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The leverage effect of bank disclosures

Philipp J. König
(Deutsche Bundesbank)

Christian Laux
(Vienna University of Economics and Business and
Vienna Graduate School of Finance)

David Pothier
(University of Vienna and
Vienna Graduate School of Finance)

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

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Non-technical summary

Research Question

Disclosure requirements and market discipline play a key role in modern bank regulation. The general view is that disclosed information allows market participants to better assess a bank's risk. This assessment then affects the funding costs of the bank, such as the interest rate it has to pay for uninsured debt, which, in turn, mitigates its risk-taking incentives. We develop a model to investigate the role of market discipline through information disclosures on bank leverage and bank risk.

Contribution

The debate on the role of disclosures for market discipline and financial stability focuses on banks' risk taking incentives and ignores the effect on banks' funding choices. Taking into account the endogenous leverage choice of banks, we show that the effect of market discipline on bank risk is more nuanced than is generally perceived. We show that market discipline induces banks to increase their leverage, which can lead banks to take on more, not less, risk. The reason stems from the interaction between insured and uninsured debt.

Results

In line with the reasoning underlying disclosure regulations, we first show that bank disclosures make the price of uninsured debt more responsive to banks' risk. Disclosures thereby mitigate the agency problem between uninsured debt and equity and, for given leverage, reduce banks' risk-taking incentives. However, the very fact that disclosures reduce the agency cost of debt incentivizes banks to increase their funding with uninsured short-term wholesale debt.

Short-term debt can be withdrawn when economic conditions deteriorate, thereby circumventing the de jure seniority of insured deposits and increasing banks' subsidy from deposit insurance. Thus, an increase in uninsured short-term wholesale debt increases this dilution of insured deposits, which ratchets up the expected wealth transfer from the deposit insurance fund to the bank. The increase in dilution of insured deposits has the same negative effect on a banks' monitoring incentives as an increase in insured deposits. Thus, ceteris paribus, banks monitor less when issuing more short-term debt.

The overall effect of market discipline on banks' monitoring incentives depends on the magnitude of the leverage adjustment in response to disclosures of bank-specific information. If the increase in leverage is sufficiently large, bank disclosures decrease banks' monitoring incentives. We show that the total effect of market discipline on banks' loan portfolio risk tends to be more negative for banks with a small deposit base.

Nichttechnische Zusammenfassung

Fragestellung

Offenlegungspflichten und Marktdisziplin sind zentrale Bausteine der modernen Bankenregulierung. Dabei wird üblicherweise davon ausgegangen, dass die Bereitstellung zusätzlicher Informationen im Rahmen von Offenlegungspflichten es den Marktteilnehmern ermöglicht, das Ausfallrisiko einer Bank besser einzuschätzen. Diese Einschätzung beeinflusst die Höhe der Refinanzierungskosten der Bank, die sie für unbesicherte Einlagen zahlen muss, und soll mithin ihre Anreize mindern, ineffizient hohe Risiken einzugehen. Wir untersuchen im Rahmen eines theoretischen Modells, wie sich Offenlegungspflichten und Marktdisziplin auf die Verschuldung und das Risiko von Banken auswirken.

Beitrag

In der Debatte über die Rolle von Offenlegungspflichten für Marktdisziplin und Finanzstabilität werden meist die direkten positiven Auswirkungen auf das Risiko von Banken hervorgehoben. Auswirkungen auf die Finanzierungsentscheidungen der Banken finden dagegen weniger Beachtung. Wir zeigen, dass die Wirkung von Offenlegungspflichten und Marktdisziplin nicht eindeutig ist, wenn die optimale Verschuldung von Banken berücksichtigt wird. Verstärkte Marktdisziplin veranlasst Banken, mehr Fremdkapital einzusetzen, wodurch ihre Anreize steigen, höhere Risiken einzugehen. Folglich kann die durch Offenlegungspflichten bedingte Marktdisziplin das Ausfallrisiko von Banken erhöhen, anstatt es zu senken.

Ergebnisse

Offenlegungspflichten steigern die Preissensitivität unbesicherter Schuldtitel gegenüber dem Risiko der Bank. Dadurch werden etwaige Agency-Probleme zwischen Fremdkapital- und Eigenkapitalgebern reduziert. Bei einem gegebenen Verschuldungsgrad verringert dieser Mechanismus die Risikonahme der Banken. Die Verringerung der Agency-Kosten der Fremdkapitalfinanzierung veranlasst Banken jedoch auch dazu, ihren Verschuldungsgrad zu erhöhen und verstärkt unbesicherte, kurzlaufende Schuldtitel zu emittieren. Die Halter kurzlaufender Schuldtitel können ihr Kapital bei sich verschlechternden wirtschaftlichen Bedingungen abziehen und dadurch die Seniorität besicherter Einlagen umgehen. Diese Umgehung der Senioritätsreihenfolge durch Abzug unbesicherter Gelder kommt einem Vermögenstransfer aus der Einlagensicherung an die Bank gleich. Folglich erhält eine Bank durch die Emission unbesicherter kurzfristiger Schuldtitel eine zusätzliche Subvention aus dem Einlagensicherungsfonds, die denselben negativen Einfluss auf ihre Risikoanreize hat, wie eine Zunahme versicherter (und nicht fair bepreister) Einlagen. Die Gesamtwirkung der Marktdisziplin auf die Risikonahme von Banken hängt vom Anstieg des Verschuldungsgrades ab, der als Reaktion auf zusätzliche Offenlegungspflichten erfolgt. Ist dieser Anstieg hinreichend groß, dann führen Offenlegungspflichten zu einem höheren Ausfallrisiko von Banken. Wir zeigen, dass dies insbesondere für Banken gilt, die sich mit einem relativ kleinen Anteil an besicherten Einlagen finanzieren.

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The Leverage Effect of Bank Disclosures

Philipp J. König, Christian Laux, and David Pothier*

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Abstract

The general view underlying bank regulation is that bank disclosures provide market discipline and reduce banks' risk-taking incentives. We show that bank disclosures can increase bank leverage and bank risk. The reason stems from the interaction between insured and uninsured debt. Bank disclosures reduce the agency problem between uninsured debt and equity, thereby lowering the cost of leverage for banks. By issuing uninsured short-term debt that is repaid ahead of insured deposits when economic conditions deteriorate, banks dilute insured deposits. Higher levels of uninsured short-term debt increase the subsidy provided by deposit insurance, which increases banks' risk-taking incentives. We identify conditions under which this negative leverage effect dominates the standard market discipline effect, so that providing market discipline through bank disclosures increases banks' risk.

Keywords: Bank Disclosures, Market Discipline, Bank Leverage

JEL Classifications: D80, G21, G14

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1 Introduction

Disclosure requirements are a cornerstone of modern bank regulation. As early as 1998, the Basel Committee discussed the importance of bank disclosures to promote market discipline and introduced Pillar 3 (market discipline) in the 2004 Basel II Accord as a complement to capital regulation. The Committee emphasizes that disclosure requirements incentivize banks to reduce their risk and leverage since "the market will require a higher return from funds invested in, or placed with, a bank that is perceived as having more risk" (BIS, 1998, p. 6).[1]

We show that providing market discipline through bank disclosures can increase banks' leverage and risk, in contrast to the original intention. The reason is the interaction between insured deposits and uninsured short-term debt. In line with the argument underlying disclosure regulations such as Pillar 3, we show that bank disclosures make the price of uninsured debt more responsive to banks' risk when debt is rolled over. Bank disclosures thereby decrease the agency problem between uninsured debt and equity and, for given leverage, reduce banks' risk-taking incentives. However, the very fact that bank disclosures reduce the agency costs of uninsured debt also induces banks to issue more uninsured short-term debt. Uninsured short-term debt dilutes the claims of insured deposits, which negatively affects banks' risk-taking incentives. The negative effect of higher leverage can outweigh the positive market discipline effect of bank disclosures. Consequently, bank disclosures can lead banks to take on more, not less, risk.

Our results are based on a stylized three-period model. In period 0, a bank originates a long-term loan portfolio. Loans are risky and bank monitoring at origination determines the quality of the loan portfolio. Monitoring is costly and not observable. The bank's preferred choice of financing are retail deposits, which are insured at a flat rate. However, retail deposits are not sufficient to finance the loan portfolio. To raise the missing funds, the bank can choose any combination of short-term wholesale debt and equity. Wholesale debt is uninsured, and the bank has to roll it over or repay it by selling part of its loan portfolio in period 1. In period 2, loans mature and claims are settled according to their seniority. All agents are risk neutral and the wholesale debt market is competitive.

The key benefit of wholesale debt over equity is that banks can repay wholesale creditors in period 1 by selling loans if economic conditions deteriorate. As a result, wholesale debt withdrawals circumvent the *de jure* seniority of insured deposits and increase the subsidy provided by deposit insurance. This dilution of insured deposits creates a cost-advantage of short-term wholesale debt over equity financing.[2] Such dilution occurred, for example, when wholesale creditors withdrew funds from US banks in 2008 (Rose, 2015).[3] More recent empirical evidence shows that the sensitivity of deposit flows rela-

[1] See also BIS (2001, 2014); Flannery and Bliss (2019). In the Basel III Accord, the Committee directly refers to 'Pillar 3 disclosure requirements'.

[2] To focus on the dilution benefits of uninsured debt, we assume that there are no tax benefits of debt, no implicit bail-out guarantees of uninsured debt, and no exogenous cost of equity relative to debt.

[3] For Indy Mac, Washington Mutual, National City, Sovereign or Wachovia – all of which experienced

tive to bank performance is stronger for uninsured deposits, implying that these funds are withdrawn quicker and in larger quantities than insured deposits (Chen, Goldstein, Huang, and Vashishtha, 2018, 2020).

At the same time, in the absence of information about the quality of the bank's loan portfolio, wholesale debt financing subjects the bank to a debt overhang problem. The resulting agency problem between wholesale debt and equity reduces the bank's monitoring incentives. For a given level of debt, disclosing bank-specific information unambiguously increases the bank's monitoring incentives. The reason is that bank disclosures allow market participants to update their beliefs about the quality of the bank's loan portfolio, which affects the terms at which the bank can roll over its wholesale debt. As a consequence, the bank internalizes the effect of its monitoring on wholesale debt. We refer to this effect as the "direct effect" of market discipline.

Importantly, bank disclosures also affect the bank's optimal leverage decision since reducing the agency cost of wholesale debt incentivizes the bank to issue more wholesale debt. Issuing more wholesale debt increases the dilution of insured deposits, which ratchets up the expected wealth transfer from the deposit insurance fund to the bank. We refer to this effect as the "leverage effect" of market discipline.

The bank's use of wholesale debt to dilute insured deposits is reminiscent of the "maturity rat race" of Brunnermeier and Oehmke (2013).[4] An important difference to our paper is that dilution in their model operates across uninsured creditors. Hence, the costs from diluting long-term creditors are ultimately borne by the bank's shareholders, which implies that the bank would be better off if it could commit to a long-term debt maturity structure. In contrast, the bank in our model does not internalize the costs from diluting retail depositors since retail deposits are insured at a flat rate.

Because of the leverage effect of market discipline, bank disclosures can increase the bank's loan portfolio risk. The reason is that the dilution of insured deposits has the same negative effect on the bank's monitoring incentives as increasing the amount of insured deposits. The bank, seeking to maximize the value of the put option implied by deposit insurance, therefore monitors less when it issues more wholesale debt even if bank disclosures eliminate the agency problem between wholesale debt and equity.

Whether market discipline increases or decreases the bank's monitoring incentives depends on the magnitude of the bank's increase in the level of wholesale debt in response to bank disclosures. If the increase in wholesale debt is sufficiently large, the negative leverage effect dominates the direct effect of market discipline and bank disclosures decrease the bank's monitoring incentives. We show that the negative leverage effect is more likely to dominate if the bank is more constrained in its issuance of insured retail deposits. Hence, the total effect of market discipline on banks' loan portfolio risk tends

runs during the 2008 financial crisis – the share of insured deposits on the overall deposit base was between 60 and 80 percent. Rose (2015) argues that around 70 percent of the withdrawn deposits in the runs on these banks were uninsured. Iyer and Puri (2012), using data from India, also show that withdrawn funds during a bank run are largely those of uninsured depositors or those close to the insurance limit.

[4]See also Bizer and DeMarzo (1992) and Parlour and Rajan (2001) for models of how firms can dilute pre-existing debt by issuing new claims.

to be more negative for banks with a small deposit base compared to otherwise similar banks with a larger deposit base.

Our model also has implications for prudential regulation. Banks can only increase their leverage in response to bank disclosures if their regulatory capital constraint is not binding. Our results therefore suggest that disclosures are more likely to have the desired effect of reducing banks' risk-taking incentives if capital requirements are tight. Alternatively, the negative externality implied by the dilution of insured deposits can be eliminated using an appropriately calibrated Pigovian tax. Taxing away the dilution benefits of wholesale debt eliminates the cost advantage of wholesale debt over equity and strictly increases the bank's monitoring effort. This Pigovian tax can be implemented by requiring the bank to pay a deposit insurance premium that increases in the bank's total leverage and depends on the available information about the quality of the bank's loan portfolio.

Related Literature. Our paper contributes to several strands of the literature. First, we contribute to the literature studying the effects of market discipline on bank risk-taking.[5] While the notion of market discipline is often emphasized in both the academic literature and policy discussions, the underlying mechanisms through which it operates remain a debated issue (Hellwig, 2005; Admati and Hellwig, 2014).

One channel is using short-term uninsured debt to discipline banks by allowing creditors to "vote with their feet" and withdraw funds upon the arrival of negative information (Calomiris and Kahn, 1991; Diamond and Rajan, 2001). The downside of such fragile debt structures is that they expose banks to the risk of inefficient bank runs (Diamond and Dybvig, 1983; Rochet and Vives, 2004; Goldstein and Pauzner, 2005; Huang and Ratnovski, 2011). While withdrawals of short-term debt are important in our model, they have no disciplining role and uninsured depositors do not monitor the bank.

Another important channel of market discipline operates *via* the pricing of uninsured debt. A number of papers have analyzed this channel empirically by considering the risk-sensitivity of subordinated debt issuance and their effect on banks' risk-taking (Gorton and Santomero, 1990; Jagtiani and Lemieux, 2001; Sironi, 2003; Krishnan, Ritchken, and Thomson, 2005). Cordella, Dell'Ariccia, and Marquez (2018) propose a model in which greater transparency increases banks' monitoring incentives by mitigating moral hazard frictions in debt markets. We show that this channel is unambiguously positive only if banks' leverage is fixed.

Only few empirical papers investigate the effects of disclosures and market discipline on bank leverage. Nier and Baumann (2006) conduct a cross-country study over the years 1993 to 2000 and find a positive relation between bank disclosures and bank capital ratios. However, they do not consider which banks have access to wholesale funding or the interaction between wholesale debt and insured deposits. Granja (2018) shows that the adoption of disclosure regulation during the National Banking Era led banks to reduce their capital ratios as well as their risk. The findings are consistent with bank disclosures reducing agency costs of debt financing as in our model. Importantly, due

[5] See Flannery and Nikolova (2004) for an early survey.

to the absence of deposit insurance in this period, the negative leverage effect stemming from the dilution effect of insured deposits could not arise.

Second, our paper contributes to the literature studying the negative effects of bank transparency (Dang, Gorton, Holmström, and Ordonez, 2017; Monnet and Quintin, 2017; Goldstein and Leitner, 2018). These papers build on Hirshleifer (1971)'s original insight that transparency may hamper the efficient functioning of financial markets by destroying valuable risk-sharing opportunities. Relatedly, Bouvard, Chaigneau, and de Motta (2015) show that disclosing bank-specific information can increase the likelihood of inefficient bank runs due to coordination failures among uninsured creditors. Our model complements these papers by showing that bank disclosures can be detrimental even in the absence of risk-sharing motives or coordination failures due to its effect on banks' leverage and monitoring incentives.[6]

Finally, we contribute to the literature that investigates the role of uninsured debt and banks' capital structure. This literature generally focuses on asymmetric information between banks and investors (Bolton and Freixas, 2006), soft information about the risk of banks' lending opportunities (Inderst and Mueller, 2008), the liquidity premium investors ascribe to safe debt (DeAngelo and Stulz, 2015), or segmented markets that limit uninsured depositors' access to outside investment opportunities (Allen, Carletti, and Marquez, 2015). In contrast, we emphasize the benefit of using uninsured short-term debt to dilute insured deposits.

2 The Model

We consider a model with three periods, $0, 1, 2$. All agents are risk neutral and the risk-free rate is normalized to zero.

Lending and monitoring. There is a representative bank that provides loans to a unit measure of borrowers. Borrowers receive a loan of 1 in period 0 and promise to repay $\overline{R}$ in period 2. Each borrower can either repay the promised repayment in full or default on the loan and only repay $\underline{R} < \overline{R}$. The probability that the borrower does not default is $\alpha\theta \in [0, 1]$. θ captures the state of the economy and affects borrowers' ability to repay their loans, while α captures the quality of the bank's loan portfolio. Conditional on the state of the economy and the quality of the loan portfolio, repayments are independent across borrowers. Thus, the share of borrowers that do not default is $\alpha\theta$, and the bank's total repayment is $R = \underline{R} + \alpha\theta(\overline{R} - \underline{R})$.

We assume that the state θ is a continuously distributed random variable over $[0, 1]$. The quality of the loan portfolio can be high or low, with $\alpha \in \{\alpha_h, \alpha_l\}$. To simplify the exposition, we assume that $\alpha_h = 1$ and $\alpha_l = 0$. Thus, if the bank has a low quality loan portfolio, then $R = \underline{R}$. That is, the repayment is independent of θ and all borrowers default. If the bank has a high quality loan portfolio, then $R = \underline{R} + \theta(\overline{R} - \underline{R})$, and the

[6] Goldstein and Sapra (2014) discuss the costs and benefits of disclosing bank stress test results and provide an overview of the extant literature. Leuz and Wysocki (2016) provide a recent survey on the role of disclosure regulation.

total loan repayment is increasing in θ. We denote the distribution of R conditional on the bank having a high quality loan portfolio by $F(R)$.

The probability that the bank has a high quality portfolio is $q \in \{q_g, q_b\}$, with $q_g > q_b$. We refer to a bank with $q = q_g$ ($q = q_b$) as a good (bad) bank. The bank can increase the probability of being a good bank by exerting monitoring effort $e \in [0, 1/p]$ in period 0:

$$\mathbf{Pr}(q = q_g|e) \equiv p(e) = pe,$$

with $p > 0$. By monitoring borrowers at origination, the bank increases the likelihood of having a high quality loan portfolio. Monitoring is not observable by outside investors and involves a cost $c(e)$ borne by the bank in period 0:

$$c(e) = \frac{1}{2}ce^2,$$

with $c > 0$.

Assumption 1. *The bank's monitoring technology satisfies:*

$$c > p^2 \Delta q \Delta R \quad \textit{and} \quad \Delta q < q_b,$$

where $\Delta R \equiv \mathbf{E}[R|\alpha_h] - \underline{R}$ *and* $\Delta q \equiv q_g - q_b$.

Assumption 1 is a technical assumption guaranteeing that the bank's monitoring effort is unique and interior. It implies that the marginal benefit from monitoring is bounded relative to the marginal costs, and that the likelihood that a bad bank has a high quality loan portfolio is sufficiently high.

Information structure. Market participants receive information in period 1 that allows them to update their beliefs about the bank's future loan repayments. To simplify the exposition, we assume that market participants observe the state θ in period 1.[7] Information about θ captures information about general economic conditions (e.g., GDP growth or unemployment rate) that market participants receive independently of any bank disclosures. In our model, learning θ is equivalent to learning the repayment R for a bank with a high quality loan portfolio since $R = \underline{R} + \theta(\overline{R} - \underline{R})$ for $\alpha = 1$.

In addition to information about general economic conditions, market participants may learn the bank's type in period 1. The availability of bank-specific information depends on the disclosure regime. We distinguish two disclosure regimes $s \in \{o, \tau\}$. First, uninformative or no disclosure ($s = o$), where no useful information is available to update beliefs about q. Second, informative disclosure ($s = \tau$), which allows market participants to perfectly infer the bank's type q. Since market participants do not know the actual quality of the bank's loan portfolio, uncertainty about the bank's future loan repayments remains even if market participants observe both θ and q.

[7] Our results would not change if market participants observe a noisy signal of θ, as long as the signal is sufficiently precise.

We assume that the bank does not know the realization of q absent bank disclosure. This assumption captures the idea that disclosure requirements require the bank to put additional internal reporting and control systems in place that generate information that the bank would otherwise not voluntarily acquire.[8]

Funding. The bank requires one unit of funds to originate the loan portfolio and has three sources of financing: insured retail deposits, uninsured short-term wholesale debt, and equity.[9] Retail deposits are insured at a flat rate normalized to zero and are therefore the bank's preferred source of financing. However, the amount of available retail deposits δ is not sufficient to finance the loan portfolio: i.e., $\delta < 1$.[10]

Wholesale debt D is uninsured and junior to retail deposits in resolution. Thus, if the bank defaults on its outstanding debt, the claims of retail depositors have priority over wholesale creditors' claims.[11] If $\delta + D < 1$, the bank has to invest equity $E = 1 - \delta - D$ in order to finance its loan portfolio. The (opportunity) cost of wholesale debt and equity are both equal to the risk-free rate. The wholesale debt market is competitive and wholesale creditors supply funds provided that they break even in expectation.

For ease of exposition, we assume zero-coupon debt so that the face values include all promised payments to wholesale creditors, including any compensation for default risk. D_1 is the repayment obligation in period 1 of wholesale debt that the bank issues in period 0. D_2 is the repayment obligation in period 2 if the bank rolls over wholesale debt in period 1.[12] If the bank does not roll over wholesale debt in period 1, it has to sell (liquidate) part of its loan portfolio to repay the wholesale debt that is withdrawn.

Loan sales. We assume that the bank can repay the wholesale debt before a resolution authority intervenes, thereby *de facto* circumventing insured depositors' seniority in resolution.[13] The assumption that wholesale creditors can withdraw before the resolution authority intervenes captures the observation that resolution authorities generally do not intervene before financial problems become apparent. Reasons for a slow reaction include that the resolution authority fears allegations of triggering the bank's problems in the first place, or that formal protocols and information processing constraints delay

[8]As Khan, Ryan, and Varma (2019) point out: "Unlike largely predetermined amortized cost measurement, recurring fair value measurement requires firms to invest in information and control systems to assess relevant economic conditions and estimate fair values quarterly." (Khan et al., 2019, p. 285).

[9]We show in Section 7 that short-term debt is always preferred to long-term debt. Short-term debt is equivalent to a complete contract that conditions the repayment on all available information in period 1 as long as repayments are restricted to be monotonic in R.

[10]A possible interpretation is that issuing additional retail deposits is too costly for the bank and therefore not optimal.

[11]This seniority rule reflects standard practice in most countries. For example, in the United States, uninsured claims are treated as junior in bank resolution (Kroszner and Melick, 2008).

[12]Our results do not change if the bank finances maturing wholesale debt by raising external equity in period 1 instead of rolling over wholesale debt.

[13]Banks can also dilute the claims of insured depositors through payouts to equity (e.g., by paying dividends or through share repurchases). However, regulators often constrain payouts to equity, while they do not constrain the withdrawal of maturing short-term debt or deposits.

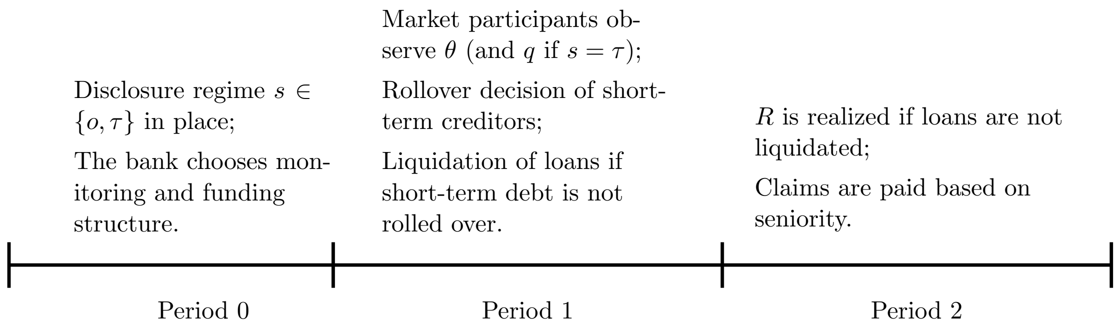


Figure 1: Sequence of Events

regulatory intervention.[14] However, we assume that the resolution authority does react after wholesale debt has been withdrawn in period 1 by closing the bank and enforcing a complete liquidation of the bank's loan portfolio. This assumption is not critical for our main results. We discuss the effects of a resolution authority that does not close the bank in period 1 if the bank does not roll over its wholesale debt in Section 7.

The loan portfolio can be sold at its fundamental value in period 1, equal to the loans' expected cash flow (given all available information at the time of the sale). Again, the assumption is not critical and our results hold in the presence of liquidation costs as long as the liquidation proceeds are sufficiently high to repay maturing wholesale debt.

Assumption 2. *The repayment of the bank's loan portfolio satisfies:*

$$q_b \mathbf{E}[R|\alpha_h] + (1 - q_b)\underline{R} > 1 \quad \textit{and} \quad 1 - \delta < \underline{R} < \delta.$$

Assumption 2 has three components, which simplify the exposition of the model and are without loss of generality. First, the expected repayment of a bad bank's loan portfolio exceeds the initial investment. This assumption allows to focus on cases where funding the loan portfolio is always feasible and optimal, regardless of the bank's monitoring effort. Second, the lowest possible loan repayment, $\underline{R}$, is insufficient to repay δ to retail deposits. This assumption implies that the bank cannot issue risk-free wholesale debt maturing in period 2. Third, $1 - \delta < \underline{R}$ implies that the value of the loan portfolio never falls below the bank's funding need net of retail deposits. Thus, the bank can always repay up to $1 - \delta$ by selling loans in period 1.

The sequence of events is summarized in Figure 1.

3 Market discipline with fixed leverage

In this section, we take the amount of wholesale debt D as given and discuss the effect of bank disclosures on bank monitoring.

[14] An overview of the timing of bank closure and resolution processes is provided in FDIC (2019).

The bank chooses its monitoring effort in period 0 to maximize its expected profit. The expected profit depends on whether the bank can roll over its wholesale debt in period 1 and the face value of rolled over debt D_2.

Rolling over debt. In period 1, the bank can either roll over maturing wholesale debt or repay it by selling loans. Thus, wholesale debt maturing in period 1 is risk free as long as the proceeds from selling loans are sufficiently high, which is the case given Assumption 2. Competition ensures that wholesale creditors' period 0 participation constraint binds and $D_1 = D$.

In contrast, wholesale debt that the bank rolls over is risky since wholesale debt receives a positive payment only if $R > \delta$. The ability to roll over wholesale debt and the required repayment D_2 depend on the state θ and the market's period 1 conjecture about the probability that the bank has a high quality loan portfolio, which we denote by q^e. Absent bank disclosures, $q^e = \mathbf{E}[q|e]$, which is the probability that the bank has a high quality loan portfolio given market participants' rational beliefs about the bank's monitoring effort. With bank disclosure, market participants know the bank's type and $q^e \in \{q_b, q_g\}$.

To roll over wholesale debt in period 1, the bank has to offer wholesale creditors a face value D_2 that satisfies:

$$q^e \min\{R - \delta, D_2\} \geq D. \tag{1}$$

Thus, the bank's ability to roll over its wholesale debt in period 1 can be expressed as an indicator function:

$$\Phi(q^e, R) = \begin{cases} 1 & \text{if } R \geq \hat{R}(q^e) \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

where $\hat{R}(q^e) = \delta + D/q^e$. Competition ensures that wholesale creditors' period 1 participation constraint (1) binds when $R \geq \hat{R}(q^e)$, implying that $D_2 = D/q^e$.

The bank always rolls over its wholesale debt if it is feasible to do so. The reason is that rolling over wholesale debt in period 1 keeps the default put option of deposit insurance alive, which increases the bank's profit in high payoff states. If the bank does not roll over its wholesale debt, the resolution authority enforces a complete liquidation of the loan portfolio. In this case, the bank only receives a positive payoff if the liquidation value of its loan portfolio exceeds insured depositors' claims. Not rolling over wholesale debt therefore reduces the bank's expected profit. Thus, the bank always rolls over its wholesale debt if it is able to do so, and the resolution authority closes down the bank in period 1 otherwise.

The effect of bank disclosure on monitoring. The bank's expected profit is:

$$\Pi(e, D_2) = \mathbf{E}\left[q \int_{\underline{R}}^{\overline{R}} \Phi(q^e, R) \max\{R - \delta - D_2, 0\} dF(R) \middle| e \right] - E - c(e), \tag{3}$$

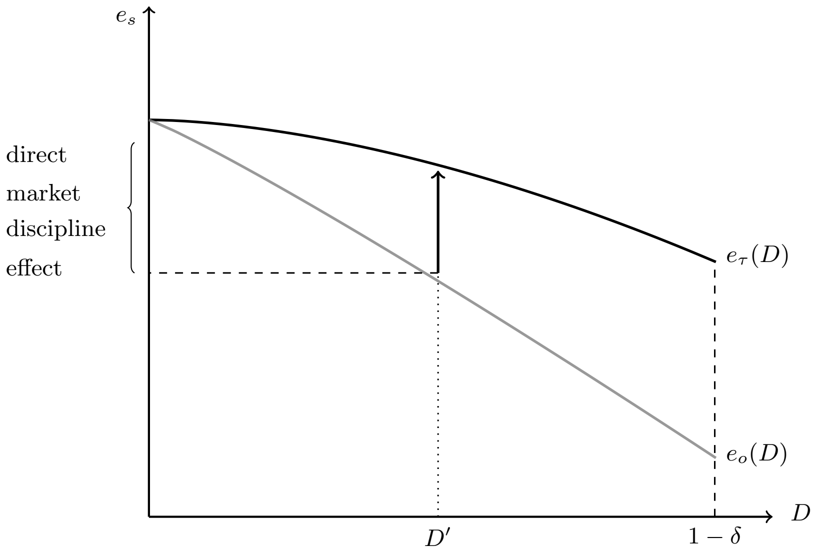


Figure 2: The effect of bank disclosures on monitoring effort. The black (gray) line shows the optimal monitoring effort with (without) bank disclosures. For a given debt level D', disclosure of bank-specific information increases the bank's effort.

which equals the expected cash flow to equity, net of the initial equity investment and the costs of monitoring. The bank chooses its monitoring effort, e, and debt face values, D_1 and D_2, in order to maximize its expected profit subject to wholesale creditors' participation constraints in period 1 and 2.

Proposition 1. *Given $D > 0$, bank disclosures strictly increase the bank's monitoring effort.*

Proposition 1 reflects the standard market disciplining effect of bank disclosures. In the absence of disclosure, debt financing subjects the bank to a debt-overhang problem that reduces its monitoring incentives (Jensen and Meckling, 1976). Disclosure introduces market discipline by making D_2 sensitive to the bank's type. In particular, a bad bank has to pay wholesale creditors a higher face value when rolling over its wholesale debt than a good bank. This adjustment in the face value of wholesale debt disciplines the bank by increasing the profit if it is a good type compared to a bad type, leading the bank to monitor more.

Figure 2 illustrates Proposition 1. It plots the bank's optimal monitoring effort with and without bank disclosure against the level of wholesale debt. Monitoring with disclosures, $e_\tau(D)$, is higher than without disclosures, $e_o(D)$. Thus, the direct effect of market discipline leads the bank to increase its monitoring effort for any debt level $D' > 0$.

4 The leverage effect of market discipline

In the previous section, we treated the amount of wholesale debt as fixed. The fixed leverage case may, for example, be relevant if the bank's regulatory capital constraint is binding absent bank disclosures so that the bank cannot increase its leverage in the presence of disclosures. In practice, most banks' regulatory capital constraint is not binding as banks hold capital in excess of the regulatory minimum (Dagher, Dell'Ariccia, Laeven, Ratnovski, and Tong, 2016, 2020). Thus, banks can change their debt levels, i.e., change the capital buffer they hold.

In addition to its monitoring effort, the bank now chooses the mix of wholesale debt D and equity E in period 0 to maximize its expected profit. The bank takes into account the effect of its leverage decision on its monitoring incentives. The bank also takes into account how its leverage decision affects its refinancing conditions in period 1, including its ability to roll over wholesale debt. Formally, the bank chooses e, E, D and debt face values, D_1 and D_2, solving the following optimization problem:

$$
\begin{aligned}
&\max_{e,E,D,D_1,D_2} \Pi(e, D_2) && \\
\text{s. t.}\quad & e = \arg\max_{e'} \Pi(e', E, D_2) && (4)\\
& D_1 = D && (5)\\
& D_2 = D/q^e \;\text{ if } R \geq \hat{R}(q^e) && (6)\\
& E = 1 - \delta - D && (7)\\
& \Pi(e, D_2) \geq 0 && (8)
\end{aligned}
$$

Equation 4 is the bank's incentive compatibility constraint, which pins down the bank's optimal monitoring effort. Equation 5 and Equation 6 are wholesale creditors' participation constraints in period 0 and 1, respectively. Equation 7 is the bank's funding constraint, which states that the difference between the bank's funding need and its total debt issuance (retail deposits plus wholesale debt) must be covered using equity. Finally, Equation 8 requires the bank's expected profit to be non-negative so that the bank is willing to finance the loan portfolio.

No bank disclosures. We begin by characterizing the bank's optimal leverage decision in the absence of bank disclosures.

Proposition 2. *Without bank disclosures, the bank chooses the maximal amount of retail deposits and a strictly positive level of wholesale debt* $D^*_\tau \in (0, 1-\delta]$.

The difference between retail deposits and wholesale debt is that retail deposits are insured at favorable terms that do not reflect the bank's true risk. For this reason, the bank always takes on the maximum amount of retail deposits. In contrast, wholesale debt is not insured and the bank has to compensate wholesale creditors for the risk that it defaults in period 2.

As discussed in Section 3, the absence of bank-specific information implies that wholesale debt financing subjects the bank to a debt overhang problem that reduces its monitoring incentives. Wholesale creditors form rational expectations about the bank's monitoring effort in equilibrium and equity bears the cost of reduced monitoring effort through a higher face value of wholesale debt. We refer to this increase in the face value of wholesale debt as the *agency costs* of wholesale debt.

Notwithstanding the agency costs of wholesale debt, the bank chooses a positive level of wholesale debt in the absence of bank disclosures. The benefit is that the bank can liquidate loans to repay wholesale debt instead of rolling it over if θ is sufficiently low. Rolling over wholesale debt only if $R \geq \hat{R}(q^e)$ reduces the risk borne by wholesale creditors in period 2. Absent withdrawals (e.g., in the case of long-term debt), the bank has to compensate wholesale creditors for the risk that it defaults in low payoff states where $R < \hat{R}(q^e)$. Repaying wholesale debt in period 1 given $R < \hat{R}(q^e)$ therefore increases the payments to wholesale creditors in low payoff states, which allows the bank to reduce the face value of wholesale debt if it is rolled over. The cost is borne by the deposit insurance fund as the payments to insured depositors decreases. Thus, we refer to the reduction in the face value of wholesale debt as the *dilution benefits* of short-term debt.

The profit-maximizing level of wholesale debt in the absence of bank disclosures trades off the agency costs and dilution benefits of wholesale debt financing. Formally:

$$\Pi_o'(D) \;=\; \underbrace{F(\hat{R}(\mathbf{E}[q|e_o]))}_{\text{marginal dilution benefits}} \;+\; \underbrace{(1 - F(\hat{R}(\mathbf{E}[q|e_o])))D\left(\frac{p\Delta q}{\mathbf{E}[q|e_o]}\right)\frac{\partial e_o}{\partial D}}_{\text{marginal agency costs}} \;\geq\; 0, \tag{9}$$

where e_o denotes the bank's optimal monitoring effort in the absence of bank disclosures. The marginal agency costs reflect the decline in expected profit caused by a reduction in monitoring from increasing D. Wholesale creditors anticipate this reduction in monitoring, which leads them to demand a higher repayment D_2. The marginal dilution benefits reflect the reduction in D_2 due to wholesale creditors circumventing the seniority of insured depositors in low payoff states. If the marginal agency costs are sufficiently high compared to the marginal dilution benefits, the bank chooses a mix of equity and debt financing. Otherwise, if the marginal agency costs are low, the bank chooses maximum debt and does not use equity.

The effect of bank disclosures on leverage. Bank disclosures resolve the debt-overhang problem of wholesale debt financing. As a result, bank disclosures affect the bank's optimal leverage decision.

Proposition 3. *With bank disclosures, the bank chooses the maximal amount of retail deposits and finances the rest of its loan portfolio using wholesale debt:* $D_\tau^* = 1 - \delta$.

Eliminating the agency costs of wholesale debt leads the bank to increase its leverage in order to maximize the dilution benefits. The marginal value of wholesale debt on the bank's expected profit with bank disclosures is:

$$\Pi'_\tau(D) = \underbrace{p(e_\tau)F(\hat{R}(q_g)) + (1-p(e_\tau))F(\hat{R}(q_b))}_{\text{marginal dilution benefits}} > 0, \tag{10}$$

where e_τ denotes the bank's optimal monitoring effort with bank disclosures. In contrast to the case without bank disclosures (*cf.,* Equation 9), equity owners bear no agency costs if they issue wholesale debt, reflecting the direct effect of market discipline. Thus, only the positive dilution benefits remain and the bank issues as much short-term debt as possible net of retail deposits.

5 The leverage effect and bank monitoring

Taken together, Propositions 1 and 3 summarize the two different effects of bank disclosures. On the one hand, disclosing bank-specific information increases the bank's monitoring effort for a given level of D. On the other hand, the very fact that market discipline reduces the agency costs of debt incentivizes the bank to increase its leverage in order to maximize the dilution benefits of short-term debt financing.

Lemma 1. *The bank's monitoring effort decreases in D, regardless of whether or not bank-specific information is disclosed.*

If bank-specific information is not disclosed, increasing leverage reduces monitoring since it exacerbates the bank's debt overhang problem. The bank's monitoring effort also decreases in D if bank-specific information is disclosed, even though there are no agency costs of wholesale debt. The reason is that the dilution benefits of short-term debt create an externality which distorts the bank's monitoring incentives. Since a good bank is more likely to roll over its wholesale debt than a bad bank, i.e., $\hat{R}(q_g) < \hat{R}(q_b)$, the wealth transfer implied by the dilution of insured deposits is greater for a bad bank than a good bank. This wedge in dilution benefits decreases the difference between a good and a bad bank's expected profit, which in turn reduces the bank's monitoring effort for a given level of D. Since the wedge in dilution benefits between a bad bank and good bank increases in D, higher leverage leads the bank to monitor less.

Because of the negative effect of leverage on monitoring, increasing market discipline through bank disclosures can decrease the bank's monitoring effort if the bank optimally chooses its leverage.

Proposition 4. *There exists a threshold debt value $\bar{D} \in (0, 1-\delta)$ such that:*

$$e_\tau(1-\delta) < e_o(D^*_o) \quad \textit{if and only if} \quad D^*_o < \bar{D}.$$

Proposition 4 states that market discipline reduces the bank's monitoring effort whenever the optimal level of wholesale debt without bank disclosures is below the threshold $\bar{D}$. In this case, the negative effect of higher leverage on bank monitoring dominates the direct market disciplining effect of bank disclosures. The threshold value $\bar{D}$ corresponds to the wholesale debt level at which the bank's optimal effort without disclosures equals the optimal effort with bank disclosures given maximum leverage: i.e., $\bar{D}$ satisfies $e_\tau(1-\delta) = e_o(\bar{D})$. Thus, for $D_o^* = \bar{D}$, the direct effect and the leverage effect of market discipline fully offset each other.

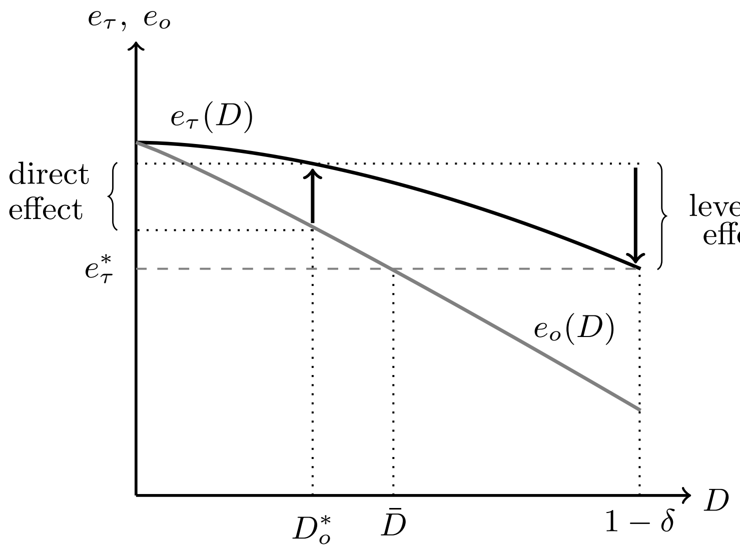


Figure 3: Monitoring effort without bank disclosures (e_o) and with bank disclosures (e_τ) as a function of the level of wholesale debt (D). The figure shows the case where $D_o^* < \bar{D}$: the leverage effect dominates the direct effect of market discipline and disclosures reduce monitoring effort.

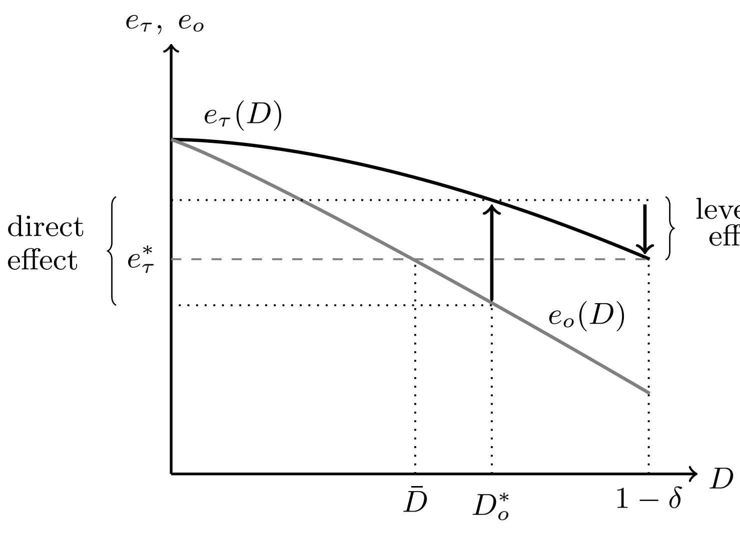


Figure 4: Monitoring effort without bank disclosures (e_o) and with bank disclosures (e_τ) as a function of the level of wholesale debt (D). The figure shows the case where $\bar{D} < D_o^*$: the direct effect of market discipline dominates the leverage effect and disclosures increase monitoring effort.

Figures 3 and 4 illustrate the two offsetting effects of market discipline on bank monitoring. The black (gray) lines depict the bank's optimal monitoring effort with (without) bank disclosures as a function of D. Because of the direct effect of market discipline (*cf.*, Proposition 1), the effort curve with disclosures, $e_\tau(D)$, is strictly higher than the effort curve without disclosures, $e_o(D)$, for any $D > 0$. The two effort curves are downward slopping, reflecting that the bank's monitoring effort decreases in D (*cf.*, Lemma 1). The critical threshold $\bar{D}$ is determined by the intersection of $e_\tau(1-\delta)$ (the gray dashed line) and $e_o(D)$. The direct effect of market discipline corresponds to the increase in monitoring due to bank disclosures for given D_o^*. The leverage effect of market discipline corresponds to the decrease in monitoring due to the increase in wholesale debt from D_o^* to $D_\tau^* = 1-\delta$.

Figure 3 illustrates the case where $D_o^* < \bar{D}$. In this case, the direct effect of market discipline is smaller than the leverage effect, and disclosing bank-specific information reduces the bank's optimal monitoring effort. Figure 4 shows the opposite case where $\bar{D} < D_o^*$. In this case, the direct effect of market discipline exceeds the leverage effect, and disclosing bank-specific information increases the bank's optimal monitoring effort.

6 Retail deposits and market discipline

The total effect of market discipline depends, *inter alia*, on the amount of retail deposits the bank can issue.

Given the bank's optimal leverage choice with and without bank disclosures, the total effect of market discipline can be written as:

$$\mathcal{M} = e_\tau(1-\delta) - e_o(D_o^*).$$

Totally differentiating this condition with respect to δ yields:

$$\frac{d\mathcal{M}}{d\delta} = \underbrace{\left(\frac{\partial e_\tau(1-\delta)}{\partial \delta} - \frac{\partial e_\tau(1-\delta)}{\partial D}\right)}_{\gtrless 0} - \underbrace{\left(\frac{\partial e_o(D_o^*)}{\partial \delta} + \frac{\partial e_o(D_o^*)}{\partial D}\frac{dD_o^*}{d\delta}\right)}_{<0} \tag{11}$$

The first (second) term of condition (11) measures the total effect of changing δ on monitoring effort with (without) bank disclosures. For a given D, increasing δ aggravates the bank's debt overhang problem and reduces its monitoring incentives, regardless of whether bank-specific information is disclosed: i.e., $\partial e_i/\partial\delta < 0$ for all $i \in \{o, \tau\}$.

Changing δ also changes the optimal level of D. Absent bank disclosure, the optimal level of D can increase or decrease in δ, but the bank's total debt $D_o^* + \delta$ is strictly increasing in δ whenever $D_o^* < 1-\delta$. As a consequence, increasing the amount of insured deposits unambiguously lowers the bank's monitoring effort absent bank disclosures. In contrast, with bank disclosures, the total effect of changing δ on monitoring effort is ambiguous. The reason is that the bank chooses the maximum amount of debt, so that increasing δ leads to a one-for-one reduction in the level of wholesale debt since

$D_\tau^* = 1 - \delta$. Reducing D_τ^* lowers the dilution benefits, and this reduction is larger for a bad bank than for a good bank. Thus, increasing δ reduces the negative externality implied by the dilution of insured deposits and increases monitoring. This positive effect on monitoring can dominate the negative effect of a higher δ on monitoring. As a consequence, with bank disclosures, a higher amount of insured deposits can increase or decrease the bank's monitoring effort.

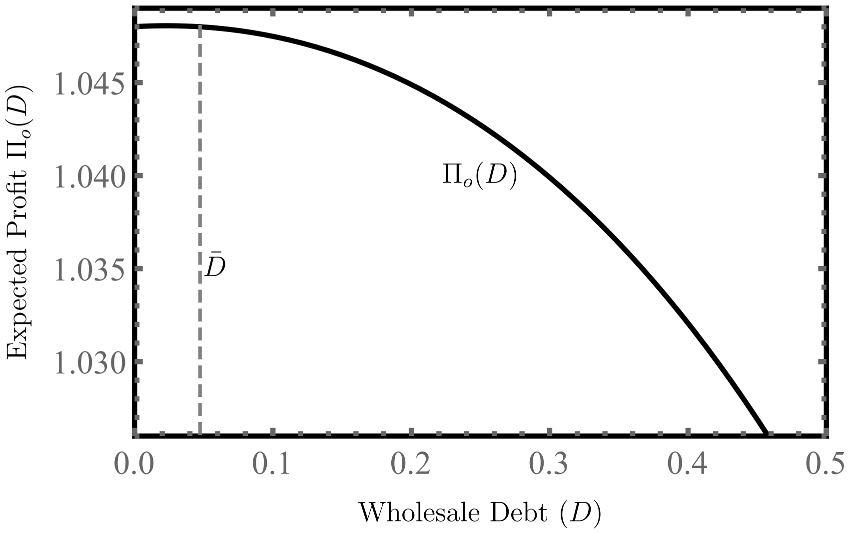
Proposition 5. *The total effect of market discipline increases in the amount of insured deposits, i.e., $d\mathcal{M}/d\delta > 0$, if:*

$$F(\hat{R}(q_b)) - F(\hat{R}(q_g)) > q_g(1 - F(\hat{R}(q_g)) - q_b(1 - F(\hat{R}(q_b)) \tag{12}$$

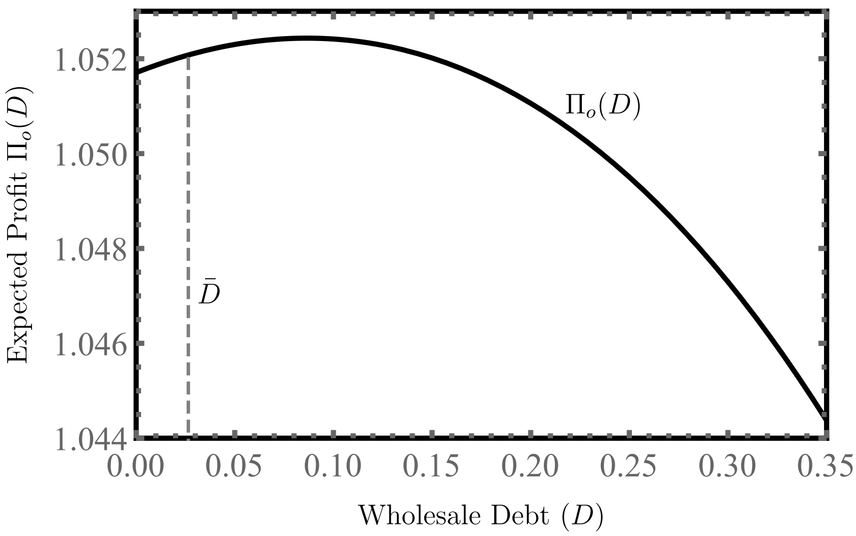
The left-hand side of condition (12) is the difference in the probability that wholesale debt is not rolled over if $q^e = q_b$ instead of q_g when bank-specific information is disclosed. It measures the reduction in the negative externality from the dilution of insured deposits following a marginal increase in δ. The right-hand side is the difference in the probability of not defaulting between a good bank and a bad bank. It captures the additional debt overhang caused by a marginal increase in δ. If (12) holds, then a higher δ unambiguously increases monitoring effort with disclosures and decreases monitoring without disclosures, thus strengthening the direct effect of market discipline relative to the leverage effect.[15]

We illustrate the effect of an increase in δ with a numerical example. Figure 5 plots the bank's expected profits without disclosures against wholesale debt. In Panel (a), the share of retail deposits equals $\delta = 0.55$. The threshold $\bar{D}$ lies strictly to the right of the peak of the profit function, implying that $D_o^* < \bar{D}$. In this case, the leverage effect dominates the direct market discipline effect and the disclosure of bank-specific information reduces the bank's monitoring effort. Increasing the level of retail deposits from $\delta = 0.55$ to $\delta = 0.65$ in Panel (b) shifts D_o^* to the right while it lowers $\bar{D}$. In this example, the direct effect of market discipline dominates the leverage effect and the disclosure of bank-specific information increases the bank's monitoring effort.

[15] (12) is a sufficient, but not necessary, condition for $d\mathcal{M}/d\delta > 0$.



(a) Case $D_o^* < \bar{D}$: Retail deposits $\delta = 0.55$, leverage effect dominates direct market discipline effect.



(b) Case $\bar{D} < D_o^*$: Retail deposits $\delta = 0.65$, direct market discipline effect dominates leverage effect.

Figure 5: Change in retail deposits. Numerical example using truncated normal distribution for loan repayment R with support $[0.5, 4.5]$. The parameters of the underlying normal distribution are $\sigma = 2$ and $\mu = 3.5$. The truncated distribution has a mean of 2.8 and variance of 1.12. Other parameter values are $p = 0.5$, $c = 0.4$, $q_g = 1$, $q_b = 0.65$.

7 Discussion and Extensions

In this section, we discuss our model's implications and some extensions to highlight the robustness of our key results.

The social value of information. We can rank the different disclosure regimes in terms of aggregate surplus by comparing their effect on monitoring. Since liquidating the loan portfolio does not generate a deadweight loss, information affects aggregate surplus only insofar as it changes the bank's monitoring effort. Hence, due to the offsetting effects of market discipline on the bank's monitoring incentives, disclosing bank-specific information can either increase or decrease aggregate surplus.

The social cost of information in our model differs from other models that emphasize how transparency either reduces risk-sharing (so-called *Hirshleifer effects*) or aggravates coordination failures. In our model, disclosures benefit the bank's shareholders by reducing the agency costs of wholesale debt and allowing the bank to maximize the dilution benefits of short-term debt financing. However, it comes at the cost of exerting a negative externality on the deposit insurance fund which distorts the bank's monitoring incentives. Whether disclosing information about the quality of the bank's loan portfolio increases or decreases aggregate surplus depends on how much the bank increases its leverage in response to such disclosures (*cf.,* Proposition 4).

Interaction between disclosure requirements and capital regulation. The result that disclosing bank-specific information can either increase or decrease monitoring effort, and hence the riskiness of the bank's loan portfolio, points to an interesting interaction between disclosure policy and capital regulation. In particular, it can be optimal to complement disclosures with higher regulatory capital constraint to prevent banks from increasing their leverage.[16] This result is captured by Proposition 1, which shows that if the bank cannot increase its leverage in response to increased market discipline, bank disclosures unambiguously increase monitoring effort.

Taxing away the dilution benefits. The negative effect of bank disclosures caused by the dilution of insured deposits can be addressed by taxing short-term wholesale debt. Such a Pigovian tax can be implemented by requiring the bank to pay a deposit insurance premium that depends on its leverage and its disclosed type.

Proposition 6. *Any tax schedule $T(D,q,R)$ satisfying the bank's limited liability constraint, $T(D,q,R) \le \max\{R-\delta-D/q, 0\}$, such that*

$$q\int_{\hat{R}(q)}^{\overline{R}} T(D,q,R)dF(R) = F(\delta)D + \int_{\delta}^{\hat{R}(q)} (D - q(R-\delta))dF(R), \quad \forall q \in \{q_g, q_b\} \tag{13}$$

[16]Since the opportunity cost of wholesale debt and equity are equal, policies that restrict the bank's use of wholesale debt unambiguously increase aggregate surplus in our model. In a more general setting where the opportunity cost would differ (e.g., due to a liquidity premium investors ascribe to safe short-term debt), full equity financing would no longer necessarily maximize aggregate surplus.

eliminates the dilution benefit of short-term wholesale debt.

The Pigovian tax is paid when $R > \hat{R}(q)$ and set such that the bank's expected tax payment (the left-hand side of Equation 13) equals the dilution benefits of short-term debt (the right-hand side of Equation 13). Since a bad bank is less likely to roll over its wholesale debt than a good bank, the dilution benefits are decreasing in the bank's type. As a consequence, the expected tax payment is greater for a bad bank than a good bank. The expected tax payment also increases if the bank issues more short-term debt since the dilution benefits are increasing in D.

Given the tax schedule in Proposition 6, the bank no longer benefits from the dilution of insured deposits if it issues short-term debt. With bank disclosures, the absence of both agency costs and dilution benefits implies that the bank's expected profit is unaffected by how it finances its loan portfolio net of retail deposits. That is, issuing any amount of wholesale debt $D \in [0, 1-\delta]$ is optimal for the bank.[17] Regardless of its level of wholesale debt, the bank's monitoring effort always corresponds to the optimal monitoring effort without wholesale debt, i.e., $e_\tau(0)$, since the tax eliminates the negative externality caused by the dilution of insured deposits.

The result that the negative leverage effect of bank disclosures can be eliminated by penalizing the issuance of short-term debt is in line with recent reforms of deposit insurance schemes. For example, the Dodd-Frank Act in the United States required the Federal Deposit Insurance Corporation (FDIC) to revise its methodology for calculating risk-based premiums. The reform required the FDIC to broaden its definition of the "assessment base" from domestic deposits to average consolidated total assets minus average tangible equity (FDIC, 2020). A consequence of this revision, and the accompanying change in "assessment rates", is that the total burden of assessments has shifted from smaller banks to larger banks that rely more on short-term wholesale funding (Kreicher, McCauley, and McGuire, 2013).

Long-term debt. Our model focused on the issuance of short-term wholesale debt. Short-term debt financing is always preferred to long-term debt. To see this formally, consider the participation constraint for long-term debt with a fixed repayment obligation B in period 2:

$$\mathbf{E}[q|e] \int_{\underline{R}}^{\overline{R}} \min\{R - \delta, B\} dF(R) \geq D. \tag{14}$$

Given the seniority of retail deposits and the assumption that $\delta > \underline{R}$, wholesale creditors receive no payment in period 2 if the bank has a low quality loan portfolio. Otherwise, if the bank has a high quality loan portfolio, wholesale creditors either receive the face value B or the bank's residual cash flow net of the payment made to retail depositors.

Proposition 7. *The bank never issues any long-term debt.*

Since long-term debt cannot be withdrawn in period 1, it cannot be used to dilute insured deposits. However, because the face value of long-term debt does not depend on

[17] Without bank disclosures, the presence of agency costs would lead the bank to never issue short-term debt if the dilution benefits are taxed away.

the bank's type (regardless of whether bank-specific information is disclosed), long-term debt financing worsens the bank's debt overhang problem and generates agency costs. As a consequence, it is never optimal for the bank to issue long-term debt.[18]

Passive resolution authority. In the main part of the paper, we assumed a resolution authority that liquidates the bank in period 1 if the bank does not roll over its wholesale debt. As a result, the bank was always better off rolling over its wholesale debt if it could. We now consider a resolution authority that never liquidates the bank in period 1. Under such a "passive resolution authority," the bank can continue operating even if it does not roll over its wholesale debt in period 1. We maintain the assumption that the bank does not know its type in the absence of bank disclosures.

Proposition 8. *Given a passive resolution authority, the bank never rolls over wholesale debt in period* 1 *and the dilution benefits of short-term wholesale debt financing are larger.*

Under a passive resolution authority, the bank's expected profit is unambiguously higher if it repays outstanding short-term debt in period 1 rather than rolling it over until period 2. The reason is that, because wholesale debt is junior to retail deposits in resolution in period 2, the bank has to compensate wholesale creditors for the risk that it defaults if it rolls over its debt. If the bank instead repays its entire wholesale debt by selling part of its loan portfolio in period 1, the bank benefits from cash flows that would otherwise accrue to the deposit insurance fund in case the bank defaults. Selling loans to repay debt therefore allows the bank to exploit the dilution benefits of short-term debt to an even greater extent compared to the case where the resolution authority closes down the bank if it does not roll over its debt.

8 Conclusion

Market discipline is generally viewed as a way to rein in banks' risk-taking incentives. We challenge this view by identifying a novel, adverse effect of market discipline. The disclosure of bank-specific information (i.e., increasing market discipline) reduces the agency costs of uninsured short-term debt and leads banks to increase their leverage, which in turn reduces banks' incentives to monitor loans. The negative leverage effect stems from banks' use of uninsured short-term debt to circumvent the seniority of insured deposits. By selling loans to repay maturing wholesale debt rather than rolling it over when economic conditions deteriorate, banks dilute insured deposits. Issuing uninsured short-term debt therefore ratchets up the subsidy provided by deposit insurance and incentivizes banks to increase the riskiness of their loan portfolios. As a result, the total effect of providing market discipline through bank disclosures is ambiguous and banks may monitor less and take on more risk when market discipline increases.

[18] If the bank could issue state-contingent long-term debt whose repayment depends on its disclosed type (e.g., by using covenants), bank disclosures would eliminate the agency costs and the bank would be indifferent about how it finances its loan portfolio net of retail deposits.

Appendix

In what follows, we suppress the arguments in the repayment thresholds for simplicity and instead write:

$$\hat{R}_g \equiv \hat{R}(q_g), \quad \hat{R}_o \equiv \hat{R}(\mathbf{E}[q|e]), \quad \hat{R}_b \equiv \hat{R}(q_b).$$

Moreover, when $\hat{R}_o$ is evaluated at the optimal debt level D_o^*, we write $\hat{R}_o^* = \hat{R}(\mathbf{E}[q|e_o(D_o^*)]$.

Proof of Proposition 1. For given $D > 0$, the bank's optimization problem is:

$$\begin{aligned} &\max_{e,D_1,D_2} \Pi_o(e, D_2) \\ \text{s.t.} \quad & e = \arg\max_{e'} \Pi_o(e', D_2) \\ & D_1 = D \\ & D_2 = D/q^e \ \text{ if } R \geq \hat{R}(q^e) \end{aligned}$$

No bank disclosures. The bank rolls over its debt for $R \geq \hat{R}(q^e)$. The first-order condition for effort is

$$\frac{\partial \Pi_o}{\partial e} = p\Delta q \int_{\hat{R}(q^e)}^{\overline{R}} (R - \delta - D_2) dF(R) - ce = 0. \tag{A1}$$

Substituting $D_2 = \frac{D}{q^e}$ into the first-order condition (A1) and imposing rational expectations, $q^e = \mathbf{E}[q|e]$, implicitly defines the bank's effort choice, e_o:

$$\psi(e) \equiv e - \frac{p\Delta q}{c} \int_{\hat{R}_o}^{\overline{R}} \left(R - \delta - \frac{D}{\mathbf{E}[q|e]} \right) dF(R) = 0 \tag{A2}$$

The following auxiliary lemma shows that the bank's effort choice is well-defined.

Lemma A1. *Equation A2 has a unique solution, $e_o = e_o(D)$, which is strictly decreasing in D, $\frac{\partial e_o}{\partial D} < 0$.*

Proof of Lemma A1. We first show existence of a solution e_o to Equation A2. The bank can choose effort levels in $[0, 1/p]$. Note that Assumption 2 implies $\psi(0) < 0$ and

$$\psi(1/p) = \frac{1}{cp} \left(c - p^2 \Delta q \int_{\hat{R}_o}^{\overline{R}} \left(R - \hat{R}(\mathbf{E}[q|1/p]) \right) \right) > 0.$$

Since $\psi(e)$ is continuous in e, a solution to $\psi(e) = 0$ exists by the intermediate value theorem. For uniqueness, we show that $\psi(e)$ is monotonic in e. We have

$$\psi'(e) = 1 - \gamma(D),$$

where we define

$$\gamma(D) \equiv \frac{1}{c} \left(\frac{p\Delta q}{\mathbf{E}[q|e_o]} \right)^2 (1 - F(\hat{R}_o))D.$$

We show that $\psi'(e) > 0$ by showing that $\gamma(D) \in (0, 1)$. Note that

$$\left(\frac{p\Delta q}{\mathbf{E}[q|e]} \right)^2 D < \frac{p^2 \Delta q}{q_b}(1 - \delta) < \frac{c(1-\delta)}{q_b \Delta R},$$

where the first inequality follows because $\Delta q < q_b < \mathbf{E}[q|e]$ (by Assumption 1) and $D < 1 - \delta$ (by Assumption 2); the second inequality follows from Assumption 2 since $c > p^2 \Delta q \Delta R$. Because, by

Assumption 2, $q_b \Delta R + \underline{R} > 1$ and $\delta > \underline{R}$, it follows that $\frac{1-\delta}{q_b \Delta R} < 1$. Thus,

$$c > \left(\frac{p\Delta q}{\mathbf{E}[q|e]}\right)^2 D.$$

Because $1 - F(\cdot) < 1$, we have:

$$\gamma(D) \equiv \frac{D}{c}(1 - F(\hat{R}_o)) \left(\frac{p\Delta q}{\mathbf{E}[q|e]}\right)^2 < 1,$$

implying that $\psi'(e) > 0$. This establishes uniqueness of e_o.

Applying the implicit function theorem to $\psi(e) = 0$ yields:

$$\frac{\partial e_o}{\partial D} = -\frac{\frac{p\Delta q}{\mathbf{E}[q|e_o]}(1 - F(\hat{R}_o))}{c(1 - \gamma(D))} < 0, \tag{A3}$$

□

Bank disclosures. If the bank-specific signal is disclosed, the bank's problem is the same as above, except for the face value of wholesale debt in $t = 1$ which now reflects the bank's true type: i.e., $D_2(q) = \frac{D}{q}$ for $q \in \{q_g, q_b\}$. The first-order condition for the bank's optimal effort choice with disclosure is

$$\frac{\partial \Pi_\tau}{\partial e} = p\left(q_g \int_{\hat{R}_g}^{\overline{R}} \left(R - \delta - \frac{D}{q_g}\right) dF(R) - q_b \int_{\hat{R}_b}^{\overline{R}} \left(R - \delta - \frac{D}{q_b}\right) dF(R)\right) - ce = 0.$$

Solving for e yields the bank's optimal effort under disclosure:

$$e_\tau = \frac{p}{c}\left(q_g \int_{\hat{R}_g}^{\overline{R}} \left(R - \delta - \frac{D}{q_g}\right) dF(R) - q_b \int_{\hat{R}_b}^{\overline{R}} \left(R - \delta - \frac{D}{q_b}\right) dF(R)\right) \tag{A4}$$

To show that $e_\tau(D) > e_o(D)$ for $D > 0$, pre-multiply Equations A2 and A4 by c/p and note that $\hat{R}(q_g) < \hat{R}(\mathbf{E}[q|e_o] < \hat{R}(q_b)$ for $D > 0$. The difference in effort levels with and without disclosure satisfies:

$$\begin{aligned} e_\tau - e_o \propto\ & q_g \int_{\hat{R}_g}^{\hat{R}_o} \left(R - \delta - \frac{D}{q_g}\right) dF(R) + q_b \int_{\hat{R}_o}^{\hat{R}_b} \left(R - \delta - \frac{D}{\mathbf{E}[q|e_o]}\right) dF(R) \\ & + q_g \int_{\hat{R}_o}^{\hat{R}_b} \left(\frac{D}{\mathbf{E}[q|e_o]} - \frac{D}{q_g}\right) dF(R) + q_b \int_{\hat{R}_b}^{\overline{R}} \left(\frac{D}{q_b} - \frac{D}{\mathbf{E}[q|e_o]}\right) dF(R) > 0, \end{aligned}$$

where the inequality follows from $q_b < \mathbf{E}[q|e_o] < q_g$. □

Proof of Proposition 2. The bank's expected profit after substituting for the optimal effort choice (A2), the face value $D_2 = \frac{D}{\mathbf{E}[q|e_o]}$, and the bank's funding constraint is:

$$\Pi_o(D) = \mathbf{E}[q|e_o(D)] \int_{\hat{R}_o}^{\overline{R}} \left(R - \delta - \frac{D}{\mathbf{E}[q|e_o(D)]}\right) dF(R) - (1 - \delta - D) - c(e_o(D)).$$

Differentiating the bank's expected profits with respect to D yields:

$$\Pi_o'(D) = \left(p\Delta q \left(\int_{\hat{R}_o}^{\overline{R}} R - \delta - \frac{D}{\mathbf{E}[q|e_o]}\right) dF(R) - ce_\tau\right) + F(\hat{R}_o) + (1 - F(\hat{R}_o))D\frac{p\Delta q}{\mathbf{E}[q|e_o]}\frac{\partial e_o}{\partial D}. \tag{A5}$$

Since effort is optimally chosen, the first-term is equal to zero by the envelope theorem, i.e., $\frac{\partial \Pi_\tau}{\partial e} = 0$.

The first-order condition for debt (A5) can therefore be written as:

$$\Pi_o'(D) = F(\hat{R}_o) + (1 - F(\hat{R}_o))D\frac{p\Delta q}{\mathbf{E}[q|e_o]}\frac{\partial e_o}{\partial D} = \frac{F(\hat{R}_o) - \gamma(D)}{1 - \gamma(D)} \geq 0. \tag{A6}$$

where the second equality follows by using the expression for $\partial e_o/\partial D$ and the definition of $\gamma(D)$.

Equation A6 implies that the bank always issues a positive amount of wholesale debt since $\Pi_o'(0) > 0$ as $\gamma(0) = 0$ and $F(\delta) > 0$. The bank chooses the maximal amount of wholesale debt, $1 - \delta$, whenever $\Pi_\tau'(1-\delta) > 0$. Otherwise, the bank chooses an interior debt level $D_o^* \in (0, 1-\delta)$. An interior maximum D_o^* must satisfy the second-order condition:

$$\begin{aligned}\Pi_\tau''(D_o^*) &= \frac{\left(f(\hat{R})\frac{d\hat{R}_o^*}{dD} - \gamma'(D_o^*)\right) + \gamma'(D_o^*)\Pi_o'(D_o^*)}{(1-\gamma(D_o^*))} \\ &= \frac{\left(f(\hat{R}_o^*)\frac{d\hat{R}_o^*}{dD} - \gamma'(D_o^*)\right)}{(1-\gamma(D_o^*))} < 0,\end{aligned}$$

where the second line follows because at any interior optimum $\Pi_o'(D_o^*) = 0$. Since $\gamma(D) \in (0,1)$ for all D, a necessary and sufficient condition for $\Pi_o''(D_o^*) < 0$ to hold is that the numerator is negative at D_o^*. Substituting $d\hat{R}_o/dD$ into the numerator and evaluating it at $D = D_o^*$ yields:

$$\begin{aligned}&\frac{f(\hat{R}_o^*)}{\mathbf{E}[q|e_o^*]}\left(1 + \frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o^*]}\right)^2 D_o^*\right)^2 - \frac{2}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o^*]}\right)^2 F(\hat{R}_o^*) - \frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o^*]}\right)^2 (1 - F(\hat{R}_o)) \\ &= \frac{f(\hat{R}_o^*)}{\mathbf{E}[q|e_o^*]}\left(\frac{1}{1-F(\hat{R}_o^*)}\right)^2 - \frac{(1+F(\hat{R}_o^*))F(\hat{R}_o^*)}{D_o^*(1-F(\hat{R}_o^*))}\end{aligned} \tag{A7}$$

where we again used in the second line that at $D = D_o^*$ we have $\gamma(D_o^*) = F(\hat{R}_o^*)$. A necessary and sufficient condition for the second-order condition to hold is:

$$\frac{f(\hat{R}_o^*)}{1-F(\hat{R}_o^*)} < F(\hat{R}_o^*)(1+F(\hat{R}_o^*))\left(\frac{\mathbf{E}[q|e_o^*]}{D_o^*}\right), \tag{A8}$$

which says that the hazard rate of the repayment distribution $F(\cdot)$ must be bounded from above.

Finally, by the envelope theorem, observe that maximized profits strictly increase in δ:

$$\frac{d\Pi_o(D_o^*;\delta)}{d\delta} = -\mathbf{E}[q|e_o(D_o^*)](1-F(\hat{R}_o^*)) + 1 > 0.$$

The participation constraint for equity is satisfied by Assumption 2. This is because for any D:

$$\Pi_o\left(e_o(D_o^*), 1-\delta-D_o^*, \frac{D_o^*}{\mathbf{E}[q|e_o(D_o^*)]}\right) \geq \Pi_o\left(e_o(D), 1-\delta-D, \frac{D}{\mathbf{E}[q|e_o(D)]}\right) \geq \Pi_o\left(0, 1-\delta-D, \frac{D}{\mathbf{E}[q|0]}\right) > 0$$

where the last inequality follows from Assumption 2 since we have:

$$\Pi_o\left(0, 1-\delta-D, \frac{D}{\mathbf{E}[q|0]}\right) = q_b\left(\int_{\underline{R}}^{\hat{R}_b}\hat{R}_b dF(R) + \int_{\hat{R}_b}^{\overline{R}} R dF(R)\right) + (1-q_b)\delta - 1 > q_b\mathbf{E}[R] + (1-q_b)\underline{R} - 1 > 0.$$

□

Proof of Proposition 3. With bank disclosures, the bank's expected profit is:

$$\Pi_\tau(e, E, D_2) = peq_g\int_{\hat{R}_g}^{\overline{R}}(R - \delta - D_2(q_g))\,dF(R) + (1-pe)q_b\int_{\hat{R}_b}^{\overline{R}}(R - \delta - D_2(q_b))\,dF(R) - E - c(e).$$

Substituting the optimal effort choice (A4), the face values $D_2(q) = D/q$, and the bank's funding constraint into the profit function yields:

$$\Pi_\tau(D) = pe_\tau(D)q_g \int_{\hat{R}_g}^{\overline{R}} \left(R - \delta - \frac{D}{q_g}\right) dF(R)$$
$$+ (1 - pe_\tau(D))q_b \int_{\hat{R}_b}^{\overline{R}} \left(R - \delta - \frac{D}{q_b}\right) dF(R) - (1 - \delta - D) - c(e_\tau(D)).$$

Differentiating with respect to D and using the envelope theorem $\partial\Pi_\tau/\partial e = 0$ yields:

$$\Pi'_\tau(D) \;=\; pe_\tau(D)F(\hat{R}_g) + (1 - pe_\tau(D))F(\hat{R}_b) > 0.$$

Thus, with bank disclosures the bank optimally chooses the maximal debt level, $\hat{D}^*_\tau = 1 - \delta$. Finally, as in the proof of Proposition 2, maximized bank profits strictly increase in δ and equity's participation constraint is always satisfied by Assumption 2. □

Proof of Lemma 1. That $e'_o(D) < 0$ follows from the proof of Proposition 1. $e_\tau(D)$ is given by (A4). Differentiating $e_\tau(D)$ with respect to D yields:

$$\frac{\partial e_\tau}{\partial D} = -\frac{p}{c}\left(F(\hat{R}_b) - F(\hat{R}_g)\right) < 0,$$

where the inequality follows from $\hat{R}_b > \hat{R}_g$ for all $D > 0$. □

Proof of Proposition 4. We show the existence of a unique critical value $\bar{D}$ such that $e_o(\bar{D}) = e_\tau(1-\delta)$. By Proposition 1, we have $e_o(D) < e_\tau(D)$ for all $D \in (0, 1-\delta]$. Furthermore, e_o and e_τ are continuous and strictly decreasing in D, implying that $e_o(D) \in (e_o(1-\delta), e_o(0))$ and $e_\tau(D) \in (e_\tau(1-\delta), e_\tau(0))$. As $e_o(0) = e_\tau(0)$, by the intermediate value theorem, there exists a critical value $\bar{D}$ such that $e_o(\bar{D}) = e_\tau(1-\delta)$. Since e_o is strictly decreasing in D, $\bar{D}$ is unique. For $D < \bar{D}$, we have $e_o(D) > e_\tau(1-\delta)$ and conversely for $D > \bar{D}$, we have $e_o(D) < e_\tau(1-\delta)$. Thus, whenever $D^*_o < \bar{D}$, the optimal effort without bank disclosures exceeds the optimal effort with bank disclosures. □

Proof of Proposition 5. We first show that

$$\frac{de_o(D^*)}{d\delta} = \frac{\partial e_o}{\partial \delta} + \frac{\partial e^*_o}{\partial D}\frac{dD^*_o}{d\delta} < 0.$$

For $D^*_o < 1-\delta$, applying the implicit function theorem to the first-order condition, $\Pi'_o(D^*_o) = 0$, yields:

$$\frac{dD^*_o}{d\delta} = -\frac{\frac{\partial\Pi'_o(D^*_o)}{\partial\delta}}{\Pi''_o(D^*_o)},$$

where

$$\frac{\partial\Pi'_\rho(D^*_o)}{\partial\delta} = \frac{\left(f(\hat{R}^*_o)\frac{\partial\hat{R}^*_o}{\partial\delta} - \frac{\partial\gamma(D^*_o)}{\partial\delta}\right)}{(1-\gamma(D^*_o))}.$$

We can rewrite the latter equation in terms of the second-order condition, $\Pi''_o(D^*_o)$. Notice that:

$$\frac{\partial\gamma(D_o)}{\partial\delta} = \mathbf{E}[q|e_o]\left(\gamma'(D_o) - \frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o]}\right)^2(1 - F(\hat{R}_o))\right).$$

Notice further that:

$$\frac{\partial\hat{R}_o}{\partial\delta} = \mathbf{E}[q|e_o]\frac{\partial\hat{R}_o}{\partial D}.$$

It follows that we can write:

$$\frac{\partial\Pi'_o(D^*_o)}{\partial\delta} \;=\; \mathbf{E}[q|e^*_o]\Pi''_o(D^*_o) + \mathbf{E}[q|e^*_o]\left(\frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e^*_o]}\right)^2\right),$$

where we have used the fact that at any interior optimum $F(\hat{R}_o^*) = \gamma(D_o^*)$. Thus:

$$\frac{dD_o^*}{d\delta} = -\mathbf{E}[q|e_o^*] - \frac{\mathbf{E}[q|e_o^*]\left(\frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o^*]}\right)^2\right)}{\Pi_o''(D_o^*)} > -1, \tag{A9}$$

where the sign follows from $\Pi_o''(D_o^*) < 0$. Thus, total leverage, $D_o^* + \delta$, increases in δ.

The total effect of δ on e_o^* can then be written as:

$$\frac{de_o^*}{d\delta} = \frac{\partial e_o^*}{\partial \delta} + \frac{\partial e_o^*}{\partial D}\frac{dD_o^*}{d\delta} = \left(\mathbf{E}[q|e_o^*] + \frac{dD_o^*}{d\delta}\right)\frac{\partial e_o^*}{\partial D}, \tag{A10}$$

where we again used $\frac{\partial e_o^*}{\partial \delta} = \mathbf{E}[q|e_o^*]\frac{\partial e_o^*}{\partial D}$. If $D_o^* < 1-\delta$, we can substitute Equation A9 into Equation A10 to obtain:

$$\frac{de_o^*}{d\delta} = -\frac{\mathbf{E}[q|e_o^*]\left(\frac{1}{c}\left(\frac{p\Delta q}{\mathbf{E}[q|e_o^*]}\right)^2\right)}{\Pi_\rho''(D_o^*)}\frac{\partial e_o^*}{\partial D} < 0,$$

where the inequality follows from $\Pi_o''(D_o^*) < 0$ and $\frac{\partial e_o^*}{\partial D} < 0$.

Evaluating Equation A4 at $1-\delta$ and totally differentiating with respect to δ gives the marginal effect of δ on e_τ^*:

$$\frac{de_\tau^*}{d\delta} = \frac{p}{c}\left(-\left(q_g(1-F(\hat{R}_g)) - q_b(1-F(\hat{R}_b))\right) + \left(F(\hat{R}_b) - F(\hat{R}_g)\right)\right) \gtreqless 0.$$

The first term is negative (reflecting the reduction in market discipline) and the second term is positive (reflecting the reduction in dilution benefits). It follows that increasing δ increases the effort level in the presence of bank disclosures if condition (12) is satisfied. □

Proof of Proposition 6. Given the tax schedule (13), the bank's expected profit with disclosures is:

$$\Pi_{\mathcal{T}} = \Pi_\tau - \mathbf{E}\left[q\int_{\hat{R}(q)}^{\overline{R}} T(D,q,R)dF(R)\middle|e\right] = \mathbf{E}\left[q\left(\int_\delta^{\overline{R}}(R-\delta)dF(R) - \frac{D}{q}\right)\middle|e\right] - (1-\delta-D) - c(e),$$

which simplifies to:

$$\Pi_{\mathcal{T}} = \mathbf{E}[q|e]\int_\delta^{\overline{R}}(R-\delta)dF(R) - (1-\delta) - c(e) \tag{A11}$$

Since the bank's expected profit no longer depends on the level of wholesale debt, any debt issuance $D_{\mathcal{T}}^* \in [0, 1-\delta]$ is optimal. Differentiating Equation A11 with respect to e and solving the first-order condition yields the bank's optimal monitoring effort under the tax:

$$e_{\mathcal{T}}^* = \frac{p\Delta q}{c}\int_\delta^{\overline{R}}(R-\delta)dF(R),$$

which corresponds to the bank's optimal monitoring effort without wholesale debt, $e_\tau(0)$. □

Proof of Proposition 7. When debt is long-term, the first-order condition for effort is given by:

$$\frac{\partial \Pi_\ell}{\partial e} = p\Delta q\int_{\hat{R}_\ell}^{\overline{R}}(R-\delta-B)dF(R) - ce = 0,$$

where the repayment threshold satisfies $\hat{R}_\ell = \delta + B$. From the participation constraint for long-term debt (14), it follows that:

$$B = \frac{D - q^e\int_\delta^{\hat{R}_\ell}(R-\delta)dF(R)}{(1-F(\hat{R}_\ell))q^e},$$

which implicitly determines the face value B.[19] Substituting B into the first-order condition for effort and imposing rational expectations, $q^e = \mathbf{E}[q|e]$, yields:

$$p\Delta q \left(\int_{\delta}^{\overline{R}} (R-\delta)dF(R) - \frac{D}{\mathbf{E}[q|e]} \right) - ce \;=\; 0.$$

By the implicit function theorem, the derivative of the optimal effort e_ℓ with respect to D satisfies:

$$\frac{\partial e_\ell}{\partial D} = -\frac{\frac{p\Delta q}{\mathbf{E}[q|e_\ell]}}{c - \left(\frac{p\Delta q}{\mathbf{E}[q|e_o]}\right)^2 D} < 0.$$

The sign follows because the denominator is strictly positive (*cf.* Proof of Lemma A1).

Substituting the optimal effort choice, the face value of long-term wholesale debt and the funding constraint into the bank's expected profit function yields:

$$\Pi_\ell(D) = \mathbf{E}[q|e_\ell(D)] \left(\int_{\delta}^{\overline{R}} (R-\delta)dF(R) - \frac{D}{\mathbf{E}[q|e_\ell(D)]} \right) - (1-\delta-D) - c(e_\ell(D)). \tag{A12}$$

Differentiating with respect to D yields:

$$\Pi'_\ell(D) = \left(p\Delta q \left(\int_{\delta}^{\overline{R}} (R-\delta)dF(R) - \frac{D}{\mathbf{E}[q|e_\ell]} \right) - ce_\ell \right) \frac{\partial e_\ell}{\partial D} + D \left(\frac{p\Delta q}{\mathbf{E}[q|e_\ell]} \right) \frac{\partial e_\ell}{\partial D}. \tag{A13}$$

The first-term is equal to zero by the envelope theorem and the optimality of the effort choice: $\frac{\partial \Pi_\ell}{\partial e} = 0$. The first-order condition for long-term debt (A13) therefore simplifies to:

$$\Pi'_\ell(D) \;=\; D \left(\frac{p\Delta q}{\mathbf{E}[q|e_\ell]} \right) \frac{\partial e_\ell}{\partial D} < 0.$$

Since the bank's expected profits $\Pi_\ell(D)$ are strictly decreasing in D, the bank optimally chooses $D^*_\ell = 0$. □

Proof of Proposition 8. Denote by $V_s = \mathbf{E}[q|e_u]\mathbf{E}[R|\alpha_h] + (1-\mathbf{E}[q|e_u])\underline{R}$ the expected value of the bank's loan portfolio in period 1 for $s \in \{o, \tau\}$, and let R^d_s denote the repayment threshold of a high quality loan portfolio. For $R < R^d_s$, the bank defaults in period 2 if it sells a fraction D/V_u of its loans in period 1 in order to repay its wholesale debt:

$$R^d_s : \quad R^d_s \left(1 - \frac{D}{V_u}\right) = \delta,$$

where $R^d_s < \hat{R}_s$ for all $s \in \{o, \tau\}$. In period 1, the bank can either roll over its debt or repay it by selling loans. The difference in expected profit from repaying versus rolling over wholesale debt for $s \in \{o, \tau\}$, given R and monitoring effort e_s is:

$$\Delta_s(D) = \max \left\{ \mathbf{E}_s[q|e_s] \left(R \left(1 - \frac{D}{V_s} \right) - \delta \right), 0 \right\} - \max \left\{ \mathbf{E}_s[q|e_s] \left(R - \delta \right) - D, 0 \right\} \geq 0,$$

with a strict inequality whenever $R > R^d_s$. Thus, the bank never rolls over its short-term debt in period 1 under lenient resolution authority, regardless of whether bank-specific information is disclosed. □

[19] A straightforward application of the intermediate value theorem and the implicit function theorem shows that the face value of long-term debt is uniquely pinned down.

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