Sovereign Default Risk and Bank Fragility in Financially Integrated Economies*

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Abstract

We analyze contagious sovereign debt crises in financially integrated economies. Under financial integration banks optimally diversify their holdings of sovereign debt in an effort to minimize the costs with respect to an individual country's sovereign debt default. While diversification generates *risk diversification* benefits ex ante, it also generates *contagion* ex post. We show that financial integration without fiscal integration results in an inefficient equilibrium supply of government debt. The safest governments inefficiently restrict the amount of high quality debt that could be used as collateral in the financial system and the riskiest governments issue too much debt, as they do not take account of the costs of contagion. Those inefficiencies can be removed by various forms of fiscal integration, but fiscal integration typically reduce the welfare of the country that provides the "safe-haven" asset below the autarky level.

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1 Introduction

This paper considers government debt management, sovereign default risk, and the implications of sovereign debt crises for the banking sector in financially integrated economies. The recent literature on sovereign debt has generally abstracted from the link between a sovereign debt crisis in a country and *contagion* to other countries through an integrated banking system. But, as the recent European sovereign debt crisis has highlighted, contagion of the crisis in one country to other countries through the banking system can be a major issue.[1] When the safety of a country's government debt starts being questioned, problems quickly spill over to the financial system and, given the high degree of international financial integration, to other countries.

A first question we address is, what determines bank portfolios of sovereign debt? Why do banks hold sovereign bonds and why do they diversify their government debt holdings? A second, closely related question, is how government debt management policies are affected by banks' demand for government bonds? Given that there is a risk of contagion of a crisis through an integrated banking system, a third question is how countries that are potentially affected by the crisis deal with the costly fiscal adjustments that may be necessary to forestall it? This latter question, in particular, has been at the core of the European crisis, and underlies the debates around the *European Financial Stabilization Fund* that has been set up to deal with the *Greek, Irish*, and possibly other European Union '*peripheral*' member-country sovereign debt crises. Finally, given the potential contagion risk and fiscal adjustment costs that may come with greater financial integration, a fourth question is whether these risks and costs may eliminate the benefits of greater integration altogether?

Banks hold government debt for several different reasons. In developing countries most

[1]The fact that banks are exposed to the risk of default on government debt, including foreign government debt, has been observed in previous crises. This was true in the debt crises of the 1980s (where advanced-country banks were hit by sovereign defaults, mostly in Latin America) and in the crises of the 1990s (e.g. Mexico, Russia, Argentina). The form of the contagion across countries has changed, however, as government debt increasingly took the form of bonds that could be held by non-bank investors. Also, the fact that bonds were continuously traded and priced in secondary markets has accelerated contagion, even if the risk could be more evenly spread between bank and non-bank investors.

government debt is held by banks. This has been attributed to the underdeveloped nature of financial systems in these countries (see e.g. Kumhof and Tanner, 2008). However, in advanced economies banks also hold a substantial fraction of their assets in the form of government bonds, mostly for risk and liquidity-management purposes. One reason, in particular, why banks hold government and other AAA-rated bonds is that they may serve as collateral for interbank loans or *repos*. This is the reason we emphasize in our model. Another important reason why banks hold government bonds is accesss to public liquidity, as central banks generally require collateral in the form of government and other highly rated securities in return for cheap lending to banks through the *discount window*. This latter reason may have played a particularly important role in the *Euro zone* and may explain why there has been substantially faster financial integration among Euro member countries than elsewhere, as De Santis and Gerard (2006) have highlighted. To the extent that *monetary union* brings about a greater financial integration, the analysis in this paper is particularly pertinent for the unfolding European debt crisis. However, it is also more widely relevant given that many central banks around the world accept foreign government bonds as collateral, and given that foreign bonds can be used as collateral in repo markets.

A first innovation of the sovereign debt model we propose is, thus, to introduce a role for government debt securities as collateral for interbank loans. In our model, the safer is the government debt held by the banking sector as collateral, the more investments the banking system as a whole can originate and therefore the higher will be the country's output. With a higher output in turn, it is easier for the government to be able to service its debt with tax revenues. Our model is set up to capture in very simple terms a key feedback loop faced by governments in the recent European sovereign debt crises: a loss of credibility in government debt almost inevitably has the effect of reducing investment and output growth, thereby reducing the tax base available to service the debt. This feedback operates through the banking system in our model, but in practice it could also operate through other channels, such as reduced household wealth, confidence, and consumption, and therefore also reduced

investment and overall economic activity.

Another innovation that we introduce into the model is financial integration. We consider a set of countries, where possibly as a result of a monetary union, the government debt of each country can be readily used as collateral in the financial system of all the countries, just as Italian debt for example can be used as collateral by a German bank in the Euro zone. This naturally leads to financial integration, as banks in each country will want to hold debt instruments from several different government issuers as a way of diversifying their risk with respect to sovereign debt default. Indeed, we show that international financial integration can thereby bring important benefits and enhance economic activity in the union. However, this diversification benefit also gives rise to greater systemic risk, as a sovereign debt crisis in one country may now more easily spread to other countries. *Contagion risk* depends, of course, on how prudently member-country governments manage their debt. Under financial integration, each country is responsible for preserving the safety of the entire financial system. By prudently managing its indebtedness each country provides a *public good* to all the other countries that are part of the system. Whether countries will efficiently provide this public good is far from obvious.

Indeed, we show that individual incentives of member countries are to supply an *excessively low amount of safe debt* and an *excessively high amount of risky debt* from the point of view of the integrated financial system as a whole. On the one hand, a country that issues safe debt may derive a rent from being the monopolistic supplier of the "safe haven" asset and may choose to exploit its monopoly power by supplying an excessively low level of safe debt. On the other hand, countries have insufficient incentives to keep their outstanding debt safe because they do not internalize the costs to other member countries in terms of greater financial fragility.

Interestingly, these incentives are present even when there is no *bailout* of the country facing a sovereign debt crisis. Thus, our analysis points to the importance of fiscal integration following financial (and monetary) integration even when a monetary union can commit

not to bail out a member country. If such a commitment is not possible, as the recent European crisis has highlighted, then *a fortiori* there is an even stronger argument for fiscal integration. We also show that the benefits of economic integration are unevenly distributed across member-countries. Financial and fiscal integration are generally seen to benefit primarily the countries that would otherwise find it difficult to produce good collateral for their banking systems. However in our model, financial integration actually increases the welfare of the country that provides a "safe haven" asset to other economies, and only the combination of financial and fiscal integration generally reduces the welfare of the "safe haven" country relative to the equilibrium with no integration at all.

With the exception of a few recent papers, the sovereign debt literature has not considered the issue of spillovers of a sovereign debt crisis to a banking crisis (and vice-versa), nor the issue of contagion of one sovereign debt crisis to other countries. It is typically assumed in this literature that all the sovereign debt is held by foreign (non-bank) creditors (see e.g. Obstfeld and Rogoff, 1996). Following the Asia, Russia, and Argentina crises much of the sovereign debt literature has focused on the issue of crisis resolution, bailouts, and debt restructuring (see e.g. Bolton and Jeanne, 2007, 2009, and Sturzenegger and Zettelmeyer, 2006). While this literature contains important lessons for the resolution of the European debt crisis (for instance the proposal for a restructuring procedure of the Greek debt by Buchheit and Gulati, 2010), it cannot deal with the issues related to financial integration, bank fragility, and contagion that have been at the core of the crisis.

There is only a handful of recent papers that address the interaction between sovereign default and the stability of the domestic financial system. Most closely related to our analysis is the paper by Gennaioli, Martin and Rossi (2010), who also consider a model where public default weakens the balance sheet of banks who hold public bonds, causing a decline in private credit. As in Broner, Martin and Ventura (2010), they and we assume that sovereign debt is traded between residents and nonresidents in secondary markets, which prevents selective defaults on foreign creditors. They highlight two empirical facts that are consistent

with their model (and ours): *i)* public defaults are followed by large contractions in private credit, and *ii)* these contractions are more severe in countries where banks hold more public debt. One important difference with our model is their focus on a small open economy, while the heart of our analysis is the international spillovers between financially integrated economies.

Broner and Ventura (2010) also consider a model of international financial integration and show that it may reduce domestic incentives to enforce private contracts—including domestic contracts—which, in turn, may lead to a decrease in welfare. In our model, international financial integration may also reduce welfare, but through a different channel: it does not directly affect the enforcement of private contracts, but it gives rise to contagion of sovereign debt crises, as foreign debt is used as collateral in lending between domestic banks. Sandleris (2010) presents a model in which a government default induces a credit crunch in the domestic private sector by sending a bad signal about future fundamentals. A common theme running through these papers is that integration between domestic and international finance helps the sovereign to credibly commit to repay its foreign creditors, but may contribute to weakening the domestic financial system. Finally, Reinhart and Rogoff (2009) present evidence on the relationship between government debt crises and banking crises, which is consistent with the predictions of our model in terms of equilibrium bailouts to prevent a contagious debt crisis.

Our model of the costs and benefits of joining a monetary union is also related to the literature on the breakup of nations (see Alesina and Spolaore, 1997 and 2005, and Bolton and Roland, 1996 and 1997). This literature focuses on non-financial variables such as the greater heterogeneity of preferences in larger nations making it more difficult to provide public goods under majority voting, or regional wealth inequalities and inter-regional transfers making it harder to maintain political support for a union in the wealthier regions. While these non-financial variables have played a major role in Europe, our analysis in this paper adds the important monetary and financial dimensions to this issue. In particular, our analysis highlights that wealthier countries may resist greater fiscal integration not only for fear of

the fiscal transfers to poorer regions but also for fear of losing the rents obtained from the supply of scarce safe haven assets.

The paper is structured as follows. The next section reviews the main facts that are relevant to our analysis. The following section presents the basic assumptions of our model in a closed economy. Section 4 presents the model with two financially-integrated economies. Section 5 studies fiscal integration and section 6 presents extensions of the model. Finally, section 7 concludes.

2 Facts

We review in this section some stylized facts that motivate the theoretical analysis presented in the rest of the paper. We start with a presentation of the European government debt crisis, before moving on to a more systematic examination of the exposure of advanced economy banks to domestic and foreign government debt.

2.1 The 2010 European government debt crisis

Sovereign spreads in Europe widened in the Fall of 2008 in the wake of the Lehman crisis (Figure 1). The discrimination among sovereign issuers may have initially reflected the relative liquidity of different government bond markets, with a flight to the safety and liquidity that could be found in the most liquid sovereign bond markets – such as the benchmark Bunds (Sgherri and Zoli, 2009). However, the attention of investors quickly turned to country-specific solvency concerns, with a clear link being made between government debt risk and weaknesses in the banking sector (Mody, 2009; Ejsing and Lemke, 2009). In Ireland, for example, sovereign spreads started to increase after the government extended a guarantee to Irish banks. But the causality between bank fragility and government debt fragility was going both ways: investors could also see that increased sovereign risk would have a negative impact on the banks that were holding government debt.

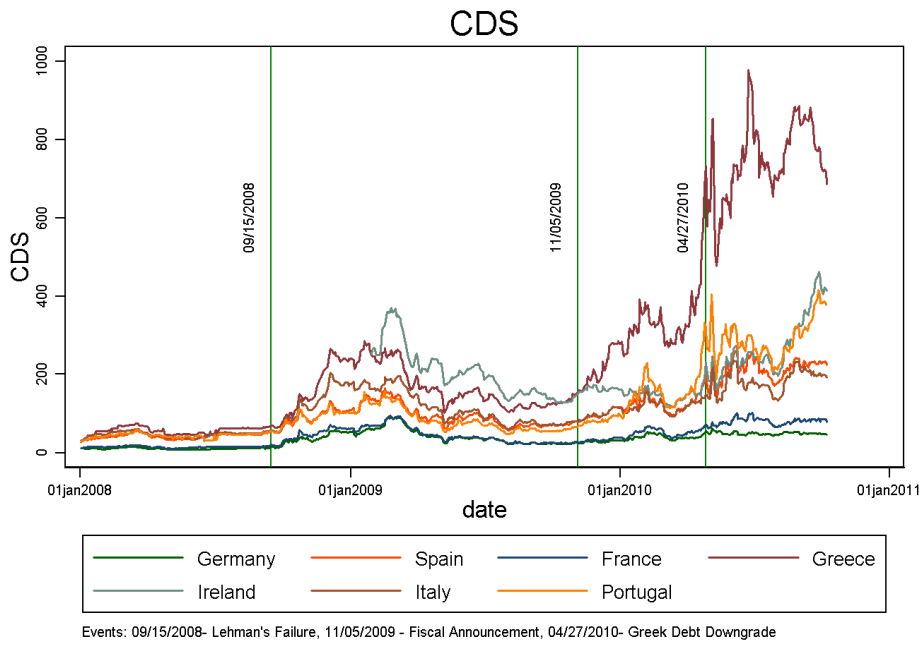

Figure 1: CDS spreads in Europe

The European sovereign debt worries started to turn into a full-fledged crisis in November 2009, when the new Greek government revealed that the fiscal deficit was twice as large as previously believed. As can be seen from the CDS spread data reported in Figure 1, the Greek CDS spread increased rapidly to more than 4 percent in early 2010, reflecting a significant increase in market expectations of a Greek default or debt restructuring. But until March 2010, there was relatively little contagion to other European economies—it was still believed by many at the time that the impact of a Greek credit event could be contained as Greek debt amounted to a small fraction of total euro government debt.

However, it became increasingly apparent in March that, as the European economic recovery was weak, the fiscal austerity measures adopted in Greece were not reassuring investors, and the crisis was starting to spill over to other European countries. The main concern was that a Greek default would lead investors to lose confidence in other euro area countries with less severe but similar debt and deficit problems, such as Portugal and Ireland, and perhaps even to larger countries such as Italy or Spain. If the crisis were allowed to spill over to a large fraction of euro area government debt, it could then engulf the whole

euro area banking system, including the banks of countries, such as Germany or France, where government debt itself was not perceived to be a problem. Another concern was that a downgrading of the riskiest government debts by rating agencies would destabilize the euro interbank lending market as such debts would no longer be acceptable as collateral by the European Central Bank (ECB).

In March, EU countries announced that they were setting up—together with the IMF—a crisis lending mechanism for Greece or other countries that might need it. The effect of this announcement on market confidence, however, was limited by several factors, including Germany's perceived reluctance to rescue Greece, and the insufficient size of the funds committed to the mechanism if countries other than Greece had to be helped.

The crisis entered its most acute phase at the end of April. After Greece posted a worse than expected budget deficit, market participants started to worry that the Greek government would be able to roll over a relatively large amount of debt coming due in May if a rescue package was not quickly put in place. On 23 April 2010, the Greek government requested that the EU/IMF crisis lending mechanism be activated. On April 27 the Greek debt rating was downgraded to junk status by Standard & Poor's, making the Greek debt government ineligible as collateral with the ECB. Portugal's simultaneous downgrade and Spain's subsequent one added to the negative sentiment. CDS spreads Greek debt rose to more than 900 basis points, a level that was seen before only in emerging market or developing economies. European equity markets fell, and the euro depreciated against major currencies. Soon, the impact spread beyond Europe, causing a sell-off in global equity markets. The crisis spilled over into interbank money markets, reviving the same concerns about rising counterparty risk as in the Fall of 2008. "This is like Ebola," declared the OECD Secretary General Angel Gurria on April 28, adding that the Greek crisis was "contaminating all the spreads and distorting all the risk-assessment measures."

Gripped by a sense of urgency, the European authorities reacted with a number of far-reaching measures. Early May 2010, a crisis loan agreement was reached with Greece for a

total of €110 bn, enough to cover Greece's funding need until 2012. The European Central Bank modified its rules and declared that Greek bonds would remain eligible as collateral even with junk status, before announcing a policy of supporting the price of certain government debts through open market purchases.[2] A new entity, the European Financial Stability Facility (EFSF), was created to grant conditional crisis loans to euro area governments affected by contagion from the Greek crisis.[3] The EFSF was endowed with enough resources to cover the budget financing needs of Greece over 2009-2012 (Blundell-Wignall and Slovik, 2010).

Asset price movements immediately following these announcements initially suggested that the contagion from the Greek crisis was abating. Euro sovereign credit spreads narrowed and the euro appreciated. The relief in markets turned out to be temporary, however, as investors continued to worry about the mutually-reinforcing negative interactions between fiscal retrenchment, banking problems and economic recession. In June, EU government leaders, inspired by the earlier success of the US stress test, sought to dispel the worst fears of investors about the health of European banks by announcing the publication of the results of a stress test covering 91 banks. The main focus of the stress test was the exposure of banks to government debt. The results of the stress test released in July showed that all banks passed the test except for seven (five in Spain, one in Greece and one in Germany), which were asked to raise new capital.[4]

It is too early to tell whether the measures taken by the European authorities last May

[2]The member banks of the European System of Central Banks (ESCB) would start buying government debt in "those market segments which are dysfunctional."The ESCB's decision was motivated by the belief that the price of certain government debts had reached levels that were abnormally low, given the commitment of those governments to fiscal adjustment. The reasons for this alleged mispricing were not made explicit.

[3]The EFSF was endowed with € 750 bn of resources. The EFSF can issue up to € 440 billion of debt on the market to raise the funds needed to provide loans to crisis countries in the euro area. These resources are augmented by € 60 billion coming from the European Financial Stabilisation Mechanism (EFSM), i.e. funds raised by the European Commission, and up to € 250 billion from the International Monetary Fund (IMF). The EFSF should access markets only after a euro member has submitted a request for support. The first EFSF bonds were issued in January 2011 as part of the EU/IMF financial support package for Ireland.

[4]In order to pass the stress test a bank needed to have a Tier 1 capital ratio in excess of 6 percent, in line with the benchmark used in the US stress test.

set the stage for a successful resolution of the European government debt problems. The spread on the Greek debt remains elevated, and that on the Irish debt increased sharply at the end of 2010. The Irish crisis differs from the Greek one in that it originated in the banking sector and spilled over to the debt of the government. After several bailouts of Irish banks by the Irish government, the Irish banking system had to rely on liquidity provision by the ECB, while the Irish government was losing access to private markets, with spreads over German bunds reaching 600 basis points. At the end of November 2010, the Irish government requested and obtained a €85 bn package from the EU and the IMF.

If there is one clear lesson from the crisis, it is the extent of the economic and financial interdependence created by the fact that euro area banks hold euro area government debt. A consequence of financial integration is that euro area banks are exposed to the average risk in euro area government debt, not only to the risk in the debt of their home country government. This implies—since no government can be indifferent to the health of its banking system—that distressed government debt tends to become a liability for all governments in a crisis.

Indeed, the measures adopted during the crisis have already resulted in a certain measure of collectivization of government debts. First, euro area central banks have assumed some of the sovereign debt risk through their purchase of distressed debt in secondary markets, a quasi-fiscal operation that could potentially result in a loss for the taxpayers in all euro area countries. Second, the EFSF also institutes a certain degree of fiscal solidarity between euro area governments. Lenders to the EFSF are protected by credit enhancements, taking the form of a cash buffer and a limited collective guarantee if one member country came to default.[5] This means that a default by one of the EFSF member countries might not be without a fiscal cost to the other members. A key point of contention in the design of the European Stability Mechanism, which should succeed the EFSF in 2013, is the strength of the safeguards against the collectivization of government debts and the extent of the

[5]It is partly thanks to those credit enhancements that the EFSF received the top rating from all three major credit rating agencies in September 2010 .

reliance on hard fiscal conditionality. Unsurprisingly, the crisis has also given a new impetus to proposals to reinforce economic governance in the EU, in particular the oversight of fiscal policies.

2.2 Exposure of banks to government debt in advanced economies

The central issue in this paper is the international contagion coming from the fact that banks are exposed to the sovereign risk of foreign countries. In this section we take a look at the data to get a sense of the magnitude of this exposure in advanced economies. It is generally difficult to find consistent cross-country data on the exposure of banks in a given country to the government debt of another country, and the richest source of data that we could find was the 2010 European stress test. But before we come back to Europe, let us try and look at this problem from a more global perspective.

Table 1 reports the share of central government debt that is held by domestic banks, and the share of domestic government debt in bank financial assets for the US, the euro area and Japan. The share of government debt in banks' financial assets might underestimate the systemic implications of government debt risk to the extent that government debt has a key function (as collateral) in the interbank lending market. This caveat notwithstanding, the numbers reported in Table 1 are instructive in several ways.

There seems to be a lot of heterogeneity in the exposure of banks to domestic government debt. At the end of 2009, US banks invested only about 1 percent of their financial assets in federal government debt (about 9 times less than their exposure to Agency- and GSE-backed securities). The US central government debt was held mostly by the foreign sector, US households and mutual funds. By contrast, one half of the Japanese central government debt was held by Japanese banks, and government debt amounted to almost one fourth of banks' financial assets. For Europe,[6] the table reports the unweighted cross-country average

[6]The number of 14.9 percent reported for Europe is an underestimate because it does not include the

of the ratios across 17 countries that had banks covered by the stress test. In terms of the share of domestic government debt held by domestic banks, Europe seems to be between Japan and the US.

Table 1. Central Government Debt and Banks (end 2009)

	U.S.	Europe	Japan
Share of government debt held by domestic banks (%)	2.4	14.9	50.0
Share of government debt in domestic bank financial assets (%)	1.3	na	23.0

Source: Federal Reserve flow of funds; BoJ flow of funds (banks defined as depository corporations); European stress test.

We unfortunately do not have good data to assess the exposure of foreign banks to US or Japanese government debt. According to the US Treasury International Capital (TIC) database, the share of the outstanding stock of US Treasury securities held by foreign private investors was 12.6 percent at the end of 2009.[7] We do not know how much of this was held by banks as opposed to non-bank foreign investors, but it is quite possible that a larger share of US government debt was held by foreign banks than by domestic banks. This is certainly not the case for Japan: the share of Japanese government debt held by foreigners is about 7 percent, much smaller than the share held by domestic banks.

Whereas it is generally difficult to find information on cross-border holding of government debt by banks, the European stress test has produced a wealth of information on this topic. The stress test covered 91 banks in 18 EU countries, representing 65 percent of the EU banking sector in terms of total assets.[8] Five of those countries are not members of the

banks that were not covered by the stress test. It is a cross-country average of the share of government debt held by domestic banks and so does not include intra-EU cross-border holdings of government debt by banks. If we consolidate government debt across Europe, we find that 26 percent of European government debt was held by European banks.

[7]This share is of course much larger (47.3 percent) if one also includes the foreign official sector—mainly foreign central banks that have accumulated US Treasury securities as international reserves.

[8]The 18 countries whose banking sector is covered by the test are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden and the UK.

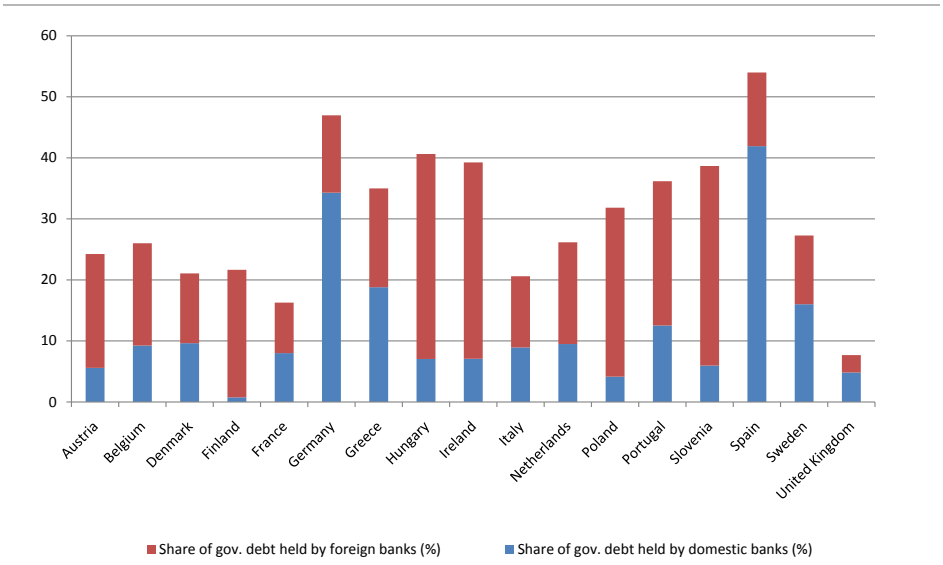

Figure 2: Share of government debt held by domestic banks and by foreign banks (%)

euro area (Denmark, Hungary, Poland, Sweden and the United Kingdom). Each bank in the sample was requested to provide its exposure to the government debt of each EU country at the end of March 2010. By aggregating the information across the banks of a given country, we can derive the exposure of any country's banking system to the government debt of any other country in the sample.[9]

It will be convenient to introduce some notations in order to characterize the exposure of banks to domestic and foreign government debt. We denote by b_{ij} the holdings of government debt of country j by the banks of country i (in billions euros). We also denote by d_j the total government debt of country j.

The first fact that we observe is a significant share of European government debt is held by European banks, especially foreign banks. Figure 2 shows the share of government debt held by domestic banks, b_j/d_j, and by foreign (European) banks, $\sum_{i \neq j} b_{ij}/d_j$, for each country j in our sample. We observe that close to 30 percent of government debt is held by the banking sector, with significantly higher shares for the debt of the German and Spanish

[9]The data are available in excel format at http://www.piie.com/realtime/?p=1711, thanks to Jacob Kirkegaard of the Peterson Institute for International Economics.

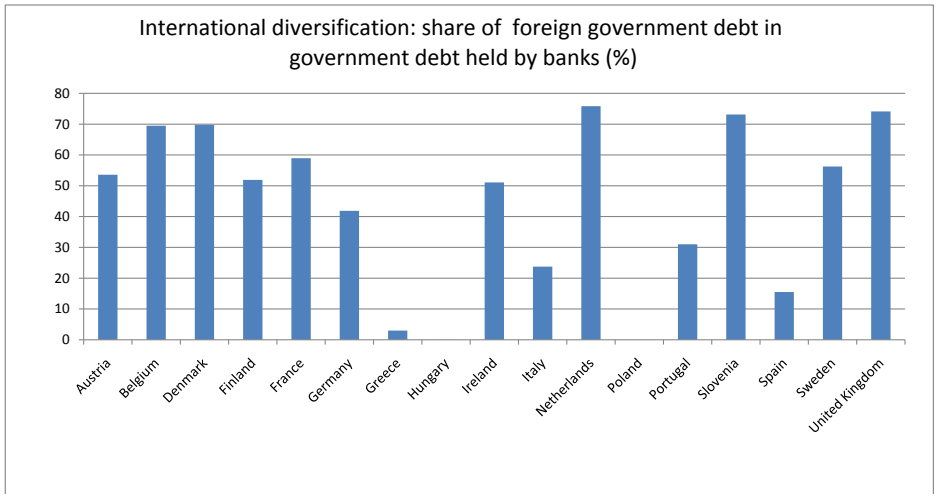

Figure 3: Share of foreign debt in government debt held by banks (%)

governments.[10] In addition, foreign banks own a larger share of the government's debt than domestic banks in most countries.

Figure 3 shows a measure of the exposure of European banks to foreign (as opposed to domestic) sovereign risk. The figure reports, for each country in our sample, the share of the government debt held by banks that was issued by a foreign government rather than the domestic government, that is, $\sum_{j \neq i} b_{ij} / \sum_j b_{ij}$, for each country i. The figure shows that in several countries (Belgium, Denmark, the Netherlands, Slovenia and the UK) banks invested about 70 percent of their government debt portfolio in the debt of foreign governments. By contrast, the exposure of Greek banks to foreign sovereign risk was very low (which may reflect moral suasion by the Greek authorities), and it was zero in Hungary and Poland, two countries that have not yet adopted the euro as their currency. However, there is no clear correlation between euro membership and the international diversification of banks' government debt portfolios since the share of foreign government debt was high in the three other non-euro-members (Denmark, Sweden and the UK).

Finally, Figure 4 shows the average composition of banks' foreign debt portfolio and compares it to the outstanding stocks of government debt. We construct a "foreign government

[10]The shares reported in Figure 2 are likely to be underestimates as they reflect only the banks included in the stress test.

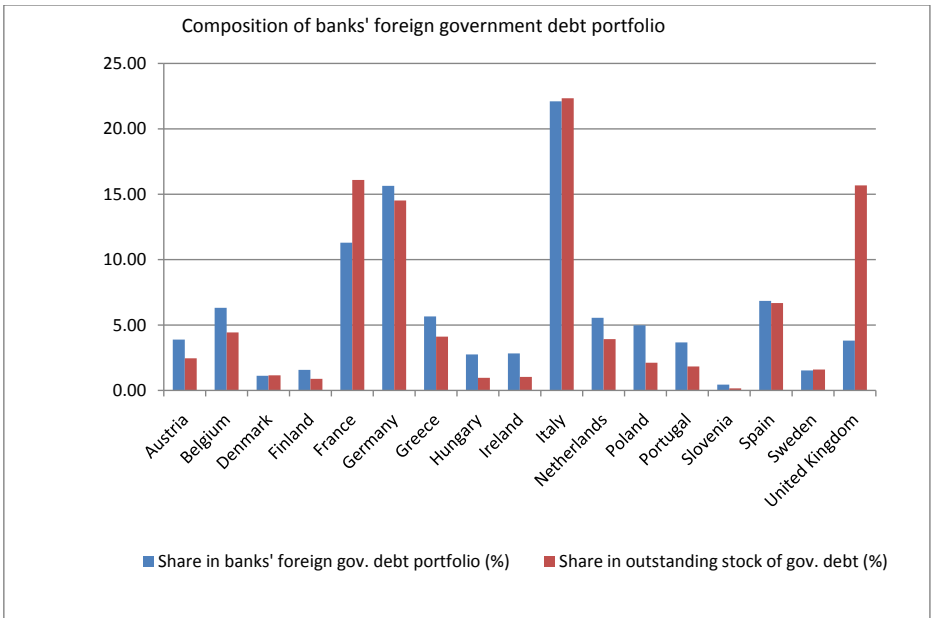

Figure 4: Composition of banks' foreign government debt portfolio (%)

debt portfolio" by adding the holdings of foreign government debt across all the banks in the sample, that is $(\sum_{i,i\neq j} b_{ij})$ for each country j in the sample. The share of each country's government debt in the portfolio held by banks, $\sum_{i,i\neq j} b_{ij} / \sum_{i,j,i\neq j} b_{ij}$, is represented by the blue bars. The red bars represent the share of each country's government debt in total debt, i.e., $d_j / \sum_k d_k$. We observe that the two measures are very close to each other, i.e., the banks' portfolio of foreign government debt tend to reflect the outstanding stocks. In particular, the main instrument of international diversification is the Italian debt (more than the German and French debt) because this debt is in large supply. The countries that are under-represented in the foreign debt portfolio are the UK (perhaps because of the currency risk) and to a lesser extent, France.

To summarize, cross-border holdings of government debt by banks have played an important role in how the European debt crisis developed as well as the policy response of the authorities. The bank stress test has revealed a very high degree of international integration between government debt markets and the banking systems of european countries. Financial integration implies that a government debt crisis in one country tends to spill over to the

banking system of other countries. Financial integration, in other words, led to financial contagion. Efforts to prevent or mitigate contagion, through ESCB interventions or the creation of new mechanisms such as the EFSF, may have resulted in a certain degree of collectivization of government debts. This makes sound fiscal policy a common good, and may create a force toward fiscal integration, although it is not yet quite clear what weight will be put on fiscal transfers (bailouts) versus fiscal adjustment. We now turn to a model than can shed light on these phenomena.

3 One Country

This section presents the main assumptions or our theoretical framework. We will consider (in section 4) a world with two countries that are perfectly financiall integrated, and we will focus on the analysis of cross-country spillovers in government debt and banking risk. For the sake of expositional clarity, however, this section starts by presenting the assumptions of our model for the case of a closed economy. This will make the analysis of a two-country world easier to understand in a second step.

We consider an economy with a single homogenous private consumption good and a public good. Time in the model is divided into three periods $t = 0, 1, 2$. Consumption can take place in all three periods, but for simplicity investment can only take place once at time $t = 1$—and returns on investment are realized once at time $t = 2$.

The private sector of the economy is composed of a continuum of mass 1 of identical agents whose utility is given by

$$U = c_0 + c_1 + c_2,$$

where $c_t \geq 0$ is private consumption at time t.

These agents play a dual role as "bankers" and households. For simplicity we do not model banks explicitly as independent deposit-taking institutions, since "bank fragility" caused by bank runs à la Diamond and Dybvig (1983) plays no role in our model. The

banking sector only serves the role of reallocating savings from banks without investment opportunities to banks with investment opportunities. This reallocation takes place in the form of interbank loans collateralized by government debt. Our model thus captures in a simple way one important channel through which the value of government debt can affect the banking sector and real activity.[11]

The budget constraints of the government and private sector are summarized in Table 2. Income (or output) in period t is denoted by y_t. The government finances a fixed level g of expenditures on public goods in period 0 by issuing debt that is repaid in the last period. This debt is purchased by banks, who then can use their government debt securities as collateral to borrow in the interbank market. The government's and individual household-bankers' budget constraints in period 0 are given by respectively:

$$g = p_0 b$$

and

$$c_0 + p_0 b = y_0,$$

where:

1. y_0 is the exogenously given initial level of output,
2. b is the level of debt the government must repay at $t = 2$, and
3. p_0 is the price of government debt at $t = 0$.

Bankers are identical in period 0 but are divided into two groups from period 1 onwards, with respective mass ω and $(1-\omega)$. The first group $\omega \in [0, 1]$ of bankers obtain an investment opportunity in period 1, which yields a return $I + f(I)$ at $t = 2$, for an investment I at time

[11] As mentioned in the introduction, one can think of other channels that do not involve the role of government debt as collateral in the interbank market. The assumption that matters for our analysis, in reduced form, is that a fall in the price of government debt negatively affect the banking sector and real activity.

1. We assume that the surplus from the investment $f(I)$ is a concave function of I and reaches its maximum at $I = I^*$. The maximum amount, I, that an individual banker can invest in is given by his endowment y_1 plus the (collateralized) loans d the banker is able to get from the second group $(1-\omega)$ of bankers, who do not obtain an investment opportunity in period 1.

The size of interbank loans, in turn, is limited by the value of collateral (government bonds) held by bankers. Let $\lambda \geq 1$ denote the size of an interbank loan per dollar of collateral. To the extent that $\lambda > 1$, each dollar of government bond brings more than one dollar of interbank lending. Part of the benefit of government debt then is to bring about more credit between private agents ("financial development"). We assume that collateral in an interbank loan must be held to maturity, and each banker can borrow a maximum collateralized amount $d \leq \lambda p_1 b$, so that the maximum he can invest is $I = y_1 + \lambda p_1 b$.[12] Any individual banker with an investment opportunity can borrow the maximum amount $\lambda p_1 b$ from the other bankers, provided that the aggregate demand for collateralized interbank loans from the first group of bankers, $\omega d = \omega \lambda p_1 b$, does not exceed the total available supply of liquidity from the second group of bankers, which is given by their total endowment at time 1, $y_1(1-\omega)$.[13] So that, the following condition must hold for bankers with investment opportunities to be able to borrow the maximum collateralizable amount $\lambda p_1 b$:

$$\omega d = \omega \lambda p_1 b \leq y_1(1-\omega).$$

We assume that this condition holds in the remainder of our analysis.

Bankers without investment opportunities can trade bonds among themselves. We denote by b' the end-of-period holdings of bonds by the representative banker without investment

[12] We could assume that banks with investment opportunities can purchase government bonds in the secondary market so as to increase their collateralized borrowing capacity. However, the analysis becomes more involved, without adding major new insights. For simplicity, therefore, we do not allow banks to collateralize loans with government bonds that are purchased in the secondary market in period 1.

[13] Recall that we have assumed that consumption at any date must be non-negative, $c_t \geq 0$, so that the maximum amount any banker can lend in period 1 is y_1.

opportunity. In a symmetric equilibrium (in which all bankers of a given type behave in the same way), there is no trade of bonds among bankers so that $b' = b$, but the existence of this market pins down the price of bonds, p_1.

Table 2. Budget constraints

	Bankers with investment opportunity	Bankers without investment opportunity	Government
$t = 0$	$c_0 = y_0 - p_0 b$		$g = p_0 b$
$t = 1$	$c_1 = y_1 - I + d$ with $d \leq \lambda p_1 b$	$c_1 = y_1 - \frac{\omega}{1-\omega} d$	
$t = 2$	$c_2 = I + f(I) - d + \delta b - T$	$c_2 = \frac{\omega}{1-\omega} d + \delta b - T$	$\delta b = T$

We introduce a government debt risk in the model by assuming that the government may not repay its debt in period 2. We assume that in period 1, the private sector receives a signal about the probability that the government will repay or default in $t = 2$. This signal affects the market price of government debt and so its value as collateral. For simplicity, we assume that the period-1 signal is perfectly informative—i.e., the private sector learns in period 1 whether the government will default in period 2—and that the government repays nothing if it defaults. (These assumptions could be relaxed without affecting the main insights.)

Viewed from period 0, the probability that the government will default is denoted by π, a measure of the ex ante default risk. In the budget constraints the government's action is represented by a variable δ that is equal to 1 if the government repays and to 0 if it defaults. For now, and for the sake of simplicity, we do not model the underlying determinants of the government's repayment and take the default risk as exogenous. Government default will be endogenized in section 6.

We now review the timeline of events by proceeding backwards and deriving at the same time the equilibrium conditions for a (competitive) Perfect Bayesian Equilibrium (PBE).

Timing:

In period 2, investment yields its payoff $I + f(I)$; the bankers who borrowed in the interbank market must repay d out of final output $I + f(I)$, and the government repays its debt (if it does) by levying a lump-sum tax $T = \delta b$ on the bankers. Period-2 consumption levels are then given by

$$c_2 = \frac{\omega}{1-\omega} d,$$

for the bankers with no investment opportunities (given that interbank loans are riskless) and by

$$c_2 = I - d + f(I),$$

for the bankers with an investment opportunity.[14]

In period 1, the private sector learns whether the government will repay its debt or not (variable δ). Government debt is then traded between the bankers without investment opportunity at an equilibrium price of

$$p_1 = \delta.$$

Bankers with an investment opportunity invest the optimal level I^* if they can. We assume that:

$$\omega I^* < y_1 < I^*.$$

This condition ensures that aggregate demand for collateralized interbank loans does not exceed the total supply of liquidity in the economy, but that the bankers cannot finance the efficient level of investment without borrowing. Investment is equal to the efficient level unless it is constrained by collateral value, that is

$$I = \min\left(I^*, y_1 + \lambda p_1 b\right).$$

[14]The government repays its debt b in period 2, but at the same time levies a tax T to repay its debt. This is why b does not appear (in the aggregate) in period 2 consumption.

In period 0, the government borrows $p_0 b$ from households and uses the proceeds to fund public goods g. Households then mechanically consume g and $c_0 = y_0 - p_0 b$.

We conclude this section by deriving some properties of the equilibrium that will be useful to understand the case with two countries. We begin by deriving an expression for the welfare of the representative banker in period 0 when the government issues a fixed amount of bonds b. In period 0 consumption is $c_0 = y_0 - p_0 b$, and the government bond entitles the representative banker to a future consumption of b. However, with probability π the government defaults and the bond is worthless. In addition, when the government does not default, it must levy a (lump-sum) tax of T in period 2 to finance the repayment b, so that the net future expected consumption out of the government is only $(1-\pi)(b-T)$.

As for private consumption in subsequent dates, its level depends on whether the representative banker belongs to the first group (with investment opportunities) in period 1 or to the second group (without investment opportunities).

Bankers in the first group invest their entire endowment y_1 in period 1 and borrow $d \leq \lambda p_1 b$ from the second group. Thus these bankers don't consume at all in period 1 and postpone their consumption to period 2, when their investment pays off. In the last period they then consume the entire output of the investment net of debt repayments, or

$$\min(I^*, y_1 + \frac{d}{p_1}) + f(\min(I^*, y_1 + \frac{d}{p_1})) - d.$$

With probability $1-\pi$, there is no default and the price of government debt in period 1 is $p_1 = 1$. Bankers with investment opportunities can then borrow $d \leq \lambda b$, produce a total output of $\min(I^*, y_1 + d) + f(\min(I^*, y_1 + d))$, and therefore consume $c_2 = y_1 + f(\min(I^*, y_1 + d))$. With probability π, there is a default and the price of government debt in period 1 is then $p_1 = 0$. Bankers with investment opportunities can therefore not borrow in the interbank market and invest only y_1. Their output (and consumption) in period 2 is then $y_1 + f(y_1)$.

Bankers in the second group do not generate any surplus and simply consume their period

1 endowment y_1. Therefore, the ex-ante expected utility of a representative banker is given by:[15]

$$U = y_0 - p_0 b + y_1 + (1-\pi)\left[b - T + \omega f(\min(I^*, y_1 + \lambda b))\right] + \pi\omega f(y_1).$$

Next, from the first-order condition for the demand for government bonds, $\partial U/\partial b = 0$, we observe that:

$$p_0 = (1-\pi)[1 + \omega\lambda f'(y_1 + \lambda b)^+], \tag{1}$$

where we use the standard notation $x^+ = \max(0, x)$.[16] In other words, the equilibrium price of government bonds at $t = 0$ is equal to the probability of repayment times a factor reflecting the extra value of bonds as collateral (the "collateral premium"). The collateral premium is decreasing with the quantity of bonds that can be used as collateral and falls to zero if b is larger than a critical threshold

$$b^* \equiv \frac{I^* - y_1}{\lambda}.$$

If $b \geq b^*$ banks with an investment opportunity hold more government debt than they need to finance the efficient level of investment if there is no government default and the collateral premium is then equal to zero. Equation (1) implicitly defines the banks' demand for government debt, which is decreasing with its price.

The equilibrium price p_0 results from the equality between supply and demand in the market for government bonds, $b = g/p_0$. Using equation (1) the condition for market equilibrium can therefore be written as,

$$(1-\pi)P(b)b = g, \tag{2}$$

[15]Note that this expression does not include the utility from the public expenditure g. Adding a constant term would obviously not change any of the results, so that we simply normalize the utility from the public expenditure to zero.

[16]We have $\partial f(\min(I^*, y_1 + \lambda b))/\partial b = f'(y_1 + \lambda b)^+$ since the marginal net return $f'(I)$ is positive for I smaller than I^* and equal to zero for $I = I^*$.

where $P(b) \equiv 1 + \omega\lambda f'(y_1 + \lambda b)^+$ is the inverse of the demand function for government debt when the probability of default is equal to zero. We assume that $P(b)b$ is increasing with b, that is, the government does not decrease its resources by issuing more debt. This ensures that the market for government bonds has a unique equilibrium in period 0.[17]

The market equilibrium condition (2) reveals that the number of bonds that the government must issue, b, is increasing with the level of public expenditure, g, and the probability of default, π. The equilibrium price, thus, is decreasing with the level of public expenditures. If

$$\frac{g}{1-\pi} > b^*, \tag{3}$$

the government must issue an amount of bonds that is larger than b^*, implying that there is no collateral premium (and that the equilibrium amount of bonds is $b = g/(1-\pi) > b^*$). That the banking sector is not constrained by a structural shortage of public debt seems a natural assumption to make in our context.[18]

To summarize, the government is assumed to default with probability π in period 0. Default in period 2 can be perfectly anticipated in period 1, so that the price of government bonds in period 1, p_1, drops to the recovery value of the debt whenever default is anticipated. For simplicity we assume the recovery value β to be zero, so that $p_1 = 0$ when default is anticipated.[19] Moreover, when default is expected, bankers with an investment opportunity are unable to borrow in the interbank market and can only invest their endowment in the investment project: $I = y_1$. As a result an impending debt default hurts the banking sector and aggregate investment. Note that this highly stylized model is consistent with a scenario

[17] This is not necessarily true because $P(b)$ is decreasing with b. One could imagine a situation in which the government can levy a given level of funds by issuing a large amount of bonds at a low price or a smaller amount of bonds at a higher price. This possibility does not complicate the analysis in an interesting way and we rule it out in the following.

[18] When the US government debt was shrinking in the late 1990s, some economists expressed the concern that it might ultimately become insufficient for the financial system to operate efficiently. This is clearly no longer an issue.

[19] The analysis can be straightforwardly generalized to allow for a positive recovery value $0 \leq \beta < b$, and a positive price $p_1 = \beta$ in period 1 in the event of default. As no substantive new insight is obtained from this more general model we assume for simplicity that $\beta = 0$.

where a government debt crisis spills over into a banking crisis, as in Argentina. It may also be consitent with a scenario where a banking crisis spills over into a debt crisis, as in Iceland.[20]

4 Two countries

We now consider two countries that are *financially integrated*, in the sense that banks can buy the government debt of both countries in a single frictionless market, but not *fiscally integrated*, as each country's government determines its fiscal policy independently. We are interested in the implications of financial integration for the investment decisions of banks and for financial contagion between the two countries.

We begin again by taking the default risk in each country as given (this will be endogenized in the next section). For simplicity, we assume that the government default risk is equal to zero in one country (the *safe country* S) and that it is positive and equal to π in the other country (the *risky country* R). This means that the price of government debt of the safe country in period 1 is always equal to one ($p_{S1} = 1$), while the price of the risky country government debt is such that:

$$p_{R1} = \begin{cases} 1 & \text{with probability} \quad 1-\pi, \\ \\ 0 & \text{with probability} \qquad \pi. \end{cases}$$

In all other respects the two countries are identical: they have the same level g of expenditures on public goods in period 0, the same economies with a continuum of mass 1 of

[20] Admittedly, under the latter scenario, the timing of the model would have to be changed as follows. In period 1, bankers with investment opportunities would invest in two stages: first, they invest their endowment y_1, and subsequently they would learn whether their investment pays off or not. If it pays off (with probability $(1-\pi)$) the government has enough fiscal revenues to be able to service its debt, in which case $p_1 = b$ and bankers can in a second step expand their investment opportunity by borrowing $d = \lambda b$. If it does not pay off (with probability π) the government does not get enough tax revenues in period 2 to be able to repay its debt. The banking 'crisis' then triggers a debt crisis.

identical agents with utility function $U = c_0 + c_1 + c_2$, the same endowments y_0 and y_1, and the same investment opportunities $f(.)$ open to the same mass ω of group 1 bankers with investment opportunities.

4.1 Equilibrium under Integration

We first derive the bankers' demand for government bonds. In each country a banker is faced with a portfolio choice problem $\{b_{ij}\}$ in period 0 of how much of each government's debts to hold, where $i = S, R$ denotes the banker's country of residence and $j = S, R$ the issuing country.

Bankers choose their bond portfolios so as to maximize their expected welfare, which like before is determined by the probabilities of having an investment opportunity and/or a government default. In the *safe country* the optimal portfolio for a banker maximizes the banker's period-0 welfare:

$$\begin{aligned} U_S &= y_0 - p_{S0}b_{SS} - p_{R0}b_{SR} + y_1 + (1-\pi)\left[b_{SS} + b_{SR} - T_S + \omega f\left(\min(I^*, y_1 + \lambda(b_{SS} + b_{SR}))\right)\right] \\ &\quad + \pi\left[b_{SS} - T_S + \omega f\left(\min(I^*, y_1 + \lambda b_{SS})\right)\right], \end{aligned} \tag{4}$$

and in the *risky country* the optimal portfolio for a banker maximizes:

$$\begin{aligned} U_R &= y_0 - p_{S0}b_{RS} - p_{R0}b_{RR} + y_1 + (1-\pi)\left[b_{RS} + b_{RR} - T_R + \omega f\left(\min(I^*, y_1 + \lambda(b_{RS} + b_{RR}))\right)\right] \\ &\quad + \pi\left[b_{RS} + \omega f\left(\min(I^*, y_1 + \lambda b_{RS})\right)\right]. \end{aligned} \tag{5}$$

The demand for bonds is determined by the four first-order conditions $\partial U_S/\partial b_{SS} = \partial U_S/\partial b_{SR} = \partial U_R/\partial b_{RS} = \partial U/\partial b_{RR} = 0$. One can see that the first-order conditions are the same for the banks of the safe country as for those of the risky country. This is not surprising, as what differentiates the two countries is *sovereign default risk*, not the bankers' objectives or constraints. Thus, in a *symmetric equilibrium*—in which all bankers of the same type and

of the same country behave the same—the portfolio allocations in each country (given by the first-order conditions) will be the same.[21] The banking system of a given country then holds one half of the domestic government's debt and one half of the foreign government's debt in a symmetric equilibrium. As can be seen from the first-order conditions, banks are induced to diversify their portfolio risk by the concavity in the return function $f(I)$.

We denote by b_S and b_R respectively the holdings of safe debt and risky debt of the representative banker. The demand for the two types of debt is characterized by the first-order conditions

$$p_{S0} = (1-\pi)\left[1+\omega\lambda f'(y_1+\lambda(b_S+b_R))^+\right] + \pi\left[1+\omega\lambda f'(y_1+\lambda b_S)^+\right], \tag{6}$$

and

$$p_{R0} = (1-\pi)\left[1+\omega\lambda f'(y_1+\lambda(b_S+b_R))^+\right]. \tag{7}$$

Like before, the price of debt includes a collateral premium, which now reflects the quantities of both debts in banks' portfolios. The equilibrium price and quantities in the period-0 market for government debt can then be determined by using the two equations for supply

$$2p_{S0}b_S = g, \tag{8}$$

and

$$2p_{R0}b_R = g, \tag{9}$$

(with a factor 2 as the debt is purchased in equal amounts by the bankers from the two countries). The equilibrium of the government debt market is characterized by a quadruplet of quantities and prices, $(b_S, b_R, p_{S0}, p_{R0})$, that satisfies equations (6), (7), (8) and (9). The main properties of the equilibrium are summarized in the following proposition.

[21] To be precise, the allocation of the debt without collateral premium is indeterminate. We pin it down by restricting attention to *symmetric equilibria*, where all bankers choose the same portfolio allocation unless they have a strict reason not to do so. The allocation of the debt with a collateral premium is uniquely determined.

Proposition 1 *Assume $b^* < g < 2b^*$. Then financial integration is associated with (i) portfolio diversification, (ii) financial contagion and (iii) improved welfare in both countries:*

(i) portfolio diversification: in period 0, the banks of both countries hold the same portfolio of safe and risky government debt;

(ii) financial contagion: in period 1, a government default in the risky country lowers investment and output equally in both countries;

(iii) welfare: ex ante welfare is higher than under autarky in both countries.

Proof. *See appendix.* ■

Portfolio diversification, as we saw above, results from the bankers' desire to insure against sovereign risk. Financial contagion is then a natural consequence of portfolio diversification—a default by the risky country affects the banks of both countries. The condition $b^* < g < 2b^*$ implies that investment is equal to the efficient level if there is no default (i.e., there is no structural shortage of government debt), but that banks start to be collateral-constrained if one country defaults. The prices of government debt in period 0 are given by

$$p_{S0} = 1 + \pi\omega\lambda f'(y_1 + \lambda b_S), \tag{10}$$

and

$$p_{R0} = 1 - \pi. \tag{11}$$

The premium in the price of safe government debt reflects the fact that it becomes a scarce collateral if the risky country defaults. By contrast, the price of risky debt does not have a premium because collateral is not scarce when there is no default.

One can easily understand that the banks of the risky country benefit from financial integration, which gives them access to a safe collateral. Perhaps more surprisingly, the safe country also gains from financial integration in spite of the fact that this exposes its banking system to financial contagion, and makes its output both more volatile and lower in

expected value than under autarky. The reason is that the safe country sells its government debt at a high price that reflects the value of insurance for foreign banks. Using (8) and (9), $y_1 + \lambda b_S < I^* < y_1 + \lambda(b_S + b_R)$ as well as $T_S = 2b_S$ and $T_R = 2b_R$ to substitute out T_S and T_R and equation (11) to substitute out p_{R0} from (4) and (5) we obtain the following expressions for welfare:

$$U_S = y_0 + y_1 - g + \omega\left[(1-\pi)f(I^*) + \pi f(y_1 + \lambda b_S)\right] + (p_{S0} - 1)b_S, \tag{12}$$

and

$$U_R = y_0 + y_1 - g + \omega\left[(1-\pi)f(I^*) + \pi f(y_1 + \lambda b_S)\right] - (p_{S0} - 1)b_S. \tag{13}$$

In words, the welfare of the safe country is equal to: *i)* the value of initial endowments net of the public expenditure, y_0+y_1-g, plus *ii)* expected period 2 output, $\omega\left[(1-\pi)f(I^*) + \pi f(y_1 + \lambda b_S)\right]$, plus *iii)* the profit made from selling domestic government debt at a high price to the other country's banks, $(p_{S0} - 1)b_S$. The welfare of the risky country is the same, except that the premium it pays on safe debt enters as a cost instead of a profit. The safe country gains from financial integration because of the *collateral premium* that is paid by foreign banks on the safe government debt. The safe country, in other words, is fairly compensated through the market price of its debt for the insurance that it provides to the risky country.

To summarize, under financial integration bankers in the risky country compete with bankers in the safe country for safe-country debt. In the process, they effectively export sovereign risk to the safe country. While under autarky, safe-country bankers would have held only safe debt, under financial integration they may be driven to *diversify* and hold both safe and risky debt. As a result, when the risky country defaults on its debts it exports the crisis to the safe country by restricting the amount of collateralized borrowing that the safe country's banks can undertake. On the other hand, the bankers of the risky country benefit from holding safe country debt as this reduces their government domestic debt risk. Moreover, they are willing to pay a premium for holding this debt, which amounts

to a transfer from the risky country to the safe country. Financial integration generates important *risk diversification* benefits ex ante, but at the cost of *contagion* ex post. On balance, the welfare gains are positive for both countries.

4.2 Endogenous supply of collateral

A natural question to ask, at this juncture, is what amount of insurance the safe country will find it optimal to provide to the risky country. Under the assumption that we have made so far, each government issues just enough debt to finance g so that the level of debt is not a choice variable. We now relax this restriction by assuming that governments can do open market operations by which they issue their own debt in order to buy the debt of the other government. In this way, the fiscally safe government can increase the supply of safe debt and reduce the supply of risky debt to the banking sector of both countries.[22]

More formally, we now write the bond market equilibrium equations in period 0 as:

$$p_{S0}B_S = 2p_{S0}b_S + (p_{R0}B_R - g)\,,$$

and

$$p_{R0}B_R = 2p_{R0}b_R + (p_{S0}B_S - g)\,,$$

where B_S and B_R are the supplies of government bonds by respectively the safe and risky countries. By issuing a total amount of debt B_j the government of country j can raise revenues $p_{j0}B_j$, which it can use to fund the public good expenditure g and, to the extent that it raises more than g, to purchase government bonds from the other country's government. The left-hand side of these equations is the total supply of bonds, and the right-hand side is the sum of the demands from bankers (first term) and from the other government (the

[22]This is one interpretation of what the *European Financial Stabilization Fund* was created to do (buy risky government debt by issuing debt that is guaranteed by the fiscally safe governments).

second term). Adding up these equations implies that

$$p_{S0}b_S + p_{R0}b_R = g,$$

that is, the representative banker must hold the amount of debt that is necessary to finance the expenditure g.

The fiscally risky government will never find it optimal to increase the relative supply of risky debt (which hurts its own bankers without benefit to anybody else), so that we can assume $p_{R0}B_R = g$. The question is whether the safe government may find it optimal to increase the supply of its debt by setting $p_{S0}B_S > g$. The answer can be found by looking at the variation of the safe country's welfare with respect to its supply of bonds.[23] Using (10) to substitute out p_{S0} from (12) and differentiating with respect to b_S gives,

$$\begin{aligned}\frac{\partial U_S}{\partial b_S} &= \omega\pi\lambda f'(y_1 + \lambda b_S) + \omega\pi\lambda[f'(y_1 + \lambda b_S) + \lambda f''(y_1 + \lambda b_S)b_S] \\ &= \omega\pi\lambda\left[2f'(y_1 + \lambda b_S) + \lambda f''(y_1 + \lambda b_S)b_S\right].\end{aligned}$$

The safe country's welfare is thus maximized for a level of bond supply b_S^* that satisfies the first-order condition:

$$f'(y_1 + \lambda b_S) = -\frac{\lambda}{2}f''(y_1 + \lambda b_S)b_S.$$

Since $f''(.) < 0$ we observe that at the optimum b_S^* for the safe country government we have $f'(y_1 + \lambda b_S^*) > 0$.

The supply of safe government bonds is lower than the level that would be chosen by a "federalist social planner" maximizing the sum of the payoffs in the risky and safe countries

[23]Note that we assume that the level of safe government debt can be increased without making it more risky. That is, we are considering debt increases that are not large enough to endanger the solvency of the government in the safe country.

given below:

$$U_S + U_R = 2[y_0 + y_1 - g + \omega((1-\pi)f(I^*) + \pi f(y_1 + \lambda b_S)].$$

Differentiating with respect to b_S we obtain the first-order condition for the welfare optimum:

$$\frac{\partial(U_S + U_R)}{\partial b_S} = \omega\pi\lambda f'(y_1 + \lambda b_S) = 0,$$

which requires that b_S be set at b^*. The social planner increases the supply of safe debt to a level such that banks are not constrained even if there is a default in the risky country.

In sum, financial integration results in an inefficient supply of safe collateral. In our illustration with only one safe government and one risky government, the safe country government acts like a monopoly issuer and rations the amount of safe debt available, so as to be able to extract a *collateral scarcity premium* from the bankers in the risky country. Our results are summarized in the following proposition.

Proposition 2 *Assume that the fiscally safe government may increase the relative supply of safe bonds through open market operations. Then the safe government will keep the supply of safe bonds inefficiently low from the point of view of the two countries' welfare.*

Proof. *See discussion above.* ■

Figure 5 presents a numerical illustration of our results. To construct the figure we assumed a quadratic specification for $f(\cdot)$

$$f(I) = \phi I \left(I^* - \frac{I}{2} \right),$$

and set the model parameters to the following values: $y_0 = y_1 = g = 1$, $\omega = 0.2$, $\pi = 0.2$, $\lambda = 5$ and $I^* = 5$. We observe that the safe country maximizes its own welfare by limiting the supply of its own bonds to $b_S = 0.54$, whereas the risky country's welfare as well as total

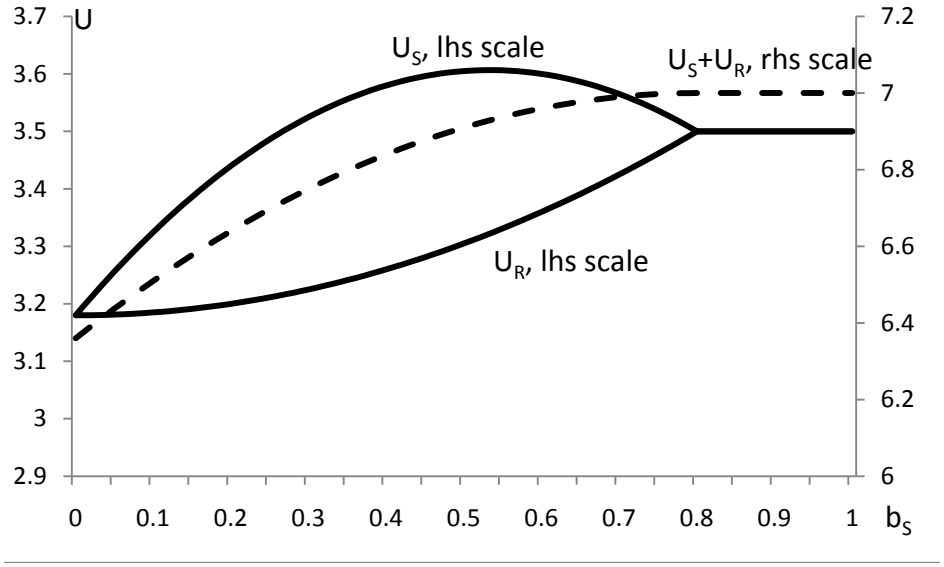

Figure 5: Variation of welfare in the safe and risky countries with the supply of safe debt

welfare are maximized by setting b_S above 0.8.

5 Fiscal integration

We have assumed so far that the default of the risky country, and its consequences on the banking system of both countries, were exogenous events that could not be remedied. We now introduce into the model the possibility for the risky country to restore its solvency either through a *fiscal adjustment* or a *bailout* from the safe country. Ex post, the safe country may be ready to contribute to a bailout to the extent that it improves the situation of its own banks. Successfully restoring the solvency of the risky government, thus, may involve a combination of fiscal effort and transfer—in other words, a certain degree of fiscal integration. Such an arrangement, if it prevents the default of the risky country and the resulting drop in investment, will increase total welfare to the first-best (no-default) level. The key question, however, is whether it is possible to design the arrangement in such a way that both countries benefit ex ante.

We expand our basic model by adding the possibility of a *fiscal adjustment* in period

1.[24] The fiscal adjustment and bailout mechanism can be characterized, in reduced form, by an allocation of a *fiscal effort* between the two countries. In order to avoid a default, the repayment on each bond of the risky country government must be increased from 0 to 1.[25] We denote by α the fraction of the repayment that comes from the risky country's own resources, the residual $(1-\alpha)$ being financed by a transfer (*bailout*) from the safe country. Parameter α captures the weight that is put by the mechanism on the defaulting country's own fiscal effort as opposed to external help—or, in other words, α is a measure of the mechanism's reliance on discipline rather than insurance via transfers.

The reduced-form parameter α is sufficient to determine the welfare of both countries (ex ante and ex post). However, it is interesting to ask how the value of α may be determined by the rules that govern the fiscal integration between the two countries. Consider first the case of *discretion*, that is, the case where the two governments negotiate ex post (in period 1) the allocation of the fiscal effort between the two countries. Avoiding a default ex post increases output by the same amount, $\omega\left[f(I^*)-f(y_1+\lambda b_S)\right]$, in both countries. It follows that the welfare gain from the fiscal adjustment is also the same in both countries if they share the cost equally ($\alpha=1/2$). In this case, the safe country simply provides a bailout of b_R to the risky country, with half of this transfer coming back to the safe-country banks in the form of a repayment of their claims on the risky country government.

In general, the transfer from the safe country to the risky country depends on the relative bargaining power of the two countries. For example, assume that the safe country has all the bargaining power and can make a take-it-or-leave-it offer to the risky country. Then there are two cases to consider. If the output gain from the adjustment is larger than the cost of

[24] We assume that this commitment is possible one period ahead, in $t=1$ but not in $t=0$. If the risky country could commit to the fiscal adjustment in period 0, it would always do so and there would be no crisis.

[25] Without much loss of generality, we restrict attention to mechanisms that prevent default completely rather than merely increase the debt recovery value in a partial default. Also, our model is too spared down to allow for a meaningful distinction between a sovereign bailout and a bank rescue (see Philippon, 2009, for an analysis of bank recapitalization in an open economy).

repaying foreign banks for the risky country,

$$\omega \left[f(I^*) - f(y_1 + \lambda b_S) \right] > b_R, \tag{14}$$

then the risky country is ready to make the adjustment without external help. The safe country then indeed does not offer any help in equilibrium ($\alpha = 1$), and there would never be a default in equilibrium because the risky country would always find it optimal to do a fiscal adjustment in period 1.

The more interesting case is when condition (14) is not met, so that the risky country does not implement the fiscal adjustment without external help. Using the fact that if the mechanism is successful there is no default, so that $b_S = b_R = g/2$, we note that condition (14) is *not* satisfied if and only if

$$\frac{g}{2} > \omega \left[f(I^*) - f(y_1 + \lambda \frac{g}{2}) \right]. \tag{15}$$

This condition says that the benefit of the fiscal adjustment in terms of increased output (the r.h.s.) is smaller than the payment of the debt to the safe country's banks (the l.h.s.). Note that in this case, the risky country does not implement the fiscal adjustment (in the absence of external transfer) *because of international financial integration.* Under autarky, the risky country would implement the fiscal adjustment because it would capture all the benefits of the adjustment in terms of higher output. Under financial integration, by contrast, those benefits are divided between the two countries whereas the taxpayer of the risky country bears the entire burden of the adjustment.

Subject to condition (15), the adjustment can take place only if it is supported by a transfer from the safe country. The risky country's share of the burden of adjustment cannot exceed a bound given by,

$$\alpha \leq \overline{\alpha} \equiv \frac{\omega \left[f(I^*) - f(y_1 + \lambda g/2) \right]}{g/2}.$$

Thus, even if the safe country has all the bargaining power ex post, it must make a transfer to the risky country in order to induce the fiscal adjustment.

We have assumed so far that the countries do not relinquish any fiscal sovereignty, so that the best that they can do is bargain over the welfare gains from a fiscal adjustment ex post. A deeper form of fiscal integration would be a *federalist system* allowing the countries to commit ex ante to the value of α. As an example of fiscal federalism, the risky country could accept ex ante to let the safe country take over its fiscal policy in the event of default. In this case, the safe country will make sure that the risky country bears all the burden of the adjustment ex post ($\alpha = 1$).

How does fiscal integration affect welfare ex ante (in period 0)? The welfare of the two countries can be written

$$U_S = y_0 + y_1 - g + \omega f(I^*) - \pi(1-\alpha)g,$$

$$U_R = y_0 + y_1 - g + \omega f(I^*) + \pi(1-\alpha)g.$$

Thus, the welfare of the safe country is equal to expected output net of public expenditures minus the expected transfer to the risky country. The welfare of the risky country involves the same terms except that the transfer is counted positively.

The welfare of the safe country is obviously maximized when the fiscal adjustment mechanism puts all the weight on discipline rather than insurance ($\alpha = 1$). Even in this case, however, the safe country's welfare is the same as under autarky, and it is strictly lower than the welfare level that the safe country would obtain in the absence of a fiscal adjustment mechanism (this is an implication of point (iii) of Proposition 1). Thus we have the following result.

Proposition 3 *Conditional on financial integration, the safe country always loses ex ante from fiscal integration. The safe country is strictly worse off with financial plus fiscal integration than under autarky, except in the limit case where the fiscal adjustment mechanism*

involves no transfer (in which case the safe country is indifferent between autarky and integration).

Proof. *See discussion above.* ■

The incentives of the safe country to reduce the risk of default in the other country are very different ex ante and ex post. Ex post (in period 1) the safe country looses output and welfare from a default in the risky country, and is ready to contribute some resources to avoid this outcome. Ex ante, however, the safe country benefits from the riskiness of the other country's government debt because it extracts a monopoly rent from issuing the safe haven asset. Thus, the safe country increases its welfare ex ante by *committing not to help* the risky country resolve its default.

The safe country's ex ante commitment not to help, however, may not be credible since it benefits from helping the risky country ex post.[26] If commitment is not possible, the next best solution for the safe country is to ensure that the default-avoiding mechanism relies as much as possible on discipline rather than transfers (i.e., maximizes α). If transfers cannot be completely ruled out (i.e., α is smaller than 1), the safe country is worse off ex ante in the equilibrium with financial plus fiscal integration than it would be under autarky. This means that the safe country is strictly better off not participating in the union, except in the extreme case where the fiscal adjustment mechanism relies entirely on discipline and involves no international transfer ($\alpha = 1$). Even in this extreme case, the welfare of the safe country is not higher than under autarky. Thus, it seems very difficult to find a form of fiscal integration that satisfies the ex ante participation constraint of the safe country, unless the risky country compensates the safe country ex ante for its insurance services.

Our results are illustrated in Figure 6. This figure reports the welfare of the safe countries under three scenarios: under autarky, financial integration, and financial plus fiscal integration. The figure is constructed by assuming that the two countries bargain ex post

[26]Note that in this model, commitment reduces total welfare. The sum of the welfare of the two countries is maximized under discretion. This is because commitment is put at the service of extracting a monopoly rent.

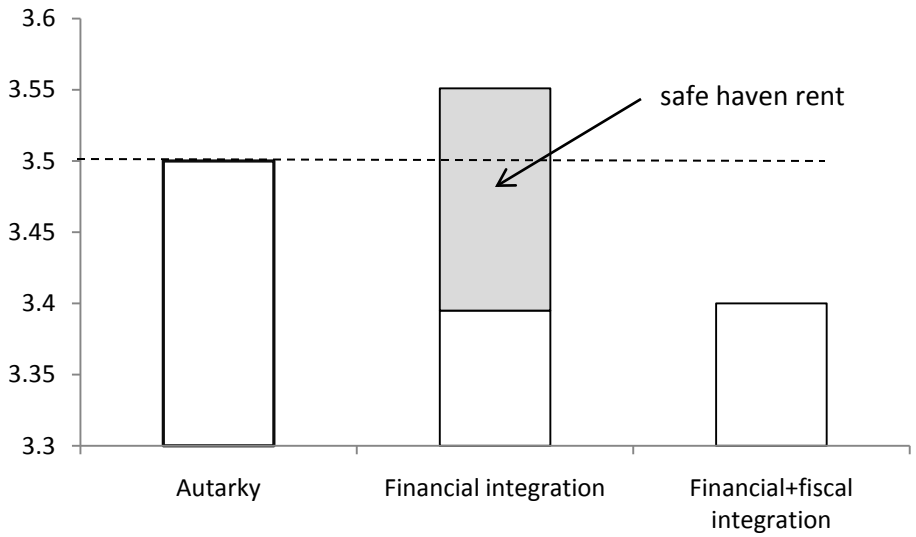

Figure 6: Welfare of the safe country under autarky, financial integration and financial plus fiscal integration

over the fiscal adjustment and have the same bargaining power ($\alpha = 1/2$), while otherwise using the same parameter values as for Figure 5. As Figure 6 illustrates, the welfare of the safe country is increased by financial integration as the output cost of financial contagion is more than offset by the rent from providing the safe haven asset to the risky country. Once fiscal integration is introduced, however, the safe country not only looses the safe haven rent but must also pay a transfer to the risky country when there is a crisis, so that its welfare falls below the autarky level. Thus, the model explains why Germany, as the provider of the safe government debt for the Euro area, might suffer from fiscal integration while at the same time benefiting from financial integration. It also explains why Germany has a strong interest in developing a form of fiscal integration that puts as much emphasis as possible on discipline rather than transfers.

6 Productivity shocks

In this section we present an extension of the model in which a default results explicitly from a negative productivity shock. This will show how the model with exogenous default that we have used so far can be viewed as a reduced form for a model in which default is

the result of real shocks. This will also bring out new properties, in particular self-fulfilling crises and "government debt contagion" that may capture real world phenomena.

Consider again the model with a single country, where we have assumed that the government defaults with probability π. To illustrate this default event more explicitly we now augment the model by adding a stochastic shock to period 2 output. Thus, we shall assume that net output $f(I)$ is affected by a multiplicative shock θ, which can take two values: $\theta \in \{\theta_L, \theta_H\}$, where $0 < \theta_L < \theta_H$ and where the probability that $\theta = \theta_L$ is π. We suppose that the government's fiscal receipts in period 2 are given by,

$$\tau\omega\theta f(I),$$

where τ is the tax rate and net output $\omega\theta f(I)$ is the tax base.[27] If in period 2 the fiscal receipts are lower than the debt coming due,

$$b > \tau\omega\theta f(I),$$

then there is a default in which the government repays nothing. We assume that θ is observed in period 1.

The one-country model that we have presented in section 3 is a reduced form of this model if we assume,

$$\tau\omega\theta_L f(I^*) < g < (1-\pi)\tau\omega\theta_H f(I^*). \tag{16}$$

The optimal level of investment remains I^* because the productivity shock multiplies *net* output $f(I)$. If $\tau\omega\theta_L f(I^*) < g$, the government does not have enough fiscal resources to repay its debt if productivity is low (since $b \geq g$ and $I \leq I^*$). The condition $g/(1-\pi) = b < \tau\omega\theta_H f(I^*)$ ensures that the government can repay its debt if productivity is high.

One new feature of the equilibrium is the possibility of a self-fulfilling crisis. Assume that

[27] We could assume that the tax base is gross output $\omega(I+\theta f(I))$ without changing the qualtitative results.

we have

$$g > (1-\pi)\tau\omega\theta_H f(y_1),$$

(which can be satisfied at the same time as (16)). Then a self-fulfilling default could occur even if productivity is high. The expectation of a default is self-fulfilling because it restricts the banks' collateral constraint, investment in period 1 and the tax base in period 2. The appropriate solution could be lending-of-last-resort that pegs the price of government debt at the good equilibrium level.[28]

In the two-country model, we can assume that the difference between the safe country and the risky country is that the former has a high level of productivity with probability 1.[29] Then there is an equilibrium in which the safe country never defaults if

$$b_S < \tau\omega\theta_H f(y_1 + \lambda b_S).$$

The safe country must have enough resources to repay its debt even when those resources are reduced by a default in the risky country. We have implicitly assumed that this condition was satisfied in the model of section 4. If this condition is not satisfied, however, a negative productivity shock in the risky country triggers a government default in *both* countries. There is international contagion not only in the banking system but also in government debt. The debt of the safe country is no longer a safe haven asset and the safe country unambiguously loses from international financial integration (whereas the risky country does not gain from it).

[28] This type of lending-in-last resort can be implemented by a limited fund such as the EFSF or by central banks.

[29] Alternatively, one could assume that the safe country has a higher level of τ, so that it does not default even if productivity is low.

7 Conclusion

We have provided a first analysis of *contagion* of sovereign debt crises through an integrated banking system. At the same time, we have examined how a sovereign debt crisis in one country may be resolved by a combination of bailouts by the other countries in a union and fiscal adjustment in the distressed country. We have also highlighted the benefits and costs of joining a financially, but not fiscally, integrated union. Our framework, with one risky and one safe country, is simple enough to draw attention to some key results, but of course, too special to capture all the complexities of a crisis such as the one currently unfolding in the Euro zone. A first obvious observation is that the incentives of banks in an integrated financial system to diversify their portfolios of sovereign debt, while reducing the cost of a default for any individual financial institution, also gives rise to a risk of contagion. A second, somewhat less obvious observation is that in equilibrium the safe member country supplies too little "safe haven" debt, while the risky country may supply too much risky debt. Third, financial integration leads banks to diversify their debt portfolios, and thereby create *hostages* in the safe country, which can be used to extract *bailouts* by the risky country, as we have seen in the Greek and Irish crises. Fourth, the possibility of contagious sovereign debt crises and bailouts may substantially reduce the benefits of joining a monetary union. Indeed, we have shown that the benefits of economic integration are unevenly distributed across member-countries, and that the prospect of bailouts may eliminate the benefits of integration for the safe country.

Many important issues remain to be explored, such as the vexing question of how an optimal stabilization mechanism should be designed, and how much fiscal integration is desirable to maximize the benefits of financial integration. Other interesting issues, which probably require a richer model to be analyzed, are the optimal form of regulation of banks in a financially integrated union, and the optimal form of coordinated intervention through bank rescues and sovereign debt bailouts. We leave these important topics for future research.

APPENDIX

Proof of Proposition 1

Based on the discussion preceding the Proposition, the only result that remains to be shown, to prove points (i) and (ii) of the Proposition, is that if $b^* < g < 2b^*$ we have

$$b_S < b^* < b_S + b_R,$$

so that the banking sector is constrained if and only if the risky government defaults. Using (6) and (7) the market equilibrium conditions (8) and (9) can be written

$$(1-\pi)P(b_S + b_R)b_R = \frac{g}{2},$$

and

$$\left[(1-\pi)P(b_S + b_R) + \pi P(b_S)\right] b_S = \frac{g}{2},$$

where function $P(\cdot)$ was defined at the end of section 3. Adding up those two equations gives

$$(1-\pi)P(b_S + b_R)(b_S + b_R) + \pi P(b_S)b_S = g.$$

One cannot have $b_S + b_R < b^*$. Since $P(b)b$ is increasing in b this would imply

$$g = (1-\pi)P(b_S + b_R)(b_S + b_R) + \pi P(b_S)b_S < (1-\pi)P(b^*)b^* + \pi P(b^*)b^* = b^*,$$

which cannot be true because g is assumed to be larger than b^* (equation (3)). It follows that $P(b_S + b_R) = 1$ and the budget constraint for the safe country is

$$\left[1 - \pi + \pi P(b_S)\right] b_S = \frac{g}{2}.$$

The l.h.s. is increasing with b_S and for $b_S = b^*$ it is equal to $\left[1 - \pi + \pi P(b^*)\right] b^* = b^*$, which

is larger than $g/2$ by assumption. So the equilibrium level of b_S must be smaller than b^*.

As for point (iii) of the Proposition, we write the welfare levels under autarky as

$$U_S = y_0 + y_1 - g + \omega f(I^*),$$

$$U_R = y_0 + y_1 - g + \omega \left[(1-\pi) f(I^*) + \pi f(y_1)\right].$$

Using expressions (12) and (13) for the welfare levels of the two countries under integration, and expression (10) to substitute out p_{S0}, we find that the welfare gains from financial integration for the safe and risky countries are respectively

$$\Delta U_S = \omega\pi \left[f(y_1 + \lambda b_S) + f'(y_1 + \lambda b_S)\lambda b_S - f(I^*)\right] > 0,$$

$$\Delta U_R = \omega\pi \left[f(y_1 + \lambda b_S) - f(y_1) - f'(y_1 + \lambda b_S)\lambda b_S\right] > 0,$$

where the positive sign results from the concavity of $f(\cdot)$ and, for ΔU_S, from $y_1 + 2\lambda b_s > I^*$. **QED**

REFERENCES

Alesina, Alberto and Enrico Spolaore, 1997, "On the Number and Size of Nations", *Quarterly Journal of Economics* Vol. 112, No. 4, pp. 1027-1056

Alesina, Alberto and Enrico Spolaore, 2005, *The Size of Nations,* MIT Press

Blundell-Wignal, Adrian and Patrick Slovik, 2010, "The EU Stress Test and Sovereign Debt Exposures," OECD Working Papers on Finance, Insurance and Private Pensions No. 4.

Bolton, Patrick, and Olivier Jeanne, 2007, "Structuring and Restructuring Sovereign Debt: The Role of a Bankruptcy Regime," *Journal of Political Economy* 115(6), pp. 901-924

Bolton, Patrick, and Olivier Jeanne, 2009, "Structuring and Restructuring Sovereign Debt: The Role of Seniority", *Review of Economic Studies* 76(3), pp. 879–902

Bolton, Patrick and Gérard Roland, 1996, "Distributional Conflicts, Factor Mobility, and Political Integration", *The American Economic Review* Vol. 86, No. 2, pp. 99-104

Bolton, Patrick and Gérard Roland, 1997, "The Breakup of Nations: A Political Economy Analysis", *Quarterly Journal of Economics* Vol. 112, No. 4, pp. 1057-1090

Broner, Fernando,and Jaume Ventura, 2010, "Globalization and Risk Sharing," *Review of Economic Studies*, forthcoming.

Broner, Fernando, Martin, Alberto and Jaume Ventura, 2010, "Sovereign Risk and Secondary Markets," *American Economic Review*, forthcoming.

Buchheit, Lee C. and G. Mitu Gulati, 2010, "How to Restructure Greek Debt," available at http://ssrn.com/abstract=1603304

De Santis, Roberto and Bruno Gerard, 2006, "Financial Integration, International Portfolio Choice and the European Monetary Union", European Central Bank Working Paper No. 626

Diamond, Douglas, and P. Dybvig, 1983, "Bank Runs, Deposit Insurance and Liquidity," *Journal of Political Economy* 91, pp.401-19.

Ejsing, J. and W. Lemke, 2009, "The Janus-headed salvation: sovereign and bank credit risk premia during 2008-09," ECB Working Paper 1127.

Gennaioli, Nicola, Martin, Alberto, and Stefano Rossi, 2010, "Sovereign Default, Domestic Banks and Financial Institutions," manuscript, Universitat Pompeu Fabra.

Kumhof, Michael, and Evan Tanner, 2008, "Government debt: A key role in financial intermediation", in Reinhart, C., C. Végh, and A. Velasco (eds.), Money, Crises and Transition, Essays in Honor of Guillermo A. Calvo, 2008.

Mody, A., 2009, "From Bear Sterns to Anglo Irish: How Eurozone sovereign spreads related to financial sector vulnerability," IMF Working Paper, No. 09/108.

Obstfeld, Maurice, and Kenneth Rogoff, 1996, *Foundations of International Economics*, MIT Press.

Philippon, Thomas, 2010, "Debt Overhang and Recapitalization in Closed and Open Economies," *IMF Economic Review* 58, pp.157-178.

Reinhart, Carmen and Kenneth Rogoff, 2009, *This Time Is Different. Eight Centuries of Financiall Folly*, Princeton University Press.

Sandleris, Guido, 2010, "Sovereign Defaults, Domestic Credit Market Institutions and Credit to the Private Sector," manuscript UTDT.

Sgherri, S., and E. Zoli, 2009, "Euro Area Sovereign Risk During the Crisis," IMF Working Paper, No. 09/222

Sturzenegger, Federico, and Jeromin Zettelmeyer, 2006, *Debt Defaults and Lessons From a Decade of Crises*, MIT Press (Cambridge, MA).