Sovereign Debt Crises and Bond Ownership: Testing the Secondary Market Theory

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PRELIMINARY AND INCOMPLETE

Abstract

We assess the reallocation of debt positions through secondary markets after an adverse solvency shock to a debtor economy. In a theory part, we assume that sovereign bonds are traded in secondary markets between the time in which an adverse shock is observed and the time in which the government decides on the repayment of foreign creditors. Following the shock, the affected government bonds are reallocated from foreign to domestic investors. We test this prediction, focusing on the adverse shock that hit a number of countries in the ongoing financial crisis. Using data on cross-border and domestic banks' exposure to sovereign debt that stem, respectively, from the BIS and the IFS we provide strong support for the theory of secondary markets. The reallocation of debt positions in crisis countries from foreign to domestic banks is both statistically and economically significant.

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1 Introduction

Governments who maximize domestic welfare tend to default on their debt when it is held by foreigners. This logic has governed the conventional theory of international portfolio investment, yet fails in the presence of secondary bond markets. Under a looming default, foreign investors sell government bonds while local investors purchase them, knowing that the governments will honor its locally held debt. Secondary bond markets thus act as a substitute of the missing enforcement mechanism for sovereign debt and help sustaining levels of international asset positions, which would not be otherwise sustainable.

The rich implications of secondary bond markets have recently been highlighted by Broner, Martin and Ventura (2010) (hereafter BMV). While it is difficult to empirically assess the influence of secondary markets on the level of foreign-owned sovereign debt in cross-section, the theory exhibits a sharp and testable implication for time series data: following a shock that raises the default temptation of a sovereign, its bonds are reallocated to local investors. Intuitively, this reallocation raises the sovereign's disutility from default and restores its incentive to honor debt contracts. In the words of BMV, when "penalties are known to be insufficient foreign creditors try to sell their debts, perhaps at a discount, and 'leave' the country."

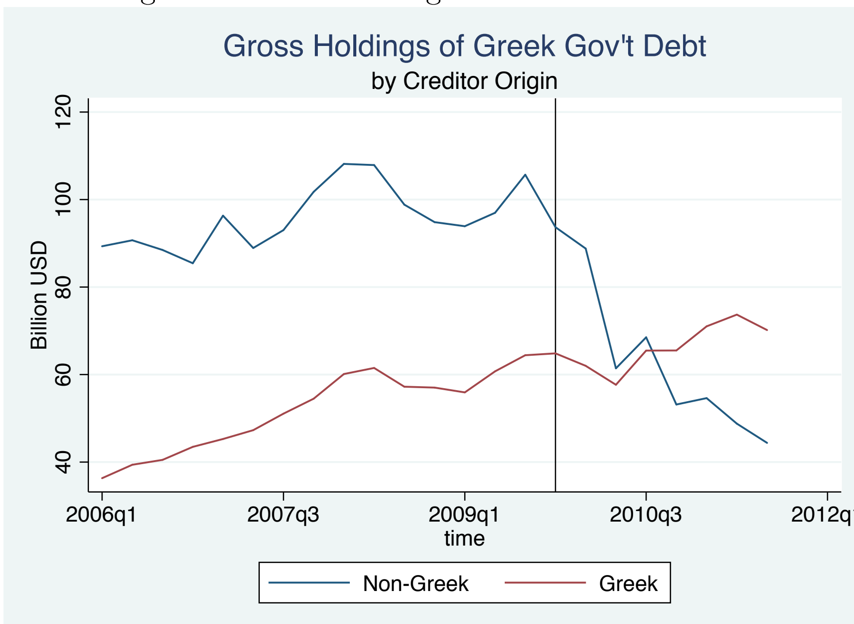
The present paper tests this prediction using data on sovereign debt positions of domestic and foreign banks. We present evidence in support of the secondary market theory, showing that the sovereign debt of those countries, whose ability (or willingness) to service debt deteriorated, was effectively reallocated to domestic banks.

A point in case is Greece. The Eurostat revision of previously misreported public finance data in late 2009 arguably scattered the market's perceived sustainability of Greek sovereign debt. Measures of Greek default risk rose from around 1 percent to over 10 percent within the following two years.[1] Figure 1 depicts the evolution of gross holdings of Greek public debt by Greek and non-Greek banks between 2006 and 2010. As predicted by the secondary market theory, the figure shows a pronounced drop in the foreign holdings of Greek sovereign debt, which is mirrored by a (somewhat less pronounced) increase in

[1] The sovereign Credit Default Swaps, a conventional measure of default risk, stood at 124.6 basis points on October 1^{st} 2009 and exceeded 1000 basis points in early 2011.

domestic holdings.[2]

Figure 1: Gross Holdings of Greek Public Debt



Source: BIS and IFS. The set of foreign countries includes Austria, Australia, Belgium, Brazil, Canada, Switzerland, Chile, Germany, Denmark, Spain, Finland, France, United Kingdom, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Sweden, Singapore, Turkey, Chinese Taipei, United States.

Motivated by these observations, we take a closer look at the data and test whether bond positions are systematically reallocated from foreign to local investors as sovereign crises unfold. Specifically, we apply a difference-in-difference approach on a panel of bilateral sovereign bond positions to test the effect of a crisis episode on bond ownership. Our data comprise quarterly bilateral positions for 29 reporting countries between the years 2006 and 2011. Focusing on the ongoing Euro Crisis, we define a country to be in crisis if, first, it is member of the Euro Area and, second, its bond yields exceed the threshold of 700 basis points, which is considered to be a critical level by financial market observers.[3] Applied to

[2]A large part of the "missing" Greek debt was transferred to the European Central Bank's balance sheet and thus does not appear in the our data sources.

[3]We check the sensitivity of our results by considering a crisis threshold of 600 and 500 basis points. We also use bond yields to capture the effect of marginal increases in the risk of default, independently of any specific crisis threshold.

our dataset, this definition identifies Greece, Ireland and Portugal as crisis countries.[4] Our results show that local investors increase their debt holdings as a country enters a crisis, while foreign investors wind down their positions. According to our baseline specification, domestic positions of sovereign debt in the crisis countries increased by more than six times (634%) relative to foreign positions. Overall, there is clear evidence that sovereign debt flows back to the originating country in times of crisis.

We acknowledge that the decision to restructure the debt of one country might be a collective choice of many states rather than that of one single country. Specifically, past negotiation rounds in the Euro Crisis that involved the Greek government, the European Commission and the European Central Bank have shown that some European states had a good share in the decision if and how to restructure Greek debt. In such situations, the notion of local investors should be expanded to residents of those countries, which ultimately decide whether a default will happen. In the specific context of the Euro Crisis, the secondary market theory predicts a reallocation of debt from non-member states to member states of the Euro area. According tests show that, indeed, debt from the European crisis countries flows not only to the originating countries but also to members of the Euro area, and to more so, the higher is their respective political weight.

A crucial assumption for our estimation strategy is that a crisis of a country is exogenous to the allocations of its sovereign debt. If this assumption is violated, our results may be biased, potentially through reverse causality or omitted variables. We argue, however, that reverse causality is not likely to affect our results. According to the usual narrative of the Euro Crisis, indeed, the increase in risk premia in our set of crisis countries (Greece, Ireland and Portugal and, in some specifications, Italy and Spain) was mainly the result of deteriorating fundamentals and unsound policies. We find instead implausible that investors charged large premia in anticipation of an increase in the relative positions of local investors. This view is also corroborated by the fact that debt positions in the crisis countries are reallocated only after the start of the respective crisis (compare Figure 1 for the case of Greece), i.e., with a lag to the financial market's awareness of the distress affecting these countries.

[4] Italy and Spain are also included in the set of crisis countries when the threshold for the crisis is lowered to 500 basis points.

Problems of omitted variables are less easily dismissed. Indeed, it is possible that an unobserved negative shock to the fundamentals of, say, the Greek economy degrades at the same time the health of its banking system and the solvency of the Greek government. If Greek banks react to such shocks by investing in risky assets in an attempt to gamble for resurrection, the reallocation of Greek sovereign debt to Greek banks could be independent of the sovereign's incentives to repay debt. In our empirical specifications we control for such effects and find that our results do not change qualitatively: we still find that positions of domestic sovereign debt in crisis countries increased significantly. We are thus confident to have identified the endogenous default temptations as the true motives for reallocations in the bond market.

Some doubts must be addressed, which necessarily arise when mapping a stylized model to the data. First, an implicit assumption of the secondary market theory is that we should observe a reallocation of debt to local investors only after an adverse shock makes the outstanding level of debt no longer sustainable. Foreign investors, in particular, will flee the local bond market only if they expect a default. If this condition is not satisfied the theory is inconclusive about the direction of bond flows. This concern, however, appears to be a minor one due to our definition of a crisis: bond yields above 7 percent have typically spurred among investors severe fear of imminent debt restructuring by the country.

Another concern that also relates to the country's default temptations would contend that some crisis countries like Greece defaulted on their debt regardless of the reallocations of its sovereign bonds. Reading the model with a grain of salt, however, we can apply the argument at the margin, suggesting that in the absence of bond reallocations the haircut could have been even larger. Alternatively, one may think of a setup where secondary markets operate in presence of some uncertainty about future economic conditions and the reallocation of sovereign debt merely reduces the probability of default without eliminating it. Describing such a scenario, BMV write that "[i]f enough trading takes place before maturity, the government no longer gains much from defaulting on foreign debts and ends up enforcing them. Default has been averted. If not enough trading takes place before maturity, the government still has sizable gains from defaulting on foreign debts and decides not to enforce them. Default takes place, and the debt renegotiation phase starts." In such a setup, local investors will purchase their own sovereign's debt only at a discount that compensates them for a possible default. Indeed, bonds of crisis countries were traded at heavy discounts in secondary markets, which underpins this interpretation of the model.

Our paper contributes to the extensive sovereign debt literature. This literature has largely focused on the lack of enforcement for sovereign debt and on the role played by default penalties (e.g., financial autarky, trade sanctions, reputation spillovers) to sustain sovereign borrowing.[5] The general policy prescription of this literature is that penalties should be harsher to expand the access to credit of countries with little credibility in the eyes of creditors, and thus improve ex-ante welfare. The secondary market theory of BMV views instead the problem of sovereign risk as one of a missing market. Indeed, their theory shows that, in the extreme case of a frictionless secondary market, the lack of enforcement in sovereign debt plays no role on borrowing. Thus, policymakers should improve the functioning of secondary markets as an alternative margin to expand emerging markets' access to credit. Our contribution to the literature is to provide evidence that is consistent with that unconventional interpretation of sovereign risk problems.

The remainder of the paper is structured as follows. Section 2 develops a tractable model to formulate the main hypothesis, which is subsequently tested in Section 3. In Section 4, we perform a number of robustness checks. Finally, Section 5 concludes.

2 The Model

In this section, we present a simple model of international borrowing by a small open economy, characterized by the existence of sovereign risk and of a secondary markets for the country's debt. Our goal is to characterize the response of secondary markets to solvency shocks to the economy.

[5]Influential contributions in the literature include Eaton and Gersovitz (1981), Grossman and Van Huyck (1988), Bulow and Rogoff (1989), Cole and Kehoe (1998, 2000), Kletzer and Wright (2000), among others. See also the survey papers by Eaton, Gersovitz and Stiglitz (1986) and by Eaton and Fernandez (1995). A more recent strand of the literature includes Aguiar and Gopinath (2006), Yue (2006), Arellano (2008), Cuadra and Sapriza (2008), Sandleris (2008), Hatchondo, Martinez and Sapriza (2009), Broner and Ventura (2010, 2011), Brutti (2011), Gennaioli et al. (2009), Mendoza and Yue (2011).

2.1 Model Setup

We consider a small open economy that lasts two periods, indexed by $t = 0, 1$. The economy is inhabited by a continuum of private agents with unit measure, who are indexed by $i \in [0, 1]$. There is a single homogenous good that can be used for consumption and cannot be stored.

In the first period, at date 0, private agents have zero endowments of the consumption good. In the second period, there are two possible states of nature. In the good state, each agent receives y_h units of the good, whereas he receives y_l units in the bad state, where $y_h > y_l > 0$. We denote the probability of the good and the bad state as π and $1 - \pi$, respectively.

Each agent has preferences represented by the utility function

$$U(i) = u\big(c_0(i)\big) + \pi u\big(c_{1,h}(i)\big) + (1 - \pi)u\big(c_{1,l}(i)\big) \tag{1}$$

where the function $u(\cdot)$ is strictly increasing and concave. For simplicity there is no discounting. Here, $c_0(i)$ denotes consumption of agent i at date 0 and $c_{1,s}(i)$ the corresponding state-dependent consumption at date 1.

In order to smooth consumption intertemporally, each domestic agent can trade a non-contingent bond with competitive and risk-neutral foreign lenders. As domestic agents have no endowment at date 0, they will want to borrow from abroad to smooth consumption. The budget constraint of each agent at date 0 is given by

$$c_0(i) = q_0 b(i) \tag{2}$$

where $b(i)$ denotes the quantity of bonds issued by agent i at date 0 at the price q_0. The consumption goods acts as the numeraire. In absence of frictions to international asset trade, the bond price equals the inverse of the foreign gross interest rate, which will be throughout normalized to one.

Finally, there is a domestic government, whose only role is to decide whether to enforce financial contracts. Enforcement frictions represent a key aspect of this model.

2.2 Timeline

We assume that, upon maturity of bonds, the domestic government can decide to enforce repayment of the bond issued at date 0. There is no other role for the government in this model.

The specific timeline is as follows. At date 0, domestic agents borrow and consume. Then, at the start of date 1, nature decides on the endowment shock of domestic individuals. Thereafter, a market opens for bonds that were issued at date 0. This market is called the secondary market. Next, the government makes his enforcement decision and finally domestic agents service their debt, provided they are obliged to, and consume.

2.3 Secondary Markets and Enforcement

Secondary markets enable domestic and foreign agents to trade the bonds issued at date 0 by the domestic agents in the primary market. We denote by $x_s(i)$ the quantity of bonds issued by other domestic agents at date 0 and purchased by agent i in the secondary market, and by $x_s(-i)$ the quantity of bonds issued by agent i at date 0 and purchased by other domestic agents in period 1. The subscripts s indicate that these quantities are state-dependent.

When financial contracts are enforced, the budget constraint of each domestic agent at date 1 is

$$c_{1,s}(i) = y_s + [x_s(i) - q_{1,s}x_s(i)] - [b(i) - x_s(-i)] - x_s(-i) \qquad s = h, l \tag{3}$$

where $q_{1,s}$ denote the market price of domestic bonds at date 1, conditional of state s. This bond price is equal for all bonds.[6] Looking at the right hand side of this equation, the term in the first squared brackets represents the return on the bonds purchased by agent i at date 1, the term in the second squared brackets is the amount of debt owed by agent i to foreign creditors at the end of period 1, while the last term is amount owed to other domestic agents.

Financial contracts, however, may not be enforced. More precisely, when the government chooses whether to enforce contracts, it may choose to enforce the repayment of foreign and domestic creditors separately. In other words, enforcement is discriminatory between

[6] Indeed, the bond price depends on the government's enforcement decisions and the government cannot discriminate by issuer, i.e. by domestic agents at the moment of enforcement.

foreign and domestic claimants in this model.[7] For simplicity, however, we will just focus on a case where the government can choose to not enforce the repayment of foreign creditors.

When financial claims of foreigners are not enforced the economy suffers a loss. Specifically, we follow a standard assumption of the sovereign debt literature and consider that, in the event of a default on foreigners, the income of each domestic agent drops by a constant fraction $\alpha \in (0, 1)$. This assumption reflects a general drop in output that could result from a wide range of different penalties applicable by foreign creditors (e.g. trade sanctions, financial markets exclusion). Thus, if the repayment of foreign creditors is not enforced, the corresponding budget constraint at date 1 is

$$c_{1,s}(i) = (1 - \alpha)y_s + [x_s(i) - q_{1,s}x_s(i)] - x_s(-i) \qquad s = h, l. \tag{4}$$

Following the extensive sovereign debt literature, we assume that the government maximizes the average utility of domestic agents. Thus, the government's choice concerning the enforcement of financial contracts depends on the size of the penalty relative to the debt owed to foreigners. More precisely, since the government decides in the second period, its decision depends on the levels of domestic welfare in the second period under enforcement and non-enforcement, which, in turn, depend on the realization of the endowment shock.

With expressions (3) and (4) it is easy to compare the respective domestic welfare. In case of debt enforcement, the second's period aggregate welfare is

$$W^r = \int_0^1 u\big(c_{1,s}(i)\big)di, \tag{5}$$

where the individual consumption is given by equation (3).

When debt contracts are not enforced, however, the output penalty applies and the value of the second's period aggregate welfare is, according to (3)

$$W^d = \int_0^1 u\Big((1 - \alpha)y_s + \big(x_s(i) - q_{1,s}x_s(i)\big) - x_s(-i)\Big)di. \tag{6}$$

[7]Several papers in the sovereign risk literature take the opposite assumption of non discrimination. As justification for this assumption is the presence of well functioning secondary markets for debt. As we will show in the remainder of the paper, even in the presence of discriminatory enforcement, the existence of a secondary market implies that foreign and domestic agents will in fact be able to redeem the bond at the same value. There is thus no difference between the assumption of discriminatory enforcement with secondary markets and non-discriminatory redemption of debt.

In the following, we will focus on symmetric equilibria, i.e. on equilibria, in which domestic agents all purchase the same amount of bonds in the secondary market. These equilibria are characterized by $x_s(i) = x_s(-i)$.[8]

We have now completed the description of the model setup. Next, we analyze the effects of an adverse shock to domestic output ($y_s = y_l$) on the allocation of debt between domestic and foreign agents. Doing so, we need to proceed by steps. We start from a benchmark case with full enforcement, i.e. a world where the domestic government has no choice but to enforce financial contracts.

2.3.1 Perfect Enforcement

When financial contracts are always enforced, the arrival of new information at date 1 about the state of the economy has no effect on secondary markets. Anticipating enforcement of debt contracts in any state s, foreign bondholders do not sell bonds at less than the face value. Thus, in equilibrium $q^*_{1,s} = q^*_0 = 1$ for any s. At this price, domestic agents have no incentive to buy and, assuming that the volume of transactions is minimized in equilibrium, there is no change in the allocation of debt. Thus, $x^*_s(i) = x^*_s(-i) = 0$ for any i.

We now solve for the quantity of bonds issued by each agent i at date 0. All individuals are identical and we can consider a representative agent, omitting the index i. With (2), (3) and $x^*_s(i) = x^*_s(-i) = 0$, $q^*_{1,s} = q^*_0 = 1$, the first-order conditions of the agent's problem yield

$$u'(c_0) = \pi u'(c_{1,h}) + (1-\pi)u'(c_{1,l}) \tag{7}$$

Together, these equations are sufficient to characterize the equilibrium. In search of a closed-form solution, we assume a quadratic utility function, i.e. $u(c) = \alpha c - \frac{\beta}{2}c^2$ with $\alpha, \beta > 0$.[9] We can thus rewrite (7) as

$$c_0 = \pi c_{1,h} + (1-\pi)c_{1,l}.$$

Substituting this condition into the agent's intertemporal budget constraint, the value of

[8] We show below that individuals have no incentive to deviate from the symmetric investment strategies in symmetric equilibria.

[9] Assume $\beta < \frac{\alpha}{y_h}$ to ensure that the marginal utility from consumption is always positive.

date 0 consumption is

$$c_0^* = \frac{1}{2}[\pi y_h + (1-\pi)y_l]. \tag{8}$$

As the agent has zero endowment at date 0, this level of consumption equals the quantity of bonds issued by the agent at date 0 ($b^* = c_0^*$). Finally, the consumption in each of the two states of date 1 is

$$c_{1,s}^* = y_s - \frac{1}{2}[\pi y_h + (1-\pi)y_l] \qquad s = h, l.$$

Throughout, we will refer to c_0^* and $c_{1,s}^*$ as the *full-enforcement* consumption allocation. Likewise, b^* and x_s^* characterize the asset allocation with full enforcement.

We have now characterized the equilibrium under perfect enforcement. In the next section, we will analyze strategic enforcement, assuming that the government can decide whether or not to enforce repayment. Doing so, we will first consider a world free of secondary markets.

2.3.2 Strategic Enforcement without Secondary Markets

We switch off trade in secondary market by setting $x_s(i) = x_s(i) = 0$ for all i. After observing the realized state and the allocation of debt at the beginning of date 1, the government chooses whether to enforce debt contracts or not by solving

$$\max\{W^r, W^d\},$$

where W^r and W^d denote the aggregate welfare with and without enforcement, as defined in (5) and (6). Clearly, the government will enforce contracts if and only if enforcement dominates default ($W^r \geq W^d$). Exploiting the symmetry across individuals, the condition for enforcement is thus

$$y_s - b \geq (1-\alpha)y_s. \tag{9}$$

We shall now distinguish between normal times, where the economy output is large and the cost of the penalty offsets the gain from default, and crisis times, characterized by the opposite situation. We thus need to impose that, when the agent's debt is equal to the full-enforcement value, repayment is not incentive compatible in the bad state of the economy, ($y_s = y_l$). Substituting for $b^* = c_0^*$ from (8) in (9), this is ensured by

$$\alpha < \overline{\alpha} \equiv \frac{1}{2}\frac{\pi y_h + (1-\pi)y_l}{y_l}. \tag{10}$$

We impose a second condition on α, assuming that

$$\alpha > \underline{\alpha} \equiv \frac{1}{2}\frac{\pi y_h + (1-\pi)y_l}{y_h}. \tag{11}$$

This condition requires that, if bonds are issued at zero premium, the government prefers to enforce contracts under high output. Notice, however, that the conditionality is strong, since bonds must be issued at premium as long as default occurs with positive probability.

In the next section, we show that in the presence of secondary markets a low realization of output will be associated with a reallocation of debt between domestic and foreign creditors, which will avert default. The premium on bonds will thus be zero, making condition (11) sufficient to guarantee that in the good state there is no trade in secondary markets.

2.3.3 Strategic Enforcement with Secondary Markets

Assume now that foreign and domestic agents can trade bonds in a secondary market at date 1, after observing the state of the economy. Suppose that the initial value of debt held by foreign creditors is incentive-compatible only in the state of the world with high output. Intuitively, low output triggers a rush by foreign creditors to sell the bond at any price, anticipating that the government prefers a default at the prevailing debt allocation.

Consider now an arbitrary domestic agent. Given that the government can discriminate across domestic and foreign contracts and given that domestic debt contracts are always enforced, the agent can profit from purchasing the bond at a low price from foreign agents and redeem it at face value upon maturity. Since domestic agents are competitive, in equilibrium the price of bonds in the secondary market must satisfy $q_{1,l} = 1$.

The reallocation of debt will continue until the value of debt held by foreign agents reaches the value of the penalty, which a default would impose on the borrowing country. Once this point is reached, foreigners will have no reason to sell the bond and, maintaining the assumption that the volume of transactions is minimized in equilibrium, the activity of the secondary market will stop. Specifically, the equilibrium is reached when $W^r = W^d$. Rearranging (3) and (4) at the respective bond prices under repayment ($q_{1,l} = 1$) and default ($q_{1,l} = 0$) and focusing on a symmetric allocation of debt across domestic individuals, we can write this condition as

$$y_l - (b - x_l) = (1-\alpha)y_l, \tag{12}$$

where x_l denotes the quantity of debt purchased by the representative domestic agent from foreign creditors. We can further compute with (2), (10), (12) and $q_0 = 1$ that the equilibrium amount of domestic repurchased debt is positive:

$$x_l = \frac{1}{2}[\pi y_h + (1 - \pi - 2\alpha) y_l] > 0.$$

Thus, conditions (10) and (11) on the cost of default, α, guarantee that there will be a reallocation of debt only after low output:

$$x_s = \begin{cases} 0 & if \quad s = h \\ \frac{1}{2}[\pi y_h + (1 - \pi - 2\alpha) y_l] & if \quad s = l \end{cases}.$$

Overall, we have thus shown that the equilibrium with strategic enforcement and secondary markets is,, in terms of real allocation and the amount of borrowing at date 0, equivalent to the equilibrium with full enforcement. More importantly, the model predicts that sovereign debt should flow back into the originating country when a shock adversely affects the country's solvency. Such reallocation will continue until the incentives of the government to enforce financial contracts are restored.

3 Empirical Evidence

In this section we test the predictions of the secondary market theory by studying the response of local and foreign investors when an adverse shock hits a sovereign borrower. Specifically, our identification strategy relies on the fact that a number of countries within the Euro Area (namely, the "PIIGS" countries) suffered a negative shock during the period 2006 to 2012 which was exogenous to the subsequent reallocations on the sovereign bond market and which put into question these countries' ability to repay debt.

Under this assumption, the secondary market theory can be tested using a panel regression of the following type

$$p_{c,b,t} = \alpha + \beta \cdot Crisis_{b,t} * I_{b=c} + \gamma \cdot controls + \varepsilon_{c,b,t} \qquad (13)$$

In the econometric model (13) the subscripts c and b indicate the creditor and borrower country, respectively, and t indicates time, measured either in years or quarters. The variable $p_{c,b,t}$ on the left then indicates the logged amount of sovereign debt issued by country b and held by country c at time t.[10]

On the right hand side, the function $Crisis_{b,t}$ is a dummy variable that equals one whenever country b was in crisis in period t, that is, when its bond yields exceeded 700 basis points. We initially apply our definition of crisis only to countries in the Euro Area to reduce the endogeneity of our crisis definition to changes in debt positions. Indeed, the crisis that hit some of these countries is commonly viewed as the result of weak fundamentals and structural imbalances in public finances and is thus exogenous to changes in sovereign debt positions. The indicator $I_{b=c}$, instead, is a dummy variable that indicates whether the borrower country is identical to the creditor country, i.e., if the reported bond positions are held by local investors.

The set of control variables includes a number of fixed effects, which is expanding across different specifications, plus some additional interaction terms, which we describe when we present the estimation results. Finally, the error term $\varepsilon_{c,b,t}$ is assumed to be iid across time and country pairs. We will relax this assumption in a subsequent stage.

Our primary aim is to estimate the coefficient β in model (13). As the set of controls includes the individual term $Crisis_{b,t}$, this coefficient measures the rate at which local exposure to government debt changes relatively to foreign exposure in periods of crisis, and thus its estimates should be positive according to the secondary market theory. A word of caution is in order here as the change in relative positions does not necessarily imply that sovereign debt did flow back in the originating country, as predicted by the model. We acknowledge indeed that policy intervention in secondary markets has been heavy during the heights of the crisis (see for instance the massive bond purchases by the ECB). Yet, the same difference in default expectations that explains why domestic investors buy back sovereign debt in the model, may also explain why locals relatively abstained from selling bonds to the ECB. Further, we also find evidence that local bond positions have increased in crisis periods both relatively to foreign positions and to local positions in non-crisis periods, substantiating the existence of secondary markets purchases by domestic investors.

[10]More precisely, $p_{c,b,t}$ denotes the log of one plus the according sovereign debt position to avoid treating zero-valued positions as missing observations. The same approach has been widely applied to deal with zero observations in gravity models of bilateral trade, as reported by Santos Silva and Tenreyro (2006). As a robustness exercise, we will apply a method proposed by these authors to deal with this and other problems that arise when estimating log-linear transformations of a specific class of models which encompass the specification in (13).

3.1 Data

We use data on bilateral bond positions of commercial banks from the Consolidated Banking Statistics of the BIS. These data comprise banks' on-balance sheet positions of government debt.[11] Positions are first consolidated within each banking group (i.e., positions are net of inter-office accounts) and aggregated at the national level, and then are broken down by country of issuance. Debt positions are reported at market values in USD millions and then classified on an immediate-borrower basis.[12] Data are reported on a quarterly basis for a set of 29 reporting countries. We focus on the period between 2006Q1 and 2011Q4, as most distress episodes in the reporting countries occur in this period.

Unfortunately, the BIS data do not include exposures of banks vis-a-vis the respective national government. We therefore complete the missing information using data stemming from the Financial Corporation Survey published by the IMF as a part of its International Financial Statistics (IFS). Specifically, this survey reports net positions of commercial banks on the central government, defined as holdings of securities plus direct lending minus government deposits. Positions are reported at market values and in national currency. We then convert the data in USD millions using end-of-quarter exchange rates from the IFS.[13]

Although the country coverage in the two datasets largely overlaps, there is a relatively small number of cases where the information on the "own exposure" is missing. Table A1 in the Appendix provides the list of countries included in our sample, specifying whether the information from the IFS is missing. We also refer to the Appendix for the description of the additional data we use in the estimations.

3.2 Results

Panel A in Table I reports the estimation results for a first set of specifications, which standard fixed effects – i.e. dummies for each country pair – as well as time fixed effects.

[11]BIS (2006) specifies that balance-sheet relevant instruments include "certificates of deposit (CDs), promissory notes and other negotiable paper issued by non-residents, banks' holdings of international notes and coins, foreign trade-related credits, claims under sale and repurchase agreements with non-residents, deposits and balances placed with banks, loans and advances to banks and non-banks, holdings of securities and participations including equity holdings in unconsolidated banks or non-bank subsidiaries." See also Brutti and Sauré (2011) for a more detailed description of the data.

[12]We use a ultimate risk basis available for a restricted set of countries in one robustness exercise.

[13]We use end-of-quarter rates for consistency with the currency conversion of the positions reported by the BIS.

The fixed effects do not only control for the average level of each country's public debt, for the size of each country's banking sector but also for specific levels of financial integration between each pair of countries as well as for cross-country differences in the home bias of local banks. Without such controls, the estimates of the coefficient of interest would be biased downward if the countries that were eventually hit by the crisis had a smaller degree of home bias than the average country.[14] Time effects, by contrast, control for a global trend in banks' holdings of government debt.[15]

Further, all specification in Panel A include two additional dummy variables. The first dummy, $Crisis_{b,t}$, captures the generalized shift in the demand for government debt of a crisis country, which is common to all banks irrespective of their country of origin. Such reactions include, for example, the response to a downgrading of a country's debt by institutional investors, which are bound from holding low-rated securities by regulatory requirements. The second dummy, $Crisis_{c,t}$, captures the effect of a crisis on the demand of local banks for government bonds in general, irrespective of the situation in the issuing country.

Column 1a reports the estimation results for a specification which excludes our key interaction term $Crisis_{b,t} * I_{b=c}$. While the coefficient on $Crisis_{c,t}$ is statistically insignificant, the coefficient on $Crisis_{b,t}$ suggests that banks, on average, tend to reduce their exposure to crisis countries. This effect come on top of the borrower, creditor and time effects, which absorb approximately 91 percent of the data's total variation.

When including the explanatory variable $Crisis_{b,t} * I_{b=c}$ (Column 2a), the picture becomes more differentiated. As predicted by the theory, the estimated coefficient β on the variable $Crisis_{b,t} * I_{b=c}$ is positive and significant at the one percent level. The coefficient on $Crisis_{b,t}$ is still negative and significant. The point estimates indicate that the average exposure of foreign banks to the government debt of crisis countries shrinks by 51 percentage points ($\exp(-0.714) - 1 \approx -0.51$) when the crisis hits. The increase in the exposure

[14]Notice also that the fixed effects for country pairs absorb the *home bias* of international portfolio investment, which comes out strongly in regressions without fixed effects and $I_{b=c}$, the dummy capturing investment in "own" government bonds.

[15]The global trend in banks' holding of government debt may be driven by a general trend towards bond investment episodes at different points in time (e.g., the 2007 Subprime Crisis) or simply by valuation effects. The latter, in particular, are likely to arise as a consequence of fluctuations in the Euro-Dollar exchange rate, as our sample is dominated by Euro Area countries while debt positions are reported by the BIS in current USD.

of local banks instead is about 634% ($\exp(1.994) - 1 \approx 6.34$) when measured relative to the bond holdings of foreign banks or 222% ($\exp(1.994 - 0.825) - 1 \approx 2.22$) when measured relative to the bond holdings of local bank in non-crisis periods. Using the average position of domestic and foreign bonds in crisis periods (51.78 and 34.67 billions dollars, respectively), we find that around 17.7 billions dollars were pulled out of the country by foreign investors ($0.51 * 34.67 \approx 17.683$) while domestic banks increased their holdings of own government debt by 115.0 billions dollars ($2.22 * 51.78 \approx 114.95$).

In Column 3a we include the interaction term $Crisis_{b,t} * EUR_c$, where EUR_c is supposed to proxy the political weight of a creditor country c within the Euro Area. We define these weights as GDP shares (relative to the aggregate GDP of the Euro Area), implicitly assuming that the size of a country is a good predictor of political influence. Further, we set $EUR = 0$ for countries that are not member of the Euro area.[16] The same theoretical argument based on secondary markets, by which Greek debt should flow to Greece in times of crisis, suggests that Greek debt should also flow to countries whose governments participate in the decisions regarding a looming default: sovereign bonds are worth more in the hands of investors about whom a political decision-taker cares. In the case of the Euro Crisis, these decision-takers are (governments of) the countries of the Euro Area and those, in particular, with a high political weight. We thus expect the coefficient on $Crisis_{b,t} * EUR$ to be positive and, indeed, it is estimated to be significantly so. At the same time, it is noteworthy that the estimated coefficient of interest on $Crisis_{b,t} * I_{b=c}$ barely changes in magnitude and significance, showing that the "own-government" effect remains to be relevant. Finally, the predicted change in exposure for Euro members can be compared to the one of crisis countries: the Euro Area's largest members, Germany, with a political weight of 0.28, experienced an inflow of sovereign debt from crisis countries that was higher than those of the crisis country themselves (compute $0.28 * 3.706 \approx 1.04$ for Germany relative to 1.214 for the pure "own government" effect of a crisis country).

Finally, in Column 4a we acknowledge that banks in crisis countries might pursue a genuinely different investment strategy than banks in stable countries. Part of the according changes in the relative portfolio composition are captured by the dummy variable $Crisis_{c,t}$. But we are specifically concerned about the possibility that the banks based in crisis countries take excessive risks in the attempt to "gamble for resurrection" and thus may invest

[16]Recall that per definition the crisis countries are all European.

primarily in sovereign bonds with high-risk and high-returns. Since for crisis countries bonds of the own government belong to this category, not controlling for such effects could lead us to overestimate the reallocation of portfolios towards domestic bonds. To avoid this bias, we include the interaction term $Crisis_{b,t} * Crisis_{c,t}$ in the specification. A positive coefficient on this term shows that banks in crisis countries invest in high-returns sovereign bonds, irrespective of the issuing country, which would be an indication of gambling. The estimated coefficient on $Crisis_{b,t} * Crisis_{c,t}$ is positive but statistically insignificant. More importantly, the estimated coefficient of interest, β, remains virtually unchanged in magnitude and significance. Together, these results provide weak support for gambling and consistently strong support for foreign-to-local reallocation of debt, as predicted by the secondary market theory.

The results for the specifications with the richest set of controls are reported in Panel B of Table 1. Here, we add dummies for each creditor-time pair and for each borrower-time pair to control for all possible time-varying determinants of debt positions that are specific to each creditor and debtor. These effects control for country-specific trends in the level of government debt as well as in the general exposure of banks to government debt. Valuation effects driven by exchange rate fluctuations would also be controlled for. We thus take the specification corresponding to Columns 1b to 3b and the resulting estimates of our coefficient of interest as the most reliable ones.

While the variables $Crisis_{b,t}$ and $Crisis_{c,t}$ drop out because of collinearity in these specifications, we find that the estimated coefficient on $Crisis_{b,t} * I_{b=c}$ is slightly reduced in magnitude but remains positive and significant at the one percent level. In particular, the point estimates in our preferred specification (Column 3b) show that, relative to the general tendency to unwind risky debt positions, banks raise their exposure to own government debt by more than three times ($\exp(1.424) - 1 \approx 3.154$).

The coefficient on the term $Crisis_{b,t} * EUR$ is still positive and significant. Its point estimate suggests that, relative to all other trends, Germany with a political weight of 0.28 in the Euro Area experienced an inflow of sovereign debt from crisis countries that was comparable with those of the country crisis themselves (compute $0.28 * 4.462 \approx 1.249$ for Germany relative to 1.424 for the average crisis country). This result suggests that, say, Greek bonds have about the same value for German than for Greek investors. Other things equal, this finding suggests that reallocations of Greek bonds to Germany is as effective in reducing the probability of a default than reallocations to Greek investors.

Finally, the interaction term $Crisis_{b,t} * Crisis_{c,t}$ enters significantly in this specification, indicating that banks in crisis countries did increase their exposure to risky debt. The coefficient on our key interaction term, however, remains positive and statistically significant, suggesting that banks prefer domestic debt also within the class of assets with similar risk-return characteristics. Further, by comparing the estimates in Columns 2b and 3b, we find that the increase in banks' holdings of own government debt nicely decomposes into roughly one third which is explained by gambling and two thirds which are explained by the own government effect (compare $0.614/1.938 \approx 0.32$ with $1.424/1.938 \approx 0.73$).[17]

3.3 Robustness

Euro Area Sample. As the first robustness check, we limit our sample to the countries within the Euro Area. We do so for a number of reasons. First, the focus on a fairly homogenous set of countries with access to deep and strongly integrated secondary markets for government bonds represents an ideal setting to test the predictions of the secondary market theory. Second, regulatory incentives and valuation concerns are unlikely to play a major role in explaining the difference between domestic and foreign banks, as these countries share a common currency and, to some extent, a unified supervisory framework. Third, given the high levels of bilateral bond positions within the Euro Area, the percentage changes in these bond positions are more relevant and informative. Finally, one might argue that the identification strategy based on an exogenous adverse shock is cleaner in the case of the Euro Crisis, since before the crisis' outbreak in late 2009 there was substantial homogeneity between the treated and the control countries, i.e. the periphery and the core of the Euro Area respectively.

As shown in Table 2, the estimation results corresponding to the limited sample of Euro Area members largely confirm the previous findings from our baseline specification (compare Table 1). However, while the coefficient of interest is positive and significant at the

[17] Tables A2a and A2b report the estimation results, where the definition on the *Crisis* dummy is based on the criteria of 600 and 500 basis points, respectively. The qualitative and quantitative results are very similar to the baseline, suggesting that banks start expanding positions of own government debt at the first sign of distress. Interestingly, the contribution of the gambling effect to the change in debt positions rises as we loosen the crisis criterium, but it remains below the fifty percent threshold (see Table A2b).

one percent level, the interaction term capturing the tendencies to gamble for resurrection is now inconclusive.

Bond Yields. Next, we repeat the baseline estimations, going back to the entire sample of countries, but replacing the crisis dummy with the yield of the corresponding bond. Specifically, we replace our previous specification (13) with the following model,

$$p_{c,b,t} = \alpha + \beta \cdot Yield_{b,t} * I_{b=c} + \gamma \cdot controls + \varepsilon_{c,b,t} \tag{14}$$

where the set of controls include the individual terms $Yield_{b,t}$ and $Yield_{c,t}$.[18] This specification has the virtue that it captures marginal effects, as it allows that moderate increases in a country's risk of default beyond or below the critical threshold of 700 basis points have an effect on the reallocation of government bonds. In addition, it allows us to estimate the change in the relative local exposure in all the countries, both inside and outside the Euro Area. On the contrary, our previous definition of crisis forced us to restrict our attention to Euro Area countries only, as it was difficult to find a discrete criterion for distress episodes that could apply to a set of countries as heterogenous as Greece and Mexico.

Table 3 reports the according estimation results. In these specifications, we do exclude the term $Yield_{b,t} * EUR$ (which would correspond to $Crisis_{b,t} * EUR$), since the variable $Yield_{b,t}$ captures crisis events of non-Euro Area countries, for which the political weight of creditors within the Euro Area has no influence. Here again, the results confirm our previous findings. While the positions of bonds with high yields are generally reduced ($Yield_{b,t}$), the coefficient of interest on the interaction term $Yield_{b,t} * I_{b=c}$ is positive and significant on the one percent level in all of our specifications. Considering that $Yield_{b,t}$ is measured in percentage points, the result in Columns 3a and 2b indicates that an increase of one percentage point in the bond yield is associated with a decline in foreign holdings of government debt of 8 percentage points ($\exp(0.08) - 1 \approx 0.084$) and with an increase in the relative local bond positions of 20% ($\exp(0.18) - 1 \approx 0.197$). Thus, an increase of 6.84 percentage points in the bond yield, which corresponds to the difference in the unconditional mean of bond yields between crisis and non-crisis periods, implies an increase of local positions relative to foreign ones of around 242 percent ($\exp(0.18*6.84) - 1 \approx 2.42$). This number is smaller but not far from the 315 percent increase estimated using a 700

[18] Recall that the definitions of $Yield_{x,t}$ are based on quarter-averages.

basis points criterion for crisis events.[19] Finally, the coefficient on the interaction term $Yield_{b,t} * Yield_{c,t}$ enters significantly only in the specification with the smallest set of controls, confirming the results on the reduced sample. However, the interpretation of this coefficient is difficult in the current specification with the yield since combinations of high-risk investors and low-risk borrowers may yield the same value for this interaction variable as a pair of medium-risk countries.

The clear downside of a specification including the bond yields is that it possibly suffers biases due to reverse causality. Specifically, an exogenous drop in foreign demand for a country's bond could potentially induce a reallocation towards local positions and, simultaneously, a rise of the corresponding bond yields. This magnitude of the rise of bond yields, in turn, depends on the ability or willingness of local investors to absorb the excess supply generated by foreign sales. The bond reallocations could in principle be associated with higher or lower changes in the bond yields.[20]

To overcome the endogeneity problems, we adopt an instrumental variable (IV) approach that allows us to predict the value of bond yields based on a small number of macroeconomic indicators which are typically taken as orthogonal to secondary market transfers of debt positions. Specifically, our set of instruments includes the level of GDP per capita, the central government's balance and debt (both as ratio of GDP), the growth rate of GDP, the current account balance as ratio of GDP and the inflation rate. These variables appear regularly among the main determinants of sovereign yield spreads (see for example Borenzstein and Panizza (2006)) and their large predictive power for debt distress episodes have led some observers to derive simple "rule of thumbs" to identify future defaulters based on these indicators (see Manasse and Roubini (2005)). Consistent with the findings in these studies, we find in our first-stage panel regression that these variables explain more than 83 percent of the variation of bond yields observed in the period 2001Q1 and 2011Q4.[21]

[19] The latter value is based on the 1.424 point estimate reported in Column 3b of Table 1.

[20] In theory, the shift towards local bond holdings might actually even lower the yield, when local demand for bonds is perfectly elastic since, domestic bond holdings would reduce the default risk, making bonds more secure investment.

[21] We report the first-stage estimation results in Table A3 in the Appendix, showing that all coefficients have the expected sign except for the coefficient on the government balance. We don't have a clear explanation for the sign of the latter coefficient, although we think it is possible that the yield responds with a lag to fiscal adjustment.

Table 3a reports the IV estimates of model (14), which largely confirm the qualitative pattern emerging from the previous OLS estimates. The number of observations drops due to data availability in the first-stage regression. The coefficient on our key interaction term $Yield_{b,t} * I_{b=c}$ is strongly significant in all specifications and the point estimate in Column 2b indicates that local debt positions expand relatively to foreign positions at an approximate rate of 44% when the bond yield increases by one percentage point ($\exp(0.361) - 1 \approx 0.435$). This number is two times the corresponding result from the OLS estimation, suggesting that the latter did indeed suffer of a downward bias. The IV coefficient on $Yield_{b,t}$ is essentially equal to the OLS estimate, except in Column 3a. Here, the difference can be attributed to the coefficient on $Yield_{c,t} * Yield_{b,t}$, which enters negatively and insignificantly in the OLS regressions while it is positive and significant in the IV estimation. Overall, these results confirm the increase in home bias in the countries hit by a crisis and substantiate further the predictions of the secondary market theory.

Yearly Observations. We next repeat the estimation of our baseline model (13), but limit the observations to end-of-year positions rather than on end-of-quarter positions. Some of the regulatory requirements, which can influence banks' asset positions are typically based on end of year positions, which could affect our estimation results (Philip, IS IT TRUE that regulatory requirements are applied to end-of-year positions only???). The number of observations drop accordingly to one quarter. In this specification, we return to the estimation of the impact of the political weight within the Euro Area via the variable $Crisis_{b,t} * EUR$. Table 4 shows that the corresponding estimation results by and large confirm the previous findings from our baseline specification (Table 1). The estimates of the coefficient of interest, however, are now somewhat larger than in the estimations based on quarterly data. The according estimates are significant at the one percent level for the basic (Panel A) as well as in the more comprehensive specifications, in which we control for creditor-time effects as well (Panel B). Here again, the coefficient on $Crisis_{b,t} * EUR$ is significant and positive, indicating that debt of crisis countries is reallocated to politically relevant creditors. The gambling for resurrection effect is once again largely insignificant.

Poisson Pseudo-Maximum-Likelihood Estimator. Next, we observe that equations (13) and (14) are reminiscent of the so-called gravity model of international trade (see e.g. Anderson (1979) and Anderson and van Wincoop (2003)), which has also been applied to explain bilateral asset positions (see for instance Portes and Rey (2005) and Rose and Spiegel (2002)). The traditional gravity equation, in which regress the log of bilateral trade flows (or bilateral bond positions in our case) are regressed on the log of the economic size of trade partners plus country-pair constant characteristics (e.g., distance or common language), is in fact nested in our specification with country-time and country-pair fixed effects.

Recent work by Santos Silva and Tenreyro (2006), however, has uncovered severe drawbacks of estimating the gravity equation using a log-linearized transformation. Specifically, these authors show the presence of heteroskedasticity can generate severely biased estimates of the log-linear model and propose to estimate the class of constant-elasticity models (which includes the gravity equation) in their multiplicative form using a Poisson pseudo-maximum-likelihood (PPML) estimator.[22] While the authors recognize that "the presence of the individual effects may reduce the severity of this problem", they also add that "whether or not that happens is an empirical issue".

We thus follow the strategy that these authors develop for cross-section setup and run a Poisson panel estimation.[23] The results reported in Table 5 paint a very similar picture to the one that emerged from our baseline estimations.[24] The coefficient on the interaction term $Crisis_{b,t} * I_{b=c}$ is significant at the one percent level in all specifications and its value ranges between 1.417 and 2.013 in the specification reported in Panel B. These numbers are of similar magnitude as those in our baseline estimates, confirming the large increase in the relative domestic exposure to government debt in the event of a crisis. The rate at which foreign positions of risky debt are rewound, indicated by the coefficient on the term $Crisis_{b,t}$, is also close to our previous estimates and is strongly significant, while the significant estimates for the coefficient on $Crisis_{b,t} * EUR$ suggest, consistently with the baseline results, that the retrenchment of foreign banks correlates inversely with the ability of the respective country to influence sovereign default decisions in the Euro Area. Finally, we find little support for the gambling for resurrection effect as in most of our previous

[22] In particular, the crucial independency assumption on the error term would be violated if the variance of the latter depends on some of the explanatory variables in the regression.

[23] Santos Silva and Tenreyro (2006) state that the "estimator can be easily adapted to deal with [...] panel data". Hausman et al (1984) and Wooldridge (1990) have developed this strategy, which has been used by Acemoglu and Linn (2004).

[24] In all our panel estimations we use the ppml Stata command developed by Santos Silva and Tenreyro (2010) and we include a number of dummies to capture the according fixed effects.

specifications.

Ultimate Risk Basis Classification. In the last robustness exercise, we consider a classification of bond positions based on a ultimate risk basis. This classification controls for off-balance sheet derivative instruments that might shift effective banks' positions of government bond across borders. The according results are shown in Table 6. Unfortunately, the sample of countries under this risk basis classification is much smaller than in the previous data and the number of observations drops substantially. The general pattern of results is unchanged and is consistent with a substitution between foreign and local positions of government debt in the crisis countries. The estimated coefficient on the main interaction term $Crisis_{b,t} * I_{b=c}$ is larger than in our baseline results (2.233 instead of 1.424 for the specification reported in Column 3b), suggesting that the effective reallocation of debt is even stronger than that suggested from our previous data. We now find strong support for the gambling for resurrection effect, although this effect is not sufficient to explain the relative increase in bank exposure to local government debt. We read this additional set of results as further confirmation of the secondary market theory.

4 Conclusion

Broner, Martin and Ventura (2010) have recently shown that secondary bond markets act as a tool for enforcement of sovereign debt. Specifically, well functioning secondary markets help sustain levels of international asset positions, which would not be sustainable in their absence. This finding is important for the literature on sovereign debt and hard to test at the same time. By focusing on the predicted changes of bond allocations following an adverse solvency shock to debtor countries, we provide a first empirical test of the theory of secondary bond markets. Specifically, we use information on the allocation of sovereign debt during the ongoing financial crisis to show that sovereign debt of those countries, whose ability (or willingness) to service debt deteriorated, was effectively reallocated to domestic banks. More precisely, we interpret a crisis as an adverse shock hitting the some European (Portugal, Ireland, and Greece) and non-European countries (Chile, India, Mexico and Turkey) that put into question their respective ability to repay debt. Our analysis shows that as a crisis hits a country, its debt tends to flow back to local banks, i.e. to banks resident to the crisis country. This result remains qualitatively intact under various specifications that, among others, control for the political decision processes in Europe as well as for the potential incentives of private banks to ”gamble for resurrection”. We read our results as strong support for the theory of secondary bond markets.

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Table* 1. *Bilateral Debt Positions and Crisis Dummies

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.714***	-0.825***	-1.039***	-1.054***			
	[0.073]	[0.075]	[0.090]	[0.094]			
$Crisis_{c,t}$	0.044	-0.058	-0.047	-0.058			
	[0.070]	[0.072]	[0.072]	[0.074]			
$Crisis_{b,t}$ * $I_{b=c}$		1.994***	2.123***	2.000***	1.791***	1.938***	1.424***
		[0.306]	[0.307]	[0.382]	[0.286]	[0.288]	[0.361]
$Crisis_{b,t}$ * EUR_c			3.706***	3.766***		4.195***	4.462***
			[0.876]	[0.883]		[0.862]	[0.869]
$Crisis_{b,t}$ * $Crisis_{c,t}$				0.146			0.614**
				[0.270]			[0.261]
Observations	11902	11902	11902	11902	11902	11902	11902
R-squared	0.908	0.908	0.909	0.909	0.920	0.920	0.920
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 7 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Bilateral Debt Positions and Crisis Dummies, Euro Area.

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.531***	-0.673***	-1.220***	-1.169***			
	[0.079]	[0.081]	[0.115]	[0.131]			
$Crisis_{c,t}$	0.650***	0.499***	0.578***	0.604***			
	[0.080]	[0.084]	[0.084]	[0.090]			
$Crisis_{b,t}$ * $I_{b=c}$		1.467***	1.840***	1.963***	1.234***	1.428***	1.273***
		[0.243]	[0.247]	[0.289]	[0.212]	[0.219]	[0.259]
$Crisis_{b,t}$ * EUR_c			5.516***	5.277***		2.851***	3.210***
			[0.832]	[0.881]		[0.819]	[0.879]
$Crisis_{b,t}$ * $Crisis_{c,t}$				-0.191			0.244
				[0.231]			[0.217]
Observations	2780	2780	2780	2780	2780	2780	2780
R-squared	0.928	0.929	0.930	0.930	0.946	0.946	0.946
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 7 percent. Countries are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Bilateral Debt Positions and Bond Yields, OLS Estimates.

	Panel A			Panel B	
	(1a)	(2a)	(3a)	(1b)	(2b)
$Yield_{b,t}$	-0.082***	-0.091***	-0.081***		
	[0.008]	[0.008]	[0.011]		
$Yield_{c,t}$	0.011	0.003	0.014		
	[0.008]	[0.008]	[0.012]		
$Yield_{b,t} * I_{b=c}$		0.164***	0.195***	0.144***	0.180***
		[0.034]	[0.041]	[0.032]	[0.039]
$Yield_{b,t} * Yield_{c,t}$			-0.002		-0.003
			[0.002]		[0.002]
Observations	11323	11323	11323	11507	11323
R-squared	0.907	0.907	0.907	0.920	0.918
Country-pair fe	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	-	-
Creditor-time fe	-	-	-	yes	yes
Borrower-time fe	-	-	-	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 3a. Bilateral Debt Positions and Bond Yields, IV Estimates.

	Panel A			Panel B	
	(1a)	(2a)	(3a)	(1b)	(2b)
$Yield_{b,t}$	-0.085***	-0.100***	-0.195***		
	[0.029]	[0.030]	[0.055]		
$Yield_{c,t}$	0.083***	0.067**	-0.034		
	[0.030]	[0.031]	[0.058]		
$Yield_{b,t} * I_{b=c}$		0.318**	0.272**	0.435***	0.361***
		[0.129]	[0.131]	[0.124]	[0.128]
$Yield_{b,t} * Yield_{c,t}$			0.023**		0.032***
			[0.011]		[0.012]
Observations	8214	8214	8214	9468	8214
R-squared	0.899	0.899	0.899	0.925	0.911
Country-pair fe	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	-	-
Creditor-time fe	-	-	-	yes	yes
Borrower-time fe	-	-	-	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. GDP per capita, real GDP growth, government debt to GDP, government balance to GDP, current account balance to GDP, inflation rate are used as instruments for bond yields in a first-stage estimation. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table* 4. *Bilateral Debt Positions and Crisis Dummies, End-of-year

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.743***	-0.888***	-1.143***	-1.160***			
	[0.145]	[0.149]	[0.181]	[0.189]			
$Crisis_{c,t}$	-0.143	-0.268*	-0.257*	-0.269*			
	[0.136]	[0.139]	[0.139]	[0.143]			
$Crisis_{b,t}$ * $I_{b=c}$		2.487***	2.646***	2.500***	2.190***	2.371***	1.854***
		[0.599]	[0.602]	[0.757]	[0.558]	[0.561]	[0.712]
$Crisis_{b,t}$ * EUR_c			4.269**	4.339**		4.800***	5.066***
			[1.731]	[1.745]		[1.690]	[1.705]
$Crisis_{b,t}$ * $Crisis_{c,t}$				0.172			0.612
				[0.538]			[0.519]
Observations	2969	2969	2969	2969	2969	2969	2969
R-squared	0.899	0.899	0.900	0.900	0.913	0.914	0.914
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-year positions between 2006 and 2011. Crisis is a dummy variable that equals one if the bond yield exceeds 7 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table* 5. *Bilateral Debt Positions and Crisis Dummies, Poisson Pseudo-ML Estimation

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.242***	-0.786***	-1.315***	-1.312***			
	[0.070]	[0.067]	[0.105]	[0.112]			
$Crisis_{c,t}$	0.046	-0.541***	-0.522***	-0.521***			
	[0.094]	[0.158]	[0.158]	[0.162]			
$Crisis_{b,t}$ * $I_{b=c}$		1.758***	2.198***	2.228***	1.417***	1.888***	2.013***
		[0.190]	[0.193]	[0.285]	[0.156]	[0.159]	[0.253]
$Crisis_{b,t}$ * EUR_c			3.234***	3.218***		3.897***	3.827***
			[0.465]	[0.488]		[0.454]	[0.456]
$Crisis_{b,t}$ * $Crisis_{c,t}$				-0.035			-0.146
				[0.332]			[0.275]
Observations	11321	11321	11321	11321	11321	11321	11321
R-squared	-	-	-	-	-	-	-
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 7 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Bilateral Debt Positions and Crisis Dummies, Ultimate Risk Basis

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.518***	-0.713***	-0.831***	-0.903***			
	[0.073]	[0.074]	[0.089]	[0.092]			
$Crisis_{c,t}$	-0.827***	-1.082***	-1.076***	-1.153***			
	[0.082]	[0.085]	[0.085]	[0.088]			
$Crisis_{b,t}$ * $I_{b=c}$		2.960***	3.023***	2.219***	2.946***	3.053***	2.233***
		[0.280]	[0.281]	[0.381]	[0.305]	[0.306]	[0.388]
$Crisis_{b,t}$ * EUR_c			2.459**	2.783***		3.649***	4.022***
			[1.016]	[1.021]		[0.981]	[0.986]
$Crisis_{b,t}$ * $Crisis_{c,t}$				0.941***			0.972***
				[0.301]			[0.282]
Observations	7236	7236	7236	7236	7236	7236	7236
R-squared	0.924	0.926	0.926	0.926	0.938	0.938	0.938
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 7 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

A Additional Data Description

This section provides a description of the data used to define the set of regressors appearing in our estimations of the bond bilateral positions.

The dummy variables indicating the crisis episodes in borrower and creditor countries in each period (either quarter or year depending on the specification) are constructed using data of the yield on 10 Years Government Bonds, which is taken from Datastream. Specifically, each dummy take a value of one if the average yield in the corresponding period and country exceeds a given value.

The measure of political weight within the Euro Area is based on the average GDP of each country over the period 2006-2011 relative to the aggregate GDP of the Euro Area. The source of GDP data is the World Economic Outlook of the IMF.

The set of macroeconomic indicators used as instruments for bond yields includes the level of GDP per capita, the central government's balance and debt (both as ratio of GDP), the growth rate of GDP, the current account balance as ratio of GDP, the inflation rate and the unemployment rate. The first three variables are obtained from the World Economic Outlook of the IMF and have an annual frequency. The remaining variables are obtained from the Key Economic Indicators (KEI) database of the Organization for Economic Cooperation and Development (OECD), which contains quarterly statistics for both member and non-member countries.

B Additional Results

Table* A2a. *Bilateral Debt Positions and Crisis Dummies

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.676***	-0.780***	-0.957***	-0.991***			
	[0.068]	[0.070]	[0.083]	[0.087]			
$Crisis_{c,t}$	0.028	-0.067	-0.061	-0.088			
	[0.065]	[0.067]	[0.067]	[0.070]			
$Crisis_{b,t}$ * $I_{b=c}$		1.879***	1.956***	1.709***	1.703***	1.794***	1.188***
		[0.283]	[0.284]	[0.338]	[0.266]	[0.266]	[0.320]
$Crisis_{b,t}$ * EUR_c			3.104***	3.196***		3.699***	3.944***
			[0.810]	[0.813]		[0.802]	[0.805]
$Crisis_{b,t}$ * $Crisis_{c,t}$				0.303			0.748***
				[0.225]			[0.219]
Observations	11902	11902	11902	11902	11902	11902	11902
R-squared	0.908	0.908	0.909	0.909	0.920	0.920	0.920
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 6 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table* A2b. *Bilateral Debt Positions and Crisis Dummies

	Panel A				Panel B		
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)
$Crisis_{b,t}$	-0.366***	-0.437***	-0.537***	-0.573***			
	[0.055]	[0.056]	[0.066]	[0.069]			
$Crisis_{c,t}$	0.112**	0.052	0.051	0.020			
	[0.051]	[0.052]	[0.052]	[0.054]			
$Crisis_{b,t}$ * $I_{b=c}$		1.307***	1.312***	1.101***	1.240***	1.246***	0.752***
		[0.227]	[0.227]	[0.255]	[0.213]	[0.212]	[0.240]
$Crisis_{b,t}$ * EUR_c			1.830***	1.827***		2.445***	2.429***
			[0.647]	[0.647]		[0.644]	[0.644]
$Crisis_{b,t}$ * $Crisis_{c,t}$				0.276*			0.648***
				[0.149]			[0.148]
Observations	11902	11902	11902	11902	11902	11902	11902
R-squared	0.908	0.908	0.908	0.908	0.920	0.920	0.920
Country-pair fe	yes	yes	yes	yes	yes	yes	yes
Time fe	yes	yes	yes	yes	-	-	-
Creditor-time fe	-	-	-	-	yes	yes	yes
Borrower-time fe	-	-	-	-	yes	yes	yes

Note: Dependent variable is log(1+x), where x denotes the holdings of public debt of country b (borrower) by banks of country c (creditor). End-of-quarter positions between 2006:Q1 and 2011:Q4. Crisis is a dummy variable that equals one if the bond yield exceeds 5 percent and the corresponding country belongs to the Euro Area. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, India, Italy, Japan, Luxembourg, Mexico, Netherlands, Panama, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A3. First-stage IV Estimation

	(1)
gdp_pc	-0.000***
	[0.000]
gdp_growth	-0.083***
	[0.012]
govt_debt	0.033***
	[0.003]
govt_primarybalance	0.101***
	[0.012]
inflation	0.079***
	[0.024]
ca	-0.001
	[0.012]
Observations	863
Adjusted R-squared	0.832
Country fe	yes

Note: Dependent variable is the yield on 10 years government bonds. Quarterly averages, 2001Q1 - 2011Q4. Countries are: Austria, Australia, Belgium, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States. Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.