Sovereign Default Risk in Financially Integrated Economies

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Abstract

We analyze contagious sovereign debt crises for 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 increases the cost of *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. We analyze how a stabilization fund mechanism would be structured ex post to reduce the risk of a sovereign debt default and to substitute for the lack of fiscal integration ex ante. We show that under a stabilization fund mechanism the benefits of financial integration for the safest countries are eliminated.

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 issues relating to the implications for an integrated banking system of a sovereign debt crisis in a country. But, as the recent European sovereign debt crisis has highlighed, an important issue in sovereign debt crises in financially integrated economies is *contagion* of the crisis in one country to other countries through an integrated banking system.[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* crisis, and to mitigate contagion risk to *Ireland* and possibly other European Union member countries. 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?

One reason why the banking system is holding a significant fraction of government debt,

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[1]That banks are exposed to risk in government debt, including foreign government debt, is not new. This was true in the debt crisis of the 1980s (which hit advanced-country banks were hit by sovereign defaults, mostly in Latin America) and also many crises of the 1990s (Mexico, Russia, Argentina). The form of the contagion has changed as debt increasingly took the form of bonds that could be held by non-bank investors. The fact that bonds were continuously traded and priced in secondary markets has accelerated contagion, but the risk was more evenly spread between banks and non-bank investors.

and may therefore be vulnerable to a sovereign debt crisis, is that government debt securities help facilitate collateralized interbank lending. Thus, a first innovation of the sovereign debt model we analyze in this paper is 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 thus captures 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.

Another innovation we introduce into the model is financial integration, which is particularly important in the European context. 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.

We then consider optimal debt management policies by member countries of the union. We begin by showing that international financial integration can bring important benefits, as the banking sector can diversify its collateral base and thereby improve its efficiency and enhance economic activity in the union. However, this diversification benefit from a monetary union relies on a prudent debt management policy of the member countries. Each country must preserve the safety of its debt and thereby the soundness of the financial system of the union, which relies on this debt for collateral.

We end by showing that individual incentives of member countries may be to supply an excessively low amount of safe debt or an excessively high amount of risky debt from the point of view of the union 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

3

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 the 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 there is an even stronger argument for fiscal integration.

Several recent papers look at the interaction between sovereign default and the stability of the domestic financial system. This link does not exist in most of the literature on sovereign debt and default, in which it is assumed that the sovereign's debt is entirely held by foreign creditors. Like Broner, Martin and Ventura (2010), we assume that sovereign debt is traded between residents and nonresidents in secondary markets, which prevent selective default on foreign creditors. Broner and Ventura (2010) show that international financial integration may reduce the domestic incentives to enforce contracts—including domestic contracts—which may lead to a decrease in welfare. International financial integration may also reduce welfare in our setting, but through a different channel. In our model, financial integration does not directly affect the enforcement of private contracts, but the repayment of government debt, which 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 theme that runs through these papers is that the integration between domestic and international finance helps the sovereign to credibly commit to repay its foreign creditors, but may contribute to weaken the domestic financial system.

This paper is most closely related to Gennaioli, Martin and Rossi (2010). Those authors present a model where public default weakens the balance sheets of banks who hold public

bonds, causing a decline in private credit. They show two empirical facts that are consistent with our model (and theirs): public defaults are followed by large contractions in private credit, and these contractions are more severe in countries where banks hold more public debt. One important difference is that we look at the international spillovers between financially integrated economies whereas they focus on a small open economy. Reinhart and Rogoff (2009) present evidence on the relationship between government debt crises and banking crises.

The paper has two parts; first, a review of the main facts relevant to our analysis, and second, a presentation of the model.

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 and diverge 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, S., and E. Zoli, 2009). The attention of investors quickly turned to country-specific solvency concerns, however, 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 was not going only from bank fragility
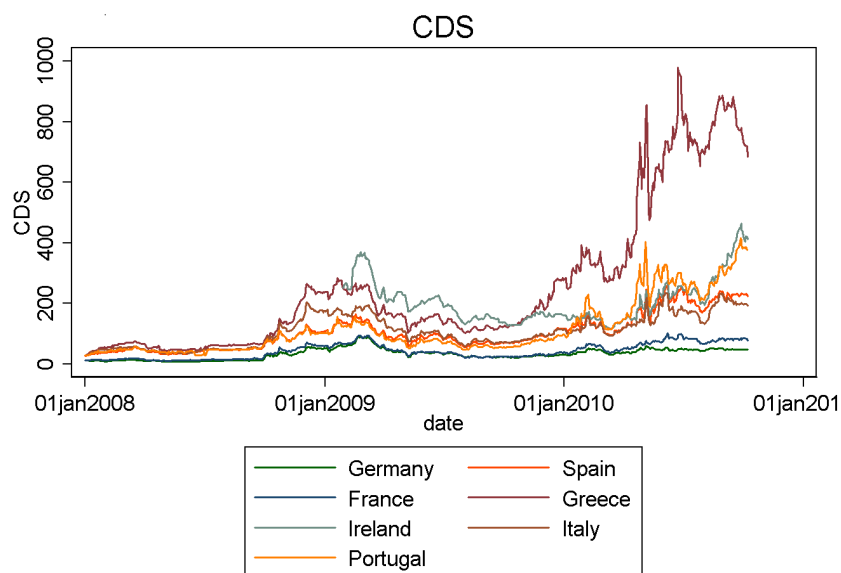
Figure 1: CDS spreads in Europe

to government debt fragility: investors could also see that increased sovereign risk would have a negative impact on the banks that were holding government debt.

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 still 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

6

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 never seen before in advanced economies. European equity markets fell, and the euro depreciated against major currencies. Soon, the impact had 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

7

all the risk-assessment measures."

Gripped by a sense of urgency, the European authorities reacted with a number of far-reaching measures. On 2 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. On 3 May 2010, the European Central Bank modified its rules and declared that Greek bonds would remain eligible as collateral even with junk status. On May 9, the ECB went further and announced a policy of supporting the price of certain government debts through open market purchases— member banks of the European System of Central Banks would start buying government debt in "those market segments which are dysfunctional."[2] The same day saw the announcement of the creation of the European Financial Stability Facility (EFSF), a new entity that could rely on € 750 bn of resources to grant conditional crisis loans to euro area governments affected by contagion from the Greek crisis.[3] The EFSF was endowed with enough resource to cover the budget financing needs of Spain, Greece, Ireland, Portugal and Italy 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

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[2]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 can—with the support of the German Debt Management Office—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, which has not been the case so far.

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 set the stage for a successful resolution of the European government debt problems—the spreads on the Greek, Portuguese and Irish debt remain elevated at the time of writing. If there is one clear lesson from the crisis, however, 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 stealth 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 European Financial Stabilization Fund (EFSF), which is operational since August, also institutes a certain degree of fiscal solidarity between euro area governments. Lenders to the EFSF will be 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 would not be without a fiscal cost to the other members. Unsurprisingly, thus, the crisis has also given a new impetus to proposals to reinforce economic governance in the EU, in particular the oversight of fiscal policies.

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[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.

[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 .

9

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 came across 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 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.

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[6]The number of 14.9 percent reported for Europe is an underestimate because it does not include 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 government debt held by foreign european banks. If we consolidate government debt across Europe, we find that 26 percent of European government debt was held by European banks.

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. 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.[8]

We observe a significant exposure of European banks to government debt, associated with a significant degree of cross-border exposure. Figure 2 shows the share of government debt held by domestic banks and by foreign (European) banks for each country in our sample.

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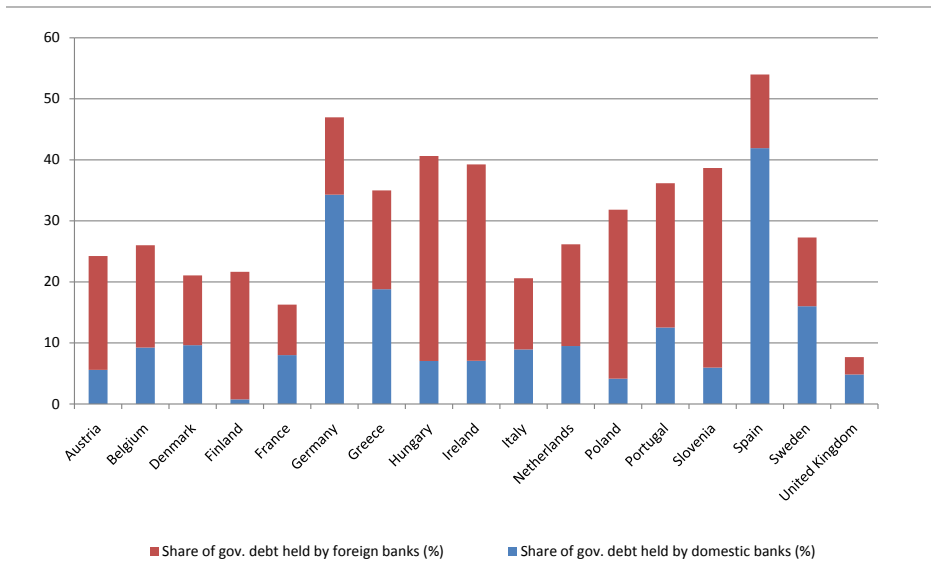
Figure 2: Share of government debt held by domestic banks and by foreign banks (%)

We observe that a significant share of government debt (close to 30 percent on average) is held by domestic or foreign banks, especially in Germany and Spain.[9] 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* sovereign risk: the share of the debt held by banks that was issued by a foreign government rather than the domestic government. 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).

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[9]The shares reported in Figure 2 are likely to be underestimated as they capture only the banks included in the stress test.
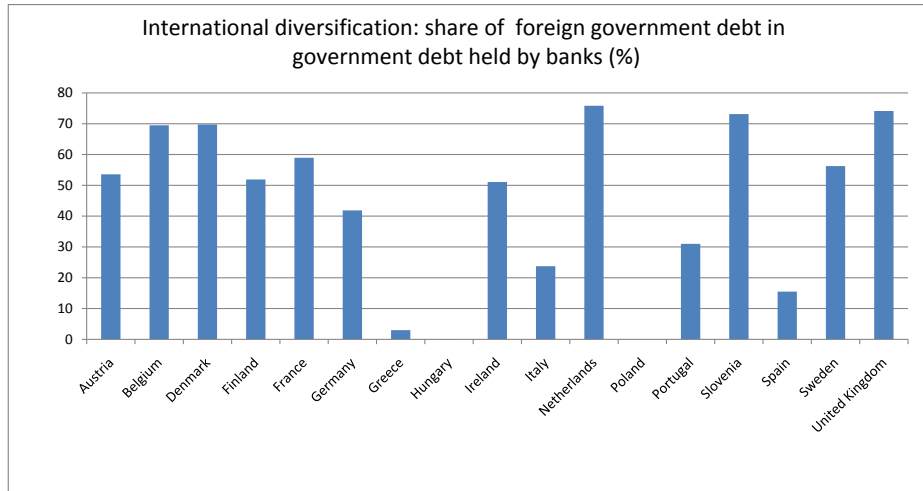
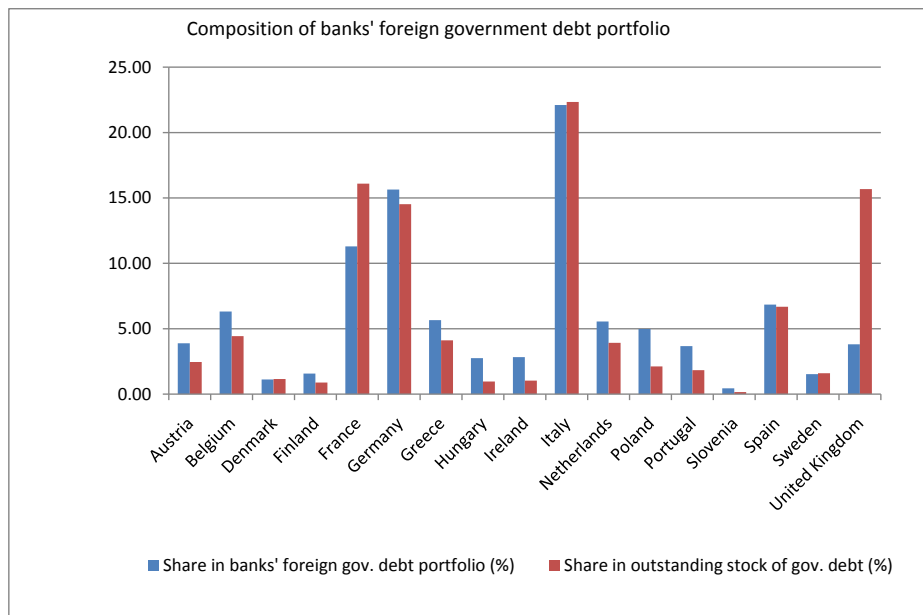Figure 3: Share of foreign debt in government debt held by banks (%)

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

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 debt portfolio" by adding the holdings of foreign government debt across all the banks in the sample. The share of each country's government debt in the portfolio is represented by the blue bars. The red bars represent the share of each country's government debt in total debt. 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 has 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 reavealed a very high degree of international integration between government debt markets and the banking systems of european countries (much larger in Europe than in other advanced economies). Financial integration implies that a government debt crisis in one country tends to spill over to the banking system of other countries. This makes sound fiscal policy a common good, and creates a force toward fiscal integration. We now turn to a model than can shed light on these phenomena.

3   One Country

We begin by outlining the model for a single closed economy. In a second stage we extend the analysis to a two-country world. 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

14

$t = 2$.

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 the role of government as collateral in private financial relationships.

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 $t = 0$.

The bankers are identical in period 0 but divide themselves into two groups after period 1. In period 1, a fraction $\omega \in [0, 1]$ of bankers obtain an investment opportunity which yields a return $I + f(I)$ at $t = 2$, for an investment I at time 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 is given by his endowment y_1 plus the (collateralized) loans d the banker is able to get from the $(1 - \omega)$ other bankers who did not obtain an investment opportunity.

The size of interbank loans is limited by the value of collateral (government bonds) held by the 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 ω can borrow a maximum collateralized amount $d \leq \lambda p_1 b$, so that the maximum he can invest is $I = y_1 + \lambda p_1 b$.[10] Bankers without investment opportunities trade bonds among themselves. There is no trade in a symmetric equilibrium $(b' = b)$ but the existence of this market determines 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 $d \leq \lambda p_1 b$	$c_1 = y_1 + p_1(b - b')$	
$t = 2$	$c_2 = I + f(I) - d + \delta b - T$	$c_2 = \frac{\omega}{1-\omega} d + \delta b' - T$	$\delta b = T$

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[10]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 purchase government bonds in the secondary market in period 1.

16

We introduce fiscal 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 fiscal 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.

Bankers with investment opportunities can borrow this maximum amount from the other bankers if the aggregate demand for collateralized interbank loans does not exceed the total supply of liquidity in the economy at time 1:

$$\omega(y_1 + \lambda p_1 b) \leq y_1.$$

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:

1. In <u>period 2</u>, 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

17

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 risk-less) and by

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

for the bankers with an investment opportunity.[11]

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

$$p_1 = \delta.$$

The bankers with investment opportunity invest the optimal level I^* if they can. We assume

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

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

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

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 $c_0 = y_0 - p_0 b$.

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[11]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.

For a fixed bond issue b, the welfare of the representative banker in period 0 is given by:[12]

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

With probability $1 - \pi$, there is no default, and a fraction ω of bankers are able to reap the surplus $f(\min(I^*, y_1 + \lambda b))$. With probability π, there is a default and the bankers with investment opportunities can invest only y_1. The first-order condition for the demand for government bonds, $\partial U / \partial b = 0$, implies

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

where we use the standard notation $x^+ = \max(0, x)$.[13] The 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 collatoral and falls to zero if b is larger than a critical threshold

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

If $b \geq b^*$ the banks with investment opportunity hold more government debt than they need to finance the efficient level of investment and the collateral premium is 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 be written,

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

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[12]This expression does not include the utility from the public expenditure. Adding a constant term would obviously not change any of the results.

[13]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 equal to zero for $I = I^*$ and is negative for I larger than 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 one unique equilibrium in period 0.[14]

Looking at the market equilibrium condition (2), one can see 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

$$g > b^*,$$

then the government must issue an amount of bonds that is larger than b^*, implying that there is no collateral premium. That the banking sector is not constrained by a structural shortage of public debt seems a natural assumption to make in our context.[15]

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

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[14]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 rules it out in the following.

[15]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.

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:

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

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:

$$
\begin{aligned}
U_S &= y_0 - p_{S0}b_{SS} - p_{R0}b_{SR} + y_1 + (1 - \pi)\left[b_{SS} + b_{SR} - T_S + \omega f\left(\min(I^*, y_1 + \lambda(b_{SS} + b_{SR}))\right)\right] \\
&\quad + \pi\left[b_{SS} - T_S + \omega f\left(\min(I^*, y_1 + \lambda b_{SS})\right)\right],
\end{aligned} \tag{3}
$$

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

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

The demand for bonds results from 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 fiscal risk, not the bankers' objectives or constraints. In a symmetric equilibrium, thus, the bankers of the two countries have the same portfolio allocation.[16] The banking system of a given country holds one half of its domestic government's debt and one half of the foreign government's debt. The 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

$$p_{S0} = (1 - \pi) \left[1 + \omega \lambda f'(y_1 + \lambda (b_S + b_R))^+ \right] + \pi \left[1 + \omega \lambda f'(y_1 + \lambda b_S)^+ \right], \qquad (5)$$

and

$$p_{R0} = (1 - \pi) \left[1 + \omega \lambda f'(y_1 + \lambda (b_S + b_R))^+ \right]. \qquad (6)$$

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

$$2 p_{S0} b_S = g, \qquad (7)$$

and

$$2 p_{R0} b_R = g, \qquad (8)$$

(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 (5), (6), (7) and (8). The

---

[16]To be precise, the allocation of the debt without collateral premium is indeterminate and is pinned down by the assumption of a symmetric equilibrium. The allocation of the debt with a collateral premium is uniquely determined.

main properties of the equilibrium are summarized in the following proposition.

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

$$p_{S0} = 1 + \pi\omega\lambda f'(y_1 + \lambda b_S), \tag{9}$$

and

$$p_{R0} = 1 - \pi. \tag{10}$$

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

23

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 (7) and (8), $y_1 + \lambda b_S < I^* < y_1 + \lambda(b_S + b_R)$ as well as $T_S = 2b_S$ and $T_R = 2b_R$ to substitute out T_S and T_R and equation (10) to substitute out p_{T0} from (3) and (4) we obtain the following expressions for welfare:

$$U_S = y_0 + y_1 - g + \omega\left[(1 - \pi)f(I^*) + \pi f(y_1 + \lambda b_S)\right] + (p_{S0} - 1)b_S, \qquad (11)$$

and

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

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 and makes it possible to reduce taxation at home. 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.[17]

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

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[17]Our model does not have externalities and laissez-faire is efficient—in spite of the financial frictions—for the same reason as in the first welfare theorem.

sovereign debt crisis to the safe country by restricting the amount of collateralized borrowing 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. This is effectively what the *European Financial Stabilization Fund* was created to do (buy risky government debt by issuing debt that is garanteed by the fiscally safe governments).

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 second term). Adding up these equations implies that

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

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[18]

$$\frac{\partial U_S}{\partial b_S} = \omega\pi\lambda f'(y_1 + \lambda b_S) + \omega\pi\lambda[f'(y_1 + \lambda b_S) + \lambda f''(y_1 + \lambda b_S)b_S]$$

$$= \omega\pi\lambda\left[2f'(y_1 + \lambda b_S) + \lambda f''(y_1 + \lambda b_S)b_S\right].$$

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

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

And 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

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[18]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 where banks are not constrained even if there is a default in the risky country .

In sum, financial integration without a fiscal union results in an inefficient supply of government debt by the member governments. 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. The safe government pursues a *Malthusian* debt policy, inefficiently restricting the amount of safe collateral in the economic union. 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 economic union's welfare.*

Proof. *See discussion above.* ∎

Figure [.] presents a numerical illustration of our results [to be added]. 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 ...We observe that the safe country

27

benefits from restricting its supply of safe bonds and it gains more in terms of welfare from financial integration than the risky country.

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 by a fiscal adjustment, or by receiving 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—that is, a certain degree of fiscal integration or even federalism. Such an arrangement, if it prevents the default of the risky country and the resulting fall in investment, will increase total welfare to the first-best (no-default) level. The question is whether it is possible to design the arrangement in such a way that both countries benefit ex ante.

Default is avoided if the risky and safe countries commit in period 1 to repay the debt of the risky country, b_R, in period 2. We expand our basic model by adding the possibility of such a commitment through a *fiscal adjustment* in period 1.[19] The fiscal adjustment mechanism can be characterized, in reduced form, by the allocation of *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.[20] 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 from the safe country. Parameter α captures the weight that is put by the mechanism on the defaulting country's own effort as opposed to external help—or, in

---

[19]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.

[20]We restrict attention to mechanisms that prevent default completely rather than merely increase the debt recovery value in a partial default.

other words, a measure of the mechanism's reliance on "discipline" rather than "insurance".

The value of α can be endogenized if one specifies how the mechanism works. For example, let us assume that the two governments negotiate ex post (in period 1) about the allocation of the fiscal effort between the two countries. Avoiding a default increases output by the same amount, $\omega\left[f(I^*) - f(y_1 + \lambda b_S)\right]$, in both countries. The welfare gain from the adjustment is also the same in both countries if they share the cost equally ($\alpha = 1/2$). In this case, the safe country transfers b_R to the risky country, and the transfer comes back to the banks of the safe country in repayment of their claims on the risky country government.

The transfer from the safe country to the risky country could be smaller or larger depending on the bargaining power of the two countries. For example, assume that the safe country 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 for the risky country is larger than the cost of repaying foreign banks,

$$\omega\left[f(I^*) - f(y_1 + \lambda b_S)\right] > b_R, \tag{13}$$

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

The more interesting case is when condition (13) is not met, so that the risky country will not do the adjustment without external help. Using the fact that if the mechanism is successful there is no default, and so no risk in government debt ($b_S = b_R = g/2$), condition(13) is not satisfied if and only if

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

In this case, the adjustment can take place only if it is supported by a transfer from the safe

country, and the risky country's share of the burden of adjustment cannot exceed a bound given by,

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

The mechanism discussed so far implies a certain degree of fiscal integration, but it does not constitute fiscal federalism because the participation of both countries is purely voluntary ex post (the countries do not relinquish any fiscal sovereignty). The risky country could accept 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

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

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

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 level that the safe country would have in the absence of fiscal adjustment mechanism (this is an implication of point (iii) of Proposition 1). Thus we have the following result.

Proposition 3 *Ex ante (in period 0) the safe country is better off rejecting any form of fiscal integration, even an adjustment mechanism that puts all the burden of the adjustment on the risky country.*

Proof. *See discussion above.* ∎

The safe country's incentives to reduce the risk in the other country's sovereign debt 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 may not be credible since it benefits from helping the risky country ex post.[21] If commitment is not possible, the next best solution for the safe country is to ensure that a default will be avoided at a minimum cost to itself by using a mechanism that relies as much as possible on discipline rather than insurance (i.e., that maximizes α). But if insurance cannot be completely eliminated (i.e., α is smaller than 1), the safe country is worse off ex ante in the equilibrium with financial and fiscal integration than it would be under autarky. The safe country is strictly better off not participating in the union, except in the extreme case where it can take control of the risky country's fiscal policy conditional on a default (to ensure $\alpha = 1$). Even in this extreme case, where a federalist system relies entirely on discipline, the welfare of the safe country is not higher than under autarky. Thus, unless there is a sufficient transfer from the risky to the safe country, it seems very difficult to find a form of fiscal integration that makes the safe country willing to participate in the union.

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[21]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.

6 Productivity shocks

We present in this section an extension of the model in which a default results 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.[22] 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,

$$\tau \omega \theta_L f(I^*) < g < (1-\pi)\tau \omega \theta_H f(I^*). \tag{14}$$

The optimal level of investment remains I^* because the productivity shock multiplies *net*

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

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 we have

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

(which can be satisfied at the same time as (14)). 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 through for instance a fund that pegs the price of government debt at the good equilibrium level.[23]

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.[24] 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).

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[23]If this is a fiscal fund, it would have to be financed by debt. Lending-of-last-resort might be a task for central banks.

[24]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.

Finally, the fiscal adjustments that we have talked about in the previous section could be implemented through an increase in the tax rate of the risky country in period 1.

7   Conclusion

International financial integration, plus the fact that the safety and liquidity of government debt remains a pillar of modern financial systems, imply that government debt credibility problems have powerful financial and international repercussions. Thus there are collective action problems between governments. We have discussed different approaches to resolving these problems, from discretionary fiscal adjustment to stronger forms of fiscal federalism, and found them wanting. Other approaches, such as regulation limiting the extent of financial integration, might be worth exploring in the context of this model.

APPENDIX

Proof of Proposition 1

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 (5) and (6) the market equilibrium conditions (7) and (8) can be written

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

and

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

and 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^*. 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 (11) and (12) for the welfare levels of the two countries under integration, and expression (9) 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 $y_1 + 2\lambda b_s > I^{*6}$.

QED

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