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*Toulouse School of Economics and Banque de France. TSE, Université de Toulouse, Manufacture des Tabacs, 21 allées de Brienne, Fr - 31000 Toulouse. Email: eric.mengus@tse-fr.eu. I would like to thank Viral Acharya, Philippe Andrade, Jean Barthélemy, Bruno Biais, Thomas Chaney, Arnaud Costinot, Emmanuel Farhi, Gaetano Gaballo, Mattia Girotti, Alexander Guembel, Christian Hellwig, Yannick Kalantzis, Arvind Krishnamurthy, George Lukyanov, Julien Matheron, Benoît Mojon, Guillermo Ordonez, Athanasios Orphanides, Guillaume Plantin, Alp Simsek, Daan Struyven, Jean Tirole, François Velde, Venky Venkateswaran and Pierre-Olivier Weill for their helpful comments, as well as the seminar participants at Harvard (Macro lunch), HEC Paris, Kellogg (Finance), MIT (International Tea) and Toulouse. I acknowledge the financial support of the CNRS, Corps des Ponts and MIT France. I thank MIT's department of economics for hospitality. The views in this paper do not necessarily reflect those of the Banque de France. All remaining errors are mine.

Résumé

Dans ce papier, j'utilise un modèle à deux pays pour évaluer les incitations qui peuvent mener un pays à prendre en charge la dette d'un autre pays en défaut. Je montre que, lorsque les transferts aux agents domestiques ne peuvent être parfaitement ciblés, cette prise en charge peut être désirable, même si cela implique de payer également les créditeurs étrangers du pays en défaut. Anticipant ce sauvetage, les agents privés parient collectivement sur la dette du pays étranger, conduisant ainsi à une garantie implicite auto-réalisatrice à l'équilibre. En retour, afin de réduire les effets indésirables de cette garantie, la politique optimale pour le pays entreprenant le sauvetage est de restreindre *ex ante* ses expositions domestiques au pays étranger, par exemple en taxant les flux de capitaux sortants. Enfin, je montre que ces résultats peuvent éclairer la crise de la dette souveraine en Europe, les effets des interventions du FMI, le plan de sauvetage des Etats par le gouvernement fédéral américain en 1790 ainsi que la crise financière américaine de 2008.

Classification JEL: F33, F34, F36, F42, F65.

Mots-clés: Keywords: Garanties implicites, plans de sauvetage, flux de capitaux internationaux, contrôles de capitaux.

Abstract

In this paper, I use a two-country model to investigate the incentives which lead one country to take charge of another country's debt. I show that, when direct transfers to residents cannot be perfectly targeted, the first country can be better off honoring the second country's liabilities, even if this means paying off foreign creditors. Anticipating the *ex post* rescue, private agents engage in a collective bet on the foreign country's debt, leading to the emergence of a self-fulfilling implicit guarantees in equilibrium. In response to the resulting inefficient outcome, the optimal policy for the rescuing country's government is to restrict domestic exposures to foreign debt *ex ante*, for example, through a tax on capital outflows. Finally, I argue that these findings can shed light on the European sovereign debt crisis, the interventions of the IMF, the 1790 US federal bailout of states and on the 2008 US financial crisis.

JEL codes: F33, F34, F36, F42, F65.

Keywords: Implicit guarantees, bailouts, capital flows, capital controls.

Executive summary

In this paper, I study self-interest implicit guarantees. To this purpose, I build a two-country model of a core and a peripheral country where both countries' private residents optimally manage liquidity needs using bonds issued by the core and the periphery. Yet, peripheral bonds are risky and, after a default, the core is tempted to compensate its domestic residents.

I show that, when the core's government has limited information on individual domestic portfolios, direct transfers to residents cannot be perfectly targeted. As a result, the core can be better off honoring the periphery's liabilities, even at the cost of paying foreign creditors. *Ex ante*, anticipating the *ex post* rescue, private agents engage in a collective bet on peripheral country's debt, and so, implicit guarantees emerge in equilibrium.

In response to the resulting inefficient outcome, the optimal policy from the core country's point of view is to restrict exposures to the periphery. This can be achieved through capital controls, for instance through a tax on capital outflows. This then provides a collective moral-hazard rationale for capital controls and, in addition, those capital controls are necessary not only from the point of view of countries receiving capital but from the one of countries emitting capital. Conversely, policies that imply a reduction in the *ex post* cost of bailouts (e.g. market transparency or bailout coordination), if *ex post* desirable, are detrimental *ex ante* as they reduce the foreign country's repayment incentives.

I then argue that these findings can shed light on the ongoing European debt crisis, the IMF's interventions, the 1790 federal bailout of US states and the 2008 financial crisis. More specifically, in the case of Europe, this paper interprets the 1999-2008 period, where international ownership of European debts rose and spreads collapsed, as a collective bet of investors in core European countries on peripheral debts.

In the end, this paper emphasizes the key role played by opaque financial exposures and markets in the emergence of implicit guarantees. By preventing perfect bailouts, the opacity of financial exposures may lead countries to take charge of defaulting countries' debt. In response, capital controls in form of a tax on capital outflows may limit large exposures to the defaulting country and avoid implicit guarantees.

I Introduction

This paper develops a two-country model of self-interested implicit guarantees, where one country takes charge of another country's defaulted debt in order to mitigate the effects of the default on its domestic residents. Anticipating the rescue, the latter purchase more foreign bonds, forcing the *ex post* intervention.

Self-interested implicit guarantees have been suggested as one of the major factors underlying the ongoing European sovereign debt crisis, in which the periphery of the euro-area accumulated deficits. The resulting debt was mainly purchased by core euro-area countries. Banks played a major role in this debt internationalization as they were usually massively exposed to the periphery, either directly or indirectly through interbank or over-the-counter markets.[1] *Ex post*, the fear of financial contagion led Europe to implement rescue plans, in particular to Greece and Portugal.

However, if the only motive for rescuing another country is to protect domestic residents, why not compensate them directly? This paper determines the conditions under which an *ex post* direct rescue of the defaulting country is strictly preferred to transfers to domestic residents, resulting in an implicit guarantee of that country's debt. It assesses the resulting welfare effects and evaluates the potential policies countries may implement in response. The main underlying assumption of this paper is that governments are unable to observe private agents' individual exposures. This lack of observability may prevent the implementation of efficient direct transfers and thus push the government to take charge of the defaulting foreign country's debt. In term of policy, this paper argues that *ex ante* restrictions should be implemented on foreign exposures (e.g. using capital controls) in countries emitting capital.

In Section II, I introduce the *ex post* compensation mechanism, in which a government is willing to compensate its residents for losses resulting from a defaulting asset. The government's transfers are limited, however, by imperfect information on the agents' needs and exposures. I therefore show that, in order to overcome this problem of asymmetric information, the optimal form of compensation might be one which features the buyback of the defaulting asset. This repurchase occurs when exposures to the defaulting asset and agents' funding needs co-vary sufficiently or, in other words, when more liquidity-constrained, or more politically connected, private agents are more highly exposed to the defaulting asset. This mechanism offers a novel explanation as to why intrinsically worthless assets are traded at

[1] The share of Greek debt held by foreign (i.e. European) investors rose to 73% in 2008 from 20% in 1999. See Section VI for evidence of increasing cross-exposures. Up to 40% of Greek debt and 36% of Portuguese debt was held by foreign banks in the 1999-2008 period (cf. Arslanalp and Tsuda, 2012). Acharya and Steffen (2012) show that banks continued loading up with peripheral debts even after 2007.

strictly positive prices in finite horizons, because of a guarantee by an external sponsor. This contrasts with the conventional infinite horizon explanation of Samuelson (1958)-type models, which stress self-fulfilling expectations of future market values.

In Section III, I embed this compensation mechanism in a model featuring a risk-free *core* country and a risky *peripheral* one. Each country is populated by a continuum of bankers who purchase both countries' public bonds in period 0 in order to store wealth. In period 1, the peripheral country may default on its debt either because it has insufficient resources to repay or because it has no incentive to honor its liabilities. In response to the default, the core country may intervene by taking charge of the defaulting country's debt or by implementing transfers to its domestic bankers. *Ex ante*, date-0 portfolio choices perfectly anticipate the future moves of each country's government in the form of repayment and bailouts. *Ex post*, date-1 government policies depend on domestic and foreign portfolio allocations.

I show, in Section IV, that the mutual feedback between policies and portfolio allocation leads to a strategic complementarity between investors' decisions, resulting in multiple equilibria. More specifically, I characterize three pure-strategy equilibria. When bankers anticipate a rescue of the peripheral country, the peripheral debt becomes a substitute for the core country's debt leading core-country agents to build up *large* and *heterogeneous* exposures. The core country is thus obliged to take charge of the peripheral country's debt, even if this also means repaying that country's domestic creditors, further increasing the attractiveness of peripheral debt (*high-exposure equilibrium*). Conversely, when no rescue is expected, core-country agents invest less in the periphery, reducing the incentive for a rescue (*low-exposure equilibrium*). When the peripheral debt is not held at all, either by domestic or foreign investors, the peripheral country may be unable to borrow, as there are no domestic holdings to back its commitment to repay (*capital dry-out equilibrium*).

In Section V, I show that the implicit guarantee on the peripheral debt arising in high-exposure equilibrium pushes the peripheral country to over-invest, at the expense of the core country. More generally, I show that the constrained optimal Pareto allocation features low exposures of the core to the periphery and, in particular, lower exposure than in a high-exposure equilibrium. I show that a positive tax on the core country's capital outflows can implement the *ex ante* constrained optimal portfolio allocation. Indeed, this tax may break the substitutability between the core and peripheral countries' bonds and, as such, can reduce the likelihood of large exposures to the periphery.[2] Conversely, policies that imply an improvement in the core country's *ex post* ability to bail out its residents (e.g. imposing transparency

[2]In particular, this contrasts with McKinnon (1997)'s emphasis on fiscal retrenchment as well as the European Stability and Growth Pact, as the ex ante policy mostly concerns the emitting-capital country.

obligations on private portfolios) may actually boost exposures to the periphery, and can potentially prove detrimental *ex ante* as peripheral bonds can become concentrated in the hands of investors in the core country - where the government is the most able to compensate its residents.[3]

Section VI discusses the relevance of the model's outcomes and assumptions to the ongoing European debt crisis, the IMF's interventions, the 1790 federal bailout of US states and the 2008 financial crisis. In particular, in the case of Europe, I argue that the 1999-2008 period, where international ownership of European debts rose and spreads collapsed, can be interpreted as a high-exposure equilibrium where investors anticipated a rescue of the periphery by the core European countries. In the case of the 1790 federal bailout of US states, I show that, in line with the paper, in 1790, the main investors exposed to US state debts were US domestic residents, whereas, in 1843, when the US Congress decided not to bail the states out, the main holders of state debt were foreign investors.

To summarize, this paper emphasizes the key role played by opaque financial exposures and markets in the emergence of implicit guarantees. By preventing perfect bailouts, the opacity of financial exposures may lead countries to take charge of defaulting countries' debt. In response, capital controls in form of a tax on capital outflows may limit large exposures to the defaulting country and avoid the creation of implicit guarantees.

Related literature This paper is related to several bodies of the literature.

It is closely related to Schneider and Tornell (2004) or Burnside et al. (2004) who study the effect of bailouts on international capital flows in the context of emerging countries' access to borrowing. The main difference is that they do not consider alternative forms of bailouts (e.g. buybacks of foreign debt or direct transfers to domestic residents).

The trading at positive values of assets that would otherwise be considered worthless, such as money or bubbles, has been extensively studied since the seminal contribution by Samuelson (1958) (see Diamond, 1965; Tirole, 1985, among others). The future expected price (and, ultimately, the price at infinity) determines the price today. In this paper, I introduce a novel mechanism where guarantees give value to the otherwise worthless asset, even over finite horizon, due to the collateral damage that would be caused if these assets were not honored. In this respect, this paper is related to the literature on inefficient transfers such as Acemoglu and Robinson (2001) or Coate and Morris (1995) as governments use non-targeted tools such as asset purchases to compensate agents.

[3] Alternative policies such as the issuance of more risk-free bonds by the core country reduce the likelihood of implicit guarantees, but cannot fully prevent their emergence.

This paper also builds on the existence of internal costs of default. Recent research has emphasized the role of these costs in explaining sovereign repayments (e.g. Guembel and Sussman, 2009; Broner et al., 2010; Mengus, 2013b). The main difference here that I consider the internal costs of a foreign default. In Mengus (2013a), I establish a connection between Ricardian equivalence and a country's ability to borrow. Here, Ricardian equivalence does not hold because of bankers' liquidity needs, allowing for credible debt repayment.

The relationship between public debt holdings and private investment or consumption derives from the use of public debt as private liquidity. This has been well documented both theoretically and empirically (see Woodford, 1990; Holmstrom and Tirole, 1998; Krishnamurthy and Vissing-Jorgensen, 2012; Caballero and Farhi, 2013), and Krishnamurthy and Vissing-Jorgensen (2013) provide evidence that public and private debt are substitutes for each other.

In terms of policy conclusion, this paper advocates capital controls. Compared with the previous literature, it provides a new motive for implementing controls, as they *ex ante* limit capital *outflows* from emitting countries thereby reducing the temptation of an *ex post* bailout. This differs from Caballero and Krishnamurthy (2003) where capital controls *ex post* protect against the undesirable effects for receiving countries of foreign capital *outflows*. This motive also differs from Broner and Ventura (2011) and Mengus (2013b) where the home bias resulting from capital controls forces a sovereign to honor its debt.

Tirole (2012) investigates *ex ante* and *ex post* forms of solidarity, as well as the role of private and official sector involvement. In this paper, however, I mainly focus on endogenous and *ex post* forms of self-interested solidarity. From this perspective, my approach is similar to that of Bolton and Jeanne (2011), who consider a two-country model of a risky and a risk-free country, although they do not allow for endogenous international bailouts based on portfolio allocation, or for endogenous repayment decisions.

This paper also identifies some stylized facts on the euro area during the onset of the sovereign debt crisis. They complement the stylized facts identified by Broner et al. (Forthcoming) who focus on events during the sovereign debt crisis (see Section VI for a more detailed discussion). The conclusions of this paper are also related to Wright (2014), who shows that the European debt crisis has mostly led to total factor productivity losses. This is consistent with mechanism I describe where bailouts and repayment incentives derive from redistributive costs and the misallocation of resources resulting from a default.[4] In terms of

[4]See Mengus (2013b) for a discussion of internal default costs and total factor productivity and Sandleris and Wright (2014) for further evidence of the domestic TFP losses resulting from defaults. Note that the figures in Wright (2014) also indicate a impact through labor supply on domestic production. In section VII,

Wright's classification of explanations of the European sovereign debt crisis, this paper combines a multiple equilibria-type of explanation with a change in perceived credit risk-type of explanation. Finally, my conclusions are consistent with Hale and Obstfeld (2014) who show that European core countries increased their lending to the EMU periphery.

II A mechanism of ex post compensation

This section characterizes the *ex post* compensation problem faced by a government. It demonstrates the conditions under which repurchasing a asset in default alleviates the frictions caused by asymmetric information, i.e. when buybacks are preferred to direct transfers.

II.1 Description of the environment

Consider a two-period economy where time is denoted as $t \in \{1, 2\}$. The economy is populated by a continuum of bankers, a government and third party investors. There is a single consumption good.

These bankers are indexed by $i \in [0, 1]$. They are risk-neutral and maximize date-1 consumption. They are endowed in period 0 with cash $\psi_i \in [0, 1]$ and hold an intrinsically worthless legacy asset in amount w_i. This asset is worthless as its actual repayment is 0.

The bankers have access to a production function that yields $A_i f(I)$ in period 2 for an investment I in period 1. I assume that f satisfies the Inada conditions. In particular, f is increasing, strictly concave and twice continuously differentiable. The productivity parameter A_i is randomly drawn from $[0, 1]$. As bankers only consume in period 1, they are always better off investing in this production technology.

I assume that bankers can hide their production in period 2 at no cost. As a result, they cannot pledge their future revenue,[5] and so, have to rely only on their wealth to invest.

A deep-pocket government puts weight $\beta < 1$ on bankers' welfare.[6] For all A_i, there exists an optimal level of investment from the government's point of view, i.e. there exists $\overline{I}_i$ such that $\beta A_i f'(\overline{I}_i) = 1$.

Third party investors hold Z units of the legacy asset, and the government puts 0 value on the bankers' consumption or production.

I discuss how implicit guarantees and downward nominal rigidities interact with each other.

[5] This assumption is made for tractability and the paper's results can be extended to imperfect pledgeability.

[6] This assumption involves no loss of generality and one might consider objective functions that only take into account production or that put different weights on bankers' production and welfare.

Government intervention Without any intervention, bankers would only be able to invest with their own cash, as the legacy asset yields nothing. In the event that cash holdings are too low ($\psi_i \leq \overline{I}_i$), the government can compensate bankers either by repurchasing the legacy asset or by directly transferring funds. The unit price at which the government is willing to purchase the legacy asset is denoted by p. Without loss of generality, I assume that the government can implement transfers before investment takes place and I denote this first transfer as T^1. It can also implement transfers after bankers invest and I denote this second transfer as T^2. The first transfer T^1 can be used by bankers to invest while the second transfer T^2 cannot.

Bankers' ability to hide their production means the second transfer T^2 is necessarily positive. Finally, I assume in this section that the government has deep-pockets.

Perfect information If portfolios and productivities are observable, the following proposition describes the unconstrained compensation:

Proposition 1 (Perfect information)**.** *The government perfectly compensates bankers with exactly the amount of liquidity they need ($\overline{I}_i$) net of their cash (ψ_i):* $\min\{\overline{I}_i - \psi_i, 0\}$*. Furthermore, the government does not purchase the asset ($p = 0$).*

As a result, the key assumption shaping the compensation problem concerns the government's information set. From now on, I make the following assumption with regard to this information set:

Assumption 1 (Limited information)**.** The government is unable to observe either the bankers' individual portfolios (ψ_i and w_i) or their production functions (A_i).

This assumption presumes that the government cannot see who it is repaying when repurchasing the legacy asset (anonymity).

II.2 Optimal compensation

The government problem Using the revelation principle, the problem solved by the government is the following: it must choose the price and transfer mapping that maximize its objective function while satisfying the feasibility (hiding) and incentive constraints:

Problem 1.

$$\max_{p,\{T_i^t\}_{t=1,2,i\in[0,1]}} \int \begin{bmatrix} \beta\left[A_i f(\psi_i + pw_i + T^1(w_i,\psi_i,A_i)) + T^2(w_i,\psi_i,A_i)\right] \\ -T^1(w_i,\psi_i,A_i) - T^2(w_i,\psi_i,A_i) - p(w_i+Z) \end{bmatrix} di,$$

$$\text{s.t. Hiding constraint: } \forall(A,w,\psi),\ T^2(w,\psi,A) \geq 0,$$

Incentive constraint:

$$\forall(A,w,\psi),\forall(A',w',\psi'),\ Af\left(\psi + pw + T^1(w,\psi,A)\right) + T^2(w,\psi,A)$$
$$\geq Af\left(\psi + pw + T^1(w',\psi',A')\right) + T^2(w',\psi',A').$$

Optimal compensation The following proposition describes Problem 1's solution.

Proposition 2. *The solution of Problem 1 takes the following form:*

- *No transfers are implemented after investment ($T^2(\psi_i, w_i, f_i) = 0, \forall i \in [0,1]$) and transfers before investment T^1 are uniform and solve:*

$$T^1 = \arg\max_{\tau} \beta \int A_i f(pw_i + \psi_i + \tau) di - \tau$$

- *Price is strictly positive $p > 0$ if and only if $cov\left(w_i, \beta A_i f'(\psi_i)\right) > Z$.*

Proof. See appendix □

When is a single uniform transfer preferred to multiple transfers? The hiding constraint forces transfers to be positive. Transfers before investment (T^1) are naturally positive as the government is willing to compensate bankers before production takes place. When unconstrained by the hiding constraint, transfers after investment (T^2) would not be positive but negative; the optimal unconstrained mechanism would feature loans granted by the government to bankers. The government thus has to bear the cost of two positive transfers rather than one.

When the cost of not perfectly bailing out the highest-productivity bankers with the smallest amounts of cash is smaller than the cost of the additional transfer, the government is better off implementing a single transfer.

This happens when the weight of bankers in the government's objective function (β) is sufficiently small. In particular, I show that a sufficient condition is that $\beta \leq 1$, and so, as, by assumption $\beta < 1$, there is no loss of generality when we consider only single uniform transfers.

When the government only uses a single transfer, the incentive constraint can be rewritten as follows:

$$\forall(A',w',\psi'),\forall(A,w,\psi),\ Af(\psi+pw+T^1(w,\psi,A)))\geq\ Af(\psi+pw+T^1(w',\psi',A')).$$

The incentive constraint can be rewritten more simply using the monotonicity properties of f_i: $\forall A,w,\psi,\forall A',w',\psi',\ T^1(w,\psi,A)=T^1(w',\psi',A')$. Direct transfers are then uniform across bankers and I denote their value as $T^1=T$. Problem 1 can be rewritten as follows:

Problem 2.

$$\max_{p,T}\int\left[\beta A_i f(\psi_i+pw_i+T)-T-p(w_i+Z)\right]di.$$

The derivatives with respect to p and T are:

$$\begin{aligned}p\text{:}&\ \int w_i\left[\beta A_i f'(\psi_i+pw_i+T)-1\right]di\leq Z,\\ T\text{:}&\ \int\left[\beta A_i f'(\psi_i+pw_i+T)-1\right]di\leq 0.\end{aligned}$$

We can link the two derivatives in the following way:

$$\begin{aligned}\forall(p,T),\ &\int w_i\left[\beta A_i f'(\psi_i+pw_i+T)-1\right]di=\\ &cov\left(w_i,\beta A_i f'(\psi_i+pw_i+T)-1\right)+\int w_i di\int\left[\beta A_i f'(\psi_i+pw_i+T)-1\right]di\end{aligned}$$

and thus, using the first order condition on T:

$$\forall(p,T),\ \int w_i\left[\beta A_i f'(\psi_i+pw_i+T)-1\right]di\geq cov\left(w_i,\beta A_i f'(\psi_i+pw_i+T)\right).$$

In other words: $\frac{\partial W}{\partial p}>0$ if and only if $cov\left(w_i,\beta A_i f'(\psi_i)\right)>Z$. When this latter condition is satisfied, p is strictly positive; otherwise, it equals $p=0$.

Ultimately, the government increases T when the marginal productivity of a sufficient number of bankers exceeds its objective: $1/\beta$ and the government selects a positive p when the covariance of exposures (w_i) with marginal productivities is sufficiently positive.

Remark. In the model, agents are able to fully hide their final output, making it both non-pledgeable and non-taxable. Positive pledgeability would decrease bankers' liquidity needs and, thus, the desirability of a rescue. However, Proposition 2's results also hold true for an imperfectly concealable output, provided pledgeability and taxability remain sufficiently limited.

Heterogeneous political weights An alternative formulation of this problem features *heterogeneous* political weights β_i, constant productivity A and cash holdings $\psi_i = \psi$. In this case, the buyback price is strictly positive when

$$cov\left(w_i, \beta_i A f'(\psi)\right) > Z,$$

i.e. the government buys back the legacy asset when more politically connected bankers are more exposed.

II.3 A simple example: piecewise linear production functions

To illustrate the previous subsection's results, I consider the case of piecewise linear production functions f_i.

Simplifying assumptions For bankers $i \in [0, 1/2]$, e.g. *high-productivity* bankers, the production function's marginal productivity is ρ_1 for $I \leq 1$ and ρ_2 afterwards, with $1 < \rho_2 < \rho_1$. For bankers $i \in [1/2, 1]$, e.g. *low-productivity* bankers, the marginal productivity is always ρ_2.

I assume that $\psi_i = 1 - w_i$, meaning that cash is negatively correlated with the endowment of legacy assets. There is no loss of generality in this example as marginal productivity is left unchanged when bankers are more or less exposed to the legacy asset (this marginal productivity always equals ρ_1 for high-productivity bankers and ρ_2 for low productivity).

Finally, I assume that

$$\beta\rho_1 > 1 > \beta\rho_2,$$

so the political weight of bankers β is sufficiently low to satisfy Proposition 2's conditions.

Optimal compensation In this context, Problem 1 amounts to comparing

- the value of transferring T to all bankers, with the following outcome:

$$W_0 = \max_T \int_0^1 \beta f_i(1 - w_i + T)di - T.$$

  Each agent i receives T, and can thus invest $1 - w_i + T$, while the transfer costs T to the government;

- with the value of repurchasing the legacy asset at a unit price $p = 1$, which yields:

$$W_1 = \int_0^1 \beta f_i(1) - w_i di.$$

Each agent i receives w_i from the legacy asset's repurchase (w_i assets purchased at the unit price p) and so can invest $w_i + (1 - w_i) = 1$.

Can asset repurchases be preferable to direct transfers ($W_1 \geq W_0$)? The answer is yes, under a simple necessary and sufficient condition:

Proposition 3 (Piecewise linear production functions)**.** *If marginal productivity (ρ_i) and the exposure to the legacy asset (w_i) are positively correlated,*

$$cov\left(\rho_i, w_i\right) \geq 0,$$

the optimal repurchase unit price is $p = 1$ and no direct transfers are implemented ($T = 0$). Otherwise, when the correlation is negative, $p = 0$, the government prefers to implement direct transfers ($T = 1$); when the correlation is 0, the government has no preference.

Proof. See appendix. □

To illustrate the results of Proposition 3, let us compare a case where productive bankers are fully exposed to the legacy asset and less productive bankers are not exposed at all ($w_i = 1$ for all i $\in [0, 1/2]$ and $w_i = 0$ for all $i \in [1/2, 1]$), with a case where productive bankers are slightly exposed to the legacy asset while less productive bankers are more exposed to this asset ($w_i = .1$ for all $i \in [0, 1/2]$ and $w_i = 0.9$ for all $i \in [1/2, 1]$).

In the first case, we obtain:

$$\text{Repurchase: } W_1 = \beta\rho_1/2 + \beta\rho_2/2 - 1/2.$$
$$\text{Direct transfers: } W_0 = \beta\rho_1/2 + \beta\rho_2/2 - 1,$$

where $T = 1$[7]. A repurchase is better at targeting productive bankers and so, costs less than direct transfers.

In the second case, there is no repurchase, as the marginal gain from increasing the repurchase price of the legacy asset is $0.1\beta\rho_1/2 + 0.9\beta\rho_2/2 - 1/2 < 0$ resulting in $p = 0$. In comparison, the marginal gain from increasing the transfer T is $\beta\rho_1/2 + \beta\rho_2/2 - 1 > 0$, and so $T = 0.1$. These two marginal gains differ as the marginal gain of the repurchase takes into account the bankers' exposure (the 0.1 and 0.9), while the marginal gain from direct transfers does not. The resulting outcome of the two policies is then:

$$\text{Repurchase: } W_1 = .9\beta\rho_1/2 + .1\beta\rho_2/2.$$
$$\text{Direct transfers: } W_0 = \beta\rho_1/2 + .2\beta\rho_2/2 - 1 > W_1,$$

[7]For $T \geq 1$, the derivative with respect to T is $\beta\rho_2 - 1 < 0$. This implicitly assumes that $\beta(\rho_1 + \rho_2)/2 > 1$, i.e. that the marginal efficiency of transfers is positive

and so, direct transfers dominate over the legacy asset repurchase.

In the next section, I embed this compensation mechanism in a richer model that includes two countries, and where I endogenize the portfolio decisions that lead bankers to hold the legacy asset, as well as the repayment decision that potentially makes the legacy asset worthless without the government's intervention.

III Implicit guarantees

This section introduces the two-country model.

There are two countries, C and P, where C stands for *central* or *core* and P for *peripheral*. Both countries issue bonds to finance a public investment opportunity. The only difference between the two is that country C is risk free, in that it always has sufficient resources and can commit to honoring its debt, whereas country P is risky, in that it cannot commit to repay and, at times, it simply does not have the resources to do so. Country P's willingness to repay will depend on the collateral damage its default would have on its own domestic bankers.

In the previous section, exposures to the legacy asset and the repayment decision for that asset were treated as exogenous. In this section, however, I consider both the *ex ante* portfolio allocation and the ex post repayment decision for country P's debt as endogenous. Country P's debt now plays the role of the legacy asset.

III.1 Environment

Consider a three-period economy where time is denoted as $t \in \{0, 1, 2\}$. Each country is populated with a continuum of bankers and a government.

Bankers Bankers are risk-neutral and make decisions so as to maximize utility $u(c_0, c_1, c_2) = c_0 + c_1 + c_2$ where c_t is their date-t consumption. In period 0, each banker receives an endowment of 1 unit of good. There are two types of bankers:

High-productivity bankers have access in period 1 to an investment opportunity that produces $f(I)$ in period 2 from an investment I. f satisfies the Inada conditions and I assume that $f'(1) > 1$, i.e. productive bankers are willing to invest in their production technology. *Low-productivity* bankers do not have access to an investment opportunity. Bankers are privately informed of their type in period 0.

Date-2 income is not pledgeable and, thus, bankers cannot borrow. To be able to invest in period 1, high-productivity bankers have to transfer wealth by purchasing country C's and/or country P's bonds. I denote as z_i^C the amount of (risk-free) country C bonds purchased by banker i, and as z_i^P the amount of (risky) country P bonds.

Finally, there is a mass 1 of high-productivity bankers in country C and a mass κ^P in country P. The mass of low-productivity bankers is λ^C in country C and λ^P in country P. Bankers are privately informed in period 0 of their date-1 production technology.

Remark. In this section, I consider a degenerate distribution for bankers' investment opportunities: $A \in \{0, 1\}$. This involves no loss of generality as it still captures the heterogeneity in investment opportunities introduced in the previous section, and introduces differences in the curvature of bankers' objective functions, and thus, different demands for bonds.

Government Each government has access to a production technology that summarizes the rest of the economy:

- Country C, when investing G^C in period 0, produces $F^C(G^C)$ in period 1, and investment is always desirable ($F'^C(G^C) > 1$).
- Country P produces $F^P(G^P)$ in period 1 with a probability $\gamma \in [0, 1]$ and 0 with probability $1 - \gamma$. Investment is also always desirable, as $\gamma F'^P(G^P) > 1$ for all $G^P \geq 0$.

Each government's revenues can be observed by the other government as well as by the bankers in both countries.

Initially, neither government has resources in period 0, and must therefore issue bonds to country C and country P bankers. In period 1, they then use the proceeds of their investment technology to reimburse their creditors. Z^C and Z^P denote the two countries' promised repayments in period 1, and p^C and p^P denote the endogenous prices at which bonds are traded in period 0.

Debt repayment I make the following assumption about the two countries' commitment abilities:

Assumption 2. Country P is unable to commit to repaying its debt while Country C is able to commit to repaying.

Debt repayment cannot be enforced by bondholders or even by the other country's government; there are no sanctions or court with enforcement powers that could force the defaulting country to honor its debt.

I denote as π^P country P government's endogenous repayment probability, which is condition on its production. When not producing, country P defaults unconditionally as it has no resources for repayment. Finally, the probability of country P honoring its debt is denoted is $\pi^P\gamma$. Without loss of generality, I do not consider partial defaults where country P reimburses a fraction of its debt (see appendix).

Conversely, country C repays with probability 1 as it can commit to do so and its production technology is safe.[8]

Bailouts To make up for the losses resulting from country P's default, country C can repurchase country P's debt and/or it can also implement transfers to its domestic residents. Here, as for country P's debt repayment, I rule out the possibility of partial repurchases.[9]

I denote as T_i^C country C's transfer to the domestic banker i, and as η the endogenous probability that country C will take charge of country P's debt in the event of a default.

Similarly, country P can implement transfers to its residents when it has a sufficient amount of resources. I denote as T_i^P country P's transfer to the domestic banker i. All these policies are contingent on country P's default.

Finally, I make the following assumption:

Assumption 3. Country C and country P are unable to commit not to bail out their residents.

In period 1, the two countries take sequential decisions on debt repayment and on potential bailout policies:[10] first, country P decides whether to default and then country C and country P determine their bailout policies. They both choose their policies so as to maximize welfare:

$$W = \beta W^e - X,$$

where W^e is bankers' welfare and $\beta > 0$ their political weight, and X the payment country C and country P have to implement in order to honor their debt and/or bail out domestic residents or the other country. As in the previous section, I assume that $\beta < 1$.

[8] This assumption involves no loss of generality. In economic terms, lower exogenous risk may derive from country C's greater ability to share risks, while its greater ability to commit may derive from better fiscal tools such as lower levels of government expenditure, less distortionary taxes or larger tax bases. In the context of Europe, this assumption is consistent with the fact that yields were lower for Germany or France than for GIIPS countries prior to the introduction of the euro.

[9] see appendix. More general environments would include policies combining repurchases and transfers as in Section II.

[10] The paper's conclusion can easily be extended to simultaneous decisions, as there is no portfolio reallocation in between the two countries' respective decisions.

However, each government's transfers are limited by the information available on bankers' portfolios. As in the compensation model in Section II, I make the following assumption:

Assumption 4 (Government information)**.** Country C and country P's governments are unable to observe either the bankers' portfolios and nor their date-2 production.

Assets Country P's total repayment probability Π^P takes into account both the probability that country P will repay directly ($\gamma\pi^P$), and the probability that country C will take charge of country P's debt ($\left(1-\gamma\pi^P\right)\eta$). It can thus be written as follows:

$$\Pi^P = \gamma\pi^P + \left(1-\gamma\pi^P\right)\eta.$$

Ultimately, there are two assets in this economy: risk-free country C's bonds that yield 1 in period 0 and trade at the endogenous price p^C, and risky country P's bonds that also yield 1 in period 1 but only with probability Π^P. The latter bonds trade at the endogenous price p^P.

Timing, strategies and equilibrium At date 0, country C and country P bankers choose their portfolios (the z_k^i's) by comparing their beliefs on both governments' future moves (their repayment and bailouts' policies $\{\pi^P, \eta, \{T_C^i\}_{i\in C}, \{T_P^i\}_{i\in P}\}$) with prevailing bond prices (p^C and p^P). At date-1, the governments design their policies on the basis of the private portfolio allocation. An equilibrium is a set of policies and a portfolio allocation that is both consistent with the portfolio choices and the design of the governments' policies.

Formally expressed, private sectors and governments' reactions functions define a correspondence Γ where $\Gamma\left(\left[\{z_i^P, z_i^C\}_{i\in C,P}, \pi^P, \eta, \{T_C^i\}_{i\in C}, \{T_P^i\}_{i\in P}\right]\right)$ is the set of repayment probabilities and bailout decisions consistent with $\left[\{z_i^P, z_i^C\}_{i\in C,P}, \pi^P, \eta, \{T_C^i\}_{i\in C}, \{T_P^i\}_{i\in P}\right]$: the expectation of some policies can lead to multiple distributions of bond holdings that in turn generate different policies. An equilibrium is then a fixed point of this correspondence: $\left[\{z_i^P, z_i^C\}_{i\in C,P}, \pi^P, \eta, \{T_C^i\}_{i\in C}, \{T_P^i\}_{i\in P}\right] \in \Gamma\left(\left[\{z_i^P, z_i^C\}_{i\in C,P}, \pi^P, \eta, \{T_C^i\}_{i\in C}, \{T_P^i\}_{i\in P}\right]\right)$.

The timing is summarized by Table 1.

Autarky As a benchmark, let me characterize autarky, which is where bankers can only use domestic bonds to transfer wealth. Country C's bond price is then $p^C_{autarky} = f'(z^C)$ where z^C is the exposure of country C bankers to country C. In country P, $p^P_{autarky} = \gamma f'(z^P)$, and finally $G_C = p^C_{autarky} z^C$ and $G_P = p^P_{autarky} z^P$. Finally, no bailouts occur as one of the outcomes of financial autarky is that there are no cross-exposures.

Period 0	Period 1	Period 2
- Governments issue bonds. - In both countries, bankers purchase bonds. - Governments invest.	- Governments produce. Country P decides whether to default. Country C decides whether to buy back country P's debt. - Governments implement direct domestic transfers. - Bankers invest in their production technologies.	- Bankers produce.

Table 1 – Timing

In the following subsection, I focus on equilibria with pure strategies for government decisions ($\pi^P, \eta \in \{0,1\}$) and solve the model backwards, starting from date-1 policies, to derive the date-0 portfolio allocation.

III.2 The date-1 policy game

Countries C and P design their policies in period 1. Country P selects its repayment probability (π^P), and the transfers it will grant to its domestic bankers in the event of strategic default (T_i^P's) and no rescue from country C. Country C determines the probability that it will rescue country P (η) in the event case of the latter's default, as well as the direct transfer it will make to its domestic bankers. However, in the event of a rescue, country C also precludes any debt repayment incentives on the part of country P. The equilibrium of the date-1 policy game can be described as follows:

Proposition 4. *Given country P and country C portfolios (z_i^P, z_i^C, $i \in C, P$), transfers $\{T_i^P\}_{i\in P}$ and $\{T_i^C\}_{i\in C}$ are uniform and the unique equilibrium for the date-1 policy game is*

- *When covariance between exposures and productivities in country C is sufficiently high ($cov(z_i^P, \beta A_i f'(z_i^C))_{i\in C} > \int_{i\in P} z_i^P di$), country P strategically defaults when receiving revenue ($\pi^P = 0$) and country C rescues country P ($\eta = 1$);*
- *otherwise, country C does not rescue country P ($\eta = 0$).*
  - *When covariance between exposures and productivities in country P is sufficiently*

high ($cov(z_i^P, \beta A_i f'(z_i^C))_{i\in P} > \int_{i\in C} z_i^P di$), country P repays when receiving revenue ($\pi^P = 1$);

- *otherwise, country P always defaults ($\pi^P = 0$).*

Uniform transfers that pool bankers result from the government's inability to observe domestic portfolios combined with its limited ability to tax or enforce payment in period 2 as in Proposition 2.

As repayment cannot be enforced, country P only honors its debt when it anticipates not being rescued by country C. The latter country's incentive to implement a rescue increases with the heterogeneity and average amount of its exposure to country P. Greater heterogeneity increases the cost of direct transfers while leaving the cost of the buyback unchanged. A higher average of exposures does not modify the cost of a buyback as country C still has to purchase the entire stock of country P's bonds; in the case of direct transfer, however, the higher the exposures, the higher the cost of the transfer. while the cost of direct transfers increases with the higher exposures. As a result, when heterogeneity and/or the average of exposures are sufficiently large, repaying foreign bondholders of country P's debt will prove cheaper than implementing a uniform transfer.

III.3 Date-0 demand for bonds

In period 0, for given expected policies ($\{\eta, \pi^P, T^C, T^P\}$), bankers allocate their portfolios between the two countries.

Bankers with an investment opportunity in period 1. Each banker with an investment opportunity maximizes his utility under a set of policy-contingent budget constraints. The corresponding program for banker i in country C can be written as:

$$\max_{z_i^C, z_i^P, I, c_0^i, c_1^i, c_2^i} E(c_0^i + c_1^i + c_2^i),$$

$$\text{s.t. If both countries repay: } c_1^i + I = z_i^C + z_i^P,$$

$$\text{Country P defaults and country C bails it out: } c_1^i + I = T^C + z_i^C,$$

$$\text{Date-0 and date-2 budget constraints: } c_0^i + p^C z_i^C + p^P z_i^P = 1 \text{ and } c_2^i = f(I).$$

or, substituting I with budget constraints and maximizing over z_i^C and z_i^P:

$$\max_{z_i^C, z_i^P} \left\{1 - p^C z_i^C - p^P z_i^P + \Pi^P f(z_i^C + z_i^P) + (1 - \Pi^P) f(T^C + z_i^C)\right\}$$

where the aggregate repayment probability is $\Pi^P = \gamma\pi^P + (1 - \gamma\pi^P)\eta$, and each banker in country P solves the following problem:

$$\max_{z_i^C, z_i^P} E(c_0^i + c_1^i + c_2^i),$$

s.t. If both countries repay: $c_1^i + I = z_i^C + z_i^P$,

Country P strategically defaults: $c_1^i + I = T^P + z_i^C$,

Country P defaults as it has no resource: $c_1^i + I = z_i^C$,

Date-0 and date-2 budget constraints: $c_0^i + p^C z_i^C + p^P z_i^P = 1$ and $c_2^i = f(I)$.

or, substituting $I$with budget constraints and maximizing over z_i's

$$\max_{z_i^C, z_i^P} \left\{1 - p^C z_i^C - p^P z_i^P + \Pi^P f(z_i^C + z_i^P) + \gamma(1 - \pi^P) f(T^P + z_i^C) + (1 - \gamma\pi^P) f(z_i^C)\right\}$$

The program for country P bankers only differs from that of country C bankers in one respect: country P bankers do not receive any compensation ($T^P = 0$) when their country has no resources (which happens with probability $1 - \gamma$) and defaults on its debts.

Bankers demand Country P's repayment probability Π^P is either:

$\Pi^P = 1$: when a rescue is expected ($\eta = 1$), both bonds carry no risk and so are perfect substitutes. Bond prices are equal ($p^C = p^P$). In this case, the portfolio allocation is indeterminate, as bankers in both countries will hold either bond indifferently.

$\Pi^P = 0$: when neither a rescue ($\eta = 0$) nor a country P repayment ($\pi^P = 0$) are expected. In this case, country P bonds are worthless ($p^P = 0$) and both countries' bankers purchase only country C bonds.

$\Pi^P = \gamma$: when no rescue is anticipated ($\eta = 0$) but country P is expected to honor its debt ($\pi^P = 1$). Both countries' bankers compare country P's bond price p^P with the repayment probability γ, but, as country C bankers may be better insured against country P's default, they attribute a different insurance premium to country C's bonds.

In the latter case, country C bankers' first order conditions are:

$$\gamma f'(z_i^C + z_i^P) \geq p^P \text{ and } \gamma f'(z_i^C + z_i^P) + (1 - \gamma) f'(z_i^C + T^C) \geq p^C, \forall i \in C,$$

and in country P:

$$\gamma f'(z_i^C + z_i^P) \geq p^P \text{ and } \gamma f'(z_i^C + z_i^P) + (1 - \gamma) f'(z_i^C) \geq p^C, \forall i \in P.$$

A strictly positive transfer T^C induces country C bankers to hold more country P bonds and fewer country C bonds compared with country P bankers. Conversely, the borrowing constraint limits country C bankers' holdings of country P bonds. Without the expectation of a transfer T^C for country C bankers, portfolios would be symmetric.

Bankers with an investment opportunity in period 0. These bankers value country C bonds at price $p^C = 1$ and country P bonds at price $p^P = \Pi^P$. Both valuations are strictly lower than the productive bankers' valuations of those bonds, and so, bankers with an investment opportunity in period 0 prefer not to purchase any bonds and consume their production in that period.

Ultimately, only bankers with investment opportunities in the future purchase peripheral bonds and they select their portfolios depending on their policy expectations: low exposures to peripheral bonds when this debt appears to be risky and high exposures when peripheral debt is guaranteed. As a result, productive bankers in period 1 purchase more of country P's bonds they safer they appear; by contrast other bankers do not purchase any bonds at all. This creates a positive covariance between exposures and liquidity needs (as measured by date-1 productivity), which decreases in line with country P's risk.

IV Equilibrium

IV.1 No-commitment

The feedback loop between bankers' portfolio choices and government policies leads to multiple equilibria as follows:

Theorem 1. *Given repayments Z^P and Z^C, there exists multiple equilibria for the no-commitment game and they take the following forms:*

(i) ***High-exposure equilibria****: Country C takes charge of country P's debt ($\eta = 1$) and country P always defaults ($\pi^P = 0$). Bond prices are equal: $p^C = p^P$, and country C bankers are massively and heterogeneously exposed to country P. These equilibria exist if, and only if, the level of country P's debt is sufficiently small (there exists a function $\overline{Z}$ such that $Z^P \leq \overline{Z}(\overline{I}(1 - 1/(1 + \lambda^C)^2)$.*

(ii) ***Low-exposure equilibrium****: Country C does not rescue country P ($\eta = 0$) and country P honors its debt when receiving revenue ($\pi^P = 1$). Bond prices diverge: $p^C > p^P$, and country C bankers' exposures to country P are small. This equilibrium exists if, and*

only if, the level of country P's debt is sufficiently small ($Z^P \leq \overline{Z}(\overline{I}(1-1/(1+\lambda^P)^2))$ and domestic transfers are more costly in country P ($\lambda^P > \lambda^C$).

(iii) ***Capital dry-out equilibrium****: Country P always defaults ($\pi^P = 0$) and country C does not rescue country P ($\eta = 0$). As a result, country P bonds are worthless $p^P = 0$ and bankers' portfolios are fully invested in country C. This equilibrium always exists.*

In particular, when country P's level of debt (Z^P) is sufficiently low and domestic transfers are more costly in country P ($\lambda^P > \lambda^C$), the three forms of equilibria coexist.

When country C portfolios are massively and heterogeneously invested in country P, country C has an incentive to step in *ex post*, making country P debt *ex ante* as attractive as country C's debt for country C investors (**high-exposure equilibria**). The latter then invest more in country P, and as bankers in both countries hold either country's bonds indifferently, portfolios may become heterogeneous.

Conversely, when country C is not expected to rescue country P, portfolio choices only hinge on expectations of a repayment by country P. Either country P's bankers anticipate their government will honor its debt (at least when country P has sufficient resources) and invest in their country's bonds, in turn making country P creditworthy (**low-exposure equilibrium**), or they do not, and so the lack of domestic holdings provides a disincentive for country P to repay *ex post*. *Ex ante*, country P is then unable to borrow (**capital dry-out equilibrium**).

The implicit guarantee in high-exposure equilibria leads to a convergence in interest rates ($p^C = p^P$), as country C perfectly insures investors against country P's sovereign risk. This convergence in interest rates is not only a by-product of high-exposure equilibria, it is also one of the key features of these equilibria, as it means that investors will hold country P or country C bonds indifferently. Conversely, when implicit guarantees do not emerge, country P requires some domestic holdings in order to build its creditworthiness and so, the price of country C's risk-free bonds needs to adjust downwards to compensate for country P's domestic risk.

However, the existence of a low-exposure and high-exposure equilibria is not a foregone conclusion. In both cases, country P's debt needs to remain sufficiently low such that the collateral damage suffered by country P or country C in the event of country P's default exceeds the amount of the debt. This collateral damage is bound by the maximum covariance between exposures and liquidity needs. For low-exposure equilibria, an additional condition is required: as portfolios in country P and country C are symmetric, country P should have a higher willingness to repay compared with country C. This is captured here by a lower willingness to implement transfers in country P ($\lambda^P > \lambda^C$).

In terms of cross-exposures, i.e. country C's holdings of country P's debt, there are two possible situations: either exposures are low and concentrated so that implicit guarantees are small or absent (low-exposure or capital dry-out equilibria) or, conversely, exposures are sufficiently large and dispersed so that the other country's debt is implicitly guaranteed (high-exposure equilibria). Intermediate levels of exposure cannot constitute an equilibrium outcome as they would be either too large for country P to have an incentive to repay, or too small for country C to have an incentive to rescue country P. In addition, for country P's bankers to remain exposed to their own country's debt in high-exposure equilibria, country C' exposures need to be sufficiently heterogeneous (and information on portfolio has to be imperfect. See Corollary 2 below).

The overall result of Theorem 1 is that the equilibrium outcome features either high exposure and low spread or low exposure and high spread. This is consistent with the European situation between 2004 and 2008 when Greece was able to borrow at interest rates close to those of Germany and in larger quantities than in previous periods (see Section VI). The divergence which occurred after 2008 may be interpreted as a shift back to a low-exposure equilibrium (e.g. for Italy and Spain), or even as a capital dry-out equilibrium, as some countries such as Greece or Portugal were no longer able to borrow in the markets.

A more theoretical contribution of this theorem relates to "low" interest rates: comparing low-exposure equilibria and capital dry-out equilibria, low interest rates in country C incentivize country P bankers to opt for their more risky domestic debt, and so make country P's debt creditworthy. This role, which derives from the internally-driven incentive to repay, differs from Hellwig and Lorenzoni (2009) where low interest rates only make *external* borrowing less costly,[11] or from Bolton and Jeanne (2011) who interpret low interest rates as an insurance premium charged to country P bankers.

Comparative statics The following Corollary describes how the set of high-exposure equilibria evolves with respect to certain parameters:

Corollary 1. *The set of high-exposure equilibria expands according to:*

- *the bankers' weight in the government's ex post objective function (β)*
- *the inverse of country P's repayment ($1/Z^P$).*

[11] This also makes savings abroad less attractive, reducing the appeal of Bulow and Rogoff (1989)'s default and saving strategy.

A decline in the relative size of the peripheral country's debt (Z^P) reduces the cost of a direct rescue and so, makes implicit guarantees more likely. This is consistent with the case of Greece (around 2% of European GDP), Portugal (1.8%) or even, to some extent, Spain (around 11%) as they have to be compared with France and Germany which account for more than 51% of European GDP. Implicit guarantees are also more likely when the political weight of the core country's bankers is high, as, for example, in countries with a relatively large banking sector.

Perfect information What role does imperfect information play in the equilibrium outcome? In this paragraph, I relax the core assumption by assuming that country C can perfectly observe its domestic residents' portfolios.

In this case, for each domestic resident with an investment opportunity, country C would guarantee a level of investment $\overline{I}$ whatever the state of nature in period 1. This makes country P bonds strictly more valuable for country C bankers than for country P bankers; the former are perfectly insured, while the latter are not insured at all. This translates into more country C holdings than country P holdings of country P debt. When the insurance provided by targeted bailouts is sufficiently high, foreign holdings of country P debt preclude any incentive for country P to repay.

Corollary 2. *When β is sufficiently high, as soon as $\gamma < 1$, all country P debt is held by country C bankers, and so, ex ante, country P has no incentive to repay in the good state ($\pi^P = 0$).*

In section VI, I provide data showing that GIIPS countries remained heavily exposed to their domestic sovereign debt. Most of banks in these countries actually held domestic public bonds in amounts exceeding their capital (either defined as common equity capital or Tier 1 capital).

IV.2 Commitment

This subsection describes how commitment assumptions affect the equilibrium outcome.

Proposition 5. *Under commitment, country C does not bail out ($\eta = 0$ and $T^C = 0$) and country P repays when it has resources ($\pi^P = 1$).*

If country P can commit to repay but country C cannot commit not to bail it out, then country P commits to repay if, and only if, it expects country C not to bail it out ($\eta = 0$).

When both countries are able to commit to repay and not to bail out, bond prices reflect fundamentals. There are no bailout expectations to distort the portfolio allocation and thus increase the incentives for a bailout, which would in turn reinforce the expectation of a bailout.

This proposition also illustrates the joint role played by the inability to commit not to bail out and portfolio non-observability. Non-observability interferes with policy decisions insofar as the government is likely to bail out and, conversely, a commitment not to bail out makes portfolio opacity irrelevant.

Finally, commitment assumptions for country P and country C are not independent: assuming that country P is capable of committing to repay, it would not necessarily use this commitment ability if it expects to be bailed out; thus, country C's inability to commit not to bail out may spill over onto country P's willingness to commit to its debt repayment.

As a result, assuming country P is able to commit would not qualitatively change the results, except in the case of the capital dry-out equilibrium, which would no longer exist as country P's ability to repay no longer hinges on its domestic bond holdings.

Note that portfolios are homogenous in both countries and they solve:

$$\forall i \in \{C, P\}, \max_{z_i^C, z_i^P} \left\{1 - p^C z_i^C - p^P z_i^P + \gamma f(z_i^C + z_i^P) + (1-\gamma) f(z_i^C)\right\}$$

I denote by $z^{C,commitment}, z^{P,commitment}$ the corresponding solution.

Remark. The assumption regarding country C's ability to commit to repay can be seen as a specific case of the more general model where the two countries are unable to commit to repay and where we focus on equilibria where country C definitely repays. We only need to check that the set of equilibria where country C can commit to repay and rescue country P is non-empty. This actually happens when Z^P is sufficiently low compared with Z^C.

V Welfare and ex ante policies

This section analyzes the welfare implications of the different equilibria and the desirable *ex ante* polices.

V.1 Ex ante Bond Issuance and Welfare

Equilibrium outcomes lead to different bond prices and, thus, to different incentives to issue debt *ex ante*. Country P issues debt as follows:

Problem 3. Given a level of country C's debt Z^C, country P's program is:

$$\max_G \gamma f_P(G) + E\left(\beta W_P^e - \frac{G}{p^P}\right),$$

In a high-exposure equilibrium, country P can borrow at a lower interest rate compared with the commitment solution and, as it expects to be rescued by country C, it also expects not to honor its debt. Country P thus borrows more than in the commitment solution. Conversely, in a capital dry-out equilibrium, country P cannot borrow and, thus, cannot invest. This results in the following proposition:

Proposition 6 (Overinvestment)**.** *In a high-exposure equilibrium, country P over-invests in period 0, while country C under-invests, comparing with the commitment solution. Conversely, in a capital dry-out equilibrium, country P under-invests.*

In the end, the consequence of implicit guarantees is then to lead the periphery to over-invest at the expense of country C. Conversely, country P can lose its ability to borrow in the case of a capital dry-out equilibrium.

V.2 Ex ante constrained optimal allocation and capital controls

To avoid the possible emergence of implicit guarantees, the core country's government has no other choice but to try to influence portfolio allocation *ex ante*, and to restrict its residents' exposures to the peripheral country. Similarly, the peripheral country wants to keep domestic savings at home in order to avoid a capital dry-out. In this subsection, I show that this may be achieved through capital controls. More specifically, I show that country P and country C can coordinate on a low-exposure equilibrium (and eliminate all other equilibria) by respectively implementing a tax on date-0 capital outflows.

First, let me define the constrained Pareto optimal portfolio allocation:

Definition 1. A portfolio allocation $\{z_i^P, z_i^C\}_{i\in C,P}$ is *ex ante* constrained Pareto optimal if there exists no other portfolio allocation that, given the resulting *ex post* optimal bailout and payment policies, increases each country's *ex ante* welfare, and strictly for at least one country.

In the next paragraph, I determine this constrained Pareto portfolio allocation.

Second, I introduce a tax on capital outflows in both countries and show that the optimal portfolio allocation can be implemented using a strictly positive level of taxation. This tax on capital outflows is non-contingent on bankers' individual portfolios satisfying the portfolio non-observability assumption: no knowledge of individual portfolios is thus required.

Optimal portfolio allocation To begin with, let me characterize the optimal portfolio allocation in period 0, when *portfolios are observable*. This optimal allocation sets the gains from portfolio diversification against the cost of *ex post* bailouts, if there are any.

Country C government's problem is to find a portfolio allocation $\{z_i^P, z_i^C\}_{i\in C,P}$ as follows:

Problem 4 (Constrained optimal portfolio)**.** Given $\{z_i^P, z_i^C\}_{i\in P}$,

$$\max_{\{z_i^P, z_i^C\}_{i\in C}} F_C\left(p^C Z^C\right) - Z^C + \beta \int_{i\in C} (1 - p^C z_i^C - p^P z_i^P) di + \beta E_0 W^C(\{z_i^P, z_i^C\}_{i\in C,P})$$

and, given $\{z_i^P, z_i^C\}_{i\in C}$,

$$\max_{\{z_i^P, z_i^C\}_{i\in P}} \gamma F_P\left(p^P Z^P\right) - \pi^P \gamma Z^P + \beta \int_{i\in P} (1 - p^C z_i^C - p^P z_i^P) di + \beta E_0 W^P(\{z_i^P, z_i^C\}_{i\in C,P})$$

so that:

$$\begin{aligned}
\text{Given } \pi^P \text{ and } T^P,\ E_0 W^C(\{z_i^P, z_i^C\}_{i\in C,P}) = \max_{\{\eta, T^C\}} & \eta(1-\gamma\pi^P)\left[\int_{i\in C} f_i\left(z_P^i + z_C^i\right) di - Z^P\right] \\
& + (1-\eta)(1-\gamma\pi^P)\left[\int_{i\in C} f_i\left(T^C + z^C\right) di - T^C(1+\lambda^C)\right] \\
& + \gamma\pi^P \int_{i\in C} f_i\left(z_P^i + z_C^i\right) di, \\
\text{given } \eta \text{ and } T^C,\ E_0 W^P(\{z_i^P, z_i^C\}_{i\in C,P}) = \max_{\{\pi^P, T^P\}} & \eta(1-\gamma\pi^P)\left[\int_{i\in C} f_i\left(z_P^i + z_C^i\right) di\right] \\
& + (1-\eta)(1-\gamma\pi^P)\left[\int_{i\in C} f_i\left(T^P + z_C^i\right) di - T^P \kappa^P (1+\lambda^P)\right] \\
& + \gamma\pi^P\left[\int_{i\in C} f_i\left(z_P^i + z_C^i\right) di - Z^P\right]
\end{aligned}$$

Country C wishes to avoid a portfolio allocation that will lead to an *ex post* rescue ($\eta = 1$ and $\pi^P = 0$) and, in the absence of an *ex post* rescue, country P wants to prevent capital dry-out ($\pi^P = 0$ and $\eta = 0$). As a result, the two countries coordinate on a portfolio allocation featuring country P's debt repayment and no rescue by country C, as in low-exposure equilibria.

Proposition 7. *The solution of Problem (4) takes the following form: there exists an upper bound $\overline{z} < z^{P,commitment}$ on country C's exposures to country P ($z_i^P \leq \overline{z}, \forall i \in C$) and there exists an lower bound $\underline{z} > z^{P,commitment}$ on country P's domestic exposures ($z_i^P \geq \underline{z}, \forall i \in P$).*

The optimal date-1 policies induced by this portfolio allocation are $\eta = 0$ and $\pi^P = 1$, as in a low-exposure equilibrium.

Proof. See Appendix. □

Country C wishes to restrict exposures to country P ($z_i^P \leq \overline{z}, \forall i \in C$) while country P wants to ensure a minimum of home bias ($z_i^P \geq \underline{z}, \forall i \in P$).

In order to achieve the optimal allocation, the governments should be able to observe portfolios *ex ante*, which is not possible by assumption. In the next paragraph, I show that it is possible to circumvent this difficulty. Note also that the two countries' objectives are consistent with each other as country P and country C both want to keep domestic savings at home.

Capital controls In this paragraph, I show that the optimal portfolio allocation described in Proposition 7 can be implemented by imposing a tax on country C's capital outflows in period 0.

I introduce a tax on capital outflows as in Costinot et al. (forthcoming) or Farhi and Werning (2012).[12]

I denote as ζ^j the tax rate on country j's capital outflows in period 0. As a resultCountry C's bankers have to pay a price $(1+\zeta^C)p^P$ for purchasing one country P's bond. This modifies country C's bankers' portfolio allocation problem as follows:

$$\max_{z_i^C, z_i^P} \left\{1 - p^C z_i^C - p^P(1+\zeta^C) z_i^P + \Pi^P f(z_i^C + z_i^P) + (1-\Pi^P) f(T^C + z_i^C)\right\}$$

and, similarly, country P's bankers solve the following problem:

$$\max_{z_i^C, z_i^P} \left\{1 - p^C(1+\zeta^P) z_i^C - p^P z_i^P + \Pi^P f(z_i^C + z_i^P) + \gamma(1-\pi^P) f(T^P + z_i^C) + (1-\gamma\pi^P) f(z_i^C(1-\zeta^P))\right\}.$$

An equilibrium with capital controls (ζ^C, ζ^P) is then a portfolio allocation and policies solving the problem of country C's bankers with capital controls ζ, the problem of country P's bankers and country C and country P's optimal policy design at date-1.

This leads to the following proposition:

Proposition 8. *There exist $\overline{\zeta}^C > 0$ and $\overline{\zeta}^P > 0$ so that the optimal portfolio allocation solving Problem 4 is an equilibrium with capital controls $(\overline{\zeta}^C, \overline{\zeta}^P)$.*

Furthermore, there exists no equilibrium with capital controls $\overline{\zeta}^C$ where country C rescues country P ($\eta = 1$) if, and only if, κ^P is sufficiently large.

Interestingly, the tax does not require portfolios to be observable, in line with Assumption 4. Also, as this is a date-0 tax, it does not require any ability to commit.

In general, the tax only weakly implements the optimal portfolio allocation. High-exposure equilibria where country C is expected to take charge of country P's debt may still exist.

[12] Capital controls are either price or quantity instruments as described by Neely (1999).

Country P's bankers attribute a higher valuation to country P's debt than country C's bankers as the former do not have to pay tax. Country P's bankers are thus willing to pay a price $p^P = 1$ while country C's bankers purchase country P's bonds at a price $p^P = 1/(1+\zeta)$.[13]

As a result, country P's portfolios are perfectly home-biased when a rescue of country P's government is anticipated, and the cost of that rescue will thus increase according to the size of country P bankers, i.e. κ^P. As a result, depending on the size of country P, country C may or may not be willing to buy back country P's debt.

When the size of country P (κ^P) becomes sufficiently large, country C has no the incentive to rescue country P and so no implicit guarantees can emerge. Conversely, when country P (κ^P) is sufficiently small, country C may be willing to rescue it, and so implicit guarantees may still emerge.

However, this implicit guarantee, when κ^P is small, is not necessarily robust. If ζ can depend on the aggregate portfolio allocation in period 0 (this is consistent with Assumption 4), then the government chooses $\zeta = -1$ at date 0 when anticipating a rescue at date-1, and implement $\zeta = \overline{\zeta}$ otherwise. This rules out any high-exposure equilibria.

Note that the core country's government also wishes to reduce exposures to the periphery even in low-exposure equilibria, as they might be too large because of the expectation of a domestic transfer T^C.

Remark. In a monetary union or when political motives make implicit guarantees more likely (as in the European Union), there is a need for instruments of financial repression such as capital controls. This moral-hazard rationale for capital controls within a monetary union adds to other motives already studied in the literature (e.g. overturning Mundell's Trilema as in Farhi and Werning, 2012).

V.3 Transparency and ex post interventions

The second friction considered is the inability to observe portfolios, which potentially leads to implicit guarantees on the peripheral debt. In response, governments may be willing to impose transparency in financial markets, so as to make portfolios observable. The following proposition shows that such transparency is *per se* not desirable:

Proposition 9. *When β is sufficiently large, Country C's date-0 welfare is lower when portfolios are ex post observable than when portfolios are not observable, while country's C welfare is greater in the former case.*

[13] See Bassetto (2005) for the implementation in the presence of multiple equilibria.

The proof of this proposition can be easily obtained by inspecting the time-consistency constraint in Problem 4, which is the only constraint modified when assuming observable portfolios. Indeed, when portfolios are observable, the government can achieve a greater date-1 welfare in the event of a default, as it has access to a larger set of instruments (that includes the instruments available when portfolios are not observable).

However, at the same time, as stated by Corollary 2, this constraints the *ex ante* portfolio allocation so that all the country P' debt is in the hands of country C bankers. More specifically, Problem (4) can be rewritten as:

Problem 5 (Constrained optimal portfolio)**.** Given $\{z_i^P, z_i^C\}_{i\in P}$,

$$\max_{\{z_i^P, z_i^C\}_{i\in C}} F_C\left(p^C Z^C\right) - Z^C + \beta \int_{i\in C} (1 - p^C z_i^C - p^C z_i^P) di + \beta \left[\int_{i\in C} f_i\left(z_P^i + z_C^i\right) - Z^P di\right]$$

and, given $\{z_i^P, z_i^C\}_{i\in C}$,

$$\max_{\{z_i^C\}_{i\in P}} \gamma F_P\left(p^P Z^P\right) - \pi^P \gamma Z^P + \beta \int_{i\in P} (1 - p^C z_i^C) di + \beta \left[\int_{i\in C} f_i\left(z_C^i\right) di\right]$$

Finally, we can notice that the solution of Problem (5) is a feasible allocation of Problem (4), and so, the *ex ante* welfare in this second case is strictly lower for country C.

In the end, portfolio non-observability ties the core country's hands: it prevents from perfectly bailing out each domestic bankers suffering losses and such perfect bailouts would have the negative effect to concentrate peripheral bonds in hands of the core country's bankers (cf. Corollary 2).

As a result of this proposition, policies resulting in enhanced transparency, such as the European Banking Association's stress-tests or the European Central Bank's Asset Quality Review, even though they appear to be optimal *ex post*. In the end, market structures that make individual exposures more opaque can be desirable (Cf. Section VII for a more detailed discussion).

Remark. Note that opacity helps both to commit not to bail out and to commit to repay (as in Mengus, 2013b). There is then no trade-off (at least in this paper's setting) and opacity is always optimal. Yet, opacity allows for equilibria featuring bailout and possibly no debt repayment, but as shown in Section V, this can be solved using tools as capital controls.

Ex post interventions A common feature of *ex post* interventions is the presence of an institution or an agency responsible for coordination. In the case of Europe, the ECB or the project of the European banking union play this role, while the IMF ensures coordination

among its members (note that the IMF also took part in the European bailouts). The role of these coordinating institutions is *ex post* desirable, at least because they reduce potential free-riding problems among core countries. *Ex ante*, this coordination unfortunately translates into more likely bailouts and into reduced repayment incentives in the periphery, both being *ex ante* inefficient.

VI Applications

This section presents examples of bailouts consistent with this paper's theory: first, the European sovereign debt crisis; second, the IMF bailouts; third, the 1791's Federal assumption of US states' debt and the 1843's decision not to bail out; fourth the 2008 US financial crisis. Finally, this section argues that official holdings of US external debt limits the applicability of implicit guarantees for 'Global imbalances'.[14]

VI.1 The European sovereign debt crisis

This subsection argues that the European sovereign debt crisis resulted from the presence of implicit guarantees on European peripheral debts. By identifying the periphery as Greece, Ireland, Italy, Portugal and Spain (known as the GIIPS) and the core as the rest of euro area, I argue that the last decade can be interpreted as a high-exposure equilibrium and that the crisis constituted a shift to a low-exposure equilibrium.[15] A first set of stylized facts indicates that, in the 1999-2008 period, the euro area was in a situation of a high-exposure equilibrium, characterized by a convergence of interest rates between the core and the periphery, and the build up in core countries of large exposures to peripheral debt. A second set of stylized facts confirms that this paper's assumptions adequately describe the euro area during this period: exposures were hard to identify and, *ex post*, bailouts took the form of buybacks or non-targeted transfers.[16]

[14] The model can also shed light on the links between sponsors and money market mutual funds, as sponsors prefer injecting capital into MMMFs rather than directly protecting themselves (see Kacperczyk and Schnabel, 2012, among others), or for bad banks, such as in Spain with the Fund for Orderly Bank Restructuring, which involved buying back troubled assets from banks, or in the US with the Home Owners' Loan Corporation for home mortgages which began in 1933. The HOLC was founded by the HOLC Act in 1933 to purchase home mortgages from initial lenders. See Lowell (1951) for a more detailed description.

[15] To the best of my knowledge, facts 2 to 5 have not been documented elsewhere.

[16] See Appendix A for a description of data sources.

VI.1.1 1999-2008: a high-exposure equilibrium

Based on Theorem 1, we can interpret the period between 1999 and 2008 as a high-exposure equilibrium. Indeed this is supported by the following two facts:

Fact 1. *Peripheral European countries' bonds became almost perfect substitutes for core countries' bonds.*

After the introduction of the euro, spreads between countries narrowed and almost converged to 0, as plotted by Figure 1. This spread convergence did not derive from an economic or institutional convergence as shown by the sudden boom in those spreads after 2008.[17]

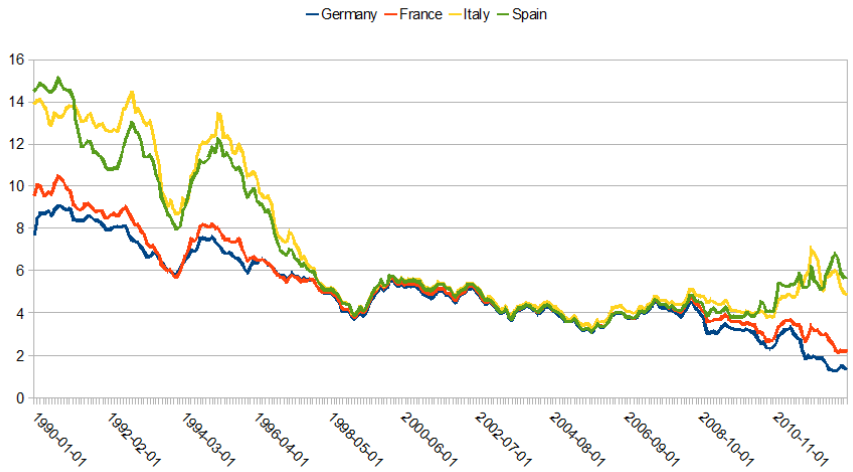

Figure 1 – Interest rates on core and peripheral countries' sovereign debts.

This graph plots the 10-year general government interest rates for France (red), Germany (blue), Italy (yellow) and Spain (green) between 1990 and the end of 2011.

Fact 2. *Peripheral debts were heavily purchased by core countries after the introduction of the euro.*

The share of Italian government debt held by foreign residents increased from roughly 17.8% at the end of 1998 to 41.9% in August 2008. For Spain, this share rose from 24.3% to 50.8%, while for Greece it jumped from 29.7% in 1999 to 66.2% in the third quarter of 2008.[18]

[17] Except, to some extent, for Spain, which grew faster at the beginning of the 2000s. See also De Grauwe and Ji (2013) who show that there is no clear relationship between spreads and fundamentals in the spread divergence, which is consistent with the theory based on a switch between equilibria.

[18] Similar externalizations of public debt were experienced by other European countries such as France or Germany and, on average, the share of externally held debt increased by 19.2 points between 1998 and 2008.

Most of these external debts were held by central European countries (see Hale and Obstfeld, 2014).

The introduction of the euro was followed not only by an increase in foreign holdings of public debt, but, more generally, by a sharp increase in countries' aggregate gross international exposures. In particular, GIIPS countries liabilities to the rest of the world increased more than their assets. For example, Greece's net foreign position fell from - 26% of domestic GDP in 1998 to -103% in 2007 while Portugal's fell from -24% in 1998 to -95.5% in 2007; the same pattern can be observed in Ireland and Spain, and, to some extent, in Italy.[19]

VI.1.2 Portfolio non-observability and non-targeted bailouts

Theorem 1 relies on the assumption that private portfolios are unobservable (Assumption 4). In this subsection, I test some specific features resulting from this non-observability.

Portfolio non-observability constrains bailouts to be either non-targeted bailout or to take the form of asset buybacks.

Fact 3. *Ex post bailouts involved the direct rescue of failing countries and buybacks of their debts.*

The rescue of peripheral countries in the euro area took the form either of buybacks or loans to peripheral governments.

The main example of a peripheral buyback was the European Central Bank's Securities Markets Program (SMP), through which it repurchased up to about EUR 200 billion of southern European sovereign bonds from the European private sector (see the ECB's weekly financial statements and Szczerbowicz, 2012, for a description of the ECB's unconventional measures).

In addition, the European sovereigns' toolbox also includes the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM). These two programs were initially designed to grant loans directly to countries, a move which can be interpreted as a direct rescue. In July 2011, the EFSF was also granted permission to intervene directly in secondary markets and thus buy back outstanding peripheral debt (see EFSF, 2011).

European countries also made transfers to banks, usually in the form of relatively non-targeted measures. The Long-Term Refinancing Operations (LTROs) of December 2011 and February 2012 allowed banks to borrow up to EUR 1 trillion for three years. Both core- and peripheral-country banks benefitted from these programs.

[19] Hale and Obstfeld (2014) further document the increased lending to the periphery by the core EMU countries.

Quantitatively, all these operations resulted in a major shift in the ownership of peripheral debt. For example, data from Arslanalp and Tsuda (2012) show that the fraction of Greek debt held by foreign official institutions climbed from 4% of total debt in Q1 2010 to 82% in Q3 2013. Similarly, for Portugal, it climbed from 8% to 50%, as plotted in Figure 2.

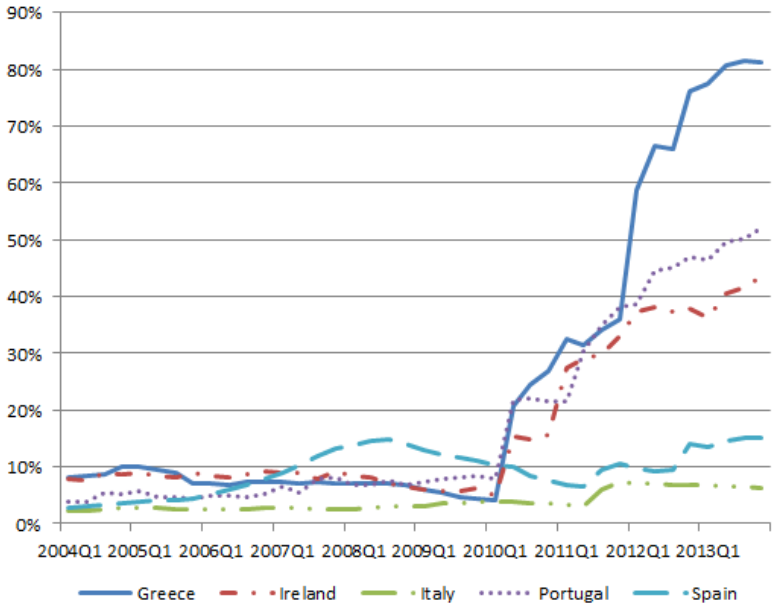

Figure 2 – Share of Foreign official sector holdings.

This graphs plot the share of foreign official holdings of domestic debt as a percentage of total debt, using the database from Arslanalp and Tsuda (2012), updated in May 2014.

Remark. The core countries' bailout of the periphery could also have taken the form of lending through the Eurosystem and the corresponding accumulation of TARGET2 imbalances (see Sinn and Wollmerhäuser (2012) or the discussion by Whelan (2014)). TARGET2 is the European real-time electronic payments system. Peripheral central banks' lending to the periphery corresponded to accumulation of liabilities towards core country's central bank.

Furthermore, because it creates the possibility of asset buybacks portfolio non-observability prevents risky assets from becoming excessively concentrated in the hands of core country investors (Corollary 2). Indeed, in the case of perfect information, agents in core countries would be perfectly insured against the peripheral default, leading them to purchase all peripheral debt.

Fact 4. *GIIPS banks remained heavily exposed to their own country's sovereign debt.*

The main banks in Greece, Italy, Portugal and Spain were highly exposed to their domestic sovereign debt, usually in amounts exceeding their Tier 1 capital (see Table 3 in the appendix).

This pattern can also be observed among Greek insurance companies. It indicates that GIIPS' sovereign debts appeared sufficiently safe to convince corporations to correlate their existence with them.

The two previous facts are only indirect assessments of the relevance of this paper's assumption on portfolio non-observability. The following stylized fact documents this non-observability in the context of the euro area.

Fact 5. *The indirect and, in some cases, even the direct exposures of European bondholders were almost impossible to identify.*

Measuring non-observability is a tough task. However, what the data suggest is that banks were highly exposed to sovereign debts and to peripheral debts, and, more specifically, that peripheral banks were heavily exposed to their domestic sovereign debt.

In addition, cross-exposures between banks were also massive. Indeed, interbank market loans represented 25% of total assets of German banks in 2005 (cf. Upper, 2007). As banks are usually exposed to their country up to more than their capital (cf. fact 4), to be exposed to a foreign bank is almost equivalent to be exposed directly to the sovereign. An alternative source of indirect exposures are repurchase agreements. In June 2006, according to ICMA (2007), 24.4% of the volume of repurchase agreements denominated in Euros in the euro area used Italian debt as collateral, 6.6% used Spanish debt and 3.1% used Greek debt. In comparison, 15% used French debt and 4.2% Netherlands' debt. Ultimately, the network of indirect exposures was hard to identify. This means that even if regulators knew banks' direct exposures, they were not necessarily able to know the exact exposure of each individual bank to each individual country.

Furthermore, information is constrained by both the number of regulated financial institutions (for instance, domestic banks or insurance companies) and the direct exposures of these regulated financial institutions. Regarding unregulated agents, their direct exposures usually account over a third of total public debts (cf. Table 4), and, in addition, regulated agents in one country can be unregulated from another country's point of view.

Remark. Anecdotal evidence on agencies in charge of issuing public debt suggests that officials do not have additional information on bond holdings. In the case of France, the corresponding agency, the Agence France Trésor, can only identify the primary dealers of its debt, i.e. those purchasing debt on behalf of other financial institutions (see EFC, 2000, for a precise description of the primary dealership for sovereign debt in the European Union).

VI.1.3 The period following 2008

Post-2008, and especially after 2010, spreads widened sharply. At the same time, in the case of Spain and Italy, peripheral public debts became more domestically owned (see Figure 3). Based on Theorem 1, this conjunction of higher spreads/lower exposures can be interpreted as a switch to a low-exposure equilibrium. In the case of Portugal or Greece, which were scarcely able to borrow from the financial markets, it can be even interpreted as a capital dry-out equilibrium.

What triggered the switch from one equilibrium to the other? An explanation consistent with this paper's model would be that, starting from 2008, investors grew increasingly fearful that they would not to be bailed out and, as a result, reduced their exposures to the periphery - a phenomenon that can be observed in the data. As government guarantees are self-fulfilling, these lower exposures would have confirmed the initial change in sentiment, and so the fear itself may have led to the equilibrium shift, so that the perception of credit risk was self-confirming.

External elements could have contributed to this equilibrium shift. Starting in 2008, European countries began to implement countercyclical fiscal measures to compensate for the slowdown in their economies. This translated into higher debt levels both in the core and in the periphery, making implicit guarantees less likely (see Corollary 1).

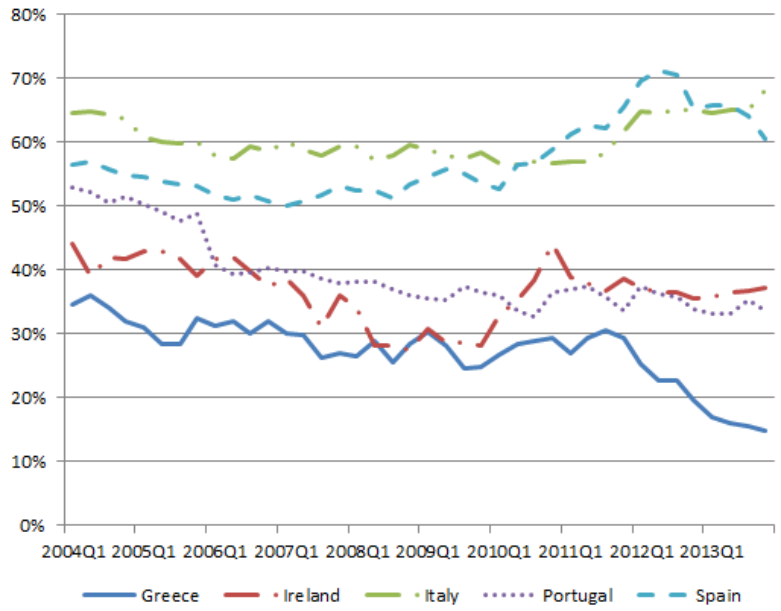

Figure 3 – Share of domestic holdings.

This graph plots the share of domestic holdings of domestic debt as a percentage of total debt, using the database from Arslanalp and Tsuda (2012), updated in May 2014.

VI.1.4 Alternative explanations and objections

The role of design of the euro area A possible objection to the application of this paper's theory to the euro area's sovereign debt crisis is that direct bailouts are explicitly ruled out under Art. 125 of the Treaty on the Functioning of the European Union:

> A Member State shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of another Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project.

However, as noted by Cooper et al. (2008), the European Union has limited power of enforcement. For deficit restrictions, for example, the European Council of Finance Ministers decided in November 2003 not to apply the penalties to France and Germany, even though their deficits exceeded the limit of 3% of GDP. This decision was enacted further in October 2005, when the European Council revised the Stability and Growth Pact and reduced the possible penalties.

Nevertheless, this paper's analysis emphasizes that a commitment not to bail out as in Art. 125 is desirable, although it should be backed up with consistent incentives (low exposures), and thus with *ex ante* measures such as capital controls. By comparison, the Stability and Growth Pact which requires EU countries to exercise fiscal discipline plays no role in preventing implicit guarantees.[20]

In particular, this paper's emphasis on limiting cross-country exposures also contrasts with McKinnon (1997), who highlighted the *ex ante* need of "national fiscal restraint".[21]

Banks' capture An alternative explanation for European bailouts could be that bailing out the periphery was a way of secretly bailing out the banks. Formally, this explanation is not very different from the one put forward in this paper, as it also emphasizes asymmetric information, here between core country residents and domestic banks/government. However,

[20] As for IMF intervention, what matters most is not the borrowing countries' policies, but the exposure of creditors. See the discussion below on "creditors' moral hazard.

[21] McKinnon (1997)'s precise statement is: "Because government bonds are widely held in pension funds, banks, and other financial institutions, any sizable European national government will be essentially "too big to fail" from the point of view of the new European Central Bank (ECB). Thus, despite what was written down at Maastricht, some kind of Europe-wide rescue operation would have to be mounted ; that might well require ECB support and threaten its independence. Thus national fiscal restraint is necessary ex ante." I thank Hugues Dastarac for indicating me this quotation.

as European banks were known to be among the main creditors of the periphery, this alternative form of asymmetric information seems to be less relevant than the non-observability of individual exposures.

Bondholder discrimination and retrenchment Broner et al. (Forthcoming) argue that domestic creditors are more likely to be repaid or compensated in the case of a default. As a result, they explain that the widening of spreads was caused by the crowding out of private capital in peripheral countries when domestic residents repurchased their countries' bonds.

By contrast, this paper argues that foreign creditors are more likely to be rescued (through buybacks or transfers) than domestic creditors, as they are backed by their less risky sovereign. This is consistent with the situation of the euro area, at least for Greece, Ireland and Portugal: first, no selective default has so far taken place within the euro area;[22] second, Greek, Irish and Portuguese debts became mostly held by official institutions rather than by domestic residents (cf. Figure 2).

Before 1999 and the elimination of currency risk Prior to the introduction of the euro, the diversity in sovereign spreads suggests that the area experienced a low-exposure equilibrium where sovereign risk was well priced in. An alternative explanation for the diversity in spreads is the presence of exchange rate risks in that period. This paper's conclusions hold for this kind of risks as well, to the extent that the exchange rate risk stemmed from an inability to commit not to devaluate.

In this regard, the idea in this paper that implicit guarantees on European peripheral countries derive from financial integration is consistent with empirical finding that financial integration resulted from the elimination of currency risk (see Kalemli-Ozcan et al., 2010).

VI.2 The IMF

A second application of this paper's theory is to the sovereign bailouts conducted by the International Monetary Fund. This application highlights the countervailing effects of two trends since the end of the Bretton Woods era: less regulated international capital flows that have led to larger cross-country exposures; and the coordination of bailouts with the IMF acting as a *crisis manager*.

[22]The private sector involvement interpreted by rating agencies as a default has not led to discrimination between nationality.

The view that the IMF's bailouts can create a moral hazard and that they could be captured by banks to bail themselves out is not uncommon (see Vaubel, 1983; Stiglitz, 2002, among others) but has also been heavily criticized (see Rogoff, 2002). This subsection only correlates the deregulation of financial flows with IMF bailouts and the increase in the private sector's (opaque) exposures to countries in crisis.

Capital-account regulation and cross-exposures Starting in the mid 1970s and accelerating in the 1980s, developed countries and then developing countries opened up their capital account. This opening up of capital flows allowed countries to build up larger foreign exposures. Obstfeld and Taylor (2003) show that the weight of foreign assets relative to world GDP was multiplied by 10 (from 6% to 62%) between 1960 and 1995. This contrasted with the Bretton Woods era of controlled capital movements and low cross-country exposures.

Larger IMF interventions At the same time, the IMF began to increase its lending: its outstanding credit substantially increased over the period as plotted in Figure 4.

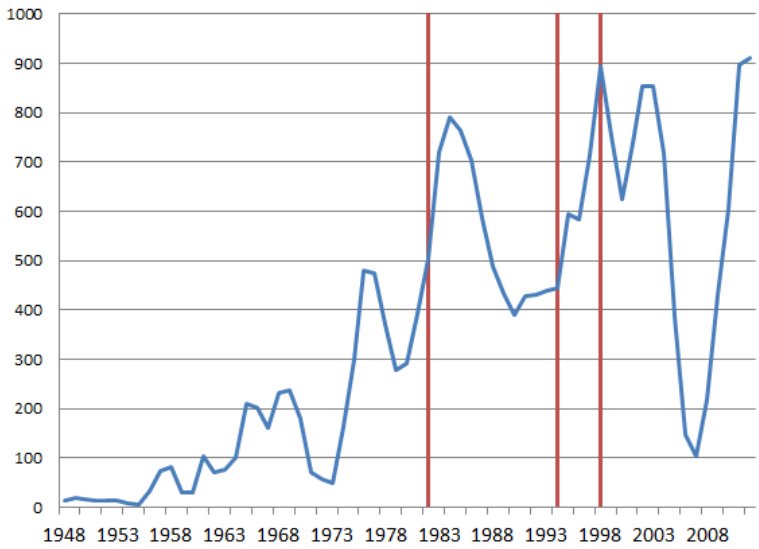

Figure 4 – IMF outstanding credit in real terms.

This graph plots the IMF's outstanding credit. Data are from the IMF's International Financial Statistics and are adjusted by GDP deflators of countries having SDRs. The vertical red lines indicate some of the main crises where the IMF intervened: Mexico in 1982 and in 1994 as well as the Asian crisis in 1997.

In addition, the proportion of IMF member placed under an IMF program increased sharply from 10% to more than 33% (see Bordo and James, 2000).[23]

[23]Note that this fraction was already as high as 25% during the Bretton Woods' era. Yet, it is interesting to note that after the IMF began to assume the role of a crisis manager in 1973, more countries were placed under

IMF interventions motivated by lenders' exposures As noted by Feldstein (1998), in 1982, "A default on [Mexican] obligations would have wiped out the capital of many leading banks in the United States, Europe, and Japan". Indeed, there is multiple evidence of the collateral effects of financial crises where the IMF intervened. For example, Kaminsky and Reinhart (2000) document that crises can spread to other countries through financial links, and Van Rijckeghem and Weder (2001) also document the impact of international banking exposures. Both of them emphasize the role of indirect financial links.

Remark. The effect on ex ante interest rates is less obvious than in the case of Europe. Indeed, as noted by Mussa (2004), emerging countries were not able to borrow at similar interest rates to those of developed countries. Nevertheless, subsequent research has shown the presence of a moral hazard component in asset prices (see Lee and Shin, 2008, among others).

Some implications These elements suggest that if we assume that emerging countries are the periphery and the IMF and developed countries' financial sector are the core, their situation can be regarded as a high-exposure equilibrium. Emerging countries benefit *ex ante* from easier and cheaper access to international capital markets and, *ex post*, the prospect of a bailout reduces the emerging countries' willingness to honor their debt.

The first implication is that, as in the benchmark model, there is a need for *ex ante* regulation of capital flows. The high-exposure situation is not optimal - taxpayers have to fund the IMF for bailouts of the periphery. Capital controls are needed in the countries where capital flows originate, in order to avoid large *ex post* exposures. This provides an alternative motive for capital controls: contrasting with the IMF's current institutional stance (IMF, 2012) which is to focus on the *ex post* effects on the countries receiving funds and holds that capital controls avoid "rapid capital inflow surges or disruptive outflows", this paper argues that capital controls are necessary from the point of view of the countries where flows originate to manage, in order to manage *ex post* bailout incentives.

The second implication concerns the sovereign "bankruptcy" regime. The absence of debt restructuring has been held up as one of the causes of IMF's bailouts; and this has been used to support calls for smooth sovereign bankruptcy procedures (cf. Miller and Zhang, 2000; Eichengreen, 2003). However, this pear argues that a defaulting country has no incentive to carry out an *ex post* debt restructuring or that, in other words, moral hazard due to foreign exposures leads to an absence of orderly debt restructurings.

programs than when it played the role of smoothing balance-of-payment crises during the fixed exchange rate regime.

VI.3 US 1790 bailout of its states and 1842 defaults

A third application of this paper's theory relates to the defaults of US states in the early 1840s. In 1790, Hamilton (1790) proposed that the Federal Government assumed responsibility for the states' debts. Conversely, between 1841 and 1843, a number of US states were allow to default on their debts (see English, 1996, for a detailed description).

Table 2 shows the fraction of US States' debts held abroad. In line with the theory put forward in this paper, the lower share of domestic exposures to states debts would suggest that a bailout of US States would be much less likely in the 1840s than in 1790 - which is precisely what happened.

	1790	1842
Total States' debt	\$18.2-25m	\$193m
State debts held abroad	\$.6m	\$ 100.0 - 150.0m
Fraction of state debts abroad	2.4-3.3%	51.8 - 77.7%

Table 2 – US state debts

Note: Total state debts in 1790 is from Hall and Sargent (2014) and in 1842 from Wallis (2000), Table 2. Foreign holdings of state debts are from Wilkins (1989), Table 3.1, pages 50-51. The figure for 1790 is actually for 1789, as no data on foreign exposures are available for 1790.

Foreign exposures to US states were built up in the anticipation a Federal bailout as argued by Sargent (2012) because of the reputation acquired due to the 1790 state bailout decided by Hamilton. To quote Sargent: "And investors in state bonds knew that the federal government *had* comprehensively bailed out state debts at the beginning of the republic." This paper argues that US Congress' decision not to implement a bailout in 1843 was caused not only by reputation concerns (the Congress considered such bailout would "cause recklessness and extravagance") but also because the domestic cost of not bailing out the states was sufficiently small.

VI.4 2008 financial crisis

This paper's framework can also shed some lights on financial crises and "bubbly" events. For example, by relabeling the systemic banks as being the core country's investors and subprime borrowers as being the periphery, the onset of the 2008 crisis can be understood as a high-exposure equilibrium where banks massively invested in securitized subprime loans

reducing interest rates charged on these loans and, ex post, resulted in bailouts, sometimes in the form of asset repurchase.

Indeed, the following facts are consistent with the model predictions that relates opacity with implicit guarantees. First, individual exposures were opaque: as discussed by Brunnermeier (2009) or Challe et al. (2013), structured products made the web of financial exposures more opaque, as, among others, those products were extensively exchanged on over-the-counter markets. Second, banks remained massively exposed to securitized loans (Coval et al., 2009; Duffie, 2008). Third, these loans ex ante benefited from relatively low interest rates (cf. Brunnermeier, 2009). Fourth, *ex post*, bailouts took the form of asset repurchases. This is, for example, the US Treasury's Trouble Asset Repurchase Program announced in 2008 or the Federal Reserve's purchases of Mortgage Backed Securities that peaked at $1200 billions in total in 2013 Q2.

In terms of policy recommendations, this paper emphasizes the need of controls such as capital requirements on banks' portfolio allocations. Yet, these requirements should not only take into account the market perception of risk (which is endogenous to the bailout expectations) as required by Basel II/Basel III, but should clearly limit the exposure of banks to some specific class of assets. Conversely, from this paper's point of view, transparency *per se* is not necessarily desirable (cf Section VII).

Remark. This application to the 2008 financial crisis and structured products offers an alternative explanation to Simsek (2013) for why financial innovation can be detrimental. Indeed, financial innovation in this episode led to more opacity, that made banks' regulation more difficult and, thus, implicit guarantees more likely.

VI.5 Global imbalances

An alternative application of this paper's framework may be 'global imbalances'. As described by Caballero et al. (2008), "global imbalances" include the following facts: first, the weight of US assets in global portfolios has increased since the early 1990s; second, the real interest rate paid by the US on their debt is very low; third, the US has run persistent current account deficits while other countries, such as emerging economies or Japan, have run current account surpluses. By relabeling the core as those countries running current account surpluses, and the US as the periphery, we can interpret global imbalances as a high-exposure equilibrium where the emerging countries' exposures to the US results in an guarantee of US debt and thus cheaper borrowing for the US.

Such an interpretation would yield very different policy recommendations compared with

current explanations of global imbalances. Indeed, these explanations often emphasize their role for insurance and international risk-sharing (Cf. Bernanke (2005) or, for example, Caballero et al. (2008) argue that the US have a better ability to produce financial assets) and so, from this point of view, "global imbalances" are efficient *per se*.[24] In contrast, this paper would argue that global imbalances are inefficient because of the resulting implicit guarantee on US debt. And the implication of Section V's conclusions would be that the countries running surpluses should restrict international financial outflows.

Yet, the application of the model to "global imbalances" is severely limited by the fact that a large fraction of US external debt is in the hands of official institutions. Concerning US government debt held abroad, two thirds are in the hands of official non-US institutions, and more precisely 41.6% are held by China and Japan.

VII Further discussion and extensions

In this section, I discuss some further issues related to implicit guarantees.

Public and private lending In the euro area, it was not only the amount of public debt that soared in peripheral countries, but also the amount of private debts. This boom in private debt may have resulted from the interaction between the guarantee one country can provide for another country's sovereign debt and the risks taken by the latter country's private sector. Indeed, the expected implicit guarantees on sovereign debt relaxed the peripheral country's budget constraint, making larger private sector bailouts possible. In addition, more protected peripheral private sectors were able to borrow more, potentially from core country lenders, thus increasing the need for core countries to rescue peripheral sovereigns, in order to protect their own domestic sectors.[25]

Implicit guarantees and real wages Implicit guarantees on peripheral debts in Europe may also have contributed to the increase in real and nominal wages in the periphery as documented by Schmitt-Grohé and Uribe (2013). Indeed, cheaper capital increased the marginal productivity of labor and, hence, real wages.[26]

[24] Of course, the resulting inflow of capital can have undesirable consequences as bubbles as sometimes argued, but this is interesting to notice that these consequences are only potential by-products of international capital flows.

[25] This assumes that the peripheral country finds a comparative advantage in bailing out its private sector.

[26] This effect on peripheral countries' labor markets may create a cost for peripheral countries in the presence of downward wage rigidities and an inability to devalue its currency (such as when a country stays within the

Central vs. decentralized international lending A possible objection to this paper's mechanism, is that, the core country can try to avoid implicit guarantees by intermediating lending to the periphery, e.g. by issuing domestic bonds backed by peripheral bonds. Yet, these bonds can also be perceived as being guaranteed by the core country's government and therefore be treated as substitutes for core bonds.

The role of leverage Hale and Obstfeld (2014) document that the EMU core countries increased their lending to the periphery, but also increased their borrowing outside the EMU. In terms of the model, this can be rationalized by considering positive pledgeable income for the core country's domestic agents and outside investors.

Outside investors would lend to core country residents, who would in turn lend to the periphery. In this case, the paper's conclusions on the existence of implicit guarantees would hold under the condition that the outside borrowing by the core is sufficiently low. Otherwise, large outside borrowing would preclude incentives for core country governments to bail out their residents. Indeed, if core countries' outside borrowing is sufficiently large, a bail out of domestic residents or a purchase of peripheral debt would ultimately be of more benefit to outside investors than to core country residents.

Shortage of safe assets and implicit guarantees Introducing agents with a strong preference for safe assets reduces the availability of risk-free assets and increases their price. More spefically, let me add to the model a continuum of mass ν of Knightian agents that are infinitively risk averse as in Caballero and Farhi (2013) and are endowed with one unit of good in period 0. These Knightian agents only purchase risk-free bonds.

In low-exposure equilibria and for a given level of G_C, these agents reduce the availability of risk-free assets for bankers from G_C to $G_C - \nu$, in turn causing the price of those assets to rise.. This pushes bankers to purchase more risky country P bonds, resulting in a greater likelihood of implicit guarantees:

Corollary 3. *The set of implicit guarantee equilibria increases with ν.*

In economic terms, this means that the likelihood of implicit guarantees is magnified by the demand for safe assets, as agents are forced to opt for foreign risky debts for liquidity purposes. Of course, one effect of implicit guarantees is that they produce a large amount of risk-free assets as country P's debt becomes risk-free as well. This also helps to satisfy the demand for safe assets.

euro area) as argued by Schmitt-Grohé and Uribe (2013).

Cross-exposures and financial networks The core country's inability to observe portfolios and to assess precisely the collateral damage that will be caused by a foreign country's default is rooted in the organization and degree of complexity of financial markets.[27] For example, in decentralized markets where financial institutions are massively interconnected, the country's ability to bail out is lower as individual exposures are much more difficult to assess, thus making implicit guarantees more likely.

Moreover, more fragile institutions, such as highly-leveraged banks, may increase the need for a rescue. Conversely, when losses due to default are small compared with financial institutions' capital, no rescue is required. This may explain why, contrary to Ireland, Portugal or Greece, Cyprus did not benefit from any large-scale foreign bailout.[28]

Financial networks are not just restricted to two countries, but can stretch across multiple countries. As a result, the cross-exposures of investment banks or financial institutions can spread losses concentrated within one country to the other countries. This *contagion effect* deeply modifies countries' bailout and rescue policies: when each country expects the others to bail out the defaulting country, there is no incentive for any country to take part in the rescue. This free-riding problem is exacerbated by the fact that country can manipulate the losses suffered by other countries by not implementing a domestic or international bailout, and so has even less incentives to carry out a rescue.

In addition, international financial networks carry an *information effect*. Countries are unable to precisely know the ultimate individual exposure of their residents, if they do not have information on the exposures of other countries' residents, even in the case where they would have have precise information on the direct exposures of their residents. This information effect has also been identified by Farhi and Tirole (2014).

These contagion and information effects are potential rationale for *ex post* coordination of policies, as the European banking union. However, the enhanced *ex post* coordination leads to a greater likelihood of implicit guarantees *ex ante*, and thus it can be detrimental.

VIII Conclusion

This paper builds a two-country model of implicit guarantees where a country's incentive to bail out another derives from its willingness to protect its domestic sector from the collateral

[27] I examine some of these points in an online appendix.

[28] In addition, Cyprus implemented the equivalent of a selective default as, in order to reimburse its debt, it taxed large deposits in domestic investment banks, which were mostly foreign-owned. Interestingly, Cyprus' problems were also rooted in the size of its banking sector's exposure to Greek debt.

damage of the other country's default. This preference for rescuing the other country derives from the inability to perfectly compensate domestic residents for their losses. Restricting financial flows *ex ante* by implementing capital controls helps to avoid the emergence of implicit guarantees. Considering alternative policies, the expectation of implicit guarantees can lead a risk-free country to issue more bonds and reduce the likelihood of such guarantees, without, however, fully preventing them.

My insights are based on a compensation mechanism that illustrates why governments might be tempted to buy back assets in order to prevent collateral damage to their own economy. As suggested in this paper, this mechanism may be at work not only for domestic or foreign sovereign debt, but for any assets. Empirical work highlighting the relationship in the data between asset prices and the allocation and opacity of asset holdings would be required to confirm the relevance of the mechanism, for example, in the case of private bubbles.

I leave all these questions for future research.

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Appendix

A Description of data

The data sources for this paper include the 2011 European Banking Authority's (EBA) stress tests for individual bank exposures. These stress tests provide data on the 90 largest banks within the European Union, furnished the banks themselves and by national banking supervisors. Available data include direct holdings of sovereign debt per country, indirect exposures through credit derivatives and exposures to the country's private sector. Further information and data are available on the EBA's website: http://stress-test.eba.europa.eu . Data are only available as of the start of the sovereign debt crisis, and banks may already have adjusted their exposures at that date.

Aggregate domestic and foreign holdings are from Arslanalp and Tsuda (2012). Their database provides estimate of holdings for 24 advanced economies, including France, Germany, Greece, Ireland, Italy, Portugal and Spain. Bond holdings are split between domestic official, banks' and non-banks' holdings as well as foreign official, banks' and non-banks' holdings.

General governments' interest rates are from the International Financial Statistics provided by the International Monetary Fund.

Greek banks' exposure to Greek debt				
Eurobank Ergasias	Nat. Bank of Greece	Alpha Bank	Piraeus Bank	TT Hellenic Postbank
172.8%	209.8%	93.8%	257.0%	434.3%
Italian banks' exposure to Italian debt				
Intesa San-Paolo	Unicredit	Montei dei Paschi	Banca Popolare	Ubi Banca
193.0%	114.0%	355.2%	173.3%	149.6%
Portuguese banks' exposure to Portuguese debt				
CGD	B. Comercial	Espirito Santo	Banco BPI	
92.4%	118.3%	46.0%	163.8%	
Spanish banks' exposure to Spanish debt				
B. Santander	BBVA	Bankia	La Caixa	B. Popular
95.9%	173.6%	140.4%	220.9%	97.8%

Table 3 – Domestic banks' exposure to domestic debt

Note: This table provides the net direct exposures as a percentage of banks' Tier 1 capital for the main Greek, Italian, Portuguese and Spanish banks, surveyed under the EBA's stress-tests.

	Greece	Portugal	Spain	Italy
Fraction of total debt held by residents	29.3%	36.2%	58.8%	56.8%
Identified part of public debt				
Foreign	51.3%	51.8%	39.0%	24.0%
Domestic	65.7%	34.4%	61.1%	21.4%

Table 4 – Identifiable exposures

Note: This table provides different fractions of public debt in 2011, during the European sovereign debt crisis. The identified portion of public debt is the ratio of debt held by official institutions and by banks surveyed by the EBA to total debt. This gives a measure of holdings by unregulated agents.

B Further extensions

B.1 Non-degenerate productivity distributions

I assume in the benchmark model that productivities follow a degenerate distribution. One may argue that introducing a non-degenerate distribution may induce country C to rescue country P when adding more heterogeneity in productivities. I show in this paragraph that this section's results are robust to such additions.

Indeed, let me substitute some high-productivity bankers with intermediate-productivity bankers with a positive productivity $0 < \underline{A} < 1$.

When anticipating no rescue (i.e. when $\Pi^P = \gamma$), low-productivity bankers would balance portfolios as high-productivity bankers. Incorporating those agents does not increase but decreases the covariance between exposures and productivities and, hence, country C's willingness to rescue country C.

Notice that these intermediate-productivity bankers are also indifferent between the two bonds when $\Pi^P = 1$ and they would only invest in country C when $\Pi^P = 0$.

B.2 Partial buybacks

In the benchmark model, I have ruled out partial buybacks, i.e. where country C chooses the price at which it buys back country P's bonds. Without affecting the general structure of equilibria, partial buybacks mainly modify high-exposure equilibria.

However, when the peripheral debt is sufficiently small $Z^P \leq 1 + \lambda^C$, there is no loss of generality to consider only full buybacks. Indeed, denoting by p the price at which country C buys back country P's debt, the optimal price p is such that:

$$\max_p \int_{i \in C} \beta f(z_i^C + p z_i^P) di - p Z^P.$$

Then p solves $\int_{i \in C} \beta z_i^P f'(z_i^C + p z_i^P) di - Z^P$. As a result, p increases with the correlation between exposures to country P (z_i^P) and marginal productivities ($f'(z_i^C + p z_i^P)$) and decreases with the total Z^P. Comparatively, the marginal cost of a transfer is at least λ^C.

From the bankers point of view, they are indifferent between holding country C's bonds and country P's bonds discounted at a gross rate p. This creates a continuum of equilibria with $p \in [0, 1]$, but all these

equilibria share the same real allocation than $p = 1$.

B.3 Ex ante bond issuance: some additional results

In this paragraph, I consider the *ex ante* bond issuance problem. I show that, for the core country, this can provide an - imperfect - alternative to capital controls, and that for the peripheral country, it can be a way to free-ride on the expectation of a bailout.

Sunspots To compare multiple equilibria *ex ante*, I introduce sunspots as a simplifying assumption. Country C and country P investors observe a common signal ξ uniformly distributed over $[0, 1]$. When $\xi \leq \overline{\xi}_1 \in [0, 1]$, I assume that country C investors coordinate on a high-exposure equilibrium leading to implicit guarantees. When $\xi \in \left[\overline{\xi}_1, \overline{\xi}_1 + \overline{\xi}_2\right]$, they coordinate on the low-exposure equilibrium and, finally, when $\xi \geq \overline{\xi}_1 + \overline{\xi}_2$, they coordinate on the capital dry-out equilibrium.

The ex ante probability of implicit guarantees is thus $\overline{\xi}_1$ and the probability of a capital dry-out in country P is $1 - \overline{\xi}_1 - \overline{\xi}_2$. Note that in the case where high-exposure equilibria do not exist, $\overline{\xi}_1 = 0$ and, when low-exposure equilibria do not exist, $\overline{\xi}_2 = 0$.

Finally, I assume that $\overline{\xi}_1$ and $\overline{\xi}_2$ are continuous and differentiable functions of parameters. In particular, when one set of equilibria with probability $\overline{\xi}_j$ expands (or decrease) according to a parameter ϵ, I assume that $\overline{\xi}'_j(\epsilon) > 0$ ($\overline{\xi}'_j(\epsilon) < 0$).

Country C Corollary 3 emphasizes that a scarce supply of risk-free bonds makes implicit guarantees more likely. In response, country C can issue more bonds.

Given a level of country P's debt Z^P, country C's program is:

$$\max_G f_C(G) + E\left(\beta W^e - \frac{G}{p^C}\right),$$

and the first order condition is:

$$\begin{aligned} &f'_C(G) + \overline{\xi}'_1(G)\left(W_{highexposure} - W_{lowexposure}\right) + \overline{\xi}'_2(G)\left(W_{capitaldryout} - W_{lowexposure}\right) \\ &+ \overline{\xi}_1(G)W'_{highexposure} + (1 - \overline{\xi}_1 - \overline{\xi}_2)W'_{lowexposure} + \overline{\xi}_2 W'_{capitaldryout} = 0. \end{aligned}$$

If country C's government would had taken the probability of implicit guarantees as given, this first order condition would have been:

$$f'_C(G) - \overline{\xi}_1(G)W'_{highexposure} + (1 - \overline{\xi}_1 - \overline{\xi}_2)W'_{lowexposure} + \overline{\xi}_2 W_{capitaldryout} = 0.$$

As $\overline{\xi}'_1(G) < 0$, the level of investment in country C, and, hence, the supply of risk-free bonds is higher when taking into account the effect on implicit guarantees than it would be if this effect were not taken into account. In other words, the potentiality of implicit guarantees forces the core country to issue more bonds.

Country P Country P's bond issuance entails other costs and benefits. Country P makes a trade-off between the gains from issuing debt that will be bought back by country C in the case of an *ex post* rescue, and the cost of repaying too much debt in the event that no rescue occurs. The optimal amount of debt solves:

$$f'^P(G^P) = (1 - \overline{\xi}_1 - \overline{\xi}_2)W'_{lowexposure} - (\overline{\xi}'_1 + \overline{\xi}'_2)W_{lowexposure}.$$

The following Proposition summarizes this paragraph's findings:

Proposition 10. *Country P's debt issuance is as follows:*

- *When the probability of a high-exposure equilibrium is strictly positive ($\bar{\xi}_1 > 0$), the riskier country P is (γ low), the more debt it will issue (G^P).*
- *When the probability that there will not be a high-exposure equilibrium is positive ($\bar{\xi}_1 < 0$), the smaller country P is (κ^P small), the less debt it will issue.*

In response, country C issues more debt as soon as this reduces the likelihood of implicit guarantees ($\bar{\xi}_1'(G) < 0$). In general, however, optimal debt issuance by country C does not rule out implicit guarantees ($\bar{\xi}_1 > 0$).

C Proofs

C.1 Proof of Proposition 2.

Single uniform transfers First, notice that cash w_i and A_i play the same role, so that I can consider only the mechanism revealing one or the other. The unconstrained problem solved by the government can be written as

$$\begin{aligned}&\max \beta(Af(T^1(A)) + T^2(A)) - T^1(A) - T^2(A)\\ &\text{s.t.} T^1_A(A)Af'(T^1(A)) + T^2_A(A) = 0\\ &T^2(A) \geq 0\end{aligned}$$

And so:

$$T^2(A) = \alpha - \int_0^A T^1_a a f'(T^1(a))da$$

This yields $T^1 = I$ and $T^2 = 1/\beta(\bar{I} - I)$. The first order condition does not guarantee that the maximum is global. In particular, while T^1 should remain positive for compensation, nothing prevents T^2 to be at a corner.

Then I can compare the outcome of two transfers with a single uniform one:

$$\beta \int_0^1 A(f(I_A) - f(T))g(A)dA + T - \int_0^1 I_A g(A)dA - \int_0^1 \frac{I_1 - I_A}{\beta} g(A)dA$$

Suppose $T = \int_0^1 I_A g(A)dA$, the expression becomes:

$$\beta \int_0^1 A(f(I_A) - f(T))g(A)dA - \int_0^1 \frac{I_1 - I_A}{\beta} g(A)dA$$

We can bound this expression, by denoting A_T the value of A such that $I_{A_T} = T$.

$$\begin{aligned}&\beta \int_{A_T}^1 A(f(I_A) - f(T))g(A)dA - \int_0^1 \frac{I_1 - I_A}{\beta} g(A)dA \leq\\ &\beta \int_{A_T}^1 f'(T)(I_A - T)g(A)dA \leq\\ &\int_{A_T}^1 \left((\beta f'(T)) (I_A - T)g(A)dA - \frac{I_1 - I_A}{\beta} \right) g(A)dA + \int_0^{A_T} \left(-\frac{I_1 - I_A}{\beta} \right) g(A)dA \leq\\ &\int_{A_T}^1 (\beta f'(T)) (I_1 - T)g(A)dA + \int_0^{A_T} \left(-\frac{I_1 - T}{\beta} \right) g(A)dA\end{aligned}$$

This latter expression can be simplified and we obtain:

$$\beta f'(T)(1-G(T)) \leq G(T)/\beta. \tag{1}$$

A sufficient condition is that:

$$\beta f'(T) \leq G(T)/\beta.$$

As $G(T) > 1/2$, a condition can be rewritten as $f'(T) < 1/(2\beta^2)$, which is satisfied when β is sufficiently small. We can further characterize the threshold $\overline{\beta}$. Indeed, inequality (1) evaluated at $\beta = 1$ yields:

$$f'(T) \leq G(T)/(1-G(T)) \tag{2}$$

Using Jensen's inequality, we have that a sufficient condition for this inequality to hold is:

$$\int_0^1 1/(A)g(A)dA \leq \int_0^1 f'(1/(A))g(A)dA$$

which holds as $f' > 1$.

C.2 Proof of Proposition 3.

Let us compare the two solutions and consider the direct bailout T using the same amount of resources as the buyback: $T = \int_0^1 (1-w_i)di$. The comparison becomes:

$$\int_0^{1/2} \rho_1(1-(w_i+T)1_{w_i+T<1} - 1_{w_i+T>1}) + \rho_2 - (w_i+T-1)1_{w_i+T>1} + di + \int_{1/2}^1 \beta\rho_2(1-w_i-T)di \geq 0$$

$$\int_0^{1/2} \rho_1(1-w_i 1_{w_i+T<1} - 1_{w_i+T>1}) + \rho_2(1-w_i)1_{w_i+T>1}di + \int_{1/2}^1 \rho_2(1-w_i)di \geq$$

$$T\left[\int_0^{1/2} \rho_1(1_{w_i+T<1}) + \rho_2 1_{w_i+T>1}di + \int_{1/2}^1 \rho_2 di\right]$$

When T is sufficiently large, this inequality becomes:

$$\int_0^1 \rho_2(1-w_i)di \geq T\rho_2 = \int_0^1 (1-w_i)di\rho_2$$

which is trivially satisfied, for sufficiently small T, we have:

$$\int_0^{1/2} \rho_1(1-w_i)di + \int_{1/2}^1 \rho_2(1-w_i)di \geq \int_0^1 (1-w_i)di(\rho_1+\rho_2)/2$$

which is condition 1. As the inequality is continuous in T, it is sufficient to satisfy condition 1 for having W_1 greater than W_0.

C.3 Proof of proposition 7

First, note that country C is better off not rescuing ($\eta = 0$) and, so, country P is better off repaying (π^P). Now, we need to find the portfolio allocation that both maximizes country P and country C's welfare. Homogenous portfolios ensure that country C does not rescue.

$$F_C\left(p^C Z^C\right) - Z^C + \beta(1-p^C Z^C - p^P Z^P) + \beta(1-\gamma)\left[f\left(T^C + z^C\right)di - T^C(1+\lambda^C)\right] + \gamma f\left(z^P + z^C\right)$$

The derivatives with respect to Z^C and Z^P are:

$$\left[(1-\gamma)f'\left(T^C+Z^C\right)-\gamma f'\left(z^P+z^C\right)\right]=p^C-\frac{1}{\beta}\left[p^C F'_C(p^C Z^C)-1\right]-\frac{\partial T^C}{\partial Z^C}(1-\gamma)f'\left(T^C+Z^C\right)$$

$$\gamma f'\left(Z^P+Z^C\right)=p^P$$

using the fact that $1+\lambda^C=f'\left(T^C+Z^C\right)$. Note that the derivative $\frac{\partial T^C}{\partial Z^C}$ is negative, implying that Z^C is higher than in the competitive market allocation. In addition, in comparison with the FOC of the commitment allocation, there is additional terms: $(1-\gamma)(f'\left(Z^C\right)-f'\left(T^C+Z^C\right)(1+\frac{\partial T^C}{\partial Z^C})$ which is positive.

Conversely, country P has to ensure that $\pi^P=1$, i.e.:

$$\int_{i\in P} f_i\left(T^P+z_C^i\right)di-T^P\kappa^P(1+\lambda^P)\leq\int_{i\in P} f_i\left(z_P^i+z_C^i\right)di-\int_{i\in C} z_C^i di-\int_{i\in P} z_P^i di$$

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