (1) in Stage 5. The second constraint simply states that the amount x chosen by S_1 does not exceed the difference between S_2's promised repayment z and the output Y_2 it produces.

We introduce the following simplifying assumptions:

Simplifying Assumptions. We assume (**A1**):

$$0 = y(\underline{\theta}) < B^*(\bar{\theta}) \leq y(\bar{\theta}), \tag{12}$$

where $B^*(\bar{\theta})$ denotes the $\bar{\theta}-$type's optimal borrowing level. **A1** simplifies our framework by making the $\bar{\theta}-$type risk-free when choosing its optimal investment level. Bail-out is therefore relevant only for $\theta = \underline{\theta}$.

We also impose (**A2**):

$$\hat{L} \geq \frac{z + C^0 + L^0 - D^0}{\psi_L}, \tag{13}$$

where $\hat{L}$ denotes the (exogenous) amount of loans that banks would extend in Stage 5 if they were unconstrained. According to **A2**, when the return z from the loans to S_2 is realized, the capital constraint (1) binds in Stage 5. As a consequence, the capital constraint also binds when $R(\cdot) < z$.

We finally assume (**A3**):

$$\frac{\partial Y_1(L)}{\partial L}\Big|_{L=\hat{L}} \geq \psi_L. \tag{14}$$

From **A2**, **A3**, and the concavity of Y_1, we have that the solution to (11) is:

$$x^* = \max\{0, z - Y_2\}, \tag{15}$$

that is, S_1 has an incentive to fully bail S_2 out whenever $Y_2 < z$, because the marginal benefit of transferring an extra dollar to S_2 (equal to $\frac{1}{\psi_L}\frac{\partial Y_1(\hat{L})}{\partial L}$) exceeds its marginal cost (equal to 1), for any $L \leq \hat{L}$. In our setting, the more stringent the capital constraint – that is, the higher ψ_L – the less eager is S_1 to bail its home banks out. This stems from the fact that from (3), the higher ψ_L, the lower is the (positive) effect of bail-out on new loans (L).

In what follows, we define $U_1^* = Y_1(L)$ when $R(x) = z$.

3.2.2 Borrowing Analysis

Because of *(i)* asymmetric information on θ and *(ii)* potential bail-out of S_2 by S_1, the efficient investment $\{B^*(\underline{\theta}), B^*(\bar{\theta})\}$ – which maximizes P's utility in (8) – may not be achieved in a decentralized setting, i.e., absent P's intervention.

To show the effect of bail-out on S_2's borrowing (and investment) levels, we follow Innes (1991) and define S_2's *indifference curves* and lenders' *offer curves* (see Figure 1 for an illustration). S_2's *indifference curve* $IC(\theta)$ is the set of points on the (B, z) space that yield a common utility level to S_2:

$$U_2(B, z, \theta) = \int_{\max\{y(\theta), z\}}^{K(\theta, B)} (Y_2 - z) f(Y_2 \mid \theta, B)\, dY_2 = \bar{U}(\theta), \tag{16}$$

for $\theta \in \{\underline{\theta}, \bar{\theta}\}$. As it is standard in models with asymmetric information, we impose that S_2 has steeper indifference curves when characterized by a large output gap ($\bar{\theta}-$type) rather than a small output gap ($\underline{\theta}-$type), that is, we assume:

$$\frac{dz}{dB}\mid_{\bar{U}(\bar{\theta})} = -\frac{\frac{\partial U_2(\bar{\theta}, \cdot)}{\partial B}}{\frac{\partial U_2(\bar{\theta}, \cdot)}{\partial z}} > -\frac{\frac{\partial U_2(\underline{\theta}, \cdot)}{\partial B}}{\frac{\partial U_2(\underline{\theta}, , \cdot)}{\partial z}} = \frac{dz}{dB}\mid_{\bar{U}(\underline{\theta})}, \tag{17}$$

where the indifference curve is upward sloping because

$$\frac{\partial U_2(\theta, \cdot)}{\partial B} = -\int_{z}^{K(\theta, B)} \frac{\partial F(Y_2 \mid \theta, B)}{\partial B} dY_2 > 0, \tag{18}$$

$$\frac{\partial U_2(\theta, \cdot)}{\partial z} = -(1 - F(z \mid \theta, B)) < 0, \tag{19}$$

for $\theta \in \{\underline{\theta}, \bar{\theta}\}$.[18]

The lenders' *offer curve* is the set of points on the (B, z) space that yield an expected profit equal to zero. It is useful to distinguish the *separating* offer curves – which would arise if lenders were able to distinguish between different types of S_2 – from the *pooling* one – which instead arises when the two types of S_2 are pooled together. Absent bail-out, the *separating offer curve* $OC(\theta)$ is given by:

[18] Note that, from (18) and (19), the inequality in (17) requires that the positive relationship between output gap and multiplier of government spending is sufficiently strong.

$$R(B,z,\theta)=E[Y_2\mid\theta,B]-\left[\int_{\max\{y(\theta),z\}}^{K(\theta,B)}(Y_2-z)\,f(Y_2\mid\theta,B)\,dY_2\right]-B=0, \tag{20}$$

for $\theta\in\{\underline{\theta},\bar{\theta}\}$. $OC(\theta)$ lies on the 45° line on the (B,z) space for values of $B\leq y(\theta)$: when $\theta=\bar{\theta}$, because $B^{*}(\bar{\theta})\leq y(\bar{\theta})$ from **A1**, we can anticipate that this is the case of interest in this paper.

The *pooling offer curve* OC^{P} is given by:

$$\alpha R(B,z,\bar{\theta})+(1-\alpha)R(B,z,\underline{\theta})=0. \tag{21}$$

Bail-out affects both the separating and the pooling offer curves through the loan repayment z (from (5)). As noted above, from **A1**, bail-out has no effect on $OC(\bar{\theta})$, for $B\leq y(\bar{\theta})$. Therefore, in our simplified setting, bail-out only affects $OC(\underline{\theta})$. From **A2** and **A3**, because banks expect S_1 to fully bail S_2 out in case $Y_2<z$, the offer curve in (20) lies on the 45° line for any value of θ.[19] As a consequence, (20) and (21) coincide.

Finally, the lenders' offer curves are upward sloping:

$$\frac{dz}{dB}\mid_{R(\theta)=0}\geq 1,\quad \text{for }\ \theta\in\{\underline{\theta},\bar{\theta}\}, \tag{22}$$

where, absent bail-out, the slope of the offer curve is decreasing in θ.

Figure 1 illustrates the equilibrium pairs $(B(\theta),z(\theta))$, for $\theta\in\{\underline{\theta},\bar{\theta}\}$, under *(i)* symmetric information and no bail-out and *(ii)* asymmetric information and bail-out.[20] The offer curves OC^{P} and $OC(\theta)$, for $\theta\in\{\underline{\theta},\bar{\theta}\}$, are depicted for the case in which bail-out is absent. Given our assumptions, in the presence of bail-out, all offer curves are identical and equal to $OC(\bar{\theta})$. Indifference curves are also depicted (continuous bold for the $\underline{\theta}-$type and dashed bold for the $\bar{\theta}-$type); higher levels of utility correspond to indifference curves moving southward. The allocations arising under complete information are represented by the pair $\{E^{*}(\underline{\theta}),E^{*}(\bar{\theta})\}$, where the indifference curves for each type are tangent to the corresponding offer curves.

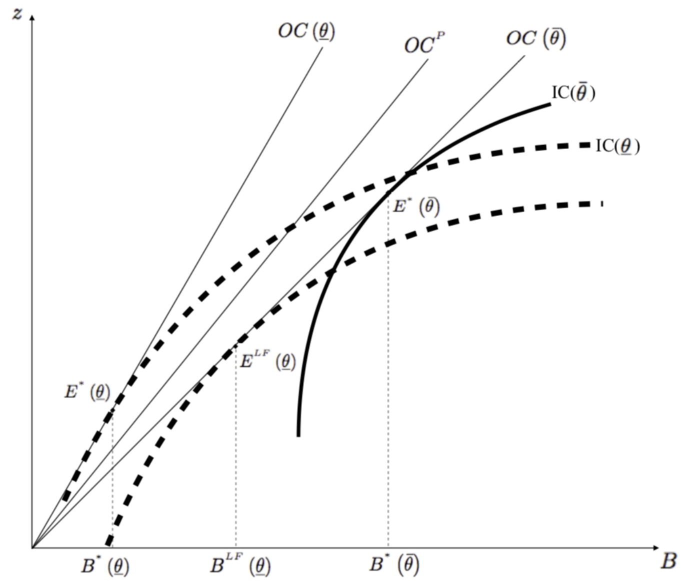
We denote by a superscript LF (for *laissez-faire*) S_2's optimal borrowing in the presence of bail-out and asymmetric information.

Proposition 1. *In the presence of bail-out and asymmetric information, given* ***A1-A2-A3****, the* $\bar{\theta}-$*type borrows optimally, i.e.,* $B^{LF}(\bar{\theta})=B^{*}(\bar{\theta})$*, whereas the* $\underline{\theta}-$*type overborrows from banks of country 1, i.e.,*

[19] More specifically, the offer curve in (20) includes an extra term equal to the expected bail-out x^{*} (from (15)) – i.e., $\mathbb{E}(\max\{0,z-Y_2\})=\int_{\min\{y(\theta),z\}}^{K(\theta,B)}(z-Y_2)\,f(Y_2\mid\theta,B)\,dY_2$, which finally gives $z(x^{*})=B$ for both types of borrowers.

[20] All figures illustrate cases with linear offer curves.

Figure 1: **Equilibria under (i) Complete Information with No Bail-out and (ii) Asymmetric Information with Bail-out.**



Note: Dashed-bold (continuous-bold) curves represent the $\underline{\theta}-$type ($\bar{\theta}-$type) indifference curves. Lines not in bold represent the lenders' separating ($OC(\underline{\theta})$ and $OC(\bar{\theta})$) and pooling (OC^{P}) offer curves under no bail-out. All offer curves are represented by $OC(\bar{\theta})$ in the presence of bail-out. The pair $\left\{E^{*}(\underline{\theta}), E^{*}(\bar{\theta})\right\}$ denotes the equilibrium under complete information and no bail-out. The pair $\left\{E^{LF}(\underline{\theta}), E^{*}(\bar{\theta})\right\}$ denotes the equilibrium under asymmetric information and bail-out.

$B^{LF}(\underline{\theta}) > B^{*}(\underline{\theta})$, *where* $B^{LF}(\underline{\theta}) < B^{*}(\bar{\theta})$.

Proof. See Online Appendix A. □

The pair $\left\{E^{LF}(\underline{\theta}), E^{*}(\bar{\theta})\right\}$ in Figure 1 represents the *decentralized* equilibrium, that is, the equilibrium arising under asymmetric information and bail-out, absent P's intervention. The inefficient over-investment by the $\underline{\theta}-$type is caused by the expected bail-out of S_2 by S_1 when $Y_2 < z$. Because the $\bar{\theta}-$type is risk-free (from **A1**), only the $\underline{\theta}-$type benefits from bail-out and, therefore, has an incentive to issue debt (and invest) in excess. Moreover, unlike the setting analyzed in Innes (1991), because bail-out makes different types of S_2 identical in terms of their ability to repay the debt, S_2 has no incentive to signal its type by, for instance, overborrowing when $\theta = \bar{\theta}$.[21]

Let $U_1^{LF}(\alpha)$ denote S_1's expected utility when $\left\{E^{LF}(\underline{\theta}), E^{*}(\bar{\theta})\right\}$ occurs. We also define $B^{LF} \equiv B^{LF}(\underline{\theta}, x)$.

[21] Our 'no-signalling' result in Proposition 1 hinges on bail-out making $\underline{\theta}-$type *identical* to $\bar{\theta}-$type (see **A2** and **A3**). More generally, to the extent to which bail-out dilutes the difference between types of borrowers (resulting in separating offer curves which are less far apart), it reduces the incentives for the $\underline{\theta}-$type to mimic the $\bar{\theta}-$type, making a separating equilibrium with 'no-signalling' arise for a larger set of parameters' values.

Lemma 1. *In the presence of bail-out and asymmetric information, S_1's expected utility under the laissez-faire regime is*

$$U_1^{LF}(\alpha) = U_1^* - (1-\alpha) \int_0^{B^{LF}} \left(B^{LF} - Y_2\right) f\left(Y_2 \mid \underline{\theta}, B^{LF}\right) dY_2, \tag{23}$$

where $U_1^{LF}(\alpha)$ is increasing in α.

Proof. See Online Appendix A. □

To summarize, in the presence of asymmetric information and bail-out, we have that *(i)* the type of S_2 characterized by a low (respectively, high) potential output inefficiently overborrows (respectively, borrows efficiently) on the market, and *(ii)* S_1's expected welfare increases with the probability (α) S_2's potential output is high (i.e., $\theta = \bar{\theta}$). In our simplified setting, on the one hand, bail-out removes inefficiencies due to asymmetric information under either separating or pooling equilibria – i.e., overborrowing (respectively, under-borrowing) by the $\bar{\theta}-$type of S_2 in a separating (pooling) equilibrium and overborrowing by the $\underline{\theta}-$type of S_2 in a pooling equilibrium. On the other hand, bail-out introduces an inefficiency due to the externality imposed by S_2 on S_1. Bail-out shifts costs imposed by the presence of the $\underline{\theta}-$type of S_2 from the $\bar{\theta}-$type of S_2 to S_1, thereby potentially calling for a coordinated response through P.

4 Fiscal Rules

From P's viewpoint, bail-out causes inefficient overborrowing by the $\underline{\theta}-$type of S_2. P's goal is to restore efficiency. This task is complicated by the presence of asymmetric information.

We first investigate the possibility for P to build a *separating* mechanism $\left\{(\underline{t}, \underline{B}), (\bar{t}, \bar{B})\right\}$ that implements the efficient level of borrowing for both types of S_2 – that is we consider $\underline{B} = B^*(\underline{\theta})$ and $\bar{B} = B^*(\bar{\theta})$ – where we assume that B is observable to P.[22] Provided such a separating mechanism exists, it maximizes P's utility in (8), although it may not Pareto dominate the *laissez-faire* solution and/or an alternative *bunching* mechanism. In Section 4.2, we solve for P's optimal *bunching* mechanism, in which P sets a rule on S_2's borrowing independent of its type θ. Finally, in Section 4.3, we study the conditions under which the *separating* mechanism Pareto dominates the *bunching* mechanism and the *laissez-faire* solution.

4.1 Separating Mechanism

In a separating mechanism, S_2's Incentive Compatibility Constraints (IC_θ) are:

[22] The revelation principle applies. Hence, we focus on direct revelation mechanisms.

$$\underline{t} + \int_{z(\underline{B},x)}^{K(\underline{\theta},\underline{B})} \left(Y_2 - z\left(\underline{B},x\right)\right) f\left(Y_2 \mid \underline{\theta},\underline{B}\right) dY_2 \geq \bar{t} + \int_{z\left(B^{LF},x\right)}^{K\left(\underline{\theta},B^{LF}\right)} \left(Y_2 - z\left(B^{LF},x\right)\right) f\left(Y_2 \mid \underline{\theta},B^{LF}\right) dY_2, \tag{24}$$

$$\bar{t} + \int_{y\left(\bar{\theta}\right)}^{K\left(\bar{\theta},\bar{B}\right)} \left(Y_2 - \bar{B}\right) f\left(Y_2 \mid \bar{\theta},\bar{B}\right) dY_2 \geq \underline{t} + \int_{y\left(\underline{\theta}\right)}^{K\left(\bar{\theta},\underline{B}\right)} \left(Y_2 - \underline{B}\right) f\left(Y_2 \mid \bar{\theta},\underline{B}\right) dY_2, \tag{25}$$

for $\theta = \underline{\theta}$ and $\theta = \bar{\theta}$ respectively, with $z\left(B,x\right) = B$ in (24) (from **A1**, **A2** and **A3**), and where recall that P only imposes upper-bounds on B.

Lemma 2. *P can implement efficient borrowing $\left(\underline{B},\bar{B}\right)$ by setting:*

$$\underline{t}^S = \int_{B^{LF}}^{K\left(\underline{\theta},B^{LF}\right)} \left(Y_2 - B^{LF}\right) f\left(Y_2 \mid \underline{\theta},B^{LF}\right) dY_2 - \int_{\underline{B}}^{K(\underline{\theta},\underline{B})} \left(Y_2 - \underline{B}\right) f\left(Y_2 \mid \underline{\theta},\underline{B}\right) dY_2 > 0, \tag{26}$$

$$\bar{t}^S = 0. \tag{27}$$

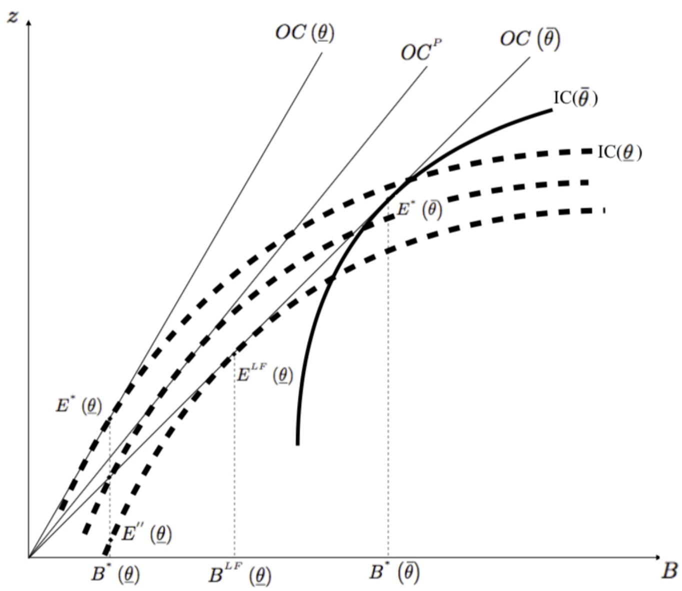
Proof. See Online Appendix A. □

The pair of points $\left\{E''\left(\underline{\theta}\right), E^*\left(\bar{\theta}\right)\right\}$ in Figure 2 denotes P's separating mechanism as described in Lemma 2. Figure 2 also shows the optimal borrowing under symmetric information (and no bail-out) and the *laissez-faire* solution. Under the separating mechanism, P commands a positive ex-post transfer from S_1 to S_2 when S_2's borrowing does not exceed $\underline{B}$. The lump-sum transfer $\underline{t}$ compensates the $\underline{\theta}$−type of S_2 for the loss in expected utility due to the lower borrowing level $(\underline{B})$ compared to that it could achieve by mimicking the $\bar{\theta}$−type (B^{LF}). Both types of S_2 are made indifferent between the *decentralized* solution and the mechanism proposed by P.

S_1's expected utility under the separating mechanism is:

$$U_1^S\left(\alpha\right) = U_1^* - \left(1-\alpha\right)\left\{ \int_{B^{LF}}^{K\left(\underline{\theta},B^{LF}\right)} \left(Y_2 - B^{LF}\right) f\left(Y_2 \mid \underline{\theta},B^{LF}\right) dY_2 - \left[\int_0^{K(\underline{\theta},\underline{B})} Y_2 f\left(Y_2 \mid \underline{\theta},\underline{B}\right) dY_2 - \underline{B}\right]\right\}. \tag{28}$$

Figure 2: **Separating Mechanism in the Presence of Bail-out.**



Note: Dashed-bold (continuous-bold) curves represent the $\underline{\theta}-$type ($\bar{\theta}-$type) indifference curves. Lines not in bold represent the lenders' separating ($OC(\underline{\theta})$ and $OC(\bar{\theta})$) and pooling (OC^{P}) offer curves under no bail-out. All offer curves are represented by $OC(\bar{\theta})$ in the presence of bail-out. The pair $\left\{E''(\underline{\theta}), E^{*}(\bar{\theta})\right\}$ denotes the equilibrium under the separating mechanism preferred by P.

4.2 Bunching Mechanism

In the presence of asymmetric information and bail-out, an alternative solution to the *separating* mechanism constructed above is represented by a *bunching* mechanism. More specifically, P can set a unique level B^{B} to act as a constraint on S_2's borrowing independently of its type θ.

To determine the optimal bunching borrowing level B^{B}, P first solves:

$$\max_{\{B\}} U_1(L, B, \theta, x) + \alpha U_2\left(B, x, \bar{\theta}\right) + (1-\alpha) U_2(B, x, \underline{\theta}) \tag{29}$$

$$\text{s.t.} \quad \alpha E\left[R\left(Y_2, x, \bar{\theta}\right)\right] + (1-\alpha) E\left[R\left(Y_2, x, \underline{\theta}\right)\right] = B,$$

where we set the transfer $\underline{t}$ and $\bar{t}$ equal to zero. Given **A1-A3** and anticipating full bail-out, from (6) and (7), the solution to (29) is:

$$\hat{B}(\alpha) = \arg\max_{\{B\}} \alpha \left\{ \int_{y(\bar{\theta})}^{K(\bar{\theta}, B)} (Y_2 - B) f\left(Y_2 \mid \bar{\theta}, B\right) dY_2 \right\} + \tag{30}$$

$$+(1-\alpha)\left\{\int_{B}^{K(\underline{\theta},B)}(Y_2-B)\,f(Y_2\mid\underline{\theta},B)\,dY_2-\int_{0}^{B}(B-Y_2)\,f(Y_2\mid\underline{\theta},B)\,dY_2\right\},$$

where bail-out implies $z(\theta)=B$, for all $\theta\in\{\underline{\theta},\overline{\theta}\}$. From (9), we have that:

$$\hat{B}(\alpha)\in\left[\underline{B},\bar{B}\right], \tag{31}$$

where $\hat{B}(\alpha)$ is increasing in α. The optimal bunching solution depends on whether $\hat{B}(\alpha)$ is greater or lower than B^{LF} – the borrowing level preferred by the $\underline{\theta}-$type under the laissez-faire regime. In particular, if $\hat{B}(\alpha)$ exceeds B^{LF}, P optimally sets $B^{B}=\bar{B}$ in order to avoid the inefficient underinvestment by the $\overline{\theta}-$type of S_2, which imposes no externalities on S_1 (see **A1**). In this case, the bunching mechanism replicates the laissez-faire regime. Formally:

Lemma 3. *The optimal upper bound on S_2's borrowing level in a bunching mechanism is:*

$$B^{B}(\alpha)=\begin{cases}\hat{B}(\alpha) & \text{if } \hat{B}(\alpha)<B^{LF},\\ \bar{B} & \text{if } \hat{B}(\alpha)\geq B^{LF},\end{cases}$$

where $B^{B}(\alpha)$ is weakly increasing in α.

Proof. See above. □

In Figure 3, E^{B} illustrates the optimal bunching borrowing level for the case in which $B^{B}(\alpha)=\hat{B}(\alpha)<B^{LF}$. Because of bail out, E^{B} lays on $OC(\overline{\theta})$, in between $E'(\underline{\theta})$ and $E^{*}(\overline{\theta})$: the higher α is, the closer is E^{B} to $E^{*}(\overline{\theta})$. All in all, for sufficiently low values of α, the bunching mechanism introduces a distortion similar to that implied by a standard pooling equilibrium in the absence of bail-out.

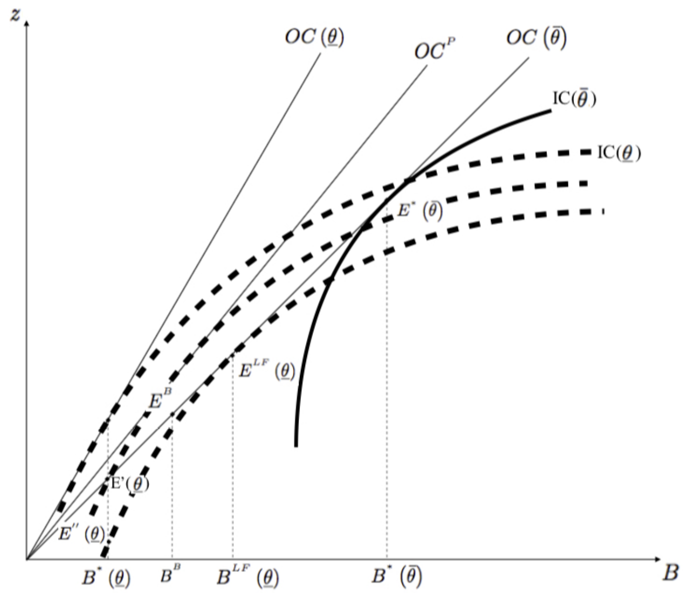
S_1's expected utility under the bunching mechanism is:

$$U_1^{B}(\alpha)=U_1^{*}-(1-\alpha)\left[\int_{0}^{B^{B}(\alpha)}\left(B^{B}(\alpha)-Y_2\right)f\left(Y_2\mid\underline{\theta},B^{B}(\alpha)\right)dY_2\right]. \tag{32}$$

4.3 Pareto Analysis

We perform a Pareto analysis of the different solutions presented in the previous subsections. Specifically, we compare the following outcomes in terms of their welfare implications for all the players involved, i.e., S_1 and both the $\underline{\theta}-$type and the $\bar{\theta}-$type of S_2:

Figure 3: **Bunching and Separating Solutions in the Presence of Bail-out.**



Note: Dashed-bold (continuous-bold) curves represent the $\underline{\theta}-$type ($\bar{\theta}-$type) indifference curves. Lines not in bold represent the lenders' separating ($OC(\underline{\theta})$ and $OC(\bar{\theta})$) and pooling (OC^P) offer curves under no bail-out. All offer curves are represented by $OC(\bar{\theta})$ in the presence of bail-out. The pair $\left\{E''(\underline{\theta}), E^*(\bar{\theta})\right\}$ denotes the equilibrium under the separating mechanism preferred by P. E^B illustrates the equilibrium under the bunching mechanism preferred by P when α is sufficiently low.

1. $\left\{E^{LF}(\underline{\theta}), E^*(\bar{\theta})\right\}$: the decentralized (*laissez-faire*) outcome arising under asymmetric information and bail-out, absent P's intervention (see Proposition 1);

2. $\left\{E''(\underline{\theta}), E^*(\bar{\theta})\right\}$: the (*separating*) outcome arising under asymmetric information and bail-out, when P implements the mechanism described in Lemma 2;

3. E^B: the (*bunching*) outcome arising under asymmetric information and bail-out, when P implements a unique constraint on S_2's borrowing level as described in Lemma 3.

We proceed by comparing first $\left\{E^{LF}(\underline{\theta}), E^*(\bar{\theta})\right\}$ to $\left\{E''(\underline{\theta}), E^*(\bar{\theta})\right\}$.

Lemma 4. *The separating mechanism* $\left\{\left(\underline{t}^S, \underline{B}\right), \left(\bar{t}^S, \bar{B}\right)\right\}$ *Pareto dominates the laissez-faire outcome.*

Proof. See Online Appendix A. □

In the presence of asymmetric information and bail-out, S_1 finds it profitable to compensate the $\underline{\theta}-$type of S_2 with a lump-sum amount to induce it to self-select into the efficient level of borrowing. Because *(i)* total welfare increases and *(ii)* the separating mechanism is such that both types of S_2 are indifferent between the efficient level of borrowing and the decentralized solution, S_1 appropriates the efficiency gains created by this type-contingent mechanism. In other words, S_1 prefers to pay S_2 a certain lump-sum transfer to induce efficient borrowing when the latter has a low multiplier of government spending, rather than face an increase in the expected cost of bail-out due to overborrowing.

Having established that the separating mechanism Pareto dominates the decentralized (*laissez-faire*) solution, we now compare the separating solution $\left\{E''(\underline{\theta}), E^*(\bar{\theta})\right\}$ to the bunching solution E^B.

Proposition 2. *There exists a unique threshold α^* such that, for $\alpha \geq \alpha^*$, the separating mechanism $\left\{\left(\underline{t}^S, \underline{B}\right), \left(\bar{t}^S, \bar{B}\right)\right\}$ Pareto dominates both the bunching rule $B^B(\alpha)$ and the laissez faire solution $\left(B^{LF}, \bar{B}\right)$.*

Proof. See Online Appendix A. □

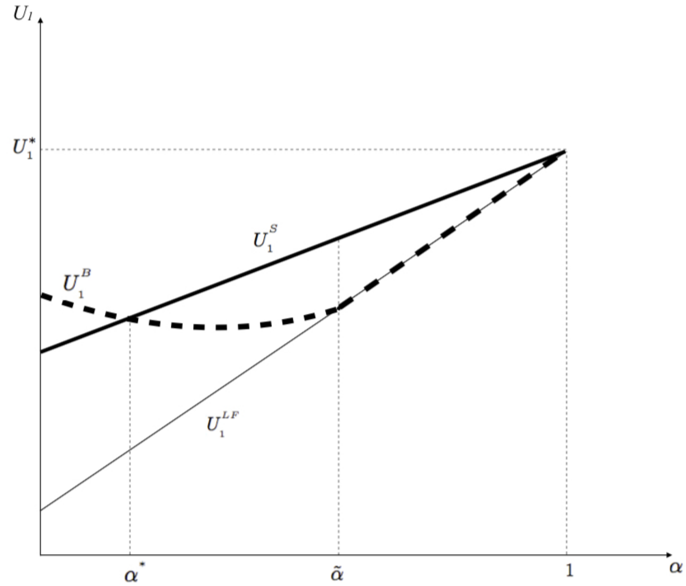
From Lemma 4, the separating mechanism Pareto dominates the *laissez-faire* regime. When compared to the bunching rule, the separating mechanism makes both types of S_2 better-off. The separating mechanism is costly to S_1 because of i) the transfer ($\underline{t}$) needed to induce an efficient level of borrowing from the $\underline{\theta}-$type of S_2 and ii) the associated expected cost of bail-out. The bunching mechanism is also costly to S_1, because of the expected cost of bailing S_2 out. Because bail-out is only needed for the $\underline{\theta}-$type of S_2, the higher α is, the lower is the probability that S_1 bears bail-out costs.

The bunching rule differs from the separating mechanism in one key aspect: the amount of borrowing allowed by the bunching rule increases with the probability (α) that S_2 is characterized by a high potential output ($\bar{\theta}$) and, therefore, a high fiscal multiplier. Hence, as α increases, the overborrowing by the $\underline{\theta}-$type of S_2 also increases, and S_1 incurs an increasing bail-out cost with a decreasing probability. In the separating mechanism, as α increases, S_1 incurs a constant bail-out cost and makes an ex-post transfer ($\underline{t}$) with a decreasing probability. The additional effect of α on the amount of bail-out in the bunching rule makes the separating mechanism dominant for sufficiently high values of α.

Figure 4 plots S_1's utility from the *laissez-faire* (light, continuous line), bunching (dashed line), and separating solutions (bold, continuous line). Figure 5 plots the utilities the $\underline{\theta}-$type (Figure 5a) and the $\bar{\theta}-$type (Figure 5b) of S_2 obtain from the three alternative solutions.

In Figure 4, S_1's utility from the separating mechanism (U_1^S) is higher than its utility from *(a)* the decentralized solution (U_1^{LF}), $\forall \alpha \in [0,1]$ (see Lemma 4), and *(b)* the bunching rule (U_1^B), for $\alpha \in \left[\alpha^*, 1\right]$ (see Proposition 2). Also, for $\alpha < \tilde{\alpha}$, S_1's utility from the bunching mechanism is higher than its utility from the decentralized mechanism, while the two utilities coincide for $\alpha \geq \tilde{\alpha}$ (see Lemma 3).

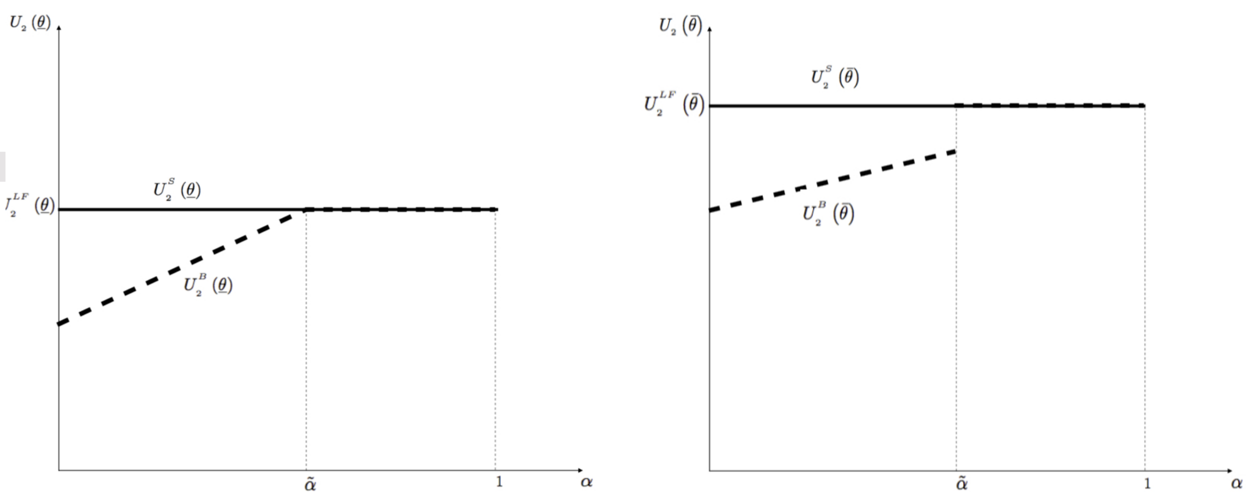
Figure 4: **Country 1's Utility under *(i)* Decentralized, *(ii)* Bunching, and *(iii)* Separating Solutions.**



Note: The line not in bold denotes S_1's expected utility from the decentralized (*laissez-faire*) solution. The continuous-bold line denotes S_1's expected utility from the separating mechanism. The dashed-bold line denotes S_1's expected utility from the bunching mechanism.

Figure 5: **Country 2's Utility under the *(i)* Decentralized, *(ii)* Bunching, and *(iii)* Separating Solutions.**

(a) Low Potential Output. (b) High Potential Output.



Note: The left (respectively, right) panel (a) (respectively, (b)) illustrates S_2's expected utility when $\theta = \underline{\theta}$ (respectively, $\theta = \bar{\theta}$) under the different solutions analyzed in Sections 3.2, 4.1 and 4.2. In both panels, the continuous-bold line denotes S_2's expected utility from the separating mechanism, which also coincides with S_2's expected utility from the decentralized (*laissez-faire*) solution. The dashed-bold line denotes S_2's expected utility from the bunching mechanism.

In Figure 5a, the bold continuous line represents S_2's utility from both the separating and the decentralized mechanism when S_2 is characterized by a *low* potential output (i.e., $U_2^S(\underline{\theta}) = U_2^{LF}(\underline{\theta})$). The $\underline{\theta}-$type of S_2 obtains a (weakly) lower utility from the bunching mechanism (bold red line) than from the alternative solutions. In Figure 5b, the bold continuous line represents S_2's utility from both the separating and the decentralized mechanism when S_2 is characterized by a high potential output (i.e., $U_2^S(\bar{\theta}) = U_2^{LF}(\bar{\theta})$). The $\bar{\theta}-$type of S_2 also obtains a weakly lower utility from the bunching mechanism (dashed line) than from the alternative solutions $\forall \alpha \in [0, 1]$. In Figure 4 and Figure 5, the separating mechanism Pareto dominates both the bunching and the decentralized solutions for $\alpha \geq \alpha^*$.

To sum up, in the presence of asymmetric information and bail-out, as the prior probability that S_2 is characterized by a high potential output increases, it pays off to both countries to design a mechanism that make each type of S_2 self-select into its efficient level of borrowing. In fact, both types of S_2 gain from this mechanism: when characterized by a low potential output, S_2 is compensated by S_1 with a transfer for not overborrowing on the financial market. When characterized by a large potential output, S_2 has access to its efficient level of borrowing. S_1 also gains from the separating mechanism, because it avoids the inefficiently large costs of bailing S_2 out implied by i) the decentralized solution and ii) the bunching rule when the prior probability that S_2 is characterized by a high potential output is sufficiently high.

5 Discussion and Applications

In this section, we discuss i) the role played by the strength of the relationship between output gap and multiplier of government spending in determining our main result, ii) the applicability of our setup to a scenario involving more than two countries, and iii) the application of our setup to the design of fiscal policies within the EMU.

5.1 Role of the Fiscal Multiplier

As discussed in Section 2, an assumption of the model is that there is a (sufficiently strong) positive relationship between the output gap (captured by θ) and the multiplier on the fiscal deficit. Specifically, such a positive relationship between these two variables is needed to validate (17):[23] in terms of the illustrative Figure 2, this assumption guarantees that the slope of the indifference curves of the $\underline{\theta}-$type country is lower than the slope of the indifference curves of the $\bar{\theta}-$type country (i.e., that the single crossing property holds). This in turn allows us to establish the existence of a separating mechanism that satisfies the incentive compatibility constraints of the two types of S_2. Intuitively, our separating mechanism prescribes that the

[23] Recall also the discussion in note 18.

$\underline{\theta}-$type of S_2 receives a transfer as a compensation for choosing a lower level of investment (and, thus, for not engaging in overborrowing). The single crossing property in (17) ensures that the transfer designed for the $\underline{\theta}-$type of S_2 is enough to compensate it for a debt reduction, but not enough to compensate the $\overline{\theta}-$type (which has a higher potential output and, hence, derives a larger benefit from carrying out investments, relative to the lower type).

Conditional on being in the region of parameters where assumption (17) holds, it is interesting to examine how the Pareto properties of the different mechanisms studied in Section 4 vary as the strength of the relationship between output gap and multiplier on the fiscal deficit varies, while fixing the prior probability α. A simple way to perform this analysis is to vary the magnitude of $F_B\left(Y_2 \mid \overline{\theta}, B\right)$, $\forall B$, while keeping $F_B\left(Y_2 \mid \underline{\theta}, B\right)$ – and, more generally, $F\left(Y_2 \mid \underline{\theta}, B\right)$ – constant. Suppose the absolute value of $F_B\left(Y_2 \mid \overline{\theta}, B\right)$ increases, $\forall B$ – that is, consider the case in which the strength of the relationship between output gap and multiplier on the fiscal deficit increases. Then, from (30) and Lemma 3, we have that $\hat{B}$ and, hence, B^B (weakly) increase. Given that $F\left(Y_2 \mid \underline{\theta}, B\right)$ does not vary, we have that $i)$ from (28), S_1's expected utility under the separating mechanism does not vary, and $ii)$ from (32), S_1's expected utility under the bunching mechanism U_1^B decreases with B^B. Hence, as the strength of the relationship between output gap and multiplier on fiscal deficit increases (respectively, decreases), we expect the separating (bunching) mechanism to prevail for a larger region of parameter values.

The intuition for this result complements that described for Proposition 2. As the quality of the 'average type' increases – either because the prior probability α increases or because the type characterized by a larger output gap gains relatively more from running higher fiscal deficits – the constraint on borrowing under the bunching mechanism becomes laxer, allowing for larger investments and thereby implying increasing expected costs of bail-out for S_1. In the Online Appendix B, we complement this discussion by developing a numerical example in which we assume that S_2's output is distributed uniformly, and in which we attach functional forms to $y(\theta)$ and $K(\theta, B)$, for $\theta \in \left\{\underline{\theta}, \overline{\theta}\right\}$, in accordance with the assumptions mentioned above and in Section 2. The numerical example illustrates how endogenous outcomes as well as the Pareto properties of the mechanisms change as the strength of the relationship between output gap and fiscal multiplier varies in S_2.

5.2 Alternative Specifications

In our setup, for tractability purposes, we have focused on the case of a single 'core' country (S_1) and a single 'periphery' country (S_2). A reader could wonder about the applicability of our setup to a more complex scenario with $N > 1$ periphery countries. To the extent that the N periphery countries feature independent shock distributions and no bank-sovereign linkages among them, the analysis would carry through unchanged. The central authority P, in fact, could implement separate transfers to the N periphery countries in order to attain a separating equilibrium with each of them, along the analysis detailed above. A setting with correlated shock returns and bank-sovereign linkages among the N periphery countries would instead be significantly more complex and would undermine the tractability of our analysis. While this can be an interesting direction for future research, one aspect worth mentioning here is the relative sparsity of bank-sovereign linkages among periphery countries of the euro area (to which our model can be applied). Craig and Von Peter (2014), Van Lelyveld and int 'Veld (2014) and Fricke and Lux (2015), for example, show that the core-periphery framework offers a reasonable approximation to bank loan networks. Looking more specifically at the cross-country nexus between banks and sovereigns, Altavilla et al. (2017) find that in periphery countries of the euro area the sovereign debt holdings of banks are significantly more 'home-biased' than in core countries. This indicates that bank-sovereign linkages among periphery countries (e.g., between Portugal and Greece) are significantly smaller than the linkages between banks of the core countries and sovereigns of the periphery. In line with this observation, Guerrieri et al. (2013) document that, before the euro area sovereign debt crisis, a disproportionate share of the Greek sovereign debt held by foreigners was held by French and German banks, rather than by banks of other periphery countries.

5.3 Applications

The analysis can be broadly applied to the design of fiscal policies in federations. As noted, the EMU constitutes a natural application. We relegate institutional details on the current EMU fiscal framework to the Online Supplement, while in this brief discussion we further outline the main elements of this application. As discussed above, the fiscal framework currently implemented within the EMU encompasses a 'cyclically-adjusted' cap on member states' borrowing level. More specifically, the target imposed on each member state regarding the nominal deficit-to-GDP ratio is adjusted – i.e., relaxed – were the member state to experience a negative output gap. Clearly, the size of the borrowing constraint's relaxation depends on the member state's potential output. If lenders expect bail-out to occur among member states, because Excessive Deficit Procedures are initiated only in case a member state overborrows with respect to its cyclically-adjusted cap, each member state has an incentive to misrepresent (upward) its potential output so as to run a higher nominal deficit.

Depending on whether one believes that member states are able to affect the EMU's estimates of their own potential output, the current EMU's fiscal framework is captured in two different ways. If one believes the EMU (possibly partially) bases its fiscal policy on the member state's estimates of their own potential output, the EMU fiscal policy is similar to one in which the EMU offers member states the possibility to freely choose between different (cyclically-adjusted) deficit-to-GDP thresholds (e.g., $B^*(\underline{\theta})$ and $B^*(\bar{\theta})$ in our setting). As shown above, in the presence of bail-out, this system induces member states to run a high deficit-to-GDP ratio, irrespective of their cyclical position. If one believes that the EMU only makes use of its own estimates ($\alpha \in [0,1]$) of a member state's potential output, instead, the current EMU fiscal policy corresponds to one in which the EMU sets a single *bunching* borrowing threshold (corresponding to $B^B(\alpha)$ in our setting); in this sense, the bunching threshold is akin to the (country-specific) Medium Term Objective (MTO) currently set by the EMU.[24] Overborrowing occurs also in this second case, when a member state is characterized by a low potential output. In light of the explanation we put forward in this paper, it is then not surprising that we observe various member states running excessive deficits and, therefore, postponing the achievement of their Medium Term Objective (European Central Bank, 2015).

The mechanism investigated in this paper differs from the current EMU fiscal framework in one key dimension. To prevent overborrowing when a member state is not far from its potential, the (relatively) low deficit required from a member state characterized by a (relatively) low potential output must come with an ex-post transfer from the other members of the Union. This mechanism entails a degree of fiscal risk sharing within the Union. It may also be targeted towards the goal of permanently increasing a member state's production possibilities.

6 Conclusion

This paper analyzes the main features of a union's fiscal framework in the presence of *(i)* asymmetric information over member states' fundamentals – i.e., *potential output* and, therefore, *output gap* – and *(ii)* bail-out among member states when shocks jeopardize the ability of some members to repay creditors (banks) from other members of the union. In such an environment, optimal counter-cyclical fiscal policies are not incentive-compatible because bail-out incentivizes member states to misrepresent their current output gap and overborrow in financial markets.

Unlike single member states, the union internalizes the externalities and distortions generated by the interplay between asymmetric information and bail-out and designs a mechanism to discriminate borrowers based on the magnitude of their potential output. Such a mechanism implies the payment by the monetary union of a lump-sum transfer to the member state characterized by a low (negative) output gap – and, therefore, a (relatively) small multiplier of government spending – so that each member state self-selects into its efficient level of borrowing. The efficiency gain generated by this separating mechanism makes it Pareto

[24] This is identified as a structural budget deficit – in cyclically-adjusted (CA) terms – net of one-off and other temporary measures. See the Online Supplement for details.

dominant with respect to a decentralized equilibrium in which member states are unconstrained in their borrowing choice. More importantly, provided there is a sufficiently high prior probability that the member state is characterized by a large output gap, the *separating* mechanism Pareto dominates a *bunching* rule in which the monetary union sets a unique borrowing constraint.

Since the *bunching* rule examined in our setting is probably the best approximation of the current cyclically-adjusted rule implemented within the European Monetary Union under the Fiscal Compact Treaty, our results can have insightful policy implications. In particular, we have shown that the main fiscal rules in place in the EMU can be suboptimal and lead to inefficient overborrowing. Either a uniform cap on national nominal deficits (such as the '3%-rule') or relying on the truthful disclosure of information by member states (which have incentives to misrepresent their current status, such as the convergence to the medium-term objective) fail to approximate an efficient fiscal rule. Thus, it is perhaps not surprising that, following the recession caused by COVID-19 and the three-year suspension of the Stability and Growth Pact, the current EMU fiscal framework is now subject to renewed scrutiny. The debate on a brand new fiscal framework is about to begin, and, as of today, little information is available on where this debate might lead.

Although our analysis does not certainly aim to propose a new fully-specified fiscal framework, it can represent a first attempt to explore the theoretical implications of recognizing that information asymmetries on countries' true potential output cannot be easily eradicated. And, therefore, if a new set of fiscal rules will still take into account cyclical positions, the European Union might consider implementing a mechanism in the spirit of that explored in this paper. For example, this might be done by appropriately designing contributions to, and transfers from, EU structural funds; or through modifications of the national reimbursement of EU-wide debt, such as the Next Generation EU plan, introduced during the COVID-19 recession and currently in its first steps. In any case, a redefinition of the EU fiscal rules can benefit from a theoretical analysis of the implications of alternative mechanisms.

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