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The Sovereign-Bank Diabolic Loop and ESBies[†]

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The "diabolic loop" or nexus between sovereign and bank credit risk was the hallmark of the 2009–2012 sovereign debt crisis in the periphery of the euro area. In Greece, Ireland, Italy, Portugal, and Spain, the deterioration of sovereign creditworthiness reduced the market value of banks' holdings of domestic sovereign debt. This reduced the perceived solvency of domestic banks and curtailed their lending activity. The resulting bank distress increased the chances that banks would have to be bailed out by their (domestic) government, which increased sovereign distress even further, engendering a "bailout loop." Moreover, the recessionary impact of the credit crunch led to a reduction in tax revenue, which also contributed to weakening government solvency in these countries, triggering a "real-economy loop." These two concomitant feedback loops are illustrated in Figure 1.[1]

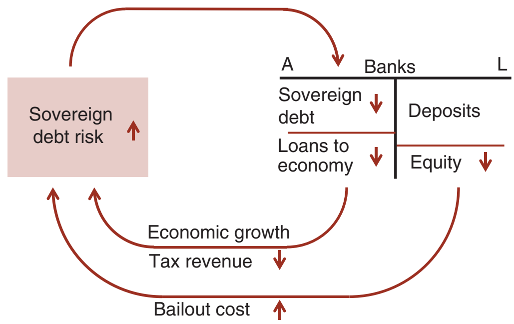

Figure 1. Two Diabolic Loops

There are three ingredients to the feedback loops. First, the home bias of banks' sovereign debt portfolios, which makes their equity value and solvency dependent on swings in the perceived solvency and market value of their own government's debt (Altavilla, Pagano, and Simonelli 2015). Second, the inability of governments to commit ex ante not to bailout domestic banks, since bailout is optimal once banks are distressed. Third, free capital mobility, which ensures that international investors' perceptions of future government solvency—whether warranted by fiscal fundamentals or not—are incorporated in the market value of domestic government debt. To break these loops, policy must remove at least one of these three ingredients. So far, capital controls are the only policy remedy adopted in response to the diabolic loop, in Cyprus and Greece.

In this paper we analyze the proposal by Brunnermeier et al. (2011), which aims to eliminate the diabolic loop by reducing the sensitivity of banks' sovereign debt portfolios to domestic sovereign risk. The proposal envisions that banks' sovereign bond holdings would consist mainly of the senior tranche of a well-diversified portfolio. This seniority structure could be achieved via a simple securitization, whereby financial intermediaries use a well-diversified portfolio of euro-area sovereign bonds to back the issuance of a senior tranche, labeled "European Safe Bonds" (or ESBies), and a junior tranche, named "European Junior Bonds" (or EJBies). ESBies would have very little exposure to sovereign risk, owing to the "double protection" of diversification and seniority: relative to a simple diversified portfolio of sovereign debt, ESBies would enjoy the additional protection provided

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[1] This feedback loop has been analyzed in several papers: Brunnermeier et al. (2011); Acharya, Drechsler, and Schnabl (2014); Cooper and Nikolov (2013); Farhi and Tirole (2015); Leonello (2015).

by seniority. The impact of a sovereign default would be absorbed in the first instance by the junior tranche, which would not be held by banks. The creation of such a safe asset would be important both for financial stability and for the conduct of monetary policy (Brunnermeier and Sannikov 2015).

This paper shows that restricting euro-area banks to hold ESBies would effectively isolate banks from domestic sovereign risk, and thereby defuse the "diabolic loop" between sovereign and bank credit risk. Interestingly, both features of ESBies—diversification and seniority—are needed. On the one hand, the price of a diversified but not tranched sovereign debt portfolio would still depend on swings in the perceived creditworthiness of euro-area governments, especially if they are correlated across countries due to a generalized "flight to quality." On the other hand, tranching sovereign debt of an individual country does not produce enough safe domestic securities in countries with weaker fiscal positions or limited sovereign debt issuance. In contrast, performing the tranching on a large pool of imperfectly correlated sovereign bonds would generate a large stock of an essentially risk-free euro-area sovereign asset, the liquidity and safety of which would be attractive for both banks and non-banks.

Last but not least, the issuance of such a security would not require any form of "fiscal solidarity" among euro-area governments: each government would remain entirely responsible for its own solvency, and the market price of its debt would remain a signal of its perceived solvency. This absence of joint liability stands in contrast to Eurobond proposals, such as the blue-red bond proposal by Von Weizsäcker and Delpla (2011).

I. One-Country Model

Consider a single country with stochastic tax revenue, resulting in a high or low primary surplus. We show that a "sunspot-driven" repricing of the country's sovereign risk can result in bailouts of banks or other systemic financial institutions, which can lead to sovereign default when the primary surplus turns out to be low. In the absence of such repricing, the government never defaults. Effectively, the sunspot acts as a selection device among two equilibria—one with bailout and possible default, and another with no bailout and no default. A key condition for the first equilibrium to exist—and hence for the diabolic loop to arise—is that banks hold a sufficiently large fraction of the stock of domestic sovereign debt.

There are four domestic agents. First, the government, which prefers higher to lower output, as this is associated with greater tax revenue. Second, dispersed depositors, which run on insolvent banks if the government does not bail them out, and also pay taxes. Third, bank equity holders, which use all of their capital for the initial equity, so they cannot recapitalize banks subsequently. Finally, investors in government bonds, whose beliefs determine the price of sovereign debt subject to a sunspot that may lead to repricing of sovereign risk. For simplicity, all agents are risk neutral and there is no discounting, so that the risk-free interest rate is zero. Short-term deposits yield extra utility compared to long-term government debt due to their convenience value in performing transactions.[2]

The model has four dates: 0, 1, 2, 3. All consumption takes place at the final date 3. At $t = 0$, the government issues a unit of a zero coupon bond at price B_0 with face value $\underline{S} > 0$, which is repaid probabilistically in the last period. The government primary surplus S (absent the diabolic loop) is low $\underline{S}$ with probability π and high $\overline{S} > S$ with probability $1 - \pi$. We denote by B_t the price of the bond at each date t. Next, we denote by α the share of debt owned by banks in the original period, the remaining fraction $1 - \alpha$ being held by other risk-neutral investors. Hence, at time $t = 0$, banks hold αB_0 in sovereign debt on the asset side of their balance sheet, as well as an amount L_0 of loans to the real economy. On the liability side of their balance sheets are deposits D_0 and equity E_0.

At date $t = 1$ a sunspot occurs with probability p.[3] When a sunspot is observed, investors become pessimistic: they expect partial government default in the last period, which in equilibrium will be a true belief. Hence, the price of the government bond drops from B_0 to B_1 and banks suffer marked-to-market capital losses of

[2] This is necessary to justify the demand for bank deposits backed by sovereign debt. Otherwise, banks would not need to hold sovereign debt.

[3] The sunspot carries no fundamental information about the primary surplus revealed in $t = 3$.

$-\alpha\left(B_1 - B_0\right)$.[4] If this leads banks' equity to drop below zero, banks are insolvent. We assume that insolvent banks cannot roll-over maturing loans of size ψL_0. This is assumed to lead to an equal output loss, which lowers the government's tax revenue by $\tau\psi L_0 \geq 0$ at $t = 3$. At date $t = 2$ the government must decide whether to bail out banks, before discovering its actual tax revenue at $t = 3$. A bailout involves the issuance of additional government bonds, which are given to the banks as extra assets. If the government chooses not to bailout, a further ψL_0 of loans are not rolled-over, resulting in even lower tax revenues at $t = 3$.

Finally, at date $t = 3$, the government's fiscal surplus is realized. If no sunspot occurred, the surplus is just the stochastic variable S, while if the sunspot occurred at $t = 1$ *and* a bailout at $t = 2$, the surplus is $S - \tau\psi L_0 + \alpha\left(B_1 - B_0\right) + E_0 =: S - C$, where C is the implied (endogenous) bailout cost plus the tax loss due to credit crunch in $t = 1$.

We make four parametric assumptions. First, the government's primary surplus before bailout costs remains positive:

$$\text{(A1)} \qquad \underline{S} - \tau\psi L_0 \geq 0.$$

Second, the bailout is assumed to be optimal at $t = 2$ if a sunspot occurred at $t = 1$, so that a no-bailout pledge is not credible for any α. This requires

$$\text{(A2)} \qquad E_0 > \left[2\pi(1-p) - 1\right]\tau\psi L_0.$$

Third, banks' aggregate equity is sufficiently small that the diabolic loop occurs at least if exposure is maximal ($\alpha = 1$):

$$\text{(A3)} \qquad E_0 < \left(1-p\right)\pi\tau\psi L_0.$$

Fourth, if the surplus is high, the government can still fully repay its debt even after a bailout at $t = 2$ (even for $\alpha = 1$):[5]

$$\text{(A4)} \qquad \overline{S} - \underline{S} \geq \frac{\tau\psi L_0 - E_0}{1 - \pi(1-p)}.$$

[4] Note that even if banks' assets were not marked to market, the diabolic loop would still arise if depositors or other creditors panic as a result of depreciation of banks' assets.

[5] This assumption is only used to simplify calculations, but can easily be relaxed.

A. *The Diabolic Loop*

The diabolic loop occurs if the fraction of sovereign debt held by banks exceeds a threshold or equivalently if banks' equity is below a critical level. When investors become pessimistic due to the sunspot, the price of sovereign debt drops, making banks insolvent. This prompts the government to bail them out (by (A2)), which precipitates default and justifies investors' pessimism.

When the primary surplus at $t = 3$ is $\underline{S}$, after a bailout the government can only pay $\underline{S} - C$. Therefore, the price of debt at $t = 1$ is $B_1 = \underline{S} - \pi C$, so $\pi C \equiv \Delta_1$ is the price discount relative to its face value $\underline{S}$. The price of the debt in period 0 is the probability-weighted average of sunspot and no-sunspot prices: $B_0 = \underline{S} - \pi p C$, with a price discount $\pi p C \equiv \Delta_0 = p\Delta_1$. Recalling the definition of bailout costs C and of prices B_0 and B_1, and noticing that $B_1 - B_0 = -(1-p)\Delta_1$, the discount at $t = 1$ is

$$\text{(1)} \qquad \Delta_1 = \pi\left[\tau\psi L_0 - \alpha(B_1 - B_0) - E_0\right] = \frac{\pi(\tau\psi L_0 - E_0)}{1 - \alpha\pi(1-p)}.$$

Hence, the bailout is avoided at $t = 2$ if banks are left with positive equity, i.e.,

$$\text{(2)} \qquad \alpha(B_1 - B_0) + E_0 > 0 \quad \Leftrightarrow E_0 > \alpha(1-p)\pi\tau\psi L_0 := \underline{E}_0,$$

where the equivalence follows from

$$\text{(3)} \quad B_1 - B_0 = -\frac{(1-p)\pi}{1 - \alpha(1-p)\pi}(\tau\psi L_0 - E_0).$$

If instead banks' equity is below the threshold $\underline{E}_0$ in (2), then the sunspot leads to the diabolic-loop equilibrium. In this equilibrium, the price drop (3) is higher in absolute value (i) the smaller bank equity E_0; (ii) the larger the fraction α of sovereign debt held by banks; (iii) the higher the probability π of low fiscal surplus; and (iv) the smaller the sunspot probability p (as a very unlikely sunspot is less priced in B_0).

Hence, the diabolic loop can be avoided by requiring banks to meet the minimum equity threshold $\underline{E}_0$, for a given size of their sovereign debt portfolio α. Equivalently, one can impose on banks an aggregate position limit on government bonds α^*, given their initial equity E_0. The total supply of safe (diabolic-loop-free) assets to the banks is $\alpha^*\underline{S}$, since bonds are risk-free. This effectively limits the amount of safe deposits that the banking system can generate.

Proposition 1 summarizes these results.

PROPOSITION 1: (*i*) *To avoid the diabolic loop, the ratio of bank equity to sovereign exposure must be at least* $(1-p)\,\pi\frac{\tau\psi L_0}{\underline{S}}$. (*ii*) *The maximum amount of safe assets available to banks is* $\alpha^* B_0 = \frac{E_0}{(1-p)\,\pi\tau\psi L_0}\underline{S}$. *Equivalently,* $\frac{E_0}{\alpha\underline{S}}$ *is the minimum ratio of aggregate bank equity to sovereign exposure.*

B. *Sovereign Debt Tranching*

We consider an alternative to an upper bound on bank holdings of debt. Sovereign debt could be split into a senior and a junior tranche, with banks permitted to hold only the senior tranche. We will show that the diabolic loop is ruled out if the face value, F^s, of the senior tranche (the tranching point) or the bank's senior tranche holdings, α^s, is sufficiently low (for a given equity level E_0) or equivalently, $E_0 > \underline{E}_0^s := \alpha^s(1-p)\pi[\tau\psi L_0 - (\underline{S} - F^s)]$). In other words, the diabolic loop equilibrium can be ruled out by picking appropriate pairs (α^s, F^s). Tranching shrinks the region in which the diabolic loop can occur: intuitively, this is because it shifts risk arising from sovereign debt from banks to holders of the junior tranche. The analysis is the same as in the case of no tranching except that C is replaced by $C^s - (\underline{S} - F^s)$. Now, the cost of default C^s reflects the price drop in the senior bond and the additional term $-(\underline{S} - F^s)$ reflects the reduction in bailout costs due to the additional protection provided by the junior tranche.

Insofar as tranching eliminates the risk of bailouts, it also makes the junior tranche risk free as in this model the government may default only if it bails out the banks.

Tranching increases the total supply of safe assets, $\alpha^s F^s$ to the banking sector. To see this, suppose banks increase their senior bond holdings, α^s. This may expose them to the diabolic loop. But by picking a lower face value F^s one can still rule out the diabolic loop. We show that the required decline in F^s is small enough that $\alpha^s F^s$, i.e., the total value of safe assets, increases.

Stating these results formally:[6]

PROPOSITION 2: (*i*) *For a given security structure* F^s, *to avoid the diabolic loop, the ratio of banks' aggregate equity to sovereign exposure must be at least* $(1-p)\,\pi\frac{\tau\psi L_0 - (\underline{S} - F^s)}{F^s}$, *where the term* $(\underline{S} - F^s)$ *reflects the protection afforded by the junior tranche.* (*ii*) *If* $E_0 > \underline{E}_0^s$, *the junior bond is also safe.* (*iii*) *If* F^s *is chosen, so as to maximize the amount of safe assets for the banking sector, tranching generates larger amounts of safe assets than no tranching. Equivalently, tranching lowers the equity to be held by banks per unit of sovereign exposure.*

II. Two-Country Model

Now consider two symmetric countries. The realizations of their primary surpluses absent bailout interventions is independently distributed. Both governments issue zero coupon bonds with face value $\underline{S}$. If banks held only their own government sovereign bond, we would effectively be in the single country case: sovereign default is only correlated to the extent that sunspots are correlated. Suppose instead that an intermediary securitizes a symmetric pool made of government bonds issued by the two countries. If banks rebalance their portfolios slightly toward this pooled asset, they will be less exposed to a drop in the price of domestic debt. So, they need less equity to avoid the diabolic loop. This is the benefit of pooling. But, if banks in both countries replace their entire domestic sovereign holdings with the pooled asset, all banks end up with identical portfolios. Now, repricing of sovereign debt cannot occur in one country without occurring in the other. For bailout to occur in one of the two countries, the repricing of its domestic debt should be large enough that the implied price drop of the pooled asset would trigger insolvency of its domestic banks. But then, by symmetry the banks of the

[6] The proofs of this and the next proposition are relegated to the online Appendix.

other country are also insolvent, and require a bailout. Hence, complete pooling leads to perfect contagion. This is the curse of pooling.

This illustrates an important insight: simply requiring banks to hold a pooled asset—or an equivalently diversified portfolio of sovereign bonds—might actually lead to contagion across countries, if it makes their sovereign debt portfolios very similar.

But contagion is contained if banks hold only the senior tranche, $\alpha^{\mathcal{E}}$, of such a pooled asset, i.e., ESBies. Pooling and tranching interact positively, since repricing of ESBies after a sunspot is smaller than that of a senior bond of a single country. Intuitively, tranching the pooled asset allows senior bond holders to push losses onto the junior bond holders in a greater number of states than tranching the debt of a single country. Hence, banks' equity requirements can be reduced. Still, the junior bond would be itself isolated from repricing risk due to a sunspot: insofar as the diabolic loop is avoided, banks' losses are an off equilibrium phenomenon so that even junior bonds are risk-free. Of course, in a more general model, in which default does not only arise from the diabolic loop, junior bonds would not be entirely risk-free.

Pooling and tranching enables a maximal supply of safe assets to banks. The logic is the same as tranching in a single country but when applied to pooled sovereign debt, the (off-equilibrium) risk can be shifted more effectively to the junior bond holders. As a result, tranching combined with pooling increases the supply of safe assets further. Proposition 3 states this formally.

PROPOSITION 3: (*i*) *Given the tranching point $F^{\mathcal{E}}$, ESBies lower the required ratio of equity to sovereign exposure compared to single country tranching* (*for $\alpha^{\mathcal{E}} = \alpha^{s}$*). (*ii*) *If this ratio is upheld, the junior bond is also safe.* (*iii*) *If $F^{\mathcal{E}}$ and $\alpha^{\mathcal{E}}$ are chosen so as to maximize the amount of safe assets for the banking sector, ESBies generate a larger amount of safe assets than single country tranching.*

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