The Risks of Bank Wholesale Funding

Rocco Huang — Philadelphia Fed

Lev Ratnovski — Bank of England

March 2008

Preliminary[*]

Abstract

Some commercial banks increasingly use short-term wholesale funding in addition to traditional retail deposits. How does this affect their credit and liquidity risks? We analyze a depository bank's decision to attract wholesale funds, and the wholesale financier's decision to become informed. In the presence of relatively passive depositors, wholesale financiers can remain uninformed and withdraw upon mild negative news, triggering inefficient liquidations. Banks do not internalize such liquidity risk, particularly when a joint failure and a central bank intervention are likely in bad states. The model sheds light on the recent credit crisis, explaining why wholesale financiers did not provide market discipline ex-ante and exacerbated liquidity risks ex-post.

[*]The views expressed are those of the authors and do not necessarily represent those of the Philadelphia Fed or the Bank of England.

Contact: rocco.huang@phil.frb.org, lev.ratnovski@bankofengland.co.uk.

1 Introduction

Many commercial banks increasingly use short-term wholesale funds to finance their long-term assets. The traditional business model based on retail deposits is under strain due to intense competition among banks and from alternative investment institutions (mutual funds, money market accounts, etc.). To substitute for a reduced core retail deposit base, banks increasingly resort to attracting cash surpluses of other financial institutions, non-financial corporations, state and local authorities, and foreign entities. Such funds are usually raised on a short-term rollover basis[1]. How does their use affect banks' credit and liquidity risks?

The existing literature mainly points to the "bright side" of wholesale funding: exploiting valuable investment opportunities without being constrained by the local deposit supply; market discipline provided by sophisticated financiers (Calomiris, 1999); refinancing of unexpected retail withdrawals for banks with established wholesale markets access (Goodfriend and King, 1998).

However recent credit market events showed a "dark side" of wholesale funding. Banks can use wholesale funds to aggressively expand lending and compromise credit quality, particularly when financiers do not exercise sufficient market discipline. Later, at the refinancing stage, there is a risk of wholesale financiers suddenly withdrawing upon a hint of negative news, triggering inefficient liquidations. When wholesale withdrawals follow a market-wide signal, correlated bank failures exacerbate systemic risk.

This paper attempts to reconcile the traditional view on the virtues of wholesale funding with the recent credit crisis experience. We believe that wholesale funding is beneficial *when informed*, but exacerbates inefficiencies and bank liquidity risks *when uninformed*. We provide a model to explain why.

In the model, we study:

[1] The main institutional arrangements are fed funds purchased, repurchase agreements, renegotiable certificates of deposit, interbank deposits, commercial paper (issued by banks or sponsored structured investment vehicles), etc.

- The incentives of wholesale financiers to become informed;
- The consequences of them remaining uninformed; and
- Banks' strategy whether to rely on wholesale funding in the first place.

To address these issues, we build a theoretic model of bank funding strategy, market discipline, and liquidity risk. Its main features are as follows. A bank is an intermediary with, for simplicity, no own funds. On the asset side, it has access to a valuable long-term investment project. The project typically produces a high return, but with a small probability can yield zero. The project is flexible in scale, but has a maximum investment size (reflecting e.g. leverage constraints).

On the liability side, the bank needs to borrow in order to invest. There are two sources of funds. Firstly, the bank is endowed with a *depositor base*. Retail "core deposits" are passive (i.e. they are insured and withdrawals are predictable according to the law of large numbers), providing a relatively cheap and stable source of long-term funds. However the local depositor base is fixed in size, as it is prohibitively expensive to expand it in the medium term (Flannery 1982; Billett and Garfinkel, 2004). When the depositor base is narrower than the maximum investment opportunity (cf. funding gap), the bank can choose to attract, in addition, *wholesale funds*.

We consider two principal features of wholesale funds. Firstly, we assume (as is consistent with what we observe in the market) that they are provided on a short-term rollover basis: have to be refinanced at the intermediate date before final returns realize. A bank that is unable to refinance faces a costly liquidation. This relates to potential *liquidity risk* of wholesale funds. Secondly, we assume that the providers of wholesale funds are relatively sophisticated investors who have capacity to become informed before lending. Wholesale financiers that invest to learn the final payoff of the project provide *market discipline* by refusing to fund invaluable investments.

The key insight of the model is that attracting deposits and wholesale funds simultaneously can lead to conflicts of interest, resulting in distorted incentives of both wholesale financiers and banks.

Wholesale financiers face two choices: whether to become informed, and whether to liquidate at the intermediate stage if uninformed. We show that, although wholesale financiers can screen the bank (at a cost) before initial lending to ensure that a project is valuable, they do not fully internalize the benefits of screening as part of them accrues to the (passive) depositors. The choice of wholesale financiers to remain uninformed leads to insufficient market discipline, and, since the use of wholesale funding allows the bank to increase investments in both good and bad projects, increases bank credit risk.

Further, we show that uninformed wholesale financiers have excessive incentives to liquidate at the refinancing stage, creating liquidity risk for the bank. The reason is the effects of creditor seniority: depositors are formally senior after final returns are realized, but at the refinancing stage effective seniority passes to the party that withdraws earlier due to sequential service. By not rolling over, wholesale financiers reclaim a larger share of the project's residual value ahead of passive depositors. As a result, we show that wholesale financiers can trigger inefficient liquidations even on very mild and noisy negative news. Moreover, the fact that wholesale financiers can contain their losses by early liquidations further reduces their incentives for ex-ante screening.

We can now turn to the bank's strategy. In deciding whether to attract wholesale funds that are uninformed, the bank faces a trade-off between making full use of spare investment opportunities (the benefit) and higher liquidity risks (the costs). We show that banks endowed with a very large depositor base choose to forego wholesale funding and remain with unused investment opportunities, in order to avoid additional liquidity risks. But, more typically, banks with a relative deficit in deposit supply choose to use wholesale funds to expand lending. The model predicts that wholesale financiers of banks that combine wholesale funds with sizeable amount of deposits are likely to be uninformed, and are more likely to withdraw based on a hint of noisy, negative news. Yet, in making the decision on the use of such wholesale funds, the bank does not fully internalize the negative effect of possible inefficient liquidations on passive depositors, and as a result is more willing to use risky wholesale funds than socially optimal.

However, interestingly, this cautioning does not apply to banks that rely little on

deposits and receive most funds from wholesale markets. For them, the model predicts that, thanks to better aligned incentives, financiers will be informed, exercising strong market discipline and not creating liquidity risks. In this finding the model is broadly consistent with the observations from the recent credit market crisis. The banks affected the most were distinguished by the combination of deposits and wholesale funds. Those relying almost entirely on deposits, or almost entirely on wholesale funds, were less affected.

Lastly, we show that all identified distortions are amplified when the liquidity risk of wholesale funding happens to realize simultaneously for many banks. This can be the case when wholesale financiers happen to coordinate liquidations on a realization of a (possibly very noisy) market-wide factor, e.g. performance in a specific sector or of a specific class of assets banks hold. The reason is that a joint bank failure is likely to trigger a central bank intervention (Acharya and Yorulmazer, 2007), which increases liquidation payoffs to wholesale financiers and preserves equity values of banks.

Moreover, the expectations of a central bank intervention drive a strategic complementarity in banks' payoffs from using wholesale funding. As more banks adopt wholesale funding, a systemic crunch upon negative market-wide news becomes more likely, and this increases incentives for the rest of the banks to follow with the same strategy. This complementarity may help explain the time-series pattern where the banks' adoption of wholesale funding has increased exponentially instead of gradually in recent years.

While we have set up this paper as a banking model, the results apply broader. The model can be used to analyze a hedge fund's decision on leverage and its prime brokerage lender's decision to get informed. Similarly to our set-up, the fund manager has an investment idea and can access limited amount of patient long-term capital. To capitalize on the entire potential of the trading idea, he could borrow additional short-term funds from his prime broker. The model helps identify the leverage ratios at which the prime brokerage lender would choose to be uninformed, or even stop funding upon observing a noisy negative signal.

The model can also be used to analyze the choice between secured and unsecured lending in the interbank market. The increasing use of secured repo borrowing has raised concerns that it may reduce peer monitoring incentives. While acknowledging this, our model suggests an offsetting effect that giving seniority to wholesale financiers reduces their incentives to inefficiently withdraw at the refinancing stage. This trade-off should be taken into account when analyzing the overall impact of secured funding on systemic risks.

The rest of the paper is structured as follows. Section 2 sets up the model. Section 3 analyzes two benchmark cases: pure depositor or pure wholesale bank funding. Section 4 presents the main analysis on the interaction between depositors and wholesale financiers. Section 5 discusses the effects of central bank intervention. Section 6 analyses implication for liquidity regulation design. Section 7 addresses robustness. Section 8 concludes.

2 Setup

2.1 The Project

Consider a bank with access to a profitable but risky long-term investment project.

For each unit invested at date 0, the project returns at date 2: $X >> 1$ with probability p or $L < 1$ with probability $1-p$. We specify that the project has a positive long-term net present value (NPV):

$$Xp + L(1-p) > 1$$

The project can be liquidated at the intermediate date 1, returning residual value L. (For simplicity we set the liquidation value at date 1 to be the same as the low realization at date 2, which can represent the selling value of equipment when the project fails.) Note that in this setting *intermediate liquidations are always value-reducing* since all

upside is lost but no downside is gained. We relate inefficient intermediate liquidations to *bank liquidity risk*.

Note however that if it was knows at date 0 that a bank will only return L at date 2, it would have been optimal not to lend to the bank at all. We will study the financiers' decision to learn the future project quality and relate its outcome to *market discipline*.

The project is variable in size, but the maximum possible investment at date 0 is 1. The maximum relates to economic/prudential leverage constraints or exogenously-given local economic outlook. For example, a bank cannot expand its asset base beyond what is allowed by regulatory capital requirement or a target set by its rating agency (to achieve a certain decent credit rating). And the mortgage loan demand a bank faces is determined by economic, property market, and demographic factors in its local market

2.2 Financing

The bank has no initial capital. The only available source of external financing is simple debt. There are two types of debt available.

Firstly, a bank has access to $D < 1$ of **retail deposits**. We treat deposits as a cheap and passive source of funds. The reason is that depositors are small and covered by deposit insurance – they do not run and any intermediate withdrawals are predictable thanks to the law of large numbers. Formally, depositors lend up to D at date 0 at the interest rate 1 and withdraw only at date 2. However the amount of deposits that a bank can attract is limited in size: extending the deposit base is prohibitively costly in the medium term. Then, $1 - D$ is spare investment capacity that cannot be financed with deposits. (Spare investment capacity can be related to *excess capital*.)

Secondly, a bank has access to **wholesale funding**. It can attract $W \leq 1 - D$ of wholesale funds. Wholesale funding is fairly priced (interest rate R set to assure required expected return of 1). Wholesale funding is provided in the form of short-term debt and can be withdrawn at date 1. (In Section 6 we consider a case with a richer term structure.)

Consistent with stylized facts, we assume that depositors are senior at date 2. However if wholesale financiers withdraw at date 1, they effectively become senior at that date due to sequential first-come-first-served service.

2.3 Information

Another distinguishing feature of wholesale finding is that its providers can become informed. There are two sources of information.

Firstly, before lending at date 0, the providers of wholesale funds can **screen** the bank to determine returns at date 2. Screening involves a cost of C and produces a perfect signal of future returns (X or L). This information allows wholesale investors not to lend to a bank that will be insolvent, exercising market discipline.

Secondly, before date 1, the providers of wholesale funds receive a **free but imprecise signal** of future bank returns. The signal takes the "good" or "bad" values. A "good" signal occurs with probability $p_G < p$ ($p - p_G = \Delta p$) and confirms that a bank is solvent: the conditional probability of an X realization is 1. The "bad" signal occurs with additional probability $1 - p_G$. Conditional on it, the probability of an X realization is $\Delta p_G/(1 - p_G)$ (smaller than unconditional p). The conditional probability of an L realization is $(1 - p)/(1 - p_G)$ (larger than $(1 - p)$). The signal can be interpreted as a market-wide factor, when in good conditions all banks perform well, while in bad conditions banks are particularly likely to fail. Note that a higher p_G implies a more precise signal, as Δp is lower.

We assume that other agents (including banks themselves) cannot become directly informed at date 0. However, a regulator can obtain information from the fact that wholesale financiers refused lending at date 0 and immediately close the insolvent bank, preventing it from making an inefficient investment of depositors' money. (The regulator will not close the bank that chose not to attract wholesale funds by itself. In this model, bankers are uninformed, so their decision not to attract wholesale funds (which will emerge as one of the equilibria) is not a signal of quality.)

When indifferent, wholesale financiers screen and don't liquidate, while banks don't attract wholesale funds. The timeline of the model is summarized in Figure 1, and the game tree for the decisions of the bank and of wholesale financiers is shown is Figure 2.

<< Figure 1 and Figure 2 here >>

3 Benchmark cases

We start with two benchmark cases.

3.1 Depositor financing

Consider a bank financed with deposits D only. Depositor financing has two inefficiencies:

1. All projects are financed at date 0 (instead of only good projects) – *insufficient market discipline.*
2. Projects are financed in the amount D but not complete 1 – *spare investment opportunity* (or *excess capital*).

In the case of depositor financing, the payoffs to bankers (indexed B) and depositors (indexed D), and the monetary value of social welfare (indexed SW) are:

$$\begin{aligned}
\Pi^{B}_{D-only} &= Dp(X-1) \\
\Pi^{D}_{D-only} &= D\left[p+(1-p)L-1\right] \\
\Pi^{SW}_{D-only} &= D\left[pX+(1-p)L-1\right]
\end{aligned}$$

3.2 Wholesale financing

Now consider a financial institution that relies only on wholesale funding (can be interpreted as a non-bank credit institution). We model wholesale funding as follows:

- A bank bids to attract $W \leq 1$ wholesale funds;
- Financiers offer a competitive interest rate R (based on expected return 1);
- Financiers choose whether to screen prior to extending financing. They have two options:
  - Don't screen and finance any bank;
  - Screen and finance a good bank only (ie, if will return X at date 2).

In the analysis, we first take $W = 1$, and in the end verify that a corner W is indeed optimal for a banker.

When wholesale financiers *screen and finance a good bank only*, the payoffs of wholesale financiers (indexed F), bankers, and the monetary value of social welfare are:

$$\begin{aligned}
\Pi^{F}_{W-only-S} &= p(R-1) - C \\
\Pi^{B}_{W-only-S} &= p(X-R) \\
\Pi^{SW}_{W-only-S} &= p(X-1) - C \\
R_{W-only-S} &= 1 + C/p
\end{aligned}$$

When wholesale financiers *don't screen and finance any bank*, the payoffs are:

$$\begin{aligned}
\Pi^{F}_{W-only-NS} &= pR + (1-p)L - 1 \\
\Pi^{B}_{W-only-NS} &= p(X-R) \\
\Pi^{SW}_{W-only-NS} &= pX + (1-p)L - 1 \\
R_{W-only-NS} &= [1-(1-p)L]/p
\end{aligned}$$

Note that it is never optimal for wholesale financiers to liquidate at date 1 upon a negative signal (they would have received $p_G R + (1-p_G)L - 1 < \Pi^{W}_{W-only-NS}$). Therefore, in this model, there is no liquidity risk for a non-depository bank.

Also, financiers internalize all the costs and benefits of screening: Screening is preferred by them $\Pi^{W}_{W-only-S} > \Pi^{W}_{W-only-NS}$ and socially $\Pi^{SW}_{W-only-S} > \Pi^{SW}_{W-only-NS}$ for

$$C \leq (1-L)(1-p) \tag{1}$$

Intuition: The cost of screening C is less than the multiple of the probability of a bad state and the loss in that state. This is the example of the result that **informed wholesale funding achieves a socially optimal outcome** – *market discipline* with sufficient financing to good projects only and *no liquidity risk*.

Observe that banks themselves are indifferent between informed and uninformed wholesale funding. Also, a bank has no incentives to select $W < 1$.

In the further analysis, we will assume that (1) holds.

4 Wholesale and Deposits

In this section we model the interaction between depository and wholesale bank funding. We demonstrate a conflict of interest between two sources of funds.

- Firstly, the providers of wholesale funds do not fully internalize the benefits of screening and can choose not to become informed.
- Secondly, passive deposits provide a cushion, enabling wholesale financiers to liquidate the project at date 1 upon observing a negative intermediate signal. The effect appears because of changing seniority: Wholesale financiers gain a complete L in intermediate liquidation, but only a risky R (and nothing in the low state) at date 2 should they stay.

In response to the risk of inefficient liquidations, bankers may choose not to attract wholesale funding at all. However in making the decision, they only take into account own exposure (and not that of depositors) to liquidity risk. Therefore, bankers can still over-rely on wholesale funding.

Formally, we show that the distortions to wholesale funding increase in the amount of deposits D:

- For low D, bank wholesale funding is *informed*.
- For intermediate D, bank wholesale funding is *uninformed*.
- For higher D, bank wholesale funding is *uninformed* and its providers can choose to *liquidate* basing on a negative intermediate signal.
  - In response, the bank can choose not to attract wholesale funding (but in that decision will still over-rely on wholesale funds compared to the social optimum).

To simplify derivations, we take L to be small: $L < D$ and $L < 1 - D$. This does not affect results; in Section 8, we derive results for larger values of L. We take $W = 1 - D$ and further verify that a corner W is optimal (alternative is $W = 0$).

4.1 Payoffs

We now consider payoffs for the provider of wholesale funds, the bank, and depositors, and the monetary value of social welfare, depending on the strategy adopted by the provider of wholesale funds. We also identify the interest rate on wholesale funds from the respective zero-profit condition. There are three possible strategies:

- Strategy S: wholesale financiers **screen and lend to a good bank only**; the regulator closes the bad bank upon observing that wholesale financiers do not lend.

The payoffs are:

$$\begin{aligned}
\Pi_S^F &= p(R-1)(1-D) - C \\
\Pi_S^B &= p(X - D - R(1-D)) \\
\Pi_S^D &= 0 \\
\Pi_S^{SW} &= p(X-1) - C \\
R_S &= 1 + \frac{C}{p(1-D)}
\end{aligned}$$

- Strategy NS: wholesale financiers **don't screen but stay upon a negative signal**. The payoffs are:

$$\begin{aligned}
\Pi_{NS}^F &= pR(1-D) - (1-D) \\
\Pi_{NS}^B &= p(X - D - R(1-D)) \\
\Pi_{NS}^D &= p \cdot D + (1-p)L - D \\
\Pi_{NS}^{SW} &= pX + (1-p)L - 1 \\
R_{NS} &= 1/p
\end{aligned}$$

- Strategy NSL: wholesale financiers **don't screen and liquidate upon a negative signal**. The payoffs are:

$$\begin{aligned}
\Pi_{NSL}^F &= p_G R(1-D) + (1-p_G)L - (1-D) \\
\Pi_{NSL}^B &= p_G(X - D - R(1-D)) \\
\Pi_{NSL}^D &= p_G D - D \\
\Pi_{NSL}^{SW} &= p_G X + (1-p_G)L - 1 \\
R_{NSL} &= \frac{(1-D) - (1-p_G)L}{p_G(1-D)}
\end{aligned}$$

Observe that payoffs under strategy NSL are strictly dominated by payoffs under strategy NS for everyone but providers of wholesale funds. The latter can choose to

liquidate when they prefer a safe return L in case of liquidation to a risky return X when they continue lending.

4.2 Financiers' Choice

We can now analyze the choice of providers of wholesale funds.

1. Wholesale financiers choose S for $\Pi_S^F \geq \Pi_{NS}^F$ and $\Pi_S^F \geq \Pi_{NSL}^F$. Substituting R and rearranging the terms gives:

$$\begin{aligned} D &\leq (1-p)(1-C) \\ D &\leq 1 - L - C\frac{p_G}{p(1-p_G)} \end{aligned}$$

This allows to define a threshold point D^*

$$D^* = \min\left\{(1-p)(1-C); 1 - L - C\frac{p_G}{p(1-p_G)}\right\}$$

such that the providers of wholesale funds always screen for $D \leq D^*$. Recall that, from (**1**), screening by wholesale financiers is socially optimal for *any* value of D. Note that this implies insufficient screening and market discipline for any bank with $D > D^*$.[2]

2. Wholesale financiers choose NSL for $\Pi_{NSL}^F > \Pi_S^F$ and $\Pi_{NSL}^F > \Pi_{NS}^F$. Substituting R and rearranging the terms gives:

$$\begin{aligned} D &> 1 - L - C\frac{p_G}{p(1-p_G)} \\ D &> 1 - \frac{p(1-p_G)}{p-p_G}L \end{aligned}$$

This allows to define a threshold point $D^{**} < 1$

$$D^{**} = \max\left\{1 - L - C\frac{p_G}{p(1-p_G)}; 1 - \frac{p(1-p_G)}{p-p_G}L\right\}$$

[2] Check $D^* \gtreqless 0$

such that the providers of wholesale funds choose not to screen and then liquidate upon a negative signal for $D > D^{**}$.

3. Wholesale financiers choose NS for $\Pi^F_{NS} > \Pi^F_S$ and $\Pi^F_{NS} \geq \Pi^F_{NSL}$. Substituting R and rearranging the terms gives

$$\begin{aligned} D &> (1-p)(1-C) \\ D &\leq 1 - \frac{p(1-p_G)}{p-p_G} \end{aligned}$$

That is they choose not to screen but stay upon a negative signal for $D^* < D \leq D^{**}$ provided that such interval is not empty.

In comparative statics, the incentives for wholesale financiers *not to* screen (given by the value of D^*) increase in C – the cost of screening, L – the payoff in case of failure, and p_G – the precision of the intermediate signal. The incentives of uninformed financiers to liquidate upon observing a negative signal increase in L and p_G.

We can now formulate the first main result – that higher values of deposits D distort incentives of providers of wholesale funds to acquire information, and can give rise to wholesale-driven liquidity risk:

Proposition 1 ***1.*** *There exist parameter values $D > D^*$ such that the providers of wholesale funds choose to be uninformed and do not provide market discipline (fund bad banks). The reason is that they do not fully internalize the benefits of screening.*

2. *There exist parameter values $D > D^{**}$ such that the uninformed providers of wholesale funds choose to inefficiently liquidate a project upon a negative signal. The reason is a seniority-driven conflict of interests between providers of wholesale funds and depositors. Such liquidity risk reduces the surplus of depositors and bankers, and leads to lower social welfare.*

The threshold points and equilibrium wholesale financiers' strategies are illustrated in Figure 3.

4.3 Bank choices

The above analysis was conditioned on the fact that bankers choose $W = 1-D$. Observe that choosing $0 < W < 1-D$ would only reduce the incentives of wholesale financiers to become informed (because they internalize less of the benefits of screening) and increase their incentives to liquidate (because in liquidation they receive more per unit invested).

Bankers are indifferent between wholesale financiers' strategies S and NS. However, they face a reduced payoffs under NSL due to inefficient liquidations upon a negative signal:

$$\Pi_S^B = \Pi_{NS}^B > \Pi_{NSL}^B$$

When bankers expect NSL to be the equilibrium strategy of wholesale financiers, they face a trade-off. Bankers can choose to rely on wholesale funds but be exposed to liquidity risk of wholesale liquidations. Alternatively they can choose not to attract wholesale funds and remain with deposits only, but have unused investment opportunities $1-D$. The latter is preferred for $\Pi_{D-only}^B > \Pi_{NSL}^B$. Substituting R and rearranging the terms gives:

$$D > D^{***} = \frac{p_G X + (1-p_G)L - 1}{p(X-1) + p_G - 1}$$

Note that $D^{***} < 1$ and, in comparative statics, D_B^{***} increases in p_G, decreases in X and increases in L.

Will the bank's decision on reliance on wholesale funding be socially optimal? Observe that inefficient liquidations reduce not only the bank's payoff, but also that of depositors. Due to limited liability, the bank does not internalize depositors' losses when making the decision on whether to attract wholesale funds. (It also does not internalize the payoff of wholesale financiers, but that effect is smaller). Therefore, its private decision can deviate from the social optimum.

It is socially optimal not to attract wholesale funds for $\Pi^{SW}_{D-only} > \Pi^{SW}_{NSL}$.

$$D > D^{***}_{SW} = \frac{p_G X + (1-p_G)L - 1}{pX + (1-p)L - 1}$$

It is easy to observe that $D^{***}_{SW} < D^{***}$. Therefore, bankers can choose to rely on wholesale funding while it is socially optimal not to for $D^{***}_{SW} < D < D^{***}$.

This leads to the following main result on the banker's choice of wholesale funding:

Proposition 2 ***1.*** *A bank chooses to attract wholesale funding for* $D < \max\{D^{**}; D^{***}\}$ *A bank with a higher volume of deposits* $D > \max\{D^{**}; D^{***}\}$ *does not attract wholesale funding. It chooses lower investment over higher liquidity risk.*

2. *A bank can over-rely on wholesale funding: on* $\max\{D^{**}; D^{***}_{SW}\} < D < \max\{D^{**}; D^{***}\}$ *that bank chooses to attract wholesale funds while it is socially optimal not to. The reason is that a bank does not internalize the externality of liquidity risks of wholesale funding on depositors.*

The threshold points and equilibrium bank strategies are shown in Figure 3.

5 Wholesale Funding and LOLR

- Assume that authorities have to intervene in a wholesale-triggered date 1 liquidation with probability p_A. In order to "save" the bank, they repay wholesale financiers (returning RW) and take their stake. **Result**: Banks are more likely to rely on (uninformed) wholesale funding; wholesale financiers are less likely to screen and more likely to liquidate.

- Consider an economy with N banks of which K rely on uninformed wholesale funding. Assume p_A depends positively on the number of banks that are inefficiently liquidated. **Result**: Distortions are the highest:

- when p_G is correlated across banks (in the extreme, when it is a market-wide signal) because it leads to correlated liquidations;
- when K/N is high. This condition is interesting, because it means that banks with relatively fewer deposits can draw more deposit-rich banks into reliance on wholesale funding.

6 Regulation

- Consider wholesale funding with a term structure where only $\lambda W < 1$ can be withdrawn at date 1. At date 0, a bank can accumulate a liquidity buffer B. **Bright side of liquidity**: $B \geq \lambda W$ allows avoiding inefficient liquidations. **Dark side of liquidity**: A higher buffer reduces wholesale funds' incentives to become informed, offsetting market discipline. Banks can under-invest in liquidity because they do not internalize the negative effect of liquidations on depositors.
- **The impacts of iquidity requirements**:
  - It is optimal to demand a liquidity buffer *only* for banks in the "risky" area with $D^{**} < D < D^{***}$.
  - For $D^{*} < D < D^{**}$ there is no liquidity risk (financiers are uninformed but do not withdraw).
  - For $D < D^{*}$ liquidity requirements can be particularly costly, because they reduce wholesale financiers' incentives to acquire information, lowering market discipline and possibly increasing liquidity risk (probability of intermediate withdrawals).
- A complementary intervention is to **alter banks' funding strategy** and rule out using wholesale funds for $D^{***}_{SW} < D < D$ [e.g. through minimal entry requirements on wholesale market access; precluded for banks with heavy reliance on deposits]
- **Seniority**: *Making depositors junior* at date 2 reduces market discipline (incentives to screen), but also *reduces liquidity risks* since wholesale financiers have

lower incentives to liquidate at date 1. (Recall that there is no depositor-driven liquidity risk in the model).

7 Robustness

tbc

8 Conclusions

tbc

FIGURE 1

Timeline

Date 0	Date 1	Date 2
* Bank is endowed with deposits D<1 and an investment project with maximum capacity 1 * Bank can attract additional wholesale funds W < 1 – D * Wholesale financier can screen the bank at cost C before lending * Regulator can close the bank upon observing wholesale financier not lending	* Wholesale financier observes an imprecise signal of bank's date-2 return * Wholesale financier can refuse refinancing and trigger liquidation, in which case he has priority in receiving L because of sequential service rule	* Project return realizes, either X (high) or L (low) * Bank repays creditors; depositors have priority

FIGURE 2

Game tree: Decisions of the bank and of providers of wholesale funds

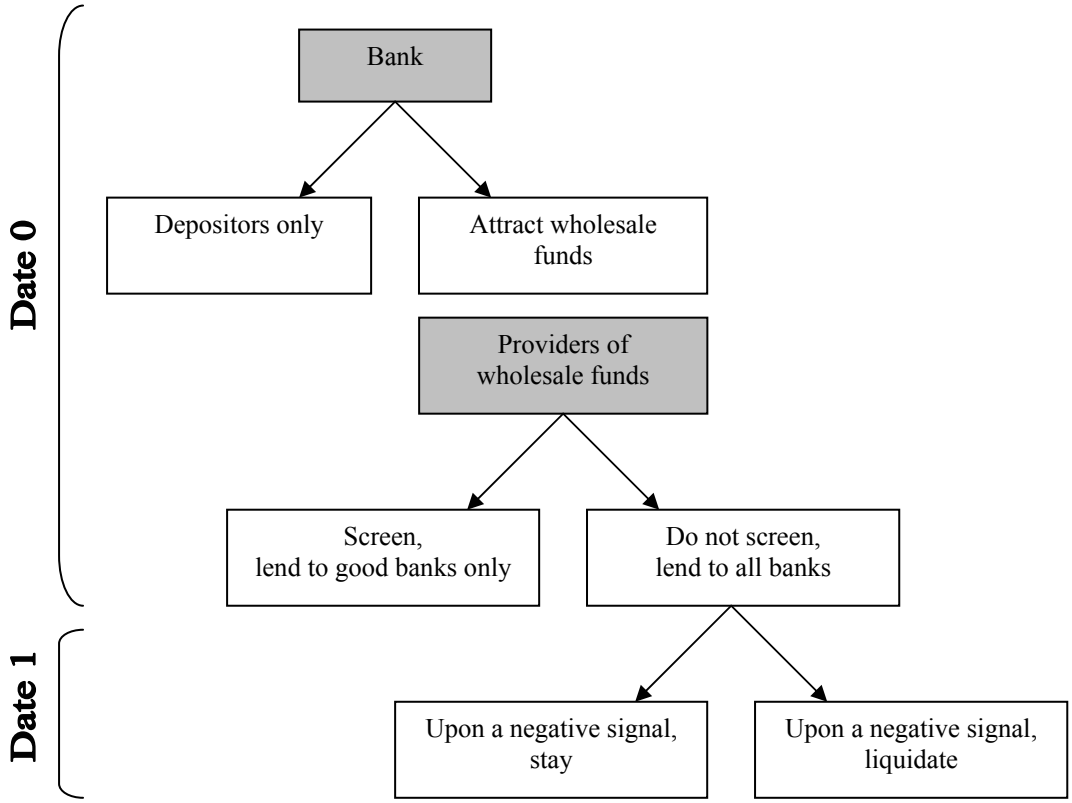
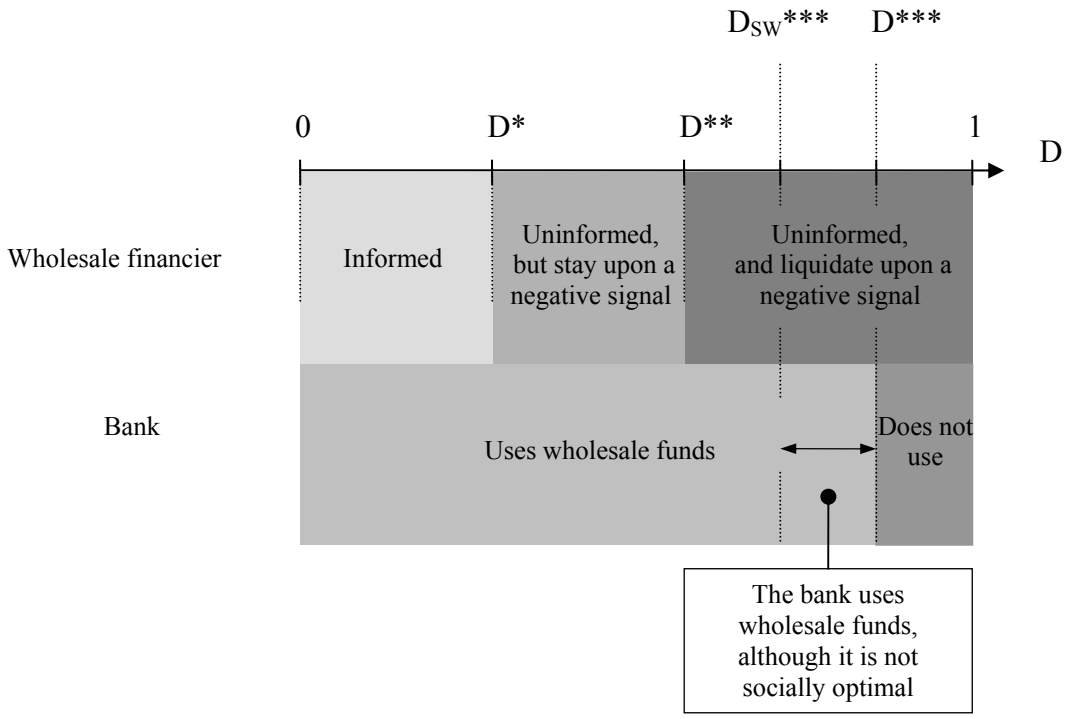


FIGURE 3

Threshold points and equilibrium strategies