Shadow Banking, Sovereign Risk and Collective Moral Hazard[*]

Giovanni di Iasio[†] Federico Pierobon[‡]

August 27, 2012

Abstract

The paper shows that the time-consistent policy of public bailout strongly affects the liquidity risk of financial firms. Firms anticipate public support in a liquidity crisis and boost their leverage by recurring to shadow banking, a technology to attract market investors with liquid debt securities (private collateral) structured with illiquid assets (e.g. mortgages). With shadow banking, the financial sector reduces its need for expensive sovereign debt securities to insure against liquidity risk. The value of private collateral in a liquidity crisis is determined by the firms' privately costly and non observable effort choice. In expanding their leverage and in their effort choice, firms take into account the extent to which their sovereign would effectively be able to bail them out: the 'safer' a sovereign, the lower the quality of private collateral, the higher the liquidity risk. This interlinkage between the balance sheet of the official and the one of the financial sector is explored even with respect to the securities portfolio allocation choice: firms protected by a healthy risk-free government load with cheaper non-domestic risky sovereign debt as they expect to extract public support even in the presence of some sovereign default. These insights have important implications for the understanding of the bank-sovereign risk loop along the entire financial cycle and in terms of fiscal discipline and regulation.

Keywords: Liquidity, systemic risk, shadow banking, moral hazard, public bailout.
JEL Classification: E44; D86; G18

1 Introduction

Recent events have highlighted interesting features of the global financial system, some of them partially new in the long literature on financial crises. Among all, we would like to single out the following stylized facts (SF):

- **Shadow banking and credit growth (SF1).** In the run-up to the Great Financial Crisis (GFC), the financial system experienced a change in the intermediation chain with the rise of non-bank entities, the so-called *shadow banking* (SB) system. According to the Financial Stability Board (2011), the size of SB rose from \$27 trillion in 2002 to \$60 trillion in 2007. The new intermediation paradigm helped sustain a credit boom in many industrialized countries, even though growth of the SB was particularly intense in the US.

- **Private collateral (SF2).** In the years before the GFC various factors, including the search for yield, the greater reliance on secured funding markets, the large demand for safe assets from surplus countries and the shortage of "parking space", led financial firms to produce complex, structured securities out of typically illiquid assets (e.g. mortgages), which often were perceived as highly safe (AAA-rated) and competed with sovereign bonds.

- **Banking-sovereign interlinkages (SF3).** A strong dependence between the balance sheet of the financial sector and the sovereign balance sheet emerged along the entire financial cycle. Before the GFC, sovereign risk spreads were historically low. In the Euro Area, a profound process of financial integration was associated to large investment of financial institutions in non-domestic sovereign debt. In the aftermath of the GFC, private debt became public debt in many countries.

This paper develops a simple theoretical framework in which these facts are interpreted in terms of a public-bailout-moral-hazard problem that affects the ex-ante liquidity choice of financial institutions with a public guarantee (from here on, simply banks). We analyze the liquidity choice in two respects. First, shadow banking (securitization and repo finance) allows banks to transform parts of their illiquid assets into liquid debt securities (private collateral, shadow securities), reducing their need for *outside liquidity*, namely low-yield sovereign debt securities, and saving on liquidity costs. However, the production of private collateral is jeopardized by agency costs related to the transfer of risk along the intermediation chain. We assume that the quality of the private collateral, defined as the liquidity of these financial instruments in a system-wide liquidity crisis, is a bank's privately costly, non observable choice. The second type of liquidity risk comes from large investment in cheaper risky sovereign debt securities.

The paper shows that the anticipation of the bailout is a crucial determinant of (i) the leverage of the financial sector, (ii) the intermediation paradigm, namely the relative size of the shadow banking system, (iii) the quality of the private collateral and (iv) the banks' exposure to sovereign risk.

We build a collateral economy in line with the well-established tradition of Bengt Holmström and Jean Tirole.[1] Private firms called banks invest in partially illiquid, long-term investment projects (*limited pledgeability*). Random liquidity shocks may create refinancing needs before these projects can be brought to completion. Similarly to Farhi and Tirole (2009) (FT), in

---

[1]For a recent work, see Holmström and Tirole (2011)

a liquidity crisis banks are forced to scale down their balance sheet (deleveraging) if their liquidity position is not adequate, putting at risk banking stakeholders. To protect against liquidity shocks, banks may hold government bonds.

The first main departure from the FT framework is that our model explicitly provides banks with an alternative way to manage liquidity risk: they have access to a technology, *shadow banking* (SB), that increases the liquidity of long-term investment projects. We intend SB as the entire class of activities (securitization and secured funding techniques) and entities (ABS issuers, brokers and dealers, money market funds,...) that contributed to the emergence of the new intermediation paradigm based on the originate-to-distribute model. In the terminology of Tirole (2006), SB expands the pledgeability of banks' assets. In principle, SB compares favorably against government securities. Indeed, while sovereign bonds provide insurance and allow for a higher continuation scale, they also reduce the size of high-yield long-term investments. On the contrary, shadow banking, reducing the key friction of limited pledgeability, relaxes both the liquidity and the leverage constraints.[2]

Tirole (2010) points out that securitization transforms otherwise illiquid assets into tradable ones when it is accompanied by scrutiny by buyers that certifies the quality of the portfolio to the market. In general, several informational problems arise once the intermediation chain is divided in sequential steps and progressive risk-shifting takes place (Ashcraft and Schuermann (2008), Keys et al. (2010)). In this spirit, we assume the SB technology has no input other than banker' privately costly and non observable effort.[3] The effort choice determines the quality of the shadow securities: lack of effort increases the fraction of private collateral that would suddenly become illiquid (non-pledgeable) in a crisis. Sometimes we refer to it as toxic shadow assets. Absent any further intervention by the official sector, toxic shadow assets would force the bank to scale down the balance sheet in a crisis.

The features of the SB technology may create strong incentives to take on liquidity risk when banks anticipate that the time-consistent policy reaction by the official sector in the event of a crisis is to bail them out. Therefore, banks re-allocate their liquidity choice from costly insurance (sovereign bonds) to shadow toxic assets and maximize the size of the pure windfall of the transfer of taxpayers' money.

The second main difference with FT is that our model extends the portfolio allocation choice of banks to different sovereign debt securities. These are the main insights of the paper:

Shadow liquidity risk (INS1). In our collective-moral-hazard interpretation of shadow banking, there is a pervasive relationship between the balance sheet of the financial sector (the aggregate of banks and shadow banking) and the one of the official sector. The government's bailout capability is related to the taxpayers' wealth and to the possibility to levy additional taxes after those that are needed to service the outstanding public debt. For this reason, banks located in "rich countries" (large taxpayers wealth and low-indebted government) are the main candidates to load with shadow liquidity risk (production of toxic shadow assets). The shift from sovereign securities towards private collateral permitted by the shadow banking technology and reflected in the abnormal balance between

---

[2]In particular, increasing the fraction of the bank's value on which state-contingent contracts can be written and enforced, SB even creates additional stores of value to back financial contracts, thereby reducing the aggregate shortage of liquid assets.

[3]More explicitly, financial innovations of SB actually expand the pledgeability of assets only if the agents involved in the new intermediation chain properly deals with the agency problems associated to the selection and the monitoring of ultimate borrowers and to the construction of structured financial products.

private and public debt before the crisis, reinforces the moral-hazard problem expanding the feasible bailout set.

Sovereign risk (INS2). The public guarantee affects the ex-ante liquidity choice of banks even with respect to the investment in sovereign debt securities issued by governments with different probabilities of default. We show that, in equilibrium, banks established in jurisdictions with a risk-free government, being able to extract the public guarantee in every state of nature, load with both toxic shadow banking and sovereign bonds issued by more risky governments. The model predicts a soaring demand for risky assets in good times, so providing theoretical ground for the observed compression of sovereign credit spreads. In particular, once one allows for cross-country differentials in the balance-sheet of the official sectors (differences in public guarantees to the domestic financial sector), the model offers insights regarding banking competition in funding markets, equilibrium sovereign risk spread and fiscal discipline.

Relationship to the literature. Our paper is related to several bodies of literature. We adopt the general approach to the demand for liquidity of Holmström and Tirole (1998). Farhi and Tirole (2009) analyze the effects of the anticipation of a public bailout onto the leverage and maturity mismatch of banks. The private sector chooses to engage in strategic complementary choices to extract the full value of the pure windfall of the transfer. In this general structure, our model expands the analysis to private collateral risk and investment in cheap sovereigns.

The link between public finances, the bailout expectation and the private investment choices is addressed in Acharya et al. (2011). Similarly to our model, the supply of contingent liquidity by the official sector is constrained by the amount of existing public debt. In addition, the announcement of the bailout and the associated dilution of existing bondholders triggers a "collateral damage" depressing the value of banks' holding of sovereign debt securities.

A large recent body of literature concentrates on the emergence and the growth of the shadow banking system. Pozsar et al. (2010) give a detailed description of the complex web of shadow entities and activities. Gorton and Metrick (2010) interpret the shadow banking system as a vehicle to exploit regulatory arbitrage. The authors argue that even if an institutional effort is underway in the reshape of the entire regulatory framework, the policy intervention is often silent on off-balance sheet financing (e.g. the Dodd-Frank Act of 2010 do not address hot issues like the regulation of money market funds, securitization and repos). At the global level, the Financial Stability Board has been requested by the G20 Leaders to develop recommendations to "strengthen regulation and supervision of shadow banking". Kashyap et al. (2010) explain that heightened capital requirements for large financial institutions increased the appetite for exposures to shadow banking. This evidence is quite clear in the years preceding the 2008 banking crisis (Acharya et al. (2010)). For the same reason, the end of the shadow game delivered striking consequences to the entire financial system and, eventually, to the real economy (Gorton and Metrick (2011)).

On the theoretical front, in Gennaioli et al. (2010) shadow banking creates financial instability when agents underestimate or neglect tail risks. The relevance of information-insensitive private collateral in the form of debt securities is the building block in Dang et al. (2010). Debt preserves the symmetric ignorance between counterparties and minimize the value of producing or learning public information about the payoff. Similarly to our model, a public signal (or a liquidity shock, as in our case) can cause debt to become information-sensitive. Gorton and Ordonez (2012) analyze the disruptive effects of a "collateral check" in an highly leveraged environment in which a large fraction of contracts are backed by private money-like instruments.

2 Stylized facts and model insights: some evidence

In the years preceding the GFC, a class of activities and entities, known as the shadow banking system, enabled the financial system to construct money-like instruments out of typically illiquid and information-sensitive assets, like mortgages. The transformation of the credit intermediation process implied a complex web of interlinkages between different types of financial firms and markets and a substantial lengthening of the intermediation chain (see Pozsar et al. (2010) for a detailed description of the shadow intermediation chain). The success of SB originally rested on the expected improvements in the management of risks provided by financial innovations as securitization and secured funding techniques. The liquification of financial firms' balance sheet produced a large amount of shadow securities that fueled the repo market with abundant collateral (Singh and Stella (2012)).

The burst of the crisis made it clear that the SB was symbiotically intertwined with financial intermediaries with guarantees from the official sector. On the one hand, there was a sizable volume of bank funding coming from non-bank asset managers via source collateral and institutional cash pool (Pozsar and Singh (2011)). On the other, banks provided large liquidity and credit puts to the SB against which insufficient amounts of capital were allocated (Acharya and Richardson (2009), Adrian and Ashcraft (2012)). In addition, Duffie (2010) highlights that a rationale for providing non contractual support to sponsored shadow entities is to protect the long-run brand reputation and customer network. In a few months, shadow liquidity suddenly evaporated, followed by a complete shut down in several markets. The severity of the 2007-08 crisis was aggravated by the fact that the "hot potato" was not all passed on to final investors but sat on the balance sheet of the largest and most sophisticated banks (Shin (2009)). The freeze of unsecured lending and the massive drop in the amount of the economy's collateral with potentially catastrophic deleveraging effects (Singh (2011)), forced governments and central banks to intervene with unprecedented injections of capital and liquidity. From an ex-post perspective, the SB constituted a vehicle to extract free insurance from implicit, indirect credit puts to the taxpayer: US healthy and deep public pocket provided large guarantees to banks that, in turn, sold underpriced private puts to SB investors. The complex and extremely opaque web of market and non-market interconnections between SB and banks bypassed national borders. Indeed, even if the SB has been mainly a US phenomenon, large European banks played a part in the shadow game, being simultaneously receivers of short-term dollar funding from US money market funds and investors in US securitized instruments. In other terms, EU banks were involved in leveraged and maturity-transforming credit intermediation between US investors and US borrowers (Borio and Disyatat (2011)).

The ultimate stage of the crisis follows from the deterioration of public finances in several countries involved in the bailouts and subsequent contagion to other sovereigns displaying a weak fiscal position. The effective transfer of private losses on the government balance sheets plus the sovereign contingent liabilities related to financial sector backstops contributed to trigger a sovereign debt crisis in the Eurozone, in an environment characterized by a weak growth outlook and underdeveloped Eurozone crisis-management structures. In current times, a perverse interaction between sovereign and banking risk has established: banking risk becomes sovereign risk when governments decide to take onto their balance sheet losses of the financial sector, sovereign risk becomes banking risk, as a significant fraction of sovereign debt of European countries is held by domestic banks. Before going into the details of our theoretical framework, we provide some evidence regarding our stylized facts and main model insights.

<div align="center">**Stylized facts.**</div>

Shadow banking and credit growth (SF1). In the years preceding the burst of the GFC, asset-backed securities (ABS) accommodated the increasing institutional investors' demand for US and other advanced economies high-rated securities, all around the world. Financial innovations increased the pledgeability of banks' investments, allowing financial institutions to boost their operating scale. The debate regarding the drawbacks of the originate-to-distribute business model has been extensively analyzed (Rajan (2006), Purnanandam (2011)). The leverage game can be read as a variation on a famous mantra, sometimes referred to by market practitioners as the First Rule of Fixed Income: *he who has the better leverage and funding always wins the asset*. Cross-sectional evidence points at the role of securitization and other asset hypothecation techniques, such as covered bonds, in fueling credit growth. Figure 1 shows the positive relationship between the average yearly growth rate of credit over the pre-crisis period and the cumulated gross issuance of ABS and covered bonds as a fraction of 2000 GDP. The positive relationship is driven by Ireland and Spain on the right end of the distribution. The main outliers are Greece, whose credit boom was fueled by the adoption of the Euro, Germany, whose established *pfandbriefe* market relies on the demand by domestic investors, and Japan.

Private collateral (SF2). In the credit boom, the banks' liquidity choice allocation between sovereign and shadow investments was strongly distorted in favor of the latter. In the 2000-2007 period, government securities as a fraction of total assets in the portfolios of financial firms, a proxy to gauge the degree of conservativeness of the banks' liquidity choice, decreased to historical lows in the developed world. Figure 2 depicts the yearly time series for the United States, the Euro Area and the United Kingdom: the evidence is particularly striking in the case of the US, whereas government securities kept declining from their post-World War highs until the start of the GFC. Market volatility and the introduction of liquidity regulation schemes by supervisory authorities across the globe reversed the downward trend in the last few years.

Banking-sovereign interlinkages (SF3). The rebound in sovereign holdings in Figure 2 is notably quite feeble in the Euro Area. This is mostly related to the opposite direction of flows of sovereign bonds holdings among domestic and non-domestic Euro Area banks. The emergence of balance of payments' imbalances between the Euro Area member states registered in the TARGET2 system (Bindseil and Koenig (2011)), can be read as a reversal of previous flows of credit from core to peripheral Europe in the pre-crisis period which led to asset prices bubbles in some countries. The regional sovereign crisis is a good example of the "public" nature of "private" banks' risks. In the wake of the collapse of Lehman Brothers, governments across the globe were trying to re-assure scared investors of the reliability of the respective banking system. A few of them, namely those of Ireland and Iceland, failed to do so due to their inability of proposing credible bailout schemes for their domestic banks. Later on, markets' concerns on the viability of the banking system extended to the Spanish sovereign, pushing the government to address the massive banks' undercapitalization which followed the burst of a real estate bubble. Figure 3 highlights the intertwined nature of sovereign and banking credit risks proxied by quarterly variation in CDS spreads levels' for the four largest Euro Area members. Indeed, the CDS spread tends to co-move over time across different sovereign/banking systems, following variations in broad market sentiment. What is more interesting is that such co-movement is strong within each country not only in the direction but also in magnitude. Moreover, such a strong relationship can be observed for peripheral Italy and Spain but even, and more surprisingly, for core Germany and France, countries relatively not exposed to contagion.

Model insights.

Shadow liquidity risk (INS1). In our framework, the correlation between banks' and sovereign credit risk stems from the moral-hazard in banks' liquidity choice: as financial institutions anticipate government ex-post incentives to bail them out, they under-insure against liquidity risk, seeking large and socially inefficient exposures to shadow liquidity risk. In the event of a liquidity crisis, the government will intervene to preserve the scale of the banks' investment and avoid deleveraging. Our model predicts that banks' ex-ante level of risk taking is correlated with the fiscal position of their sovereign. As banks anticipate the effective ability of the government to raise money from taxpayers, they calibrate their leverage/shadow banking production to maximize the feasible bailout transfer from consumers. Figure 4 plots credit growth in the 2000-2007 period for the European Union and other developed economies against the state of public finance before the investment choice was made, proxied by the Debt/GDP level in 2000. The negative relationship suggests that financial institutions in countries with healthy public finances *banked on the state* (Alessandri and Haldane (2009)) more than their counterparts in more budget constrained economies. The ex-post incentives to rescue financial institutions became all too clear throughout the crisis. Figure 5 reports for each of the European Union members the amount of State-aid to financial institutions approved by the Commission. The size of the bailout is positively related to the banks' risk taking activity, proxied by credit growth in excess of GDP growth in the 2000-2007 period. Credit growth figures include the financial system beyond deposit taking institutions, encompassing a large portion of shadow banking production.

Sovereign risk (INS2). The banks' moral hazard extends beyond the production of shadow banking to the demand for outside liquidity itself. In the model, banks pertaining to a "safe" state have the incentives to take on additional yield by diversifying their portfolio of liquid assets into "risky" sovereigns. Such prediction is confirmed by the data on sovereign exposures provided by the European Banking Authority in the follow-up of its 2011 Stress tests. Figure 6 depicts the aggregate proportion of non-domestic government debt held by banks at December 2010 against the credit risk of the pertaining sovereign at the same date, measured by its CDS spread. On the one hand, the positive relationship between a sovereign riskiness and the home bias in the portfolio allocation choice of its banks may suggest a "gamble for resurrection" strategy by local banks: as liquidity and sovereign shocks are highly correlated and the latter would prevail on any insurance strategy in a crisis event, "peripheral" banks have no incentives but to play "all in". On the other hand, there is no reason but search for yield for banks in safe countries to take on additional sovereign risk by diversifying their portfolios: despite enjoying a safe haven status thanks to the low perceived riskiness of their sovereign (CDS spread of 72bps at 2010 year end), UK banks allocate only a very small fraction of their liquidity portfolio to domestic debt (18%), the same holds for French (101bps and 26% respectively) and Dutch banks (63bps and 26%).

The rest of the paper is organized in the following way: after going through the model setup in section (3.1), we present the no shadow banking solution (section 3.2), the solution in which the official sector can credibly commit not to intervene in a liquidity crisis (section 3.3) and the outcome under the lack of commitment (section 3.4) with shadow banking. We make the case for risky sovereign securities and study the allocation in an economy with two countries in section (4). We conclude with the policy implications of our framework (section 5).

3 The model

3.1 Time, agents and liquidity shocks

There are three dates, $t = 0, 1, 2$. *Investors* are risk neutral, perfectly competitive, and demand a return normalized to 1. The economy is populated by a continuum of unit mass of ex-ante identical, risk-neutral *banking entrepreneurs* (sometimes, shortly banks). They are protected by limited liability and the representative bank at $t = 0$ has wealth A, borrows $i - A$ and invest i. The return of the investment is R in the case of success and 0 in the case of failure. The banking entrepreneur's behavior affects the probability of success. The associated moral hazard problem restricts the pledgeability of the bank's value as in Holmström and Tirole (1997). In other terms, the parties can write state-contingent and enforceable contracts on all pledgeable income, while no contracts can be made on the private part of income. Let ρ_1 be the total per-unit value of the project and ρ_0 the per-unit pledgeable income. At $t = 1$, with probability α the bank's project is intact and can be brought to completion. With probability $1 - \alpha$, the bank faces a liquidity shock (crisis) and must hence reinvest ρ units per unit of investment to be brought to completion. Otherwise the investment is liquidated (for simplicity, with liquidation value equal to 0). Partial continuation $j < i$ is admitted, and $(i - j)/i$ is the extent of downsizing. We assume that the liquidity shock is not self financing, in the sense that ρ is higher than the pledgeable income. A trade-off emerges between the initial investment scale i and the continuation scale j in a crisis. Boosting the initial scale i implies hoarding little liquidity and exhausting pledgeable income. This, in turn, would force deleveraging. Conversely, loading on liquidity and reducing the maturity mismatch requires sacrificing scale i.

Take the polar case in which liquidity shocks are perfectly correlated across banks so that mutual insurance between banks is not feasible. The economy suffers an aggregate shortage of liquidity and an outside store of value can improve efficiency (Holmström and Tirole (2011)): the government leverages its regalian power of taxation and issues non-contingent bonds (outside, public liquidity) at $t = 0$. The key distinguishing feature of the government is the right to tax its citizens. Therefore, the government can make commitments on behalf of consumers acting as an insurance broker between consumers and banks. The government promises to transfer funds from consumers to banks in states where the net returns from such transfers are high and making banks to pay for this insurance ex ante through liquidity premia on government securities. Government bonds yield one unit of good at $t = 1$ for certain. The $t = 0$ price is q. Let xi be the amount of sovereign securities the bank purchases at $t = 0$. In practice, at $t = 0$, the government issues bonds that are purchased by banks and transfers the revenues qxi to consumers. At $t = 1$, it redeems bonds taxing consumers. Finally, in the absence of the liquidity shock, the bond goes unused and banks, to maximize the initial investment, return all its value to investors. In a crisis, the bank uses the proceeds from selling the bond to cover the liquidity shock.

Consumers (taxpayers) have endowments e_0 and e_1, at date 0 and 1 respectively. They have utility $u = c_0 + \theta c_1$, do not have access to a storage technology so consume all their wealth at each date. We assume $\theta > 1$, so that taxes used to redeem government bonds are distortionary. Full compensation of the distortion embodied in taxation requires $q \geq \theta > 1$ and a positive liquidity premium $q - 1$. When not differently specified, we take $q = \theta$.

Shadow Banking. Banks have access to a *shadow banking technology* that increases the pledgeability of bank's assets. It allows to improve the leverage and the liquidity position. The

shadow technology can be intended as the mix of securitization and secured funding techniques widely acclaimed as financial innovations. In terms of our model, it allows the bank to increase the pledgeable income from ρ_0 to:

- $\rho_0 + s$ if the crisis does not occur, with $s < \rho - \rho_0$.[4]

- $\rho_0 + l$ if a crisis occurs, with $l \in [0, s]$.

The difference $s - l \geq 0$ can be interpreted as toxic shadow assets whose pledgeability plunges to zero in a crisis. We refer to s as the shadow pledgeable income (and to si as the size of the shadow banking system) and to l as shadow liquidity. The bank chooses l and the choice is not observable. The effect of the liquidity shock on SB can be interpreted in the spirit of Dang et al. (2010). In a crisis, the bank returns to market investors to raise funds to accommodate the refinancing need and preserve the continuation scale. The bank obtains the proceeds from the sale of government bonds and pledge to investors $(\rho_0 + s)i$. However, in a crisis, "information-insensitive" high-quality securities si suddenly loose the confidence of investors and become "information-sensitive". This triggers a "collateral check" (Gorton and Ordonez (2012)) that allows investors to separate pledgeable shadow income (li) from non pledgeable toxic shadow assets $(s - l)i$.

Assumption 1 *(welfare function) The public authority maximizes a combination of consumer welfare V and continuation scale j:*

$$W = V + \beta j$$

This welfare function is in line with Farhi and Tirole (2009) and is able to capture the fact that deleveraging is costly for banks' stakeholders. The government maximizes a weighted average of consumers' (taxpayers) and banking stakeholders' welfare: such stakeholders (banking entrepreneurs, debtors, shareholders, tax-collecting agencies) would be negatively affected by deleveraging. As standard, to carry over the analysis, we must assume that the equilibrium investment is strictly positive and finite:

Assumption 2 *(high return, finite investment): $\rho_0 + s < 1 + (1 - \alpha)\rho < \rho_1$*

The right inequality establishes that the investment has a positive net present value. The left one guarantees that the per-unit pledgeable income is lower than the expected cost of the investment.

3.2 No-shadow banking

The solution without shadow banking (ns) is a benchmark case and is coherent with Holmström and Tirole (2011). In the absence of the liquidity shock, full continuation is always feasible and investors receive the entire amount of pledgeable assets, i.e. the sum of the pledgeable income $\rho_0 i$ and xi. In a liquidity crisis, the maximum amount the bank can obtain diluting its initial investors is given by its pledgeable income $\rho_0 i$. Feasible continuations are derived from the liquidity constraint:

---

[4]The fact that the pledgeable income is always lower than the shock size, guarantee that the shock is not self-financed.

$$j = \frac{xi + \rho_0 j}{\rho} \leq i \qquad \text{or} \qquad j = \min\left(\frac{x}{\rho - \rho_0}, 1\right)i \tag{1}$$

With the liquidity shock, the bank's liquidity hoarding choice determines its continuation policy. If $x = \rho - \rho_0$, the bank hoards liquidity to withstand the liquidity shock and bring to completion the investment at full scale ($j = i$). In this case, investors take zero and the entire liquid resources are used to weather the liquidity shock. The bank takes the non-pledgeable part of the return from investment. The liquidity choice affects the borrowing capacity, as in the standard scale/insurance trade-off. Indeed, at $t = 0$, the bank borrows $i - A + qxi$ and promises to repay, with probability α, the amount $(\rho_0 + x)i$. The investment level is given by the borrowing constraint (with the equality, as bank's utility is always increasing in the investment scale):

$$i - A + qxi = \alpha(\rho_0 + x)i \quad \Longleftrightarrow \quad i = \frac{A}{1 + (q - \alpha)x - \alpha\rho_0} \tag{2}$$

The bank's leverage is affected by the cost of the investment (including the expected liquidity shock) and the pledgeability of the bank's balance sheet.

The utility of the banking entrepreneur is:

$$u = (\rho_1 - \rho_0)[\alpha i + (1 - \alpha)j]$$

In the optimal contract (Tirole (2006)), the bank retains the non-pledgeable return $\rho_1 - \rho_0$ on the scale brought to completion.

Assumption 3 *(full insurance): The bank always prefers full scale continuation, j=i.*

In the rest of the paper, we assume that the bank finds it very costly in terms of utility to downsize the investment project. It suffices that ρ_1 and $1 - \alpha$ are large enough. This assumption guarantees that the bank always makes a liquidity choice that preserves full scale continuation. Any departure from this situation would only reinforce our qualitative results regarding risky liquidity choices (see below). Rearranging terms, using $j = i$ and $\rho_0 + x = \rho$, the utility can be written as

$$u = (\rho_1 - \rho_0)\frac{A}{1 + (q - \alpha)\rho - q\rho_0} \tag{3}$$

Clearly, the cost q of insurance depresses the leverage and the utility of the banking entrepreneur; on the other hand, the pledgeable income boosts the equity multiplier.

Solution 1 *(no shadow banking) The no-shadow solution is characterized by a scale i^{ns} and a liquidity hoarding x^{ns} such that:*

- *i^{ns} is derived from equation (2)*

- *$x^{ns} = \rho - \rho_0$ according to assumption (3).*

The total welfare in the no-shadow solution is

$$W^{ns} = V^{ns} + \beta i^{ns} \tag{4}$$

where $V^{ns} = e_0 + \theta e_1$.

Taxpayers consume their endowment and banks' liquidity hoarding permits to achieve full continuation scale $j^{ns} = i^{ns}$.

3.3 Shadow banking: the commitment solution

In general, if the liquidity position in a crisis is not sufficient to weather the shock, i.e. $\rho_0 + l + x < \rho$, the bank must scale down the investment project. However, assumption (3) rules out this possibility and the bank always seeks a liquidity hoarding that guarantees full continuation. The generality of this statement is jeopardized by the combination of two elements.

First, in the case of a liquidity shortfall, according to assumption (1), the authority may be tempted to intervene and prevent the downsize of the investment project that would be costly in terms of social welfare. The intervention can take the form of a pure transfer T from taxpayers to banks, at $t = 1$. The second elements that may create a scope for liquidity underhoarding, when banks have access to the shadow banking technology, is the cost of liquidity. Throughout the paper we assume that public liquidity hoarding of the bank is public knowledge. However, the effort choice and, thus, the the shadow liquidity is not observable and privately costly for the bank.

Assumption 4 *(effort): Shadow liquidity is privately costly for the bank in terms of effort; the effort is non observable (contractible). Let $c_l(l)$ be the effort cost function, increasing in l.*

In this section, we analyze a simplified case in which the public authority can credibly commit not to bailout banks. The borrowing constraint for the bank:

$$i - A + qxi = \alpha(\rho_0 + s + x)i \quad \Longleftrightarrow \quad i = \frac{A}{1 + (q - \alpha)x - \alpha(\rho_0 + s)} \tag{5}$$

Result 1 *(unmonitored shadow liquidity) Risk neutral investors have always no incentive to monitor the shadow liquidity l of the bank.*

Result 1 depends on investors' risk neutrality. Feasible continuations are

$$j = \frac{xi + (\rho_0 + l)j}{\rho} \leq i \quad \text{or} \quad j = \min\left(\frac{x}{\rho - \rho_0 - l}, 1\right)i$$

The banking entrepreneur maximizes the utility:

$$u = \alpha(\rho_1 - \rho_0 - s)i + (1 - \alpha)(\rho_1 - \rho_0 - l)j - c(l)i \tag{6}$$

Assumption 5 *(liquidity pecking order) The shadow liquidity is always more attractive (cheaper) than the government bonds:*

$$c(s) < q - 1$$

Assumption 5 states that the shadow technology allows banks to produce shadow liquidity at a cost that is always lower than the liquidity premium commanded by sovereign bonds. Note that, were we to remove it, our result would be reinforced as shirking temptation (the production of toxic shadow banking) for bank is increasing with the private cost c. The solution is quite straightforward with assumption (3) that guarantees full continuation scale: $\rho_0 + l + x = \rho$ and $j = i$.

Solution 2 *(commitment solution) The commitment solution is characterized by a scale i^c and a liquidity hoarding choice l^c, x^c such that:*

- *i^c is derived from equation (5).*

- *$l^c = s$ and $x^c = \rho - \rho_0 - s$.*

The total welfare in the commitment solution is

$$W^c = V^c + \beta i^c > W^{ns} \tag{7}$$

as $i^c > i^{ns}$ and $V^c = e_0 + \theta e_1$.

Neither in the no-shadow nor in the commitment solution the government is forced to step in and bailout the private sector. Shadow banking relaxes the aggregate shortage of liquidity, improves the pledgeability of banks' balance sheet attracting new investors and increasing the scale and decreases the overall cost of liquidity. The commitment solution is characterized by a lower public debt to scale ratio ($x^c = x^{ns} - s$) and a higher leverage.

3.4 Shadow banking: the no commitment solution

The no commitment solution is characterized by the shirking behavior of banks that prefer to save on costly effort, in the expectations of a public bailout. We maintain the assumption that both the scale and the public liquidity hoarding of the bank can be freely monitored, supervised and constrained by investors and public authorities.

According to the Result 1, investors have no incentives to monitor bank's shadow liquidity position. The bank can choose $l < s$. In the case of the bailout, the government taxes consumers at $t = 1$ and transfers an amount T to banks, providing them with additional resources to avoid the downsize. Public refinancing takes always the form of a pure transfer from taxpayers. We take the simple case in which troubled banks obtain fresh funds from taxpayers to compensate the liquidity shortfall due to the investors' run on their toxic shadow assets. Anticipating the time-consistent policy reaction by the public authority, banks re-allocate the liquidity choice from costly insurance (sovereign bonds) to shadow toxic assets and maximize the size of the pure windfall of the government's transfer. Other technical forms of public support, e.g. an interest rate bailout, would have the same effects. The public transfer improves feasible continuations:

$$j = \frac{xi + (\rho_0 + l)j + T}{\rho} \leq i \qquad \Longleftrightarrow \qquad j = \min\left(\frac{x + T/i}{\rho - \rho_0 - l}, 1\right) i$$

The linearity of the welfare function yield a corner solution for the optimal transfer, either full scale or zero:

$$T = \begin{cases} (\rho - \rho_0 - x - l)i \equiv (s - l)i & \text{if} \quad \beta \geq \rho\theta \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

Assumption 6 *(ex-post bailout temptation) $\beta \geq \rho\theta$.*[5]

The government ability to bailout banks is constrained by taxpayers' wealth at $t = 1$.

---

[5]We assume that an ex-ante transfer from consumers to banks at $t = 0$ is not profitable. In formulae: $\beta \leq 1 + (q - \alpha)x - \alpha(\rho_0 + s)$. This is not incompatible with assumption (6).

Definition 1 *(feasible bailouts) In a crisis, the set Φ of feasible bailouts is defined as*

$$\Phi = \{T \geq 0 : T \leq e_1 - xi\}$$

In a collateral economy, the government ability to redeem bonds and provide backstops to the banking system depends on the credibility of the promise to tax consumers. This promise is weak when consumers are poor and/or the existing stock of public debt xi is large. As one would expect, weak public guarantees partially relax the time inconsistency problem, reducing the set of admissible transfers. Trivially, when Φ is an empty set, and no other form bailout is possible (i.e. lower interest rate policy and central banks' refunding facilities), the pure commitment solution obtains.

As before, full continuation is always optimal and banks do not seek toxic shadow banking levels $s - l$ that are not covered by an expected bailout. Second, the transfer is a pure windfall and effort is costly, so that banks try to exploit as much the transfer as they can and reduce the effort. In other terms, the marginal utility of effort is negative in the region in which the feasible bailout is higher than the full-scale bailout.

Solution 3 *(no commitment solution) Under no commitment, banks maximize the transfer from the bailout. The solution is characterized by a scale i^{nc} and a liquidity hoarding choice l^{nc}, x^{nc} such that:*

- *$i^{nc} = i^c$ is derived from equation (5).*

- *$x^{nc} = \rho - \rho_0 - s$, $l^{nc} = \max(\rho - \rho_0 - e_1/i^{nc}; 0)$*

The total welfare in the no commitment solution is

$$W^{nc} = V^{nc} + \beta i^{nc} < W^c \tag{9}$$

where $V^{nc} = e_0 + \theta[e_1 - (1 - \alpha)(s - l^{nc})i^{nc}]$.

As one would expect, the private liquidity choice is affected by the expected policy. The first effect of the lack of commitment is a net redistribution from taxpayers to banking stakeholders; the problem is exacerbated in "heathy" countries, indeed toxic shadow banking $s - l^{nc}$ is non decreasing in e_1 (INS1).

Result 2 *Shadow liquidity crowds out sovereign liquidity: $x^{ns} > x^c \equiv x^{nc}$.*

As one would expect, shadow banking partially replace government's securities in the banks' liquidity allocation choice. For a given e_1, the banks' liquidity strategy is self-reinforcing in that it expand the implicit public support, expanding the feasible bailout set. They exchange costly non-contingent securities for free contingent liquidity.

4 Risky public liquidity: a tale of two countries

So far, sovereign debt securities have been treated as a risky free store of value that alleviate the aggregate shortage of liquid instruments. Sovereigns are backed by the government's promise to tax consumers at some future date and redeem its obligations. The collective moral hazard problem presented in previous sections can be employed to investigate the banks' portfolio allocation choice in the presence of a spectrum of sovereign debt securities. Take an economy with two countries, G(ood) and B(ad), completely identical except for the expected consumers' endowment at $t = 1$. The G-consumers' endowment at $t = 1$ is always very large. Conversely, e_1^B can plunge to 0 with a positive probability $1 - r$. Therefore, country G is characterized by a riskless government that issues sovereign that yields 1 with certainty at $t = 1$ and cost q at $t = 0$. The government of country B issues risky sovereign bonds, at a price $q^r < q$, with a positive probability $1 - r$ of default. The market for sovereigns is global, but the implicit public guarantee is national. The joint probabilities of sovereign and liquidity crisis are presented in Table 1.

Table 1: Joint probabilities of sovereign and liquidity shocks.

	Liquidity crisis $(1 - \alpha)$	no Liquidity crisis (α)
Sovereign crisis $(1 - r)$	$(1 - \alpha)(1 - r) + \epsilon$	$(1 - r)\alpha - \epsilon$
no Sovereign crisis (r)	$r(1 - \alpha) - \epsilon$	$\alpha r + \epsilon$

if $\epsilon > 0$, the two shocks are positively correlated. In general, the borrowing constraint for a bank that purchases xi riskless and $x_r i$ risky sovereigns is

$$i - A + (qx + q_r x_r)i = (\alpha r + \epsilon)(\rho_0 + s + x + x_r)i + [(1 - r)\alpha - \epsilon](\rho_0 + s + x)i \qquad (10)$$

The left hand side represents the amount borrowed by the bank. The right hand side is the expected repayment to investors. As before, investors are repaid only in the absence of the liquidity shock. The first addendum is the sum investors receive if no sovereign crisis occurs. Note that they obtain the full pledgeable amount that includes the proceeds from the sale of the risky sovereign debt securities. The last addendum is the repayment in a sovereign crisis. Investors relax the borrowing constraint for banks that hold risky sovereigns when the sovereign crisis is positively correlated with the liquidity shock (large ϵ). Rearranging terms, the investment scale is:

$$i = \frac{A}{1 + (q - \alpha)x + (q_r - \alpha r - \epsilon)x_r - \alpha(\rho_0 + s)} \qquad (11)$$

Define $X = x^G i^G + x^B i^B$, the amount of G-sovereigns expressed as the sum of the amount held by G-banks and B-banks, respectively. With a similar notation, $X_r = x_r^G i^G + x_r^B i^B$ is the public debt issued by the B-government.

As in section (3.3), the commitment would solve the moral hazard problem. In particular, from assumption 3, risky sovereigns would not be purchased in equilibrium, as long as the twin crises event has a positive probability. In the no-commitment case, national public guarantees make the two banking systems heterogeneous with respect to feasible continuations. Take for simplicity the case in which both governments are always willing to provide a full-scale bailout, when intact (read: if they do not default). Feasible continuations for G-banks are

$$j^G = \begin{cases} \min\left(\frac{x^G + x_r^G + T^G(\text{no sov-crisis})/i^G}{\rho - \rho_0 - l}, 1\right) i^G & \text{if no } B\text{-sovereign crisis} \\ \min\left(\frac{x^G + T^G(\text{sov-crisis})/i^G}{\rho - \rho_0 - l}, 1\right) i^G & \text{if } B\text{-sovereign crisis} \end{cases} \tag{12}$$

where $T^G(\text{no sov-crisis}) = \rho - \rho_0 - (x^G + x_r^G + l^G)$ and $T^G(\text{sov-crisis}) = \rho - \rho_0 - (x^G + l^G)$ are the transfers from the G-government to G-banks required for a full scale bailout in the absence and in the presence of a B-sovereign crisis, respectively. The transfer is maximized when G-banks load on risky sovereigns. Moreover, the lack of commitment and the large balance sheet capacity of the G-government, make toxic shadow banking always attractive ($s > l = 0$).

Solution 4 *The optimal G-banks liquidity and effort choice is*

$$x^G = 0, \qquad x_r^G = \rho - \rho_0 - s, \qquad l^G = 0$$

The scale of G-banks is:

$$i^G = \frac{A}{1 + (q_r - \alpha r - \epsilon)x_r^G - \alpha(\rho_0 + s)} \tag{13}$$

The utility of G-banking entrepreneurs is

$$u^G = \{\alpha(\rho_1 - \rho_0 - s) + (1 - \alpha)(\rho_1 - \rho_0)\} i^G \tag{14}$$

The G-government expected bailout per-unit of investment is

$$E(t^G) = \{[(1 - \alpha)(1 - r) + \epsilon](\rho - \rho_0) + [(1 - \alpha)r - \epsilon]s\}$$

The social welfare of country G is:

$$W^{G,nc} = e_0^G + \theta e_1^G + \left[\beta - \theta E(t^G)\right] i^G \tag{15}$$

The scenario for B-banks is very different. The B-government is able to bailout banks only with probability r, when B-consumers' endowment is intact and, in this case, assume the B-government finds full scale bailout always optimal and feasible. Feasible continuations for B-banks are:

$$j^B = \begin{cases} \min\left(\frac{x^B + x_r^B + T^B/i^B}{\rho - \rho_0 - l}, 1\right) i^B & \text{if no } B\text{-sovereign crisis} \\ \min\left(\frac{x^B}{\rho - \rho_0 - l}, 1\right) i^B & \text{if } B\text{-sovereign crisis} \end{cases} \tag{16}$$

With a positive probability the B-government cannot bailout B-banks. Assumption 3 guarantees that B-banks will not purchase B-sovereigns as they cannot provide full insurance. Therefore, the liquidity choice of B-banks is such that full continuation is always supported by banks liquidity hoarding and never produce toxic shadow banking (assumption 5).

Solution 5 *The optimal B-banks liquidity and effort choice is*

$$x^B = \rho - \rho_0 - s, \qquad x_r^B = 0, \qquad l^B = s$$

The scale of B-banks is:

$$i^B = \frac{A}{1 + (q - \alpha)x^B - \alpha(\rho_0 + s)} \tag{17}$$

The utility of B-banking entrepreneurs:

$$u^B = (\rho_1 - \rho_0 - s)i^B \tag{18}$$

The B-government expected bailout is

$$E(t^B) = 0$$

From equations (13) and (17), the availability of risky sovereigns expands the differences between the size of the two banking systems, with $i^G > i^B$ as $q_r - \alpha r - \epsilon < q - \alpha$. G-banks scale is magnified by the implicit public guarantee that allows G-banks to purchase cheaper B-sovereign bonds. The shadow banking system is larger in the G-country: $si^G > si^B$ and G-banks produce as much toxic shadow assets as they can, while, in the B-economy, the shadow banking system is perfectly liquid ($l = s$). For both countries, the linearity of the model and the full insurance assumption imply that sovereign debt are completely held abroad. The B-government debt $X_r = (\rho - \rho_0 - s)i^G$ is large and completely held by G-banks.

Public and private balance sheets are tightly intertwined. In general, banks behavior strengthens the existing difference in public implicit guarantees. Feasible bailout sets (defined where bailout would be needed) are:

$$\begin{aligned} \Phi^G &= \left\{ T \geq 0 : T \leq e_1^G - (\rho - \rho_0 - s)i^B \right\} \quad \text{with prob.} \quad 1 - \alpha \\ \Phi^B &= \begin{cases} T \geq 0 : T \leq e_1^B - (\rho - \rho_0 - s)i^G & \text{with prob.} \quad r(1 - \alpha) - \epsilon \\ \varnothing & \text{with prob.} \quad (1 - r)(1 - \alpha) + \epsilon \end{cases} \end{aligned} \tag{19}$$

A larger G-banking sector i^G reduces Φ^B.

In our framework, banks' investment in sovereign securities is perfectly observable and banks are required to hold a minimum amount $\hat{x} = \rho - \rho_0 - s$. The bank can arbitrarily choose the riskiness of its sovereign portfolio. In the previous section, according to our simplifying assumptions, we obtain a fully risky portfolio for G-banks ($\hat{x} = x_r$) and a completely risk-free one for B-banks ($\hat{x} = x$).

The political economy of sovereign risk exposures. The first issue we address in this section is related to the incentives in the G-economy to avoid exposures on the risky sovereign debt. Trivially, G-banks are always willing to save on costly liquidity insurance as long as they can extract free support from the official sector. On the other hand, starting from our welfare assumption, one may ask wether the G-government would be willing to persuade domestic banks not to load with risky sovereigns. The welfare of the G-government would increase when the G-banks avoid risky sovereigns if:

$$[\beta - \theta E(t^G)]i^G < [\beta - \theta E(t)]i \tag{20}$$

where $E(t) = (1 - \alpha)s$ is the expected transfer and i the scale in the case G-banks purchase only G-sovereigns. It is interesting to note that if β and or A are large enough, the gain from the higher leverage admitted by cheap liquidity exceeds the cost of the consumers' loss from the transfer. In this case, the G-government is tempted to accommodate G-banks willingness to take on sovereign risk.

The equilibrium sovereign spread. Let's consider the supply factors that may affect the price of sovereign debt securities. In particular, we are interested in the effect of the cross-country public guarantees' differential on the equilibrium sovereign spread. Then, we take the

price of riskless sovereigns to be given at $q = \theta$, and let the price of risky sovereigns to respond to market pressures. For the sake of expositional simplicity, assume a linear equilibrium price function for risky sovereigns:

$$q_r = r\theta + z^B(X_r - D^B)$$

where D^B can be interpreted as the rollover need of the B-governments and $z^B > 0$ is a parameter that captures the sensitivity of the price to excess demand. In other terms, when the demand of risky sovereign $X_r = (\rho - \rho_0 - s)i^G$ is weak, the B-government may be willing to accept to pay a high yield to cover its rollover need. Conversely, when the demand is robust, the price of risky sovereigns is higher than its price under no-arbitrage, $r\theta$. The equilibrium equation, defined for $q_r \in [0, \theta)$, is:

$$\frac{A(\rho - \rho_0 - s)}{1 + (q_r - \alpha r - \epsilon)(\rho - \rho_0 - s) - \alpha(\rho_0 + s)} = D^B + \frac{q_r - r\theta}{z^B} \tag{21}$$

Note that it is perfectly reasonable to have a price $q_r > r\theta$. Backed by the strong public guarantee, G-banks are eager to purchase over-priced risky sovereigns as long as $q_r < q$. Note that when the banks' balance sheet is robust (large A), the demand and the market clearing price of risky sovereigns increase.[6] When $q_r > r\theta$, G-taxpayers subside B-taxpayers (at $t = 0$) and, above all, G-banks in a liquidity crisis.

Fiscal discipline. The previous insight suggests that the large demand for risky public debt from G-banks may induce indebted countries to postpone fiscal consolidation: the overpricing of debt makes it convenient to replace old debt with new cheap one. The delayed fiscal adjustment may be costly for B-taxpayers as well. Finally, if we remove the full insurance assumption, B-banks become willing to purchase risky sovereigns as well. In this case, the effects described above would be magnified. Finally, our model casts some doubts to the interest for the G-government to advice for fiscal consolidation in the B-country. Indeed, from equation (21), a reduction of the rollover need D^B of the B-government would make q_r more sensitive to excess demand, increasing the cost of liquidity and depressing the scale for G-banks.

Gamble for resurrection. The predictions of our model regarding the liquidity choice of B-banks can be discussed in the light of a possible different structure/correlation of the liquidity/sovereign shock. Were the latter strongly correlated with the former, with lower frequency but higher intensity, banks would have no strong incentives in diversifying risk away: a sovereign shock would wipe them out, no matter how much insurance they had bought in the first place. Moreover, slightly weakening our Assumption 3, the optimal strategy would be to load on national risky sovereign bonds. As general conditions deteriorate and banks can anticipate the likelihood of a shock, they would increase their sovereign bond holdings in the spirit of Downs and Rocke (1994).

---

[6]This result is confirmed even if we let q to be endogenous. Indeed, the equity multiplier is always larger for G-banks.

5 Policy implications and conclusions

The anticipation of the ex-post intervention of the official sector triggers moral hazard on the banks' side. Banks increase their liquidity risk taking, either through an increased reliance on private collateral in the form of toxic shadow liquidity and loading with risky (sovereign) debt securities. In our framework, the bailout is always (ex-ante) inefficient from a social welfare point of view. Results of section (3.3) suggest that curbing the banks' ability to extract free insurance from the public bailout should be the regulators' priority at the global level.

Shadow banking involves an expansion of bank's pledgeable income and, thus, admits a higher leverage. Investment in risky sovereign reduces the overall cost of liquidity and boosts the scale as well. Even if these strategies are detrimental for the bank's value when the official sector can credibly commit to refrain from any ex-post intervention, they become attractive with the lack of commitment. In particular, the higher the bailout transfer from taxpayers, the better-off the banks. In general, the policy of reducing the reliance on risk-free public debt and increasing exposures to private collateral and to risky sovereigns is self-reinforcing for (at least) two reasons. First, the equilibrium amount of public debt is driven/affected by the banks' demand for insurance. Private collateral crowds out public debt in the banks' liquidity choice, thus freeing up public resources for the ex-post bailout (expanding the feasible bailout set). Second, in a more general perspective, cheap shadow collateral and risky sovereigns boost the level of economic activity (proxied by the scale of the banks' balance sheet). Economic growth and high tax revenues give an additional boost to the ex-post fiscal position of the official sector.

Sovereign and shadow banking risk are tightly intertwined for an additional reason. In our framework, the liquidity choice of banks is taken to be very conservative in that, absent any ex-post bailout temptation, there is no scope for underhoarding of liquidity (and, thus, no room for supervision and regulation). Once the possibility of a sovereign default is brought into the picture, the playing field for global banks looks completely distorted. Only banks pertaining to "safe" sovereign have the incentives to expose to shadow liquidity risk. The very same banks have the convenience to diversify away from their own expensive domestic sovereign debt by increasing the riskiness of their portfolios.

A few policy implications are discussed below.

General issues.

Level playing field and single market. Implicit public national guarantees crucially affect the bank's value, through scale and cost of funding effects. Other subtle effects are commented in section (4). From the perspective of uniform market conditions and controlled state aid to domestic firms like those in place in the European Union, different types of guarantees across jurisdictions entail distortions of the level playing field and the single market.

Sovereign risk and welfare. Section (4) analyzes the welfare effects of risky sovereign debt. First, risky sovereign debt represents an opportunity for banks protected by risk-free governments to reduce the cost of liquidity and boost leverage. Second, ex-ante, the risk-free government may not have the incentives to discourage sovereign risk exposures. Finally, our model predicts the underpricing of sovereign risk in good times. On the one hand, solid government may be unwilling to impose fiscal consolidation on their indebted counterparts. On

the other, this may lead to perverse incentives for indebted governments to delay the required fiscal adjustment.

Regulation.

Curbing bailout temptations. Curbing the banks' ability to extract free insurance from public interventions promotes efficiency. A number of policy options would go into this direction. First, limits on banks' size and interconnectedness to avoid the "too-big/too-central-to fail" problem and strict monitoring of strategic complementary risky strategies, namely banks that voluntarily pursue commonality in exposures to tail risks. In the terminology of our model, these options would relax the bailout temptation, reducing β. For a practical example, see the final report of the UK's Independent Commission on Banking, which calls for ring-fencing of government-subsidized retail banking activities from wholesale ones (Vickers (2011)). In the light of our simplified model, the Vickers reform would restrict the ability of ring-fenced banks to pass out their public insurance to shadow entities. Second, building clear resolution mechanisms for large and complex institutions (Financial Stability Board (2011)) would certainly ameliorate incentives of banking entrepreneur and reduce the social cost of the bailout. Finally, improving corporate governance and discouraging excessive risk-taking through banking managers compensation schemes (Financial Stability Board (2009)) would make the need for the public intervention less likely.

Regulatory arbitrage across jurisdictions. The approach of our paper poses a serious argument against the claim that a stricter regulation in advanced countries would only maximize incentives to exploit regulatory arbitrage across jurisdictions with a flight of the financial industry towards regulation-free heavens. In our collective moral hazard interpretation, the key incentive distortion stems from the implicit guarantee of a large and solid government on "too-big/central/interconnected to fail" financial firms. Once the relationship between the public-guarantee and the financial sector is properly addressed, we expect to see no exotic Bear-Stearns-like financial firm to grow large at the Bahamas.

Skin in the game. A number of regulatory proposals (as well as the evolution of market practices) are increasingly inducing banks to have more "skin in the (shadow) game", namely to retain a larger equity tranche in securitization they originate. This helps mitigating the informational asymmetries that brought down the originate-to-distribute business model. Our simplified framework shows that such a policy option needs to be coupled with a reduction of the likelihood of ex-post bailout discussed above in order to actually improve efficiency. On the one hand, more "skin in the game" alone would entail a limit to leverage. On the other hand, it would still facilitate banks to extract the upside from risk-taking in normal times (no crisis) and to enjoy free insurance from public support in a crisis.

Regulating liquidity risk. Our model allows for a precise ranking in the welfare outcome of banks' liquidity allocation choices. Such ranking mirrors into the discussion of liquidity regulation policy options. Shadow banking improves welfare in the commitment solution. Therefore, the extreme regulation choice of banning shadow banking *tout court* is clearly sub-optimal. While indeed the new Basel III framework has not envisaged such an extreme option, our model suggests that policy interventions aimed at curbing investors' ability to take on shadow banking should be examined carefully [7]. Another policy option deals with banks' liquidity hoarding.

---

[7]A number of commentators have envisaged some potentially harmful consequences of regulation choices on the viability of the securitization market. See for example: OECD's Outlook for the Securitisation Market 2011 (http://www.oecd.org/dataoecd/36/44/48620405.pdf).

With a continuum of liquidity shocks, by forcing banks to hold excess liquid assets in the absence of perfect forecasting, regulators would ameliorate the continuation scale. This result resembles Basel III Liquidity Coverage Ratio (see BIS (2011)).

References

Acharya, V., I. Drechsler, and P. Schnabl (2011). A pyrrhic victory?-bank bailouts and sovereign credit risk. Technical report, National Bureau of Economic Research.

Acharya, V. and M. Richardson (2009). *Restoring financial stability: how to repair a failed system*, Volume 542. Wiley.

Acharya, V., P. Schnabl, and G. Suarez (2010). Securitization without risk transfer. Technical report, National Bureau of Economic Research.

Adrian, T. and A. Ashcraft (2012). Shadow banking regulation.

Alessandri, P. and A. Haldane (2009). *Banking on the State*. Bank of England London, UK.

Ashcraft, A. and T. Schuermann (2008). *Understanding the securitization of subprime mortgage credit*, Volume 2. Now Pub.

Bindseil, U. and P. Koenig (2011). The economics of target2 balances. *SFB 649 Discussion Papers*.

BIS (2011). International framework for liquidity risk measurement, standards and monitoring.

Board, F. S. (2009). Fsf principles for sound compensation practices. Financial Stability Forum.

Board, F. S. (2011). Key attributes of effective resolution regimes for financial institutions.

Borio, C. and P. Disyatat (2011). Global imbalances and the financial crisis: link or no link? *BIS Working Paper No. 346*.

Dang, T., G. Gorton, and B. Holmström (2010). Financial crises and the optimality of debt for liquidity provision. *Unpublished working paper. Yale School of Management*.

Downs, G. and D. Rocke (1994). Conflict, agency, and gambling for resurrection: The principal-agent problem goes to war. *American Journal of Political Science*, 362–380.

Duffie, J. (2010). The failure mechanics of dealer banks. *BIS Working Paper No. 301*.

Farhi, E. and J. Tirole (2009). Collective moral hazard, maturity mismatch and systemic bailouts. Technical report, National Bureau of Economic Research.

Gennaioli, N., A. Shleifer, and R. Vishny (2010). Neglected risks, financial innovation, and financial fragility. Technical report, National Bureau of Economic Research.

Gorton, G. and A. Metrick (2010). Regulating the shadow banking system. *Brookings Papers on Economic Activity*.

Gorton, G. and A. Metrick (2011). Securitized banking and the run on repo. *Journal of Financial Economics*.

Gorton, G. and G. Ordonez (2012). Collateral crises. Technical report, National Bureau of Economic Research.

Holmström, B. and J. Tirole (1997). Financial Intermediation, Loanable Funds, and the Real Sector. *The Quarterly Journal of Economics 112*(3), 663.

Holmström, B. and J. Tirole (1998). Private and public supply of liquidity. *The Journal of Political Economy 106*(1), 1–40.

Holmström, B. and J. Tirole (2011). *Inside and outside liquidity.* The MIT Press.

Kashyap, A., J. Stein, and S. Hanson (2010). An analysis of the impact of substantially heightened capital requirements on large financial institutions.

Keys, B., T. Mukherjee, A. Seru, and V. Vig (2010). Did securitization lead to lax screening? evidence from subprime loans. *The Quarterly Journal of Economics 125*(1), 307–362.

Pozsar, Z., T. Adrian, A. Ashcraft, and H. Boesky (2010). Shadow banking.

Pozsar, Z. and M. Singh (2011). The nonbank-bank nexus and the shadow banking system.

Purnanandam, A. (2011). Originate-to-distribute model and the subprime mortgage crisis. *Review of Financial Studies 24*(6), 1881–1915.

Rajan, R. (2006). Has finance made the world riskier? *European Financial Management 12*(4), 499–533.

Shin, H. (2009). Securitisation and financial stability*. *The Economic Journal 119*(536), 309–332.

Singh, M. (2011). Velocity of pledged collateral: Analysis and implications. *IMF Working Papers*.

Singh, M. and P. Stella (2012). Money and collateral.

Tirole, J. (2006). *The theory of corporate finance.* Princeton Univ Pr.

Tirole, J. (2010). Illiquidity and all its friends.

Vickers, J. (2011). Final report: Recommendations. *Independent Commission on Banking*.
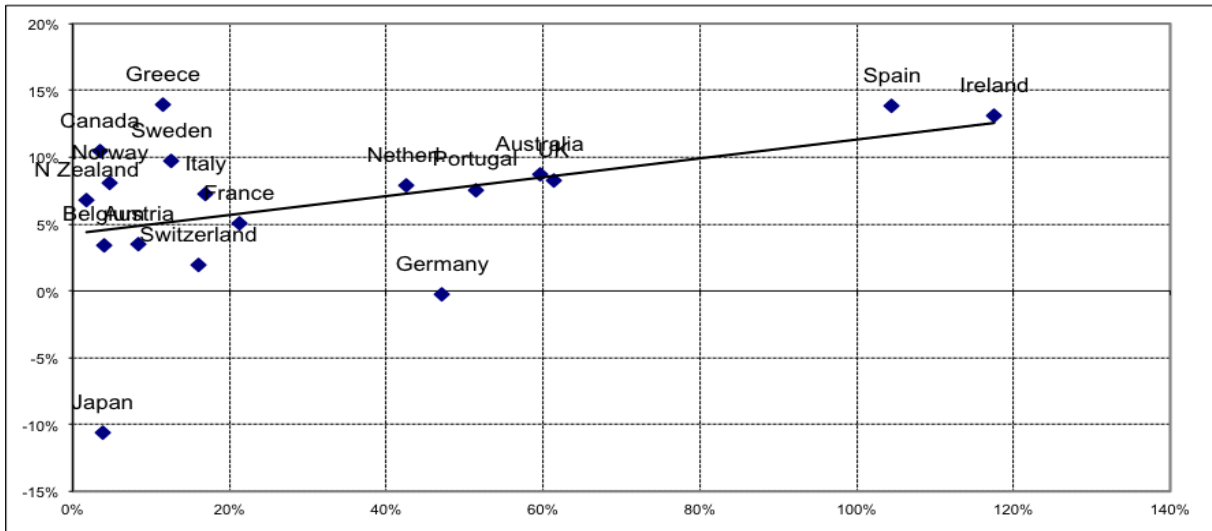
List of figures

Figure 1: Average rate of overall credit growth in the financial system 2000-2007 (Y axis - percentage points in a log scale) vs. cumulated gross issuance of ABS and covered bonds as a fraction of 2000 GDP (X axis - percentage points). Source: IMF, Dealogic.
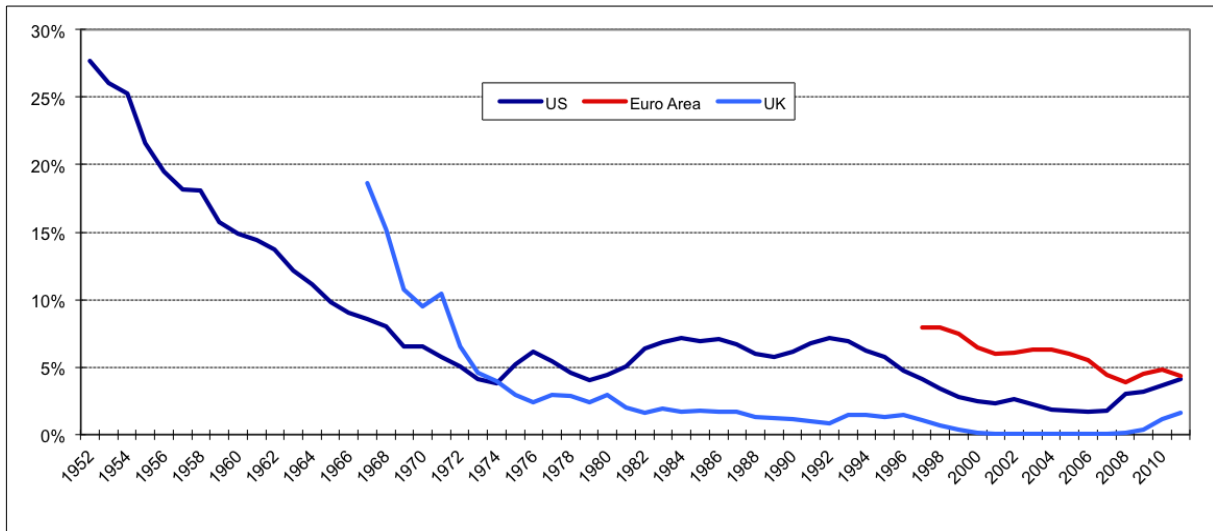
Figure 2: Financial sector holdings of government securities as a percentage of total assets. Source: Federal Reserve, Eurosystem, Bank of England.
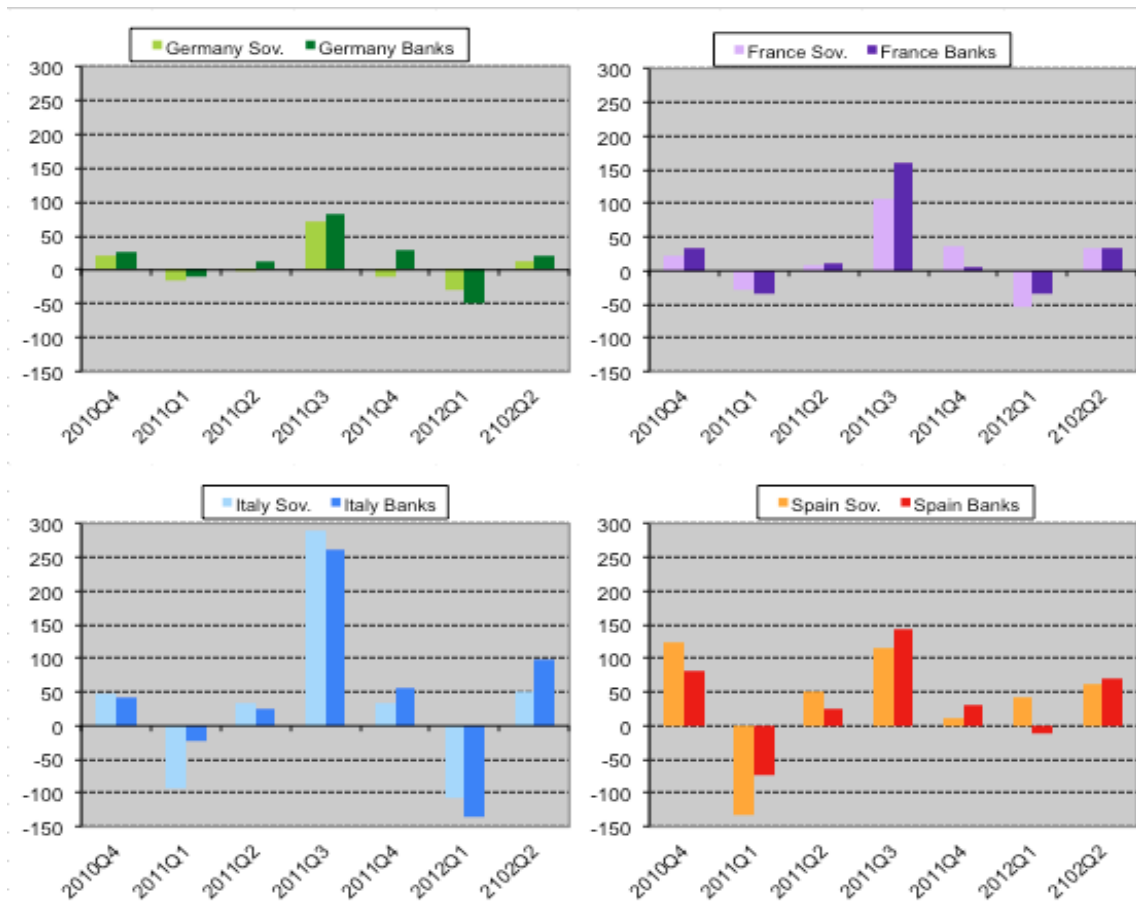

Figure 3: CDS spreads. Banks' spread are the average of the CDS contracts related to the three largest institutions in each country. Data refers to 5Y CDS contracts on USD denominated senior debt. Data for the 2nd trimester of 2012 is limited to May 10th. Source: Bloomberg.
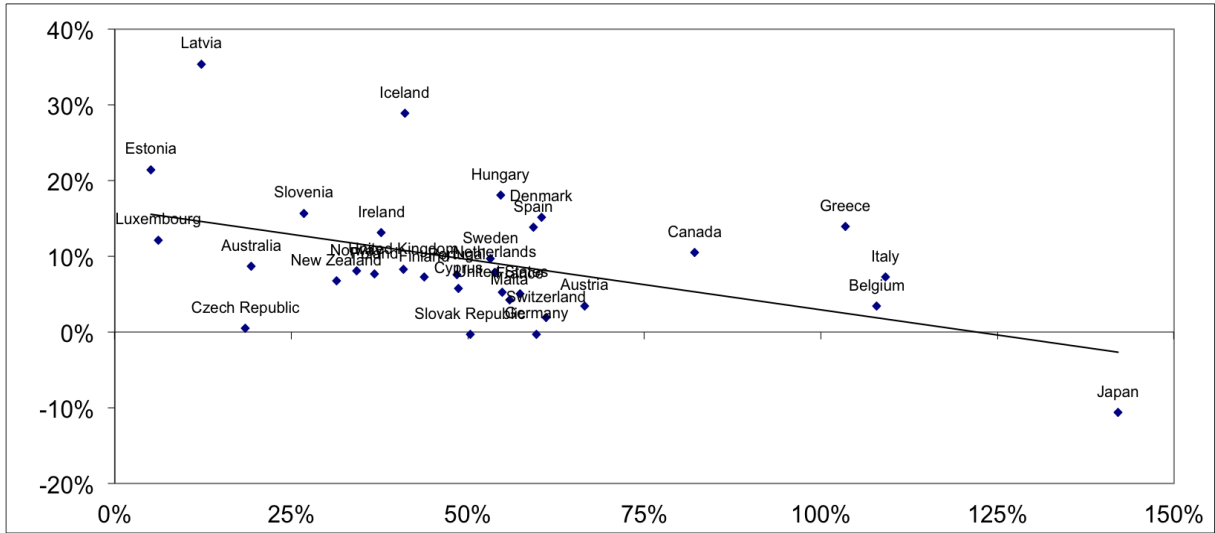
Figure 4: Average growth rate of the overall supply of credit to the economy - including shadow banking - between 2000 and 2007 (Y axis - percentage points) vs. Government debt/GDP ratio as of end 2000. Source: IMF.
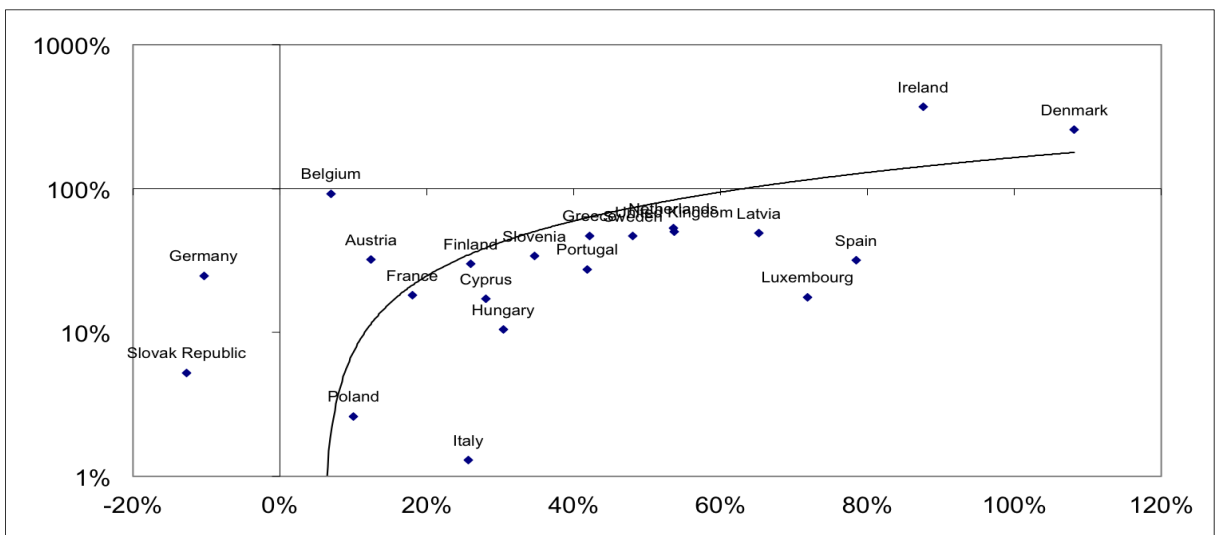

Figure 5: State aid to financial institutions as a fraction of GDP (Y axis - percentage points in a log scale) vs. cumulative growth of credit to GDP between 2000 and 2007 (X axis - percentage points. Source: European Commission DG Competition, IMF.)
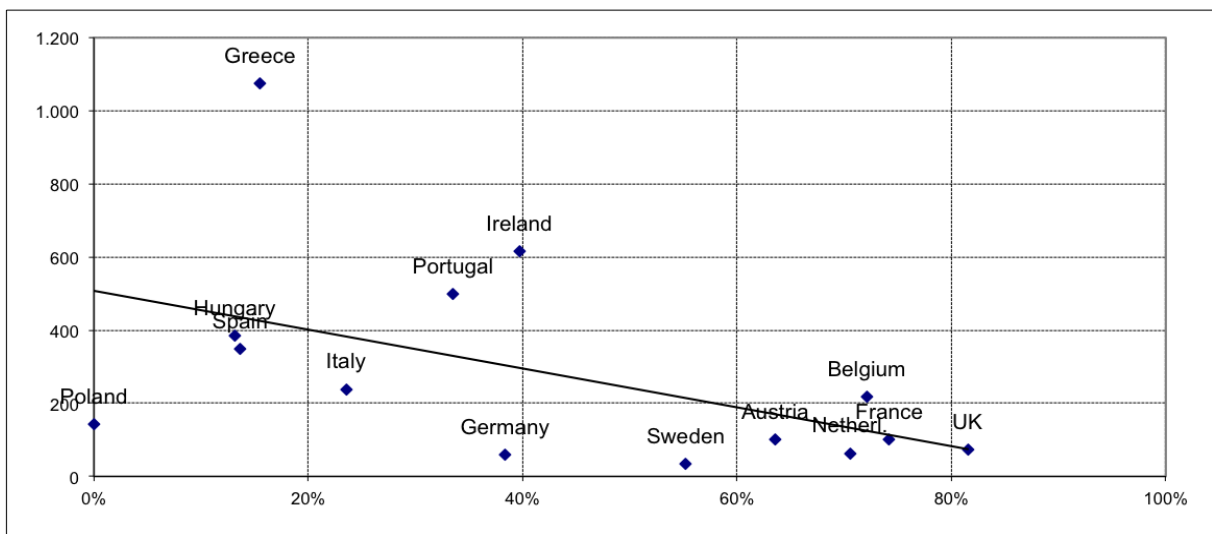
Figure 6: Sovereign CDS spread (Y axis - bps log scale) vs. non-domestic sovereign debt holdings as a fraction of the overall sovereign portfolio (X axis - %) as of end of 2010. Source: European Banking Authority, Bloomberg.