Banking Safety Nets: Information Issues

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Abstract

This paper synthesizes recent literature on the optimal design of banking safety nets. We focalize on information issues. In particular, we propose a mechanism to improve the incentives the Central Bank has to provide information to the Deposit Insurance Corporation. Such mechanism makes possible the implementation of the second-best allocation of the lender of last resort activity proposed by Repullo (2000)

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1 Introduction

In almost all countries around the world two activities are conducted, among others, in order to preserve the banking system stability: the Lender of Last Resort (LLR) activity and the Deposit Insurance (DI) one. These activities are commonly identified as the banking system’s safety nets.

The rationale for the LLR one is as follows. Banks’ traditional business are to provide liquidity to depositors at the time they provide monitoring services to investors. There is a mismatch between banks’ liquid liabilities and illiquid assets. Then, a liquidity shock associated with a information problem (i.e. the same information asymmetries that lead banks to adopt this asset and liability structure) could make it impossible for banks to borrow from the market. As a result, solvent banks could be forced into inefficient bankruptcy. In order to avoid this kind of social costs (e.g. premature liquidation of banks’ assets, end of valuable relationships, increases in the likelihood of panic, etc.) the responsibility of conducting the LLR activity is assigned.

Classical doctrine (Bagehot, 1873 and Thornton, 1802) assigns to the Central Bank (CB) the LLR activity because it is the issuing of the most liquid asset and it has the necessary reputation, as well as technical capacity, to coordinate the rescue. The classical doctrine argues that the last resort assistance should be provided to solvent but illiquid banks under certain conditions. In particular, the CB should lend against good collaterals and at a penalty rate. But this could be also done by other banks. However, the same reasons (e.g. asymmetries of information on the quality of the collateral that is offered) that prevent the bank to obtain liquidity from the market could prevent it to obtain such liquidity from other banks. Then, the CB should have access to more information than the market and other banks have in order to justify its assistance. This is the rationale for giving the CB the authority to supervise (i.e. monitoring) banks.

Many authors have been analyzing the advantages and disadvantages of allocating the supervisory and the LLR activities on the CB. The principal advantage is that the CB disposes of more and more detailed information to run its activities. For example, Peek et al. (1999) find that such information increases the Fed’s ability to predict relevant variables and help to increase the power of the monetary policy. On the other hand, Goodhart and Schoenmaker (1995 and 1995a) and Haubrich (1996) argue that the main drawback of combining this activities is the conflict of interest between them. For example, by lending in last resort the CB modifies the quantity of money and then affects the monetary policy. However, since the CB knows exactly the distortion it generates it can take actions to neutralize the intervention. A more relevant opposition of interest appears by observing (as Di Noia and Di Giorgio, 1999) that the CB has only one instrument to achieve two objectives: monetary stability and banking system stability. This conflict is
perhaps most apparent in countries in which one foreign (strong) currency circulates in addition the domestic currency.

While the LLR activity is designed to act after a liquidity shock occurs, the Deposit Insurance one is set to protect banks from runs on their deposits. Diamond and Dybvig (1983) argue that such DI removes the depositors’ incentive to run against banks.\(^1\) This gives the rationale for allocating the supervisory activity on the DI agency.

Of course, the duplication of the supervisory activity leads to duplication of costs. Then, if the cost of transferring supervisory information is smaller than the cost of gathering such information from banks, it is optimal to concentrate the supervisory activity in one agency. In this case, the institutional agreements to share the information becomes much more relevant. The same contractual problem (i.e. the signal about the bank’s assets quality is only observable through supervision but it is not verifiable, then not contractible) that prevents society to impose the responsible agency to implement the optimal policy also gives incentives to the supervisory agency not to share information with its counterpart.

Kahn and Santos (forthcoming) have proved that the second-best allocation of the lender of last resort (LLR) activity proposed by Repullo (2000) cannot be implemented through what they call a "Repullo Mechanism". Repullo (2000)'s main result is that the Central Bank (CB) should monitor banks and act as LLR when liquidity shocks are smaller than a threshold. But the CB should transfer the information that has been gathered from the bank to the Deposit Insurance (DI) agency in order it provides the last resort loan when liquidity shocks are larger. Kahn and Santos (forthcoming) prove that in this mechanism the CB has not incentives to provide the information to the DI. Thus, the second-best allocation of the LLR activity cannot be implemented through a "Repullo Mechanism".

In this paper, we are going to define a slightly "Modified Repullo Mechanism". Then, we are going to prove that in such mechanism the CB has incentives to provide information (although not all) to the DI. Then, the second-best allocation of the LLR activity can be implemented through such mechanism. The main difference of this mechanism with the original one is that it is always the CB who provides the last resort loan but, for high liquidity shocks, it is the DI who takes the decision of supporting the illiquid bank.

The paper is organized as follows. Next section presents the basic model by Repullo (2000) and defines the mechanism suggested by the author in order to implement the second-best. In section 3 we are going to prove that in such mechanism the CB does not provide any information to the DI. Then, we are going to prove that our "Modified

\(^1\)However, under certain conditions (full guarantee and flat premiums) the existence of a DI may lead to moral hazard problems.
Repullo Mechanism" mitigates the informational problem. Section 4 concludes.


Repullo (2000)'s model provides an answer to the question Who should act as LLR? The model assumes that bank's deposits are fully insured by a DI agency and that the CB or the DI agency could act as LLR. Then, Repullo's model is a model about the optimal design of the banking system's safety nets.

2.1 The Basic Model Setup

The basic model setup is as follows. There are three periods. At an initial date \( t = 0 \) a bank raises an amount of deposits which is normalized to 1. Bank deposits are completely insured by a DI agency. Intertemporal discount factor, interest rate on deposits and flat-rate DI premium are assumed to be equal the market risk-unadjusted interest rate which is equal to zero. Deposits can be withdrawn at an intermediate date \( t = 1 \) or at the final date \( t = 2 \). The fraction \( v \in (0, 1] \) of deposits that is withdrawn at date \( t = 1 \) represents the liquidity risk faced by the bank and is characterized by the following:

**Assumption 2.1** As of date \( t = 0 \), the amount of deposit that is withdrawn at date \( t = 1 \), \( \tilde{v} \), is a random variable with distribution \( G(v) \), \( G(0) = 0, G'(0) > 0 \). These withdrawals are publicly observable at date \( t = 1 \).

At date \( t = 0 \) the bank invests the deposits in an illiquid portfolio\(^2\). The bank's illiquid portfolio yields a random return \( \tilde{R} \) at date \( t = 2 \). This represents the insolvency risk faced by the bank and is characterized by the following:

**Assumption 2.2** The bank will receive a gross return \( \tilde{R} \) on its illiquid portfolio at date \( t = 2 \), where

\[
\tilde{R} = \begin{cases} 
R & \text{with probability } u ; \quad R > 1 \\
0 & \text{with probability } 1 - u ; \quad E[\tilde{R}] > 1 
\end{cases}
\]

The illiquid portfolio can be liquidated at date \( t = 1 \). In this case it yields \( L \) where \( L \in (0, 1) \).

Since the bank does not hold liquid reserves and a proportion \( v > 0 \) of deposits is withdrawn at date \( t = 1 \), the bank is declared bankrupt unless it can borrow from a

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\(^2\)It can be proved that, provided the interest rate on the last resort assistance is not too high (no penalty rate), at equilibrium the bank does not hold the liquid asset.
LLR agency\(^3\). If the LLR assistance is provided, the interest rate on it is assumed to
be equal to the market risk-unadjusted interest rate (i.e. equal to zero)\(^4\). If the LLR
assistance is not provided, the bank is liquidated. Such premature liquidation generates a
bankruptcy cost \((c)\) which comprises the administrative costs of closing the bank as well
as the negative externalities generated by the bank failure (e.g. contagion to other banks,
breakup of valuable relationships, etc.). Such cost \(c\) is also carried by the society if the
bank’s illiquid investment fails.\(^5\)

The LLR agency is given the authority to supervise the bank in order to gather
information in which support its decision. In particular, we assume that bank supervision
leads to the observation of a signal \(u \in [0,1]\) that contains information about \(\tilde{R}\) and is
characterized by the following:

**Assumption 2.3** As of date \(t = 0\), the signal on the profitability of the bank’s illiquid
assets, \(\tilde{u}\), is a random variable, independent of \(\tilde{v}\), with distribution \(F(u)\). The underlying
condition of the bank’s portfolio of illiquid assets is observable through supervision at date
\(t = 1\), but it is not verifiable.

Assumption 2.3 play a key role on the model. The decision of supporting the bank
or not cannot be specified ex ante as a function of the realization of \(\tilde{u}\) because it is not
verifiable (then, it is not contractible). Thus, such decision depends on the evaluation of
the case by the agency responsible for the LLR activity. The problem of allocating the
LLR responsibility becomes non-trivial when we consider that such agency’s objective is
not aligned with those of a social planner (i.e. that who maximizes the economy welfare).
In particular, it is assumed that:

**Assumption 2.4** Two agencies can be responsible for the LLR activity, namely the Central
Bank (CB) or the Deposit Insurance Agency (DI). The agency in charge of the LLR
activity cares about the expected value of its final wealth: \(Y\), net of its private valuation
(political cost) of the bankruptcy cost in the event of a bank failure: \(\alpha c\).

The LLR agency’s private valuation \((\alpha)\) of the bankruptcy cost could differ from the
social valuation (i.e. \(\alpha \neq 1\)) because, for example, this agency does not fully take into

\(^3\)Notice that the bank is not closed by a regulator but it is liquidated by depositors. That is, the bank
closure is not the decision of a prudential regulator but it is consequence of an action undertaken by a
safety net’s member (the LLR one).

\(^4\)This assumption implies that the last resort loan is provided at a no penalty rate. However, the
interest rate on the last resort loan should be endogenized.

\(^5\)This assumption appears a bit strange in this finite horizon model. However, we are going to preserve
it as in Repullo (2000). It is worth to highlight that Repullo makes this assumption implicitly. He does
not provide a justification for it. However, we could think that society carries such cost because it carries
the administrative costs of closing the failed bank and paying back depositors.
account the externalities associated with a bank failure. Moreover, it could differ between agencies. This is the case in Repullo (2000). However, we are going to assume that the agencies have the same private valuation of \( c (\alpha < 1) \). This assumption does not change the model’s qualitative results but it simplifies the analysis.

The time line of the model is summarized in figure 2.1.

![Figure 2.1: Basic Model Time Line](image)

### 2.2 LLR Policies

In this section, we are going to derive the LLR policy’s thresholds of the CB and the DI agency. Before doing that, we are going to derive the optimal (first-best) threshold. It is achieved when the signal \( u \) is verifiable. In such a case, the LLR policy can be made contingent on this signal. What matters from a social planner point of view is the comparison between the expected total welfare if the illiquid bank is supported and the total welfare if it is not. Given the model setup, this comparison is analogue to compare the expected gross return of the bank’s portfolio net of the expected bankruptcy cost with the liquidation value of the bank’s portfolio net of the bankruptcy cost.\(^6\) This benchmark is characterized by the following:

**Proposition 2.1 (Optimal LLR Policy - 1st. Best)** The optimal LLR policy is such that:

An illiquid bank is supported at date \( t = 1 \) if

\[
u \geq u^* \equiv \frac{L}{R + c}\]

\(^6\)We are assuming a utilitarian definition of total welfare. Note that the depositors’ change in welfare is null since their deposits are fully insured by a DI agency. Then, the expected total welfare if the bank is supported is the sum of the bank’s expected return \([u (R - 1)]\), the DI expected loss \([1 - u] 1\) and the expected bankruptcy cost \([(1 - u) c]\): \(uR - 1 - (1 - u) c\). The total welfare if the bank is not supported is equal to the sum of the bank’s portfolio liquidation value \([L]\), the DI loss \([1]\) and the bankruptcy cost \([c]\): \(L - 1 - c\). Thus, total welfare comparisons are analogue to compare \(uR - (1 - u) c\) with \(L - c\).
**Proof.** Optimal support requires that the expected gross return of the bank’s asset net of the expected bankruptcy cost \( uR - (1 - u) c \) exceeds the liquidation value of the bank’s asset net of the bankruptcy cost \( L - c \). This implies the result. □

If the CB is imposed with the LLR activity, its LLR policy is characterized by the following:

**Proposition 2.2 (CB LLR Policy)** The Central Bank LLR Policy is such that:

(i) An illiquid bank is supported at date \( t = 1 \) if

\[
u \geq u^\text{CB}_1(v) \equiv \frac{v}{v + \alpha c}\]

(ii) For liquidity shocks below \( \hat{v} = \frac{\alpha cL}{R-L+c} \) the CB practices too much forbearance (i.e. the bank is supported even if it is not optimal to do so) and for liquidity shocks above \( \hat{v} \) it practices insufficient forbearance.

**Proof.** (i) Is derived directly from comparing the CB’s expected cost if it support the bank \( (1 - u) (v + \alpha c) \) with the cost if it does not support the bank \( \alpha c \). (ii) It is easy to show that the function \( u^\text{CB}_1(v) \) is increasing and satisfies \( u^\text{CB}_1(0) = 0 \) and \( u^\text{CB}_1(1) > u^* \). Hence, there is a unique \( \hat{v} \in (0, 1) \) that solves \( u^\text{CB}_1(v) = u^* \). In particular \( \hat{v} = \frac{\alpha cL}{R-L+c} \). □

The intuition behind this result is as follows. For small liquidity shortfalls the CB has a clear incentive to support the bank. If the CB does not support the bank it incurs the cost \( \alpha c \) for sure, whereas if it does the cost is approximately equal to \( (1 - u) \alpha c \). On the other hand, when \( v \) is big the CB has to take a large stake in the bank to keep it afloat. Then, it will be willing to do so only if the probability of success \( (u) \) is large enough.

If the DI is imposed with the LLR activity, its LLR policy is characterized by the following:

**Proposition 2.3 (DI LLR Policy)** The Deposit Insurance LLR Policy is such that:

(i) An illiquid bank is supported at date \( t = 1 \) if

\[
u \geq u^\text{DI}_1(v) \equiv \frac{L}{1 + \alpha c}\]

(ii) There is insufficient forbearance regardless the size of the liquidity shock.

**Proof.** (i) The DI is willing to support the bank if the expected cost of doing so \( (1 - u) (1 + \alpha c) \) is smaller than the cost of no supporting the bank \( 1 - L + \alpha c \). Note that the DI is always responsible for the insured deposits. (ii) Provided \( \alpha < 1 \), it is immediate to check that \( u^\text{DI}_1 > u^* \). □
The intuition behind this result is the following. For \( u = u^* \) the expected return of the bank’s asset net of the expected bankruptcy cost is equal to the liquidation value of the bank’s asset net of the bankruptcy cost. Then, from a social point of view we are indifferent between continuation and liquidation. Since depositors are fully insured, and the bank owners get a positive expected return under continuation and zero upon liquidation, it must be the case that the deposit insurance corporation strictly prefers liquidation to continuation.

2.3 Second-Best: Definition and Implementation

It is useful to analyze the behavior of the agencies’ LLR Policy thresholds in order to derive the second-best allocation of LLR activity. If the bank is supported, the CB loses \( v \) with probability \( 1 - u \) but the DI agency loses \( 1 \) with the same probability. Hence, as \( v \) increases the CB becomes less willing to support the bank (i.e. \( u_{1}^{CB} (v) \) is increasing in \( v \)) but \( u_{1}^{DI} \) is constant. However, if the bank is not supported, the CB does not incur any direct cost but the DI loses \( 1 - L \). Then, there exists a critical value \( \bar{v} \equiv \frac{\alpha c L}{1-L+\alpha c} \in \left( \hat{v}, 1 \right) \) such that for liquidity shortfalls larger than \( \bar{v} \) the CB is tougher than the DI.

Figure 2.2: The Second-Best LLR Allocation

Figure 2.2 shows the optimal LLR policy threshold \( u^* \) as well as the CB’s one \( u_{1}^{CB} (v) \) and the DI’s one \( u_{1}^{DI} \). The shaded area below \( u^* \) represents values of \( v \) and \( u \) for which the
CB practices too much forbearance (i.e. the CB is softer than Optimal). In the vertically shaded area above $u^*$ the CB practices insufficient forbearance. The DI always practices insufficient forbearance as the horizontally shaded area shows.

By observing Figure 2.2 we can guess that the second-best allocation of the LLR activity involves the CB for liquidity shocks between $\hat{\nu}$ and $\bar{\nu}$, but the DI for liquidity shocks greater than $\bar{\nu}$. However, for smaller than $\hat{\nu}$ liquidity shocks things are not so clear. Figure 2.2 shows, in the bold line increasing up to $\bar{\nu}$ and constant after that, the second-best LLR allocation characterized by the following Proposition.

**Proposition 2.4 (Second-Best LLR Allocation)** Under the fairly weak sufficient condition $E\left[\bar{u} \mid u \leq u_1^{DI}\right] \geq u^*$ (equivalently $\frac{F(u^*)}{F(u_1^{DI})}$ small enough) the second-best is characterized by giving the CB the LLR responsibility for liquidity shocks smaller than the critical value $\bar{\nu} \equiv \frac{\alpha c}{1-L+c}$ and by moving such responsibility to the DI for liquidity shocks bigger than $\bar{\nu}$.

**Proof.** First, for $v > \bar{\nu}$ we have $u_1^{CB}(v) > u_1^{DI} > u^*$ then is always optimal to assign the LLR responsibility to the DI. Second, if the bank is not supported when it is optimal to support it the social cost is equal to $u (R + c) - L$ regardless the LLR agency. That is because the expected social value under continuation $uR - (1 - u) c$ is greater than the social value under liquidation $L - c$. Since the opposite case is symmetric we can express the social cost when the CB is imposed with the LLR responsibility as $L^{CB}(v) = \int_{u_1^{DI}(v)}^{u^*} [u (R + c) - L] dF (u)$ and when the DI is responsible for the LLR activity as $L^{DI} = \int_{u_1^{DI}}^{u^*} [u (R + c) - L] dF (u)$. Then $L^{DI} - L^{CB}(0) = \int_{0}^{u_1^{DI}} [u (R + c) - L] dF (u) = \left[(R + c) E\left[\hat{\nu} \mid u \leq u_1^{DI}\right] - L\right] F (u_1^{DI})$. Using the condition $E\left[\hat{\nu} \mid u \leq u_1^{DI}\right] \geq u^*$ and noting that $(R + c) u^* - L = 0$ we have proved that it is not socially optimum to allocate the LLR responsibility on the DI when the liquidity shortfall is smaller than $\bar{\nu}$.\(^7\)

Proposition 2.4 presents Repullo (2000)’s model main result. The author also argues that the model sheds some light on the allocation of the supervisory activity.\(^8\) The reasoning is as follows. If the cost of banking supervision is larger than the cost of transferring

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\(^7\)In this proof we have noticed that, since the decision is binary, the social cost $u (R + c) - L$ is always the same regardless the agency that is imposed with the LLR responsibility. Then, the expected social cost depends only on the distribution of $u$: $F (u)$. This reasoning provides the intuition for the condition $E\left[\hat{\nu} \mid u \leq u_1^{DI}\right] \geq u^*$. For small deposit withdrawals the CB practices too much forbearance while the DI practices insufficient forbearance. Now, if states above $u^*$ are much more likely than states below $u^*$, it is clear that, in expected welfare terms, the softness of the CB is going to be less costly for society than the toughness of the DI. For example, if we assume $u$ is uniformly distributed in $(0,1)$ the sufficient condition $E\left[\hat{\nu} \mid u \leq u_1^{DI}\right] \geq u^*$ becomes $u_1^{DI} - u^* \geq u^*$ which is far intuitive since, in this case, we can simply compare distances on the $u$ axis of figure 2.2.

\(^8\)Remember that, in this case, we are only speaking about the banks’ private information gathering function.
information among agencies, only one agency should have supervisory responsibilities. Proposition 2.4 suggests that if small liquidity shocks are more frequent than large shocks, the CB should act as LLR frequently. Then the CB should be in charge of the supervisory activity. However, once a large liquidity shock occurs such information should be transferred for immediate use to the DI.

This result is a particular case (i.e. one in which the CB provides truthful information to the DI) of a more general mechanism. Kahn and Santos (forthcoming) name such mechanism as "Repullo Mechanism":

**Definition 2.1 (Repullo Mechanism)** A Repullo Mechanism is any mechanism in which:

(i) only the CB obtains information about $u$;

(ii) for any $v \in [0, \bar{v})$ the CB decides whether it will lend to the bank;

(iii) for any $v \in (\bar{v}, 1]$ the CB provides a signal to the DI, after which the DI decides whether it will lend to the bank.

A Repullo Mechanism looks attractive in order to implement the second-best LLR Policy. Unfortunately, it is not feasible. We are going to discuss about this point in section 3. Previously, we are going to make a comment about the allocation of the LLR decision on the DI.

### 2.4 Why Should the DI Intervene in the LLR Decision?

The idea of allocating the LLR activity in the DI agency seems not to have empirical support. We do not know any safety net arrangement in which the DI agency is imposed with such responsibility. However, we think that the intervention of the DI in the decision of supporting illiquid banks, even if it does not provide the last resort loan, is justified by some arguments that are out of the model’s scope. Then, the relevant test should be on the decision level but not on the fund provision one. We are going to come back to this point in next section.

**Comment 2.1** The allocation of the LLR decision on the DI agency could also be justified by the following arguments: (i) early appropriation of valuable bank’s asset; (ii) protection of small depositors; and (iii) dynamic withdrawal.

In general, the net result of a bank liquidation process is used to recapitalize the deposit insurance fund. Moreover, the last resort loan from the DI (when it is collateralized) also acts as an instrument to achieve an early appropriation of valuable assets. Therefore, if solvency and liquidity problems are correlated it would be optimal that the DI appropriates in advance the most valuable bank’s asset.
The logic for the second argument is as follows. In general, the DI’s coverage of deposits is limited to a pre-specified amount. The protection of small, non-sophisticated, depositors appears as one of the main reasons behind this kind of policy (another involves moral hazard issues). In a situation in which the liquidity shortfall is due to the action of large, informed and even bank related depositors, the CB could practice too much forbearance. If after this first lending in last resort the bank is liquidated, the DI is still responsible for reimbursing the same amount of small deposits than before but the bank’s liquidation value has been reduced by the collateral the CB has. Then, the DI capacity to protect small depositors could be damaged.

The previous argument becomes clear if it is analyzed together with the third one. The aggregation of small liquidity shortfalls represents a big liquidity shortfall. The CB is too soft for small liquidity shocks and, in general, big liquidity shocks begin as a continuous process of small shocks. Thus, it would be optimal to give the DI insurance agency participation on the LLR decision (in this model on the bank closure decision) if a dynamic withdrawal process is observed. The time aggregated liquidity shock should be tanking into account to allocate the LLR activity.

3 Implementation: Budget Constraint and Information

The second-best allocation of the LLR activity cannot be implemented through a "Repullo Mechanism". Two reasons prevent that: a budget constraint problem and an information sharing one.

3.1 Budget Constraint

The model does not take into account the agencies’ budget constraint. However, such constraint is of particular importance when the DI must provide the last resort loan. In general, the DI agency does not have enough liquid funds to provide quick assistance to an illiquid bank. Moreover, DI agencies are not the "natural" channel to provide such assistance. Then, the lack of capacity and credibility on the DI agency damage the feasibility of a "Repullo Mechanism" to implement the second-best. This budget constraint problem is specially binding when liquidity shocks are big.

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9 It is the CB who has the operational network to act quickly. For example, the CB manages other banks’ accounts.
3.2 Information Sharing

Kahn and Santos (forthcoming) have proved that it is not possible to implement the second-best through a "Repullo Mechanism" due to information problems. They have noticed that "the very same reasons which lead the CB to have a lending of last resort policy different from the DI's can give the CB incentives not to share its supervisory information with the DI." (Kahn and Santos, forthcoming, pp. 2). This is a very important observation because the presentation so far has implicitly assumed that the regulatory agencies have incentives to share their private information regarding regulated banks.

Even if a regulatory agency exert the right level of monitoring, it could be the case that this agency does not share the information with other regulators. This is the main contribution on Kahn and Santos (forthcoming).

**Proposition 3.1** In a Repullo Mechanism the CB does not provide any information to the DI.

**Proof.** When the realization of the liquidity shock $v$ is such that the LLR responsibility should be allocate in the DI agency, the CB emits a signal $(s)$ from the set of signals available to it $(S)$: $s(u) : [0, 1] \rightarrow S$. Given the signal $s$, the DI decides to support or not the bank. Let $z$ denote the probability that the DI supports the illiquid bank: $z(s) : S \rightarrow [0, 1]$. Once the CB knows the LLR decision must be moved to the DI, it decides the signal it should emit. If the DI does not lend to the bank, which occurs with probability $(1 - z)$, the CB incurs a cost equal to $c$. If the DI lend to the bank, with probability $z$, the CB incurs its valuation of the bankruptcy cost only with probability $(1 - u)$: $(1 - u)c$. Therefore, the CB's expected cost is: $(1 - uz)c$, which is a decreasing function of $z$. Let $z^* = \sup \{z(s) : s \in S\}$, it is evident that the CB is going to provide a signal such that $z(s(u)) = z^*$. Then, the signal the CB emits is independent of the signal about the bank's soundness. In other words, the CB does not provide any information to the DI.  

The CB does not have incentives to provide information to the DI. This makes impossible the implementation of the second-best through a "Repullo Mechanism".

We are going to propose a regulatory arrangement that mitigates the information problem. In order to do so we are going to introduce a slight modification in the "Repullo Mechanism". Such modification takes into account the DI's budget constraint problem. In addition to that, it also takes into account that what matters for optimally is the DI's opinion about the provision of assistance, but not this agency's fund provision.

**Definition 3.1 (Modified Repullo Mechanism)** A Modified Repullo Mechanism is any mechanism in which:

(i) only the CB obtains information about $u$;
(ii) for any $v \in \left[0, \bar{v}\right]$ the CB decides whether it will lend to the bank;

(iii) for any $v \in \left(\bar{v}, 1\right]$ the CB provides a signal to the DI;

(iv) once the signal is emitted the DI decides whether the bank should be supported;

(v) if the DI decides that the illiquid bank must be supported, the CB is instructed to provide the last resort loan.

**Proposition 3.2** In a Modified Repullo Mechanism there exists an equilibrium in which the CB provides some (not all) information to the DI.

**Proof.** Suppose a realization $v \in \left(\bar{v}, 1\right]$. Then, the CB emits a signal $(s)$ from the set of signals available to it $(S)$: $s(u) : [0, 1] \rightarrow S$. Given the signal $s$, the DI decides whether the bank should be supported. Let $z$ denote the probability that the DI decides the illiquid bank should be supported: $z(s) : S \rightarrow [0, 1]$. If the DI decides that the bank should not be supported (with probability $(1 - z)$) the CB’s cost is equal to $\alpha c$. If the DI decides the bank should be supported (with probability $z$), the CB incurs an expected cost equal to: $(1 - u)(v + \alpha c)$. Therefore, the CB’s expected cost is: $\alpha c + z[v - u(v + \alpha c)]$. This cost is decreasing in $z$ if $u > \frac{v}{v + \alpha c} \equiv u_1^{CB}(v)$, and increasing if $u \leq \frac{v}{v + \alpha c} \equiv u_1^{CB}(v)$.

Then, consider the candidate equilibrium in which the CB emits a signal $s \in S$, where $S$ is the subset of $S$ such that $z\left(\frac{s}{s \in S}\right) = \sup\{z(s) : s \in S\}$, whenever it observes $u > u_1^{CB}(v)$; and it emits a signal $s \in S$, where $S$ is the subset of $S$ such that $z\left(\frac{s}{s \in S}\right) = \inf\{z(s) : s \in S\}$, whenever it observes $u \leq u_1^{CB}(v)$. Consider the DI plays $z\left(\frac{s}{s \in S}\right) = 1$ and $z\left(\frac{s}{s \in S}\right) = 1 - \frac{F(u_1^{DI})}{F(u_1^{CB}(v))}$. It is indeed an equilibrium. If the CB observes $u > u_1^{CB}(v)$ (it finds optimal to support the bank), but it provides the signal $s$, the probability that the DI decides not to support the bank is positive rather than zero. Thus, the CB has not incentive to provide the signal $s$. Once the DI knows this fact it knows for sure that $u > u_1^{CB}(v) > u_1^{DI}$ for all $v \in \left(\bar{v}, 1\right]$ and then it finds optimal to support the bank with probability 1. If the CB observes $u \leq u_1^{CB}(v)$ (it finds optimal not to support the bank) but it emits the signal $s$, the DI is going to decide that the bank should be supported with probability 1. But if the CB plays its candidate equilibrium strategy the DI decides to support the bank with a probability lower than 1. Once the DI observes the signal $s$, it is not sure whether $u$ is above or below $u_1^{DI}$. Then, it finds optimal to support the bank with a probability equal to $Pr\left(u > u_1^{DI} \mid s\right) = Pr\left(u > u_1^{DI} \mid u \leq u_1^{CB}(v)\right) = 1 - \frac{F(u_1^{DI})}{F(u_1^{CB}(v))}$. ■

Thus, this mechanism makes feasible the implementation of the second-best allocation.
of responsibilities that was found in Proposition 2.4: it avoids the budget constraint problem and (partially) the information sharing one.$^{10}$

### 3.3 Information Gathering

We have discussed about the incentives that regulators have to share information that has been already gathered from banks. However, the analysis of the incentives regulators have to gather banks’ private information remains to be done.

The incentive to observe the signal $u$ is not independent of the choice of the regulatory arrangement. It is not difficult to find examples in which a regulator has incentives to exert too little bank monitoring. For example, if the activity of observing the soundness of the bank involves monitoring costs and liquidity shocks are small, the CB does not have incentives to monitor the bank because it is biased towards forbearance. The information that the bank should be closed is not valuable information to the CB. Given the monitoring cost, the CB finds optimal not to monitor the bank.

This observation claims for the analysis in depth of the supervisory activity. Information problems (incentives to gather and to share relevant information) have proved to be really important in the model. However, the model we have been studying so far only considers the supervisory activity as a subsidiary one of the LLR activity.

### 4 Final Remarks

Incentives, interaction and information should be taken into account to analyze the optimal allocation of the safety net’s activities. Incentives to provide the last resort loan and interaction between safety net’s agencies have been considered by Repullo (2000) and Kahn and Santos (2005). However, information issues have not been carefully taking into account.

Kahn and Santos (forthcoming) have proved that the second-best allocation of the LLR activity proposed by Repullo (2000) (i.e. that the CB monitors the bank and acts as LLR for small liquidity shocks but transfers the information and the LLR responsibility to the DI for larger ones) cannot be implemented. The CB has not incentives to provide information to the DI.

We have proposed a slightly "Modified Repullo Mechanism" (i.e. one in which the CB always provides the last resort loan, monitor banks, takes the LLR decision for small liquidity shocks and transfers information to the DI in order it takes de LLR decision

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$^{10}$For $v \in (\bar{v}, 1]$ there is an random policy. However, such a policy yields an output that is closer the optimal than the CB’s policy.
for larger ones). We have also proved that in such mechanism the CB provides information to the DI. Therefore, Repullo’s second-best allocation of the LLR activity can be implemented.

In addition to the information issues, there is another point that should be highlighted. Not only the comparison between the candidate agencies’ LLR policies claims for allocating the LLR decision in the DI for big liquidity shocks. There are also other reasons: early appropriation of valuable bank’s asset, protection of small depositors and dynamic withdrawal. What is important to notice is that only the DI’ opinion is necessary for efficiency. It is not crucial (maybe it is not possible) that the DI provides the last resort loan. Moreover, in the "Modified Repullo Mechanism" the fact that the last resort loan is always provided with CB’s funds disciplines the CB and gives it incentives to share information.
References


