Fair Value Accounting, Prudential Regulation and Financial Contagion

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Abstract

This paper examines how fair value accounting can create financial contagion among banks and therefore increase bank regulators' costs of protecting insured depositors. Prior research mainly focuses on the economic consequences of marking down, whereas I contribute to the literature by providing a novel trade-off of marking up. On the one hand, by marking its assets up, a healthy bank obtains adequate capital to absorb a failing bank which would otherwise be liquidated in a less efficient secondary market, thereby saving regulators' costs. On the other hand, the otherwise healthy bank becomes more leveraged and thus may face excessive default risk after this merger, leading to financial contagion and increased overall costs for regulators.

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Introduction

Since the last financial crisis, the use of fair value accounting has been at the center of policy debate among regulators, accounting standard setters and other professional associations. Supporters argue that fair value contains more relevant and timely information vis-à-vis book value. With additional information, investors are able to make more informed decisions, regulators can take corrective actions more promptly, and market monitoring is also improved. Therefore, fair value accounting can enhance the stability of the economy. Opponents, however, point out that fair value accounting creates excessive and artificial volatility in prices that is unrelated to fundamental value. During recessions, the market for distressed assets is far from a frictionless competitive market because these assets are extremely illiquid. Furthermore, some healthy institutions are forced to mark their assets down and consequently become insolvent, even if they would have survived under historical cost accounting. In summary, fair value accounting can lead to procyclicality precisely because of marking down. Although the debate is multifaceted, the spotlight has consistently been on the downward spirals resulting from marking *down*, whereas the economic consequences of marking *up* receive less attention. In this paper, I bridge the gap and study how fair value accounting, especially marking up, affects banks' real decisions, the optimal strategy of bank regulators, and the resulting *resolution costs*, which are defined as the expected costs of protecting all insured depositors in failed banks.[1]

[1] The economic magnitude of resolution costs in the U.S. is quite significant, especially during financial crises. For example, data provided by the FDIC's *Historical Statistics on Banking* show that total resolution costs from 1986-2017 were estimated to be $182.4 billion, much of which were accumulated during 1988-1992 and 2007-2011. More details are provided in Table 4 and Figure 9 in Appendix C. In addition, Hoggarth, Reidhill, and Sinclair (2004) find that the cumulative output losses in the banking crisis of the past 25 years have amounted to 15% to 20% of annual GDP. The

I develop a simple model with two banks that are subject to capital regulation by a prudential regulator whose objective is to protect all insured depositors. Each bank raises deposits and issues equity to fund a risky investment, and banks' objective is to maximize the expected return for shareholders. Subsequently, each bank obtains new information about the expected payoff of its investment. In a benchmark which I denote as (pure) historical cost accounting, information will not be reflected and banks' assets are recorded at the origination costs. However, banks are required to report the information on their balance sheets under fair value accounting. As a result, a bank can be insolvent if its assets are critically impaired, and thus will be closed by the regulator even though its investment has not matured yet. The regulator may have two methods for resolving the failed bank: selling the bank's assets in a potentially inefficient secondary market, or merging the failed bank with a healthy bank. The regulator's preferred resolution method depends on the circumstances of failures, which in turn results in interesting trade-offs between the costs and benefits of marking down and marking up.

The intuition is as follows: Fair value accounting requires that a bank marks its assets *down* if subsequent information indicates credit deterioration. As a result, the regulator is able to intervene with the troubled bank immediately to prevent further losses, thereby protecting depositors in the troubled bank. In other words, marking down reduces the regulator's costs of resolving the troubled bank. However, if no other healthy bank is able to acquire this troubled bank, the regulator must sell the troubled bank's assets in an illiquid secondary market, which decreases the proceeds and increase the regulator's costs of resolving the troubled bank. Therefore, the costs and benefits of marking banks' assets down are relatively straightforward.

However, the trade-off of marking up is more nuanced. First, a healthy bank can mark its assets *up* following favorable information, thereby obtaining extra capital which in turn allows the bank to take more risk. One particular form of risk-taking

costs are usually paid from a deposit insurance fund or through capital injections by the government if the fund has been exhausted. Therefore, it is the taxpayers who ultimately pay for these costs.

examined in the model is to absorb the failed bank, which would otherwise be liquidated in the secondary market. Because the healthy bank is more efficient, marking up further reduces the regulator's costs of resolving the *troubled* bank. On the other hand, the healthy bank may become more fragile as this merger increases its leverage and decreases its capital ratio. As a consequence, if the troubled bank eventually fails, it may cause the healthy bank to fail as well, because the two banks' balance sheets are connected after the acquisition. This phenomenon would happen even though the otherwise healthy bank could have survived if there were no interbank acquisition. In other words, one bank's failure increases the likelihood that another healthy bank will fail in the future, consistent with the observation of *financial contagion*.[2] As a consequence, depositors in the healthy bank may become exposed to excessive default risk after the acquisition, thereby increasing regulator's costs of protecting depositors in the *healthy* bank. Therefore, the net effect taking all depositors together is not obvious. I find that marking up increases total resolution costs for the regulator if banks' investments are not sufficiently profitable, banks are highly leveraged and fair value accounting is not informative about future cash flow.[3] Overall, my results provide some novel implications for bank regulators and policy makers.

In addition, I find that accounting measurement can affect banks' capital structure decisions, consistent with the way accounting affects other management decisions

[2] In prior literature, financial contagion is typically defined as shocks that affect one bank propagating to other banks through increased systemic risk or bank runs (see, for example, Alvarez and Barlevy (2015) or Diamond and Dybvig (1983). In my paper, a healthy bank could have been more stable if the other bank is also financially healthy. Nevertheless, because the other bank is financially distressed and fails, the healthy bank becomes more volatile and faces higher risk after acquiring the failed bank. In other words, one bank's failure has negative externality on the other bank, consistent with the definition of financial contagion at the observation level.

[3] In fact, financial contagion resulted from interbank acquisitions and abuses of accounting measurement by regulators has been observed in the past, and a well-known instance is the Savings and Loan crisis. In the early 1980s, the Federal Savings and Loan Insurance Corporation (FSLIC) faced a serious deficit in their insurance fund because of historically high interest rates. To avoid bankruptcy, the FSLIC adopted misguided accounting policies to encourage healthy thrifts to acquire troubled institutions. For example, the 10-year amortization restriction on goodwill was extended to "no more than 40 years", leading to a dramatic increase in goodwill for the acquirer. As a consequence, healthy thrifts kept acquiring insolvent thrifts and goodwill constituted a large proportion of their regulatory capital, as shown in Figures 10 and 11 in Appendix C. In the end, the entire industry was devastated as more "healthy" thrifts failed: final resolution costs were estimated at more than $160 billion, which included $132 billion from federal taxpayers—much of which could have been avoided had regulators not merged insolvent thrifts with other institutions.

in the real effects literature (Kanodia and Sapra, 2016). Specifically, because shareholders are protected by limited liability, banks prefer to raise more deposits and less equity. Under historical cost accounting, banks are always solvent because the regulatory capital does not change, and therefore the regulator has no basis to intervene with any bank.[4] In return, banks raise the maximum deposits subject to capital regulation to exploit the benefit of limited liability. By contrast, banks face a trade-off under fair value accounting: First, banks still prefer to raise more deposits for the same reason stated above. However, if a bank did not issue enough equity, its capital reserves may not be adequate to absorb future unexpected losses. In other words, banks could become insolvent following negative shocks and thus be closed by the regulator. As a result, banks may forfeit some benefits of limited liability to eliminate the possibility of closure. Therefore, marking down can provide banks with an incentive to issue extra equity, which will in turn decrease systemic leverage and reduce the expected resolution costs. However, the effect of marking up is more subtle. Because of marking up, banks may be granted with an opportunity to take more risk by acquiring an insolvent bank. In anticipation of this possibility, banks' capital structure decisions will also change. I find that marking up may dampen banks' incentive to issue extra equity under certain conditions and thus increase systemic leverage and aggravate the regulator's resolution costs.

1.1 Literature Review

This paper is related to three strands of literature. First, there is a large literature on prudential regulation and optimal intervention. For example, Dewatripont and Tirole (1994) build a general framework on how external intervention affects managerial incentives and how to implement the intervention. Hellmann, Murdock, and Stiglitz (2000) find that capital regulation, while induces prudent behavior, harms banks'

[4] Deposit insurance, capital regulation, liquidity requirements and many other rules are widespread across the globe. I only focus on capital regulation in this paper because it is perhaps the most important micro-prudential regulation and accounting measurement is a key determinant of banks' regulatory capital.

franchise values and encourages gambling, and therefore can be inefficient. Acharya and Yorulmazer (2007) show that the ex-post optimal closure policy may give banks incentives to herd and thus becomes sub-optimal from an ex-ante standpoint. My paper studies how accounting measurement interacts with the optimal intervention policy, which in turn affects banks' real decisions and regulators' payoffs. In this burgeoning literature in accounting, the closest related paper is Bertomeu, Mahieux, and Sapra (2017), who examine how policy makers use accounting regulation and prudential regulation in tandem to discipline banks' risk-taking and maximize social welfare. The primary difference is that they assume that policy makers determine a capital requirement and commit to a measurement system together to control ex post incentives to intervene, whereas I compares different accounting regimes given predetermined prudential regulation (See Section 6.2).

Second, there are numerous studies on the economic consequences of fair value accounting in different settings. Beatty and Liao (2014) and Acharya and Ryan (2016) provide comprehensive review of this literature. In the context of bank regulations, Li (2017) examines how different accounting regimes affect banks' risk-taking and, in turn, affect bank regulators; Lu, Sapra, and Subramanian (2016) investigate how agency conflicts interact with fair value accounting affect prudential regulation; Bleck and Gao (2016) study the effect of marking to market on banksâĂŹ loan origination and retention decisions; Corona, Nan, and Zhang (2017) show that banks may voluntarily adopt fair value accounting to deter competition in the deposit market. In other contexts not specific to banking, Gigler, Kanodia, and Venugopalan (2013) find that fair value accounting increases the volatility of the firm's wealth, which in turn distorts firms' assets allocating decision and decreases social welfare; Bleck and Liu (2007) show that historic cost accounting can make the financial market more, rather than less volatile by veiling true economic performance. Reis and Stocken (2007) study the measurement of nonfinancial assets in imperfectly competitive markets. They find that fair value accounting can reveal a firm's inventory holding in the presence of cost uncertainty, and therefore improve the informativenessof financial reports relative to historical cost accounting. Marinovic (2017) studies the effect of accounting measurement regimes that apply to an asset on the auction for that asset. Bushman and Williams (2012) provides empirical evidence that high quality accounting measured by timely recognition of loan loss provision improves market disciplining of banks' risk-taking .

Lastly, this paper also sheds light on the connection between financial contagion and fair value accounting. Previous literature have focused on the vicious cycle effect resulting from marking down. For example, Plantin, Sapra, and Shin (2008) show that the additional information contained in market prices can lead to coordination failures among financial institutions. As a result, contagion arises through the fire-sale externality in which sales of distressed assets further depress asset prices and induce additional sales of other institutions. Allen and Carletti (2008) find that marking down could lead to financial contagion in the spirit of Allen and Gale (2000). They suggest that using market prices to assess insolvency is not desirable because market prices reflect liquidity available instead of intrinsic values. Different from the above two papers which mainly focus on marking down, I find that marking *up* can also lead to financial contagion, consistent with the contamination effect documented by Banal-Estañol, Ottaviani, and Winton (2013). Specifically, by marking assets up, a healthy bank obtains free capital that allows it to acquire an insolvent bank; however, the healthy bank may become more vulnerable to failure after the acquisition, leading to financial contagion and excessive default risk faced by depositors. To the best of my knowledge, the specific mechanism resulted from marking up has not been studied before, and it may provide interesting implications for accounting standard setting and bank regulation.

Model

2.1 Model Setup

The model has universal risk neutrality and four dates.

Date 1

To capture contagion in the most parsimonious way, I assume there are two identical banks in the financial system denoted as i and j. Banks are wealth constrained, and therefore must raise capital to fund investmentsfrom two sources: deposits D from dispersed depositors and equity E from external shareholders (Mehran and Thakor, 2011).[5] All deposits are fully insured by the FDIC and the interest rate and insurance premium are normalized to 0.[6] In addition, there is no conflict of interest between the bank's manager and its shareholders, so the manager's objective is to maximize the expected payoff for shareholders. Two banks make capital structure decisions simultaneously at date 1.

[5]Bank capital is privately costly to shareholders because of asymmetric information or the tax benefit of debts. In addition to these private costs, bank capital is also socially costly because capital will substitute information-insensitive and liquid securities such as demand deposits, which are valuable for depositors. Including private costs in the model will not qualitatively change my results, whereas endogenizing the social costs is beyond the scope of this paper. Furthermore, I assume banks do not have access to external capital after date 1, which can be extended as an alternative benchmark in Appendix B.2.

[6]Deposit insurance is heavily subsidized, especially for weaker banks. The literature has shown that the insurance premium is not appropriately risk adjusted (Chan, Greenbaum, and Thakor, 1992). For example, the FDIC based its assessments on \$11.99 trillion of liabilities at the end of 2011. However, only 206 of the 813 institutions on the FDIC's problem list paid more than 25 basis; 0.28% percent of the asset base paid more than 35 basis points (Bulow and Klemperer, 2013). In addition, risk sensitive regulation may also have side effects (Bleck, 2016). In my model, suppose the insurance premium can perfectly reflect the risk, then the regulator is able to break even. However, the healthy bank will face an increased cost of deposits after the acquisition, and thus may have less incentive to take over the insolvent bank. Therefore, a risk sensitive insurance premium may also be costly.

After collecting capital from depositors and shareholders, each bank is faced with a risky investment I which repays R at the terminal date if the investment succeeds; otherwise the repayment is normalized to 0 if the investment fails. The prior probability of success is $q \in (\frac{1}{2}, 1)$ and and the investment is profitable ex ante, i.e., $qR > I$. In other words, bank's terminal cash flow can be considered as a random variable $\tilde{R}$

$$\tilde{R} = \begin{cases} R, & \text{if succeed, with probablity } q \\ 0, & \text{if fail, with probablity } 1-q \end{cases}$$

and $\tilde{R}_i$ and $\tilde{R}_j$ are assumed to be independent for simplicity.[7]

Furthermore, bank regulation, especially capital regulation is important due to banks' risk-shifting incentive, i.e., banks are inclined to take excessive risk because of limited liability and deposit insurance. The excessive risk will in turn hurt depositors, increase regulators' costs and thus need to be disciplined.[8] Therefore, I assume that a prudential regulator referred to as the Federal Deposit Insurance Corporation (FDIC) *commits* to certain capital regulation to discipline excessive risk-taking and protect insured depositors.[9] The capital regulation is exogenous and consists of an interior

[7]In reality, banks are affected by macroeconomic shocks and their returns are correlated as a consequence. (i) Including this correlation will pollute my results without adding new insights: Suppose we observe that two banks failing together, it becomes extremely difficult to disentangle the effect of common shocks from the effect of contagion, which is the strategic interaction between the two banks. Therefore, the easiest way to examine contagion is to leave out the effect of common shocks. Meanwhile, prior research such as Allen and Carletti (2008) find that banks may choose different risk exposure ex ante to become the sole survivor, which seem consistent with this assumption. (ii) As a robustness test, I also include a correlation between $\tilde{R}_i$ and $\tilde{R}_j$ and find that the main results hold qualitatively as long as the correlation is not too high. (iii) To interpret this assumption of independence, the two banks can be specialized in different industries or located in different geographic locations.

[8]Suppose there is no capital regulation, banks will raise zero equity in equilibrium because shareholders are protected by limited liability, thereby shifting all default risk to depositors. Furthermore, because shareholders' money is not at stake, banks may invest in negative NPV projects and bet on the upside, consistent with prior literature that deposit insurance and limited liability induce excessive risk-taking. By contrast, if shareholders have skin in the game as well, the risk-shifting incentive can be mitigated.

[9] (i) I consider the FDIC as the main regulator and its objective is to reduce expected resolution costs. (ii) Banks in the model can be thought of as traditional commercial banks as modern banks such as shadow banks are quite different. For example, shadow banks are highly leveraged, heavily dependent on wholesale funding and more vulnerable to liquidity risk, and not subject to capital regulation.

minimum capital requirement ϕ and a solvency requirement defined as follows[10]:

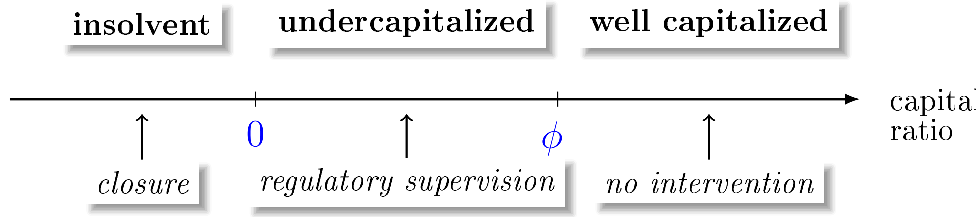

Figure 2.1: Prudential Regulation

(i) A bank is well capitalized if its capital ratio[11] is above ϕ. In this case, the bank is allowed to take more risk and will not be intervened by the regulator.

(ii) A bank is undercapitalized if its capital ratio is below ϕ. In this case, the bank is subject to regulatory supervision and restricted from taking more risk, such as underwriting more loans or paying out dividends.

(iii) A bank is critically undercapitalized or insolvent if its capital ratio falls below 0, and the bank will be immediately closed by the regulator.

Because of the minimum capital requirement ϕ, banks must raise enough equity at date 1 such that $E \geq \phi I$.

Date 2

After investments have been made, each bank will receive additional information $\tilde{Y} \in \{H, L\}$ about the likelihood that its investment will succeed. I assume the signal itself is a random variable and the prior probability of realizing H is q. In addition, the joint probability between $\tilde{Y}$ and $\tilde{R}$ is as follows:

[10]To simplify the algebra, I assume $\underline{\phi} < \phi < \bar{\phi}$ where $\underline{\phi} = 1 - \frac{(4q-1)R}{(5q-1)I}$ and $\bar{\phi} = \min\{\frac{qR-I}{(2q-1)I}, 1 - \frac{q}{2}\}$. However, the main result does not change qualitatively even if the assumption is relaxed.

[11] (i) The numerator of capital ratio is regulatory capital, which starts from the GAAP number, plus some adjustments called prudential filters. For example, goodwill and other intangible assets are not included in calculating regulatory capital now. The effect of prudential filters on banks' behavior is interesting but beyond the scope of this paper. (ii) There are two types of capital in practice: tier 1 capital, which consists largely of shareholders' equity and disclosed reserves, and tier 2 capital or supplementary capital, consisting of undisclosed reserves, general provisions, etc. I do not differentiate them for simplicity. (iii) The denominator is the risk weighted assets, and any risk-free assets such as cash or treasury bills have 0 weight.

	R	0
H	$q^2+\epsilon$	$q(1-q)-\epsilon$
L	$q(1-q)-\epsilon$	$(1-q)^2+\epsilon$

where $0<\epsilon<q(1-q)$. As a result, the correlation coefficient between $\tilde{Y}$ and $\tilde{R}$ is $\lambda \doteq \frac{\epsilon}{q(1-q)}$[12], and the posterior probabilities of success are

$$P_H = Prob(Succeed|H) = q + (1-q)\lambda$$
$$P_L = Prob(Succeed|L) = q - q\lambda$$

When $\lambda = 0$, the signal is completely uninformative, i.e., $P_H = P_L = q$. When $\lambda = 1$, the signal is perfectly informative, i.e., $P_H = 1, P_L = 0$. Lastly, P_H and $1-P_L$ are both strictly increasing in λ. Therefore, I denote λ as the informativeness of fair value accounting. In practice, λ may be affected by the accuracy of valuation models using level 2 inputs, or the precision of managers' private information using level 3 inputs.[13]

In a benchmark case which I denote as (pure form) historical cost accounting, information $\tilde{Y}$ is not reflected on banks' balance sheets and assets are always recorded as the origination costs I. In contrast, banks must report the information under fair value accounting. Specifically, if the signal is L, the bank is forced to mark its assets down from the origination costs I to the fair value $P_L R$, and its regulatory capital decreases accordingly by the same amount of marking down.[14] By contrast, if the

[12]The covariance is $Cov(\tilde{R},\tilde{Y}) = E[\tilde{R}\tilde{Y}] - E[\tilde{R}]E[\tilde{Y}]$. Since $E[\tilde{R}\tilde{Y}] = r_1Y_1(q^2+\epsilon) + r_1Y_2(q(1-q)-\epsilon) + r_2Y_1(q(1-q)-\epsilon) + r_2Y_2((1-q)^2+\epsilon)$ and $Cov(\tilde{R},\tilde{Y}) = (r_1-r_2)(Y_1-Y_2)\epsilon = R^2\epsilon$, it is easy to see that $Corr(\tilde{R},\tilde{Y}) = \frac{Cov(\tilde{R},\tilde{Y})}{\sqrt{Var(\tilde{R})}\sqrt{Var(\tilde{Y})}} = \frac{\epsilon}{q(1-q)}$. This information structure has also been use in prior literature such as Huang and Ratnovski (2011), Burkhardt and Strausz (2009). To interpret this information structure, suppose $\tilde{Y}$ represents a different risky investment with a shorter maturity, and the return of the two investments are positively correlated. Therefore, the realization of the short maturity investment $\tilde{Y}$ is informative about the long maturity investment $\tilde{R}$.

[13]I assume managers have no incremental information given the realization of Y, different from other models about adverse selection such as Reis and Stocken (2007), Bleck and Gao (2016) and Marinovic (2017). Therefore, the information content in market prices is exogenous.

[14] Fair value is defined by the FASB as "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date". This value-in-exchange perspective can be inefficient as shown in the literature (Plantin et al., 2008); for example, during financial crises, quoted prices in an illiquid market can deviate from fundamental

signal is H, the bank is allowed to mark its assets up to $P_H R$ and thereby obtains extra free capital by the same amount of marking up.

Date 3

Because of marking up or marking down, banks' capital ratio will also change. Suppose a bank receives L and becomes insolvent, it will be closed by the regulator although the investment has not matured yet. Nevertheless, after taking over the insolvent bank, the regulator must resolve its assets due to lack of expertise in using them. Depending on the circumstances of failure, the regulator may have three resolution methods:

1. A deposit payoff: The FDIC is appointed as the receiver of the failed bank and will liquidate its assets. All insured depositors are directly paid off.
2. A purchase and assumption (P&A agreement): A healthy institution (bank or thrift) acquires the failed bank, including its assets and all insured deposits.[15]
3. An open bank assistance (OBA agreement): The FDIC provides financial assistance to a failed bank such as placing deposits, making loans, etc,. Since the OBA agreement has never been used since 1992, I only consider the first two methods.[16]

In a deposit payoff, the FDIC sells the failed bank's assets in a secondary market, which can be inefficient for several reasons: (i) A bank monitors borrowers on behalf of dispersed arm's length investors, thereby saving duplicated efforts of monitoring (Diamond and Dybvig, 1983). (ii) A bank produces valuable information about borrowers via relationship lending or private communication with the management (Ramakrishnan and Thakor, 1984). (iii) A large proportion of banks' assets, such as

values. Therefore, to differentiate with prior findings, I define fair value as the expected payoff given the asset is held by banks, which is more in line with the value-in-use perspective.

[15] A P&A agreement may be assisted by the regulator; for example, the acquisition of Bear Sterns by JPMorgan Chase was facilitated by assistance from the Federal Reserve Bank of New York. The final selling price was \$10 per share, a price far below its pre-crisis 52-week high of \$133 per share, but not as low as the \$2 per share originally agreed upon between Bear Sterns and JPMorgan Chase.

[16] The Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA), requires regulators to take to take "prompt corrective action" (PCA) when the depository institutions is "critically undercapitalized". See Section 6.1 for more details.

mortgage loans, are subject to fire sales discount in an illiquid market (Corona et al., 2014). For these reasons, I assume that outside users cannot generate R, but only δR, when the investment succeeds at date 4 (Acharya and Yorulmazer, 2007). As a result, the distressed assets are sold in the secondary market at $\delta P_L R$, and $1 - \delta$ is denoted as the liquidity discount.

In contrast, the above inefficiency can be alleviated in a P&A agreement because a healthy bank can provide similar services as the failed bank. For simplicity, I assume there is no inefficiency in a P&A agreement and the distressed assets are sold to the healthy bank at the fair value $P_L R$.[17] However, since the insolvent bank has negative equity, the regulator must compensate the acquirer by providing some forms of subsidy. I assume the subsidy take the simplest form as direct capital injection, which is equal to $D - P_L R$. Given the subsidy, if the hypothetical capital ratio of the conglomerate is below ϕ, the healthy bank does not have enough capital to absorb all the risk. This could happen because the acquisition increases the healthy bank's leverage and lowers its capital ratio.[18] Lastly, I assume that dividend payout is not allowed before the investment matures.

Date 4

Banks' investments mature and all depositors are paid off. If a bank does not have enough cash to fulfill its obligation, it declares bankruptcy and the FDIC will cover the shortfall. Otherwise, shareholders are residual claimants after all depositors are fully repaid by banks.

In summary, the model is described by the following timeline:

[17] In practice, the FDIC will usually market the insolvent institution as widely as possible to encourage competition among bidders. In a perfectly competitive market, the FDIC has the full bargaining power so the equilibrium price will be such that bidders are indifferent between acquiring and not acquiring. By contrast, if there is no competition and the acquirer has the full bargaining power, the price is equal to the secondary market price $\delta P_L R$. I assume the selling price is the fair value $P_L R$, which lies in the middle of two extreme cases. However, relaxing this assumption will not qualitatively affect my results.

[18] (i) The FDIC also offers other types of subsidies in reality; for example, the acquirer could purchase the assets with a discount or enter into a loss-share agreement with the FDIC, etc,. (ii) As an anecdote, the failure of IndyMac Bank in 2008 was the 3rd largest bank failure ever. In 2009, IndyMac Bank was acquired by OneWest Bank along with controversial shared loss agreements. However, the FDIC subsequently disclosed that it has already paid out more than $1 billion to OneWest bank under shared loss agreements, and that it expects to pay out an additional $1.4 billion to the bank before 2019.

Date 1	Date 2	Date 3	Date 4
Two banks decide capital structure simultaneously. The balance sheet is $E_i + D_i = I$ and $E_i \geq \phi I$	Information $\tilde{Y}$ is reported under FV accounting. The bank may mark up or mark down based on $\tilde{Y}$.	Insolvent banks are revealed and closed. The bank regulator chooses the optimal resolution method $\mathcal{S}$.	Investments mature and depositors are paid off.

Figure 2.2: Time Line

2.2 Equilibrium

As two banks make their capital structure decisions simultaneously, the bank's decision is based on its conjecture of the other bank's strategy and its conjecture of the regulator's resolution method. Therefore, a rational expectation equilibrium is defined as follows:

Equilibrium Definition. *A rational expectation equilibrium consists of* $\{D_i, D_j, \mathcal{S}\}$ *such that:*

1. *Banks maximize the expected payoffs for shareholders conditional on the conjecture, i.e.,* $D_i \in \operatorname{argmax} \mathbb{E}[\Pi_i | \hat{D}_j, \hat{\mathcal{S}}]$*, and* $D_j \in \operatorname{argmax} \mathbb{E}[\Pi_j | \hat{D}_i, \hat{\mathcal{S}}]$.

2. *The regulator chooses the optimal resolution method* $\mathcal{S}$ *after closing a bank.*

3. *The conjectures obey rational expectations, i.e.,* $D_i = \hat{D}_i, D_j = \hat{D}_j, \mathcal{S} = \hat{\mathcal{S}}$.

The equilibrium is solved backward: I first study the regulator's optimal resolution method after closing the insolvent bank at date 3, and then examine banks' capital structure decisions at date 1.

2.2.1 Historical Cost Accounting

Since information $\tilde{Y}$ will not be reported under historical cost accounting, banks' assets are always recorded at the origination costs I. As a result, there is no basis for the regulator to intervene. In anticipation of the regulator's action, banks solve the following optimization problem:

$$\begin{aligned} \max_{D,E} \ & q(R-D)-E \\ s.t. \ & E \geq \phi I \\ & E+D=I \end{aligned} \tag{2.1}$$

Because of limited liability, shareholders at most lose their initial capital contribution E if the investment fails at date 4. In contrast, if the investment succeeds, shareholders obtain a positive return after all depositors are paid off. Apparently, equation (1) is strictly increasing in D, suggesting that banks choose the maximum (minimum) deposits (equity), which is consistent with classic bankruptcy theory: The borrower prefers to *use other people's money*, because the downside risk is completely borne by creditors. To simplify notation, I denote the maximum deposits that banks could raise under minimum capital requirement as $D_F = (1-\phi)I$.

Proposition 1. *Under historical cost accounting, banks raise the minimum equity, i.e.,* $D_{HC} = D_F$.

2.2.2 Fair Value Accounting

Under fair value accounting, information $\tilde{Y}$ must be reflected on the bank's balance sheet: If H is realized, the bank marks up its assets to $P_H R$ and consequently obtains additional capital $P_H R - D$. If L is realized, the bank marks down its assets to $P_L R$ and its capital reduces to $P_L R - D$. Therefore, a bank will be closed if and only if the following two conditions are satisfied: (i) The bank receives L; (ii) Marking down is sufficiently severe such that $P_L R < D$.

A Benchmark Case

I first study a benchmark case in which a direct payoff is the only resolution method. In this case, there is no strategic interaction between the two banks and $\mathbb{E}[\Pi_B|\hat{D}_j, \hat{\mathcal{S}}] =$

$\mathbb{E}[\Pi_B|\mathcal{S}]$. Therefore, the bank's objective is:

$$\max_{D \le D_F} \quad \mathbb{E}[\Pi_B] = \begin{cases} q(R-D) - (I-D), & \text{if } D_F < P_L R \\ qP_H(R-D) - (I-D), & \text{if } D_F > P_L R \text{ and } D > P_L R \\ q(R-D) - (I-D), & \text{if } D_F > P_L R \text{ and } D < P_L R \end{cases}$$

To understand the objective function, if accounting is not informative at all such that $P_L R \ge D_F$, a bank will stay solvent even if it raises the maximum deposits and receives L. This is a trivial case as accounting information becomes irrelevant, so I make the following assumption:

Assumption. *Accounting is at least relevant, i.e.,* $\lambda > 1 - \dfrac{D_F}{qR} \doteq \lambda_C$.

Given accounting is relevant, if a bank raises too much deposits and receives L, it becomes insolvent and thus will be closed by the regulator. Therefore, shareholders obtain a positive return only when H is realized at date 2 (the probability is q), and the investment succeeds at date 4 (the posterior probability of success upon H is P_H). In stark contrast, if the bank issues extra equity such that $D \le P_L R$, it is always solvent regardless of the signal realization, and thus will never be closed by the regulator.

Compared to Equation (1.1), D affects banks' objectives in two opposing directions: First, the bank still prefers to raise more deposits to maximize the benefit of limited liability. On the other hand, if the bank's leverage is too high, it faces the possibility of being closed by the regulator. Therefore, banks face a trade-off between the benefits of limited liability and the aversion to closure, and the optimal capital structure is as follows:

Lemma 1. *In the benchmark case, there exists a unique* λ_B *such that banks choose*

$$D_B = \begin{cases} P_L R, & \textit{if } \lambda < \lambda_B \\ D_F, & \textit{otherwise} \end{cases}$$

In addition, λ_B *is increasing in* R *and decreasing in* D_F.

Proof. All proofs are in the appendix. □

Lemma 1 shows that banks voluntarily issue extra equity if accounting is not too informative (yet still relevant). To gain the intuition, if accounting is too informative, $P_L R$ becomes very small; therefore, banks need to raise a large amount of equity ex ante to prevent closure, which is too costly for shareholders. In contrast, if the informativeness is low, banks only need to raise a small amount of equity to prevent closure. In the following text, I denote $D = P_L R$ as when banks raise extra equity. Lemma 1 suggests that the threat of regulatory closure resulting from marking down can provide incentives for banks to raise more equity, and thus decreases *systemic leverage*. Finally, the comparative statics are also intuitive: When the investment is more profitable, banks are more averse to closure and thus more prone to raising extra equity. Similarly, when the maximum deposits that banks could raise decrease, the benefits of limited liability become smaller, so banks have stronger incentives to raise extra equity.

Bank Acquisition

After establishing the basic trade-off established, I include the P&A agreement as an alternative resolution method and ask the following question: Is a healthy bank *able* and *willing* to acquire an insolvent bank? Without loss of generality, I assume bank j receives L and becomes insolvent, and bank i receives H. Suppose bank i acquired j; then the balance sheet of the conglomerate after the acquisition becomes:[19]

$$\underbrace{P_H R + P_L R}_{\text{risky investments}} + \underbrace{D_j - P_L R}_{\text{subsidy}} = \underbrace{(D_i + D_j)}_{\text{total deposits}} + \underbrace{E + (P_H R - I)}_{\text{capital}} \tag{2.2}$$

[19]FAS ASC 805 (formerly FAS 141R) *Business Combinations* sets forth the accounting standards for bank mergers and acquisitions. In general, the acquirer should use purchase accounting and record both assets and liabilities at the fair value. For example, if the impairment of the purchased assets is other-than-temporary, the amount of expected cash flows that exceeds the fair value is recorded as "accretable yield" and will subsequently be recognized as interest income over the life of the loan.

Initially, bank i capital ratio is $\frac{E_i}{I} \geq \phi$. If bank i receives H, its capital ratio becomes $\frac{E_i + (P_H R - I)}{I + (P_H R - I)} > \phi$. Finally, bank i's capital ratio after the acquisition decreases to $\frac{E_i + (P_H R - I)}{I + (P_H R - I) + P_L R}$.

Lemma 2. *The healthy bank has enough capital to acquire the insolvent bank given* $\phi < \bar{\phi}$*.*

Lemma 2 is intuitive. Since accounting is relevant, i.e., $\lambda > \lambda_C$, the information content of H is sufficiently high such that P_H will be large. As a result, the healthy bank obtains a large amount of capital by marking its assets up. At the same time, the information content of L is sufficiently high such that P_L will be small, so the denominator of the capital ratio only increases marginally. Taken together, the healthy bank is always able to acquire the insolvent bank, as long as the minimum capital requirement is not too high.

Now I examine whether bank i is willing to acquire j. After the acquisition,the conglomerate (or equivalently, bank i) owns two risky investments with independent returns, safe investment $D_j - P_L R$, and two groups of depositors D_i, D_j. Table 1 shows the payoff structure to bank i's shareholders:

Table 2.1: The Payoff Structure to the Healthy Bank

$\tilde{R}_i$	$\tilde{R}_j$	Probability	Failure	Payoff
R	R	$P_H P_L$	No	$2R - D_i - P_L R$
R	0	$(1 - P_L)P_H$	?	$max\{R - D_i - P_L R, 0\}$
0	R	$(1 - P_H)P_L$	?	$max\{R - D_i - P_L R, 0\}$
0	0	$(1 - P_H)(1 - P_L)$	Yes	0

Specifically, if both investments fail (succeed), the conglomerate will (not) fail for sure. If only one investment succeeds, however, it is unclear whether the conglomerate will fail. To simplify notation, I denote $R - D_i - P_L R$ as when the intermediate return is realized. Therefore, the expected payoff for bank i is

$$\Delta^M(D_i) = \underbrace{P_H P_L(2R - D_i - P_L R)}_{\text{both investments succeed}} + \underbrace{(P_H + P_L - 2P_H P_L) max\{R - D_i - P_L R, 0\}}_{\text{only one investment succeeds}} \tag{2.3}$$

Lemma 3. *The healthy bank's shareholders are better off after the acquisition.*

To understand Lemma 3, banks' equity can be viewed as a call option because of limited liability, and the option value is increasing in the volatility. In other words, banks' shareholders are always inclined to engage in riskier investments at the expense of depositors, consistent with the *risk shifting* incentive in the literature. Moreover, acquiring an insolvent bank, by increasing the mean preserving spreads, is equivalent to taking more risk. Therefore, shareholders in the healthy bank are always better off after the acquisition.

The Full Equilibrium

Next, I study the regulator's optimal resolution method at date 3.

Lemma 4. *The regulator uses P&A agreements whenever possible.*

Lemma 4 suggests that the regulator prefers to use a P&A agreement, as long as the healthy bank has enough capital to absorb the insolvent bank. To understand the argument, suppose healthy bank i has sufficient capital to acquire insolvent bank j, but the regulator chooses to liquidate j's assets in the secondary market. In response, bank i will issue more deposits or sell some safe investments to purchase the assets from the open market. By doing so, i's shareholders are even better off because the purchase the secondary market price will never exceed the price from the regulator. Therefore, deposit payoffs are used only when there is no other healthy bank to take over the insolvent bank, which is consistent with our real-life observation that the P&A agreement has been the most preferred method for most of the FDIC's history.[20]

[20]For example, from 1986 through 2017, 2,307 banks out of 2,638 failing or failed bank situations, or 87.5 %, were resolved with P&A agreements. Deposit payoffs were only used in 215 cases, or 8.2 % of the total. More details are provided in Table 4 in Appendix C.

By rational expectation, banks' conjectured $\hat{\mathcal{S}}$ must be consistent with the actual $\mathcal{S}$ of the regulator. Now I study the bank's capital structure decision at date 1 and discuss the following two cases:

Case 1: $\hat{D}_j \leq P_L R$, bank i believes that j will never be closed. Therefore, bank i faces the same trade-off as in the benchmark: If $\lambda > \lambda_B$, it chooses $D_i = D_F$; otherwise it chooses $D_i = P_L R$.

Case 2: $\hat{D}_j > P_L R$, bank i believes that j will be closed at L. Suppose j receives L and bank i receives H, the regulator will merge the two banks. If both banks receive L, the regulator will close j for sure and resolve its assets in the secondary market; however, bank i's solvency status depends on D_i. Specifically, if bank i chooses $D_i > P_L R$, its objective function becomes:

$$\Pi_1^M(D_i) = \underbrace{q^2 P_H(R - D_i)}_{\text{both receive } H} + \underbrace{q(1-q)\Delta^M(D_i)}_{i \text{ receives } H,\, j \text{ receives } L} - (I - D_i) \tag{2.4}$$

Equation (1.4) is strictly increasing in D_i, suggesting that bank i chooses $D_i = D_F$. Similarly, if bank i chooses $D_i \leq P_L R$, its objective function becomes

$$\Pi_2^M(D_i) = \underbrace{(1-q)P_L(R - D_i)}_{i \text{ receives } L} + \underbrace{q^2 P_H(R - D_i)}_{\text{both receive } H} + \underbrace{q(1-q)\Delta^M(D_i)}_{i \text{ receives } H,\, j \text{ receives } L} - (I - D_i) \tag{2.5}$$

Equation (1.5) is also increasing in D_i, so bank i chooses $D_i = P_L R$. Therefore, bank i either chooses D_F or $P_L R$.

Lemma 5. *Given that bank i believes $\hat{D}_j > P_L R$,*

1. *There exists a unique threshold λ_M such that* $D_i = \begin{cases} P_L R, & \text{if } \lambda < \lambda_F \\ D_F, & \text{if } \lambda > \lambda_F \end{cases}$

2. *Furthermore, $\lambda_F > \lambda_B$ if and only if* $\dfrac{R}{D_F} > \alpha^*$.

Lemma 5 suggests that bank i follows a threshold strategy if it believes that $\hat{D}_j > P_L R$.[21] To understand why, the chance to engage in risk shifting remains

[21] Bank i may choose to raise a large amount of equity so that it can acquire j even if i also receives L. In the appendix, I show that this strategy is never optimal as long as ϕ is not too high.

$q(1-q)$ even if bank i voluntarily raises extra equity at date 1. Therefore, bank i faces the same trade-off between the benefits of limited liability and the aversion to closure. Similarly, bank i issues extra equity to prevent potential closure only if it is not too costly, i.e., if accounting is not extremely informative.

However, the opportunity to engage in additional risk-shifting resulting from marking up indeed changes bank i's behavior, as reflected by $\lambda_F \neq \lambda_B$. The intuition is as follows. Suppose R is small and D_F is large; then the intermediate return $R - D_i - P_L R$ is negative even if bank i raises extra equity. Anticipating the possibility of being exposed to excessive default risk in the future, bank i becomes more inclined to take more risk at date 1. In other words, for λ that is close but less than λ_B, bank i raises the maximum deposits given $\hat{D}_j > P_L R$, but would raise extra equity given $\hat{D}_j < P_L R$. Therefore, marking up dampens the bank's incentive to issue extra equity and thus increases *systemic leverage*. In stark contrast, suppose R is large and D_F is small; then $R - D_i - P_L R$ is positive even if bank i chooses the maximum deposits. Bank i, in turn, anticipates that the potential acquisition will reduce its default risk and relies less on the benefits of limited liability. In other words, for λ that is close but greater than λ_B, bank i issues extra equity given $\hat{D}_j > P_L R$, but would raise the maximum deposits given $\hat{D}_j < P_L R$. Therefore, marking up can reinforce banks' incentives to issue extra equity and thus decrease *systemic leverage*.

With the above result, I fully characterize the rational expectation equilibrium:

Proposition 2. *Under fair value accounting, the regulator uses a P&A agreement whenever possible. In addition,*

1. *If* $\lambda > \max\{\lambda_B, \lambda_F\}$, $D_i = D_j = D_F$ *is the unique equilibrium.*

2. *If* $\lambda < \min\{\lambda_B, \lambda_F\}$, $D_i = D_j = P_L R$ *is the unique equilibrium.*

3. *If* $\min\{\lambda_B, \lambda_F\} < \lambda < \max\{\lambda_B, \lambda_F\}$, *there are two equilibria:*

   (a) when $\lambda_F > \lambda_B$, $D_i = D_F$ *and* $D_j = P_L R$, *or* $D_i = P_L R$ *and* $D_j = D_F$.

   (b) when $\lambda_F < \lambda_B$, $D_i = D_j = D_F$ *or* $D_i = D_j = P_L R$.

To understand Proposition 2, if the informativeness of accounting is too high, raising extra equity becomes too costly regardless of the possibility of additional risk shifting. As a result, it is a dominant strategy for both banks to raise the maximum deposits. Alternatively, if the informativeness is too low, preventing closure by issuing extra equity becomes more profitable regardless of the other bank's strategy. In other words, it is a dominant strategy for both banks to issue extra equity. Lastly, if the informativeness is intermediate, equilibira are *self-fulfilling*. In the first case, $\lambda_B < \lambda < \lambda_F$. Suppose bank i expects that bank j chooses the maximum deposits; then the best response for bank i is to issue extra equity, as shown in Lemma 5. In a similar fashion, anticipating that bank i will never be closed, bank j will in return raise the maximum deposits instead. Therefore, the two banks' decisions are *strategic substitution*. In the second case, $\lambda_F < \lambda < \lambda_B$. Suppose bank i expects that bank j chooses the maximum deposits; then bank i's best response is to raise the maximum deposits too. Similarly, if bank i expects bank j to issue extra equity, then it is optimal for bank j to issue extra equity as well. Therefore, the two banks' decisions are *strategic complement*.

2.3 Regulators' Resolution Costs

In this section, I study how fair value accounting affects the expected resolution costs for the bank regulator. Resolution costs are formally defined by the FDIC as the sum of the expenditures and obligations incurred for a given resolution method, including any immediate or long-term obligations and any direct or contingent liabilities for future payment, net of recoveries on assets of the failed bank. In my model, after closing an insolvent bank at date 3, the FDIC will either pay off depositors in the failed bank or subsidize the healthy bank to assist the acquisition depending on the resolution method. In addition, a bank may also fail after investments mature at date 4 if its cash flow are inadequate to pay off all depositors, and the FDIC will cover the shortfall.

This section is structured as follows: First, I disentangle marking *up* and marking *down* and study their effects separately. Next, I include both effects and examine whether fair value accounting as a whole increases or decreases resolution costs. Finally, I consider an alternative accounting regime—lower of cost or market and provide a comprehensive comparison.

2.3.1 Trade-offs: Marking down and Marking up

To parse out the effects of marking up and down, I examine the bank regulator's optimal intervention policy conditional on signal realizations (Dewatripont and Tirole 1994, Bertomeu et. al 2017). To simplify notation, for any signal realization $\tilde{Y}_i, \tilde{Y}_j$, the expected resolution costs given the regulator intervenes are denoted as $\mathbb{E}(\mathcal{C}_I|\{\tilde{Y}_i, \tilde{Y}_j\})$; the expected resolution costs given the regulator forbears are denoted as $\mathbb{E}(\mathcal{C}_{NI}|\{\tilde{Y}_i, \tilde{Y}_j\})$. In addition, total resolution costs are denote as $\mathcal{TC}$. Moreover, I assume both banks raise the maximum deposits to simplify the analysis.

Table 2.2: Expected Resolution Costs Conditional on Accounting Information

$\tilde{Y}_i, \tilde{Y}_j$	$\mathbb{E}(\mathcal{C}_{NI}\|\{\tilde{Y}_i, \tilde{Y}_j\})$	$\mathbb{E}(\mathcal{C}_I\|\{\tilde{Y}_i, \tilde{Y}_j\})$
H, L	$(1 - P_H)D_F + (1 - P_L)D_F$	$(D_F - P_L R) + EC_A$
L, H	$(1 - P_L)D_F + (1 - P_H)D_F$	$(D_F - P_L R) + EC_A$
L, L	$2(1 - P_L)D_F$	$2(D_F - \delta P_L R)$

As shown in Table 2, if both banks receive H, they are well capitalized and the regulator has no justification for intervention. If both banks receive L, the only resolution method is deposit payoffs. Therefore, the regulator can either forbear both banks, or close them and liquidate their assets in the secondary market. Lastly, if only one bank receives L, an interbank acquisition is sequential rational provided that the regulator intervenes. In other words, the regulator can either forbear the insolvent bank, or intervene and merge it with the healthy bank. Suppose the regulator chooses to merge the two banks; total resolution costs include two parts: the regulatory subsidy $D_F - P_L R$ and the expected costs of resolving the conglomerate EC_A, which is equal to

$$\begin{cases} (1-P_H)(1-P_L)(D_F+P_LR) & \text{if } R > D_F + P_LR \\ (1-P_HP_L)(D_F+P_LR) - [P_H(1-P_L)+P_L(1-P_H)]R & \text{otherwise} \end{cases} \tag{2.6}$$

Specifically, suppose $R \geq D_L + P_LR$, the conglomerate defaults only when both investments fail. In other words, the acquisition enhances the stability of the healthy bank, and I define it as the *coinsurance* effect. By contrast, if $R < D_i - P_LR$, the conglomerate defaults as long as one investment fails. In other words, the healthy bank becomes more vulnerable to failure after absorbing the insolvent bank, and I define it as the *contagion* effect. More precisely, the fundamental cause of contagion is that fair value accounting provides the healthy bank with free capital to engage in additional risk-taking, which in turn results in negative externality on the healthy bank. Hence, at the observational level, this phenomenon appears to be consistent with contagion, although it is essentially caused by banks' risk-shifting incentives. In appendix B, I show that if marking up is not allowed, the healthy bank must issue additional equity for the acquisition, and consequently financial contagion can be alleviated.

Proposition 3. *Marking down has net benefit on the regulator if and only if* $\delta > \delta_1$.

To understand the trade-off of marking *down*, we focus on the case in which both banks receive L. By forcing banks to mark their assets down following negative information, the regulator is able to intervene with insolvent banks and prevent further losses as opposed to forbearance. As a consequence, marking down reduces the regulator's costs of protecting depositors in troubled banks. However, if there is no other healthy bank to absorb this troubled bank, the regulator must sell the bank's assets in a less efficient secondary market, thus increasing the regulator's costs. To understand the net effect, suppose the liquidity discount is mild, there is a tension between its creditors and residual claimants: Depositors prefer to liquidate but shareholders always wish to continue. Since the regulator's objective is to protect depositors, the insolvent bank will be closed to prevent further losses. In other words, the benefit of marking down outweighs its cost. By contrast, if the liquidity discount is severe, the secondary market price for the bank's assets becomes so low that both depositors and shareholders prefer to continue rather than close, i.e., $\delta P_L R < P_L D_F$. However, marking down forces the regulator to intervene by revealing banks' insolvency, suggesting that the cost outweighs its benefit. Proposition 3 is consistent with prior literature such as Plantin et al. (2008), and the main difference is that they endogenize banks' liquidation decisions whereas I assume the regulator commits to an intervention policy.

Proposition 4. 1. *Marking up alleviates inefficient liquidation but may lead to contagion and increased costs of protecting the original depositors.*

2. *Marking up increases total resolution costs only when q is sufficiently high and $\frac{R}{D_F}$ and λ are adequately low.*[22]

However, the trade-off of marking *up* is more nuanced. To understand the intuition, I focus on the case in which one bank receives L and the other receives H. First, the acquisition eliminates inefficient liquidation in an illiquid market, thereby further reducing the regulator's costs of resolving the insolvent bank (as opposed to forbearance). On the other hand, this acquisition has two opposing effects on the healthy bank: On the asset side, the healthy bank obtains another risky investment which diversifies the default risk faced by depositors; on the liability side, this acquisition also leverages up the healthy bank and thus increases the default risk. To understand which effect on the *original* depositors, I discuss two cases separately. In the coinsurance case, suppose the healthy bank's own investment fails but the acquired investment succeeds, the original depositors can still be fully repaid. However, if there were no acquisition, the healthy bank would have failed and the original depositors would have received nothing from the bank. In other words, marking up reduces costs of protecting the original depositors. By contrast, in the contagion case, suppose the healthy bank's own investment succeeds but the acquired investment fails,

[22]More precisely, λ must be located in an intermediate region, as shown in Appendix A. Loosely speaking, λ is already sufficiently low in the contagion case, and thus I interpret this condition as low informativeness.

the healthy bank will fail and the original depositors are only partially repaid. Nevertheless, the original depositors would have been fully repaid by the bank if there were no acquisition. Therefore, marking up may increase the regulator's costs of the original depositors.

Furthermore, since the regulator's objective is to minimize total resolution costs, it is important to study the overall effect on all depositors. Proposition 4 suggests that marking up may increase the overall costs under certain conditions. First, most of banks' assets, such as mortgage or commercial loans, have a low probability of default ex ante. In addition, banks' investments may become less profitable during recessions, and they are also highly leveraged due to the capital crunch effect (Beatty and Liao, 2011). Under these conditions, if accounting is not adequately informative, the overall effect of marking up becomes negative. Therefore, I refer to these conditions altogether as when marking up increases overall resolution costs, or equivalently, marking up has net cost. The intuition is also simple. Suppose banks' profitability is low, the leverage is high, and the conglomerate realizes the intermediate return; then the shortfall to pay off all depositors increases, suggesting that marking up becomes more costly. When accounting is less informative, the information content of L decreases, which means that the healthy bank absorbs more risk in terms of mean preserving spreads after the acquisition. As a consequence, financial contagion is more likely and marking up decreases overall resolution costs.

2.3.2 Full Comparison: FV versus HC

In last section, I assume that both banks raise the minimum equity to isolate the effect of marking up and marking down. However, to make a full-fledged comparison between the historical cost versus fair value accounting, I need to include both tradeoffs and endogenous banks' capital structure decisions by Proportion 2.

First, since information $\tilde{Y}$ is not reported under historical cost accounting, the expected resolution costs are equal to $\mathcal{TC}_{HC} = 2(1-q)D_F$. Meanwhile, from Table

2 we know that

$$\mathop{\mathbb{E}}_{\{H,L\}\times\{H,L\}}\left[\mathbb{E}(\mathcal{C}_{NI}|\{\tilde{Y}_i,\tilde{Y}_j\})\right] = 2(1-q)D_F = \mathcal{TC}_{HC}$$

The expected resolution costs under historical cost accounting are equal to the case in which the regulator commits never to intervene. In other words, the only way to break the commitment is to obfuscate banks' information environment by adopting historical cost accounting.

In contrast, under fair value accounting, the regulator must intervene with the insolvent bank and choose the optimal resolution method. As a result, the expected resolution costs equal the weighted average of $\mathbb{E}(\mathcal{C}_I|\{\tilde{Y}_i,\tilde{Y}_j\})$ for all possible signal realizations:

$$\mathcal{TC}_{FV} = \mathop{\mathbb{E}}_{\{H,L\}\times\{H,L\}}\left[\mathbb{E}(\mathcal{C}_I|\{\tilde{Y}_i,\tilde{Y}_j\})\right]$$

Therefore, fair value accounting reduces the total resolution costs vis-à-vis if and only if $\mathcal{TC}_{FV} < \mathcal{TC}_{HC}$, and the comparison can be summarized as follows.

Proposition 5. *Fair value accounting reduces the total resolution costs if either condition is satisfied:*

1. *At least one bank issues extra equity.*

2. *The liquidity discount is mild, i,e., $\delta > \delta_2$.*

To understand the intuition of Proposition 5, I discuss four cases separately.

Case 1: If $\lambda < \min\{\lambda_B, \lambda_F\}$, both banks raise extra capital and thus no bank will be closed at the interim date. As a result, total resolution costs are $\mathcal{TC}_{FV} = 2(1-q)P_L R < \mathcal{TC}_{HC}$, and the regulator unambiguously prefers fair value accounting. The result is consistent with argument made by supports of fair value accounting: it improves banks' transparency and unveils credit deterioration (Bleck and Liu, 2007), which enables the regulator to take corrective actions in a more timely manner compared to historical cost accounting. Banks, faced with the threat of intervention, become more disciplined and take less risk (Bushman and Williams, 2012). The discipline effect, as manifested by decreased systemic leverage in my model, will consequently provide better protections on depositors and reduce the regulator's costs. Therefore, because of the *disciplinary* effect, the total resolution costs under fair value accounting are lower than historical cost accounting.

Case 2: If $\lambda_B < \lambda < \lambda_F$, one bank issues extra equity while the other chooses the maximum deposits in equilibrium. Although there are multiple equilibria in this case, the expected resolution costs are the same. Without loss of generality, I assume bank i issues extra equity so interbank acquisition could only happen by bank i absorbing j. Proposition 5 shows that fair value accounting unambiguously reduces the expected resolution costs, and the intuition is as follows. First, since bank i issues extra equity because of marking down, the expected costs of resolving bank i are already lower than historical cost accounting under which bank i would raise the maximum deposits. Second, lemma 5 implies that $\frac{R}{D_F}$ must be sufficiently large such that $\lambda_B < \lambda_F$, i.e., banks' investment is sufficiently profitable and leverage is not too high. For these two reasons, the intermediate return $R + D_j - P_L R$ will be enough to pay off both groups of depositors. In other words, fair value accounting does not lead to financial contagion. Therefore, because of the *partial disciplinary* effect, fair value accounting leads to lower total resolution costs.

Case 3: If $\lambda > \max\{\lambda_B, \lambda_F\}$, both banks raise the maximum deposits. It is obvious that

(i) fair value accounting reduces total costs if the regulator always prefers to intervene rather than forbear for any signal realization, i.e., $\mathbb{E}(\mathcal{C}_I|\{L, L\}) < \mathbb{E}(\mathcal{C}_{NI}|\{L, L\})$, $\mathbb{E}(\mathcal{C}_I|\{H, L\}) < \mathbb{E}(\mathcal{C}_{NI}|\{H, L\})$.

(ii) historical cost accounting reduces total costs if the regulator always prefers to forbear rather than intervene for any signal realization, i.e., $\mathbb{E}(\mathcal{C}_I|\{L, L\}) > \mathbb{E}(\mathcal{C}_{NI}|\{L, L\})$, $\mathbb{E}(\mathcal{C}_I|\{H, L\}) > \mathbb{E}(\mathcal{C}_{NI}|\{H, L\})$.

Otherwise, it is not obvious whether fair value accounting increases or decreases the total resolution costs. Figure 3 describes the regulator's decision tree under fair value accounting: First, the regulator has no justification to intervene with probability

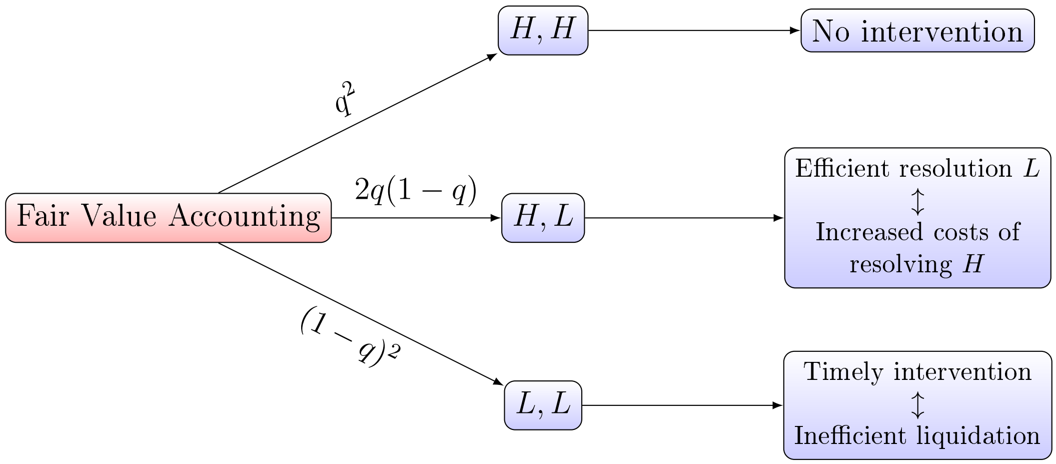

Figure 2.3: Fair Value Accounting: Marking down and Marking up

q^2. Second, with probability $(1-q)^2$, the regulator must close both banks and bear costs resulting from inefficient liquidation. Finally, the insolvent bank will be acquired by a healthy bank with probability $2q(1-q)$, which leads to the trade-off between efficient resolution of the insolvent bank versus increased cost of resolving the healthy bank. Therefore, fair value accounting involves a convex combination of the above two trade-offs and the expected costs are

$$2q(1-q)\underbrace{[EC_A - P_L R + (P_H + P_L - 1)D_F]}_{\text{net costs of contagion}} + 2(1-q)^2 \underbrace{P_L(D_F - \delta R)}_{\text{inefficient liquidation}}$$

The first term represents the potential costs of contagion net of the benefits early intervention in an efficient market, and the second term represents the trade-off between an inefficient liquidation and early intervention. Proposition 5 implies that fair value accounting is preferred to the regulator if and only if $\delta > \delta_2$. To understand the result algebraically, the first trade-off is independent of δ while the second trade-off leans toward fair value accounting for a higher δ. In summary, if both banks raise the maximum deposits, fair value accounting reduces total resolution costs if the liquidity discount is mild.

Corollary 1. *δ_2 is decreasing in R and increasing in D_F*

The comparative statics of are also intuitive: When banks' investment is more profitable and leverage is low, the regulator prefers to intervene rather than forbear.

As a result, it becomes more likely that fair value accounting is preferred, i.e., δ_2 decreases.

Case 4: If $\lambda_F < \lambda < \lambda_B$, there are two equilibria under fair value accounting which result in different expected resolution costs. If both banks issue extra equity, fair value accounting leads to lower total resolution costs same as case 1. However, if both banks raise the maximum deposits, the optimal regime depends on the liquidity discount for as shown in case 3. Furthermore, $\dfrac{R}{D_F}$ must be sufficiently small to satisfy $\lambda_F < \lambda_B$ based on Lemma 5. As a result, the threshold δ_2 will be extremely high, which means that fair value accounting will very possibly decrease total resolution cost. In summary, the regulator prefers fair value accounting in one equilibrium because of the disciplinary effect; whereas in the other equilibrium, it is quite likely that the regulator prefers historical cost accounting.

Figure 4 summarizes the above results.

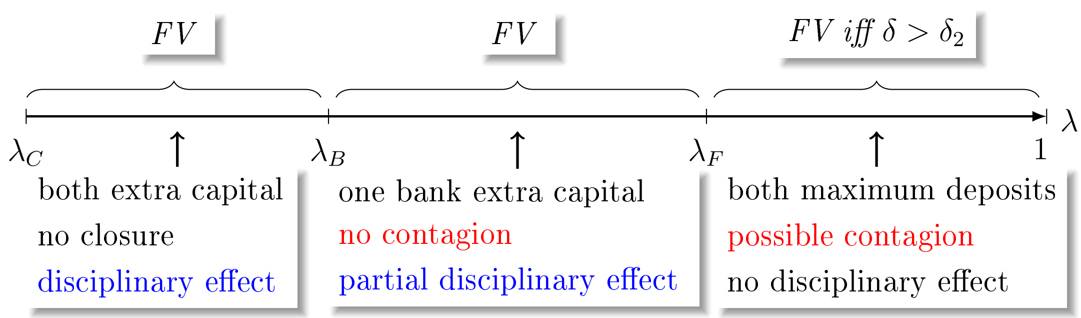

Figure 2.4: Accounting Informativeness and Regulators' Preferred Regime

2.3.3 Lower of Cost or Market

In this section, I consider an alternative regime—lower of cost or market and compare three accounting regimes collectively. Under the more conservative LCM regime (Gigler, Kanodia, Sapra, and Venugopalan, 2009), a bank is forced to mark its assets down at L, but not allowed to mark its assets up at H.[23] For simplicity, I only consider the case in which both banks raise the maximum deposits, so the only resolution

[23]The current regime in the U.S. is more like a hybrid of historical cost and fair value accounting. For example, mortgage loans and mortgage-backed securities held for sale—which constitute a significant portion of commercial banks' assets—are reported at the lower of cost or market value. In this regard, this paper responds the question raised by Hemmer (2008).

method for the regulator is direct payoffs.[24]

Lemma 6. *LCM reduces the expected resolution costs relative to fair value accounting if and only if* $\delta > \delta_3$.

Lemma 6 suggests that LCM reduces the regulator's costs compared to fair value accounting when the liquidity discount $1 - \delta$ is sufficiently low. To understand why, depositors (or equivalently the regulator) care more about bad news because their payoff is concave in the bank's value. However, the accounting treatment for good news still makes a difference because a healthy bank may obtain extra capital to absorb the insolvent bank by marking its assets up. As a result, the regulator can eliminate the inefficiency resulting from an illiquid market. Nonetheless, provided that the liquidity discount is already mild, the advantage of a peer bank relative to the secondary market becomes marginal, while the regulator still bears the costs of contagion. As a consequent, the regulator prefers LCM if $\delta > \delta_3$ as it eliminates contagion by prohibiting the healthy bank from marking up, while still facilitates regulatory intervention by marking the troubled bank's assets down.

The following Proposition summarizes the full comparison of three accounting regimes:

Proposition 6.
1. *The regulator prefers fair value accounting only if δ is intermediate.*
2. *The regulator never prefers fair value accounting if marking up has net cost.*

First, Figure 5 shows that for fair value accounting to dominate LCM, a peer bank must be sufficiently more efficient relative to the secondary market, i.e., $\delta < \delta_3$. At the same time, for fair value accounting to dominate historical cost accounting, the liquidity discount must be adequately low suggested by Proposition 5, i.e., $\delta > \delta_2$.

[24]In an untabulated extension, I find that the fixed capital structure could be endogenized by a small twist. Suppose that the informativeness λ is unobservable and follows a uniform distribution in the unit interval; I find that both banks will always raise the maximum deposits in equilibrium. In addition, as discussed in previous section, financial contagion can be prevented if any bank raise extra equity. In other words, the main concern for the regulator is the case in which banks raise the maximum deposits.

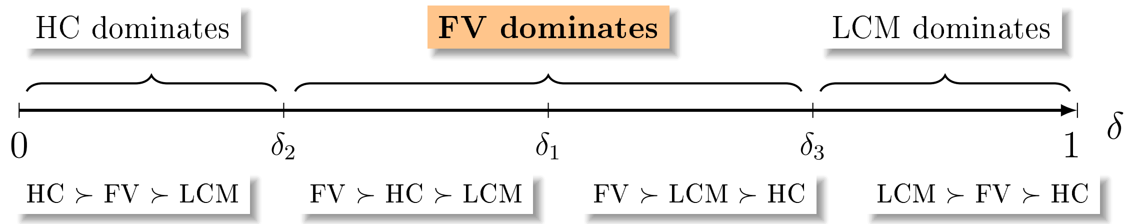

Figure 2.5: LCM Case 1: Net Benefit

Therefore, the regulator prefers fair value accounting only when the liquidity discount is intermediate.

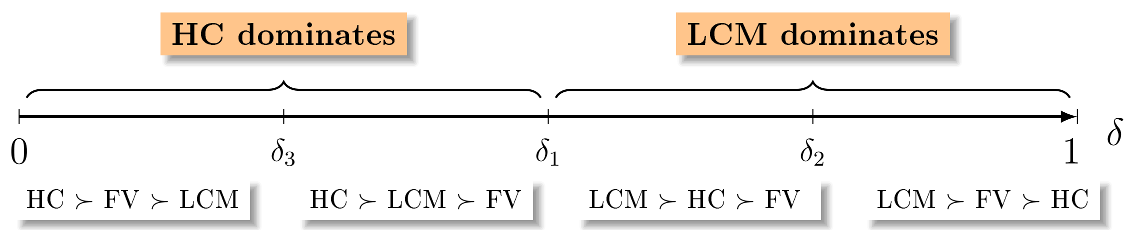

Figure 2.6: LCM Case 2: Net Cost

In stark contrast, the regulator never prefers fair value accounting is never optimal if marking up has net cost defined by Proposition 3. As shown in Figure 6, the region in which fair value accounting dominates historical cost becomes so small, i.e., δ_2 is very high. As a result, as long as $\delta > \delta_2$, the advantage of a peer bank relative to the secondary market becomes quite marginal, and LCM can further reduce total resolution costs compared to fair value accounting. In a similar fashion, when the liquidity discount is severe, the optimal accounting regime is historical cost as any inefficient liquidation could be prevented.

2.4 Extensions

2.4.1 Policy Implications

In this subsection, I discuss some interesting policy implications for bank regulators and accounting standard setters.

First, the recent move from the incurred loss model to the current expected credit loss (CECL) model is quoted as one of the biggest changes in banks' financial reporting. In fact, one of the most well-known criticisms of the incurred loss model is the "too little too late" issue: The combination that the loss must be both "probable" and "reasonably estimable" is rather restrictive, which often leads to delayed loss recognition. In that regard, the CECL model removes the "probable" threshold and requires banks to estimate the expected losses at the point when credits are originated, and therefore redefines accounting for credit losses as "measurement of banks' risk", rather than "recognition of banks' losses".[25] If more information becomes available subsequently, banks should update their estimates accordingly: Following positive information, a healthy bank can revise its estimate up and thus obtains extra capital, which further allows the bank to take more risk. In other words, the CECL model comprises both marking up and marking down, similar to fair value accounting studied in the model. Therefore, the the seemingly perfect CECL model may lead to financial contagion and *increase* bank regulators' resolution costs relative to the incurred loss model, which is an unintended consequence and has not been discussed before.

Corollary 2. *More informative accounting may* ***not*** *necessarily reduce the expected resolution costs, i.e.,* $\dfrac{\partial \mathcal{TC}_{FV}}{\partial \lambda}$ *is ambiguous.*

Corollary 2 suggests that accounting informativeness may hurt bank regulators for two reasons: First, had banks always raised extra capital to prevent closure, more informative accounting would make the regulator better off because banks will voluntarily hold more capital. However, as accounting becomes more informative, issuing extra equity to prevent closure becomes more costly and banks are more inclined to raise the maximum deposits, i.e., $\mathcal{TC}_{FV}$ is discontinuous at λ_B and λ_F. Second, suppose banks raise the maximum deposits; I decompose total resolution

[25] Since the CECL model conveys a longer "life of loan" analysis, the risk of earnings management—especially those factors reflected in forecasts of the future—could significantly increase. This argument is consistent with one famous criticism of fair value accounting that it impairs the reliability of accounting. For example, Beatty, Chamberlain, and Magliolo (1995) provide empirical evidence that banks strategically change their financial reporting to achieve primary capital, tax, and earnings goals. Kilic, Lobo, Ranasinghe, and Sivaramakrishnan (2012) find that commercial banks under SFAS 133 rely more on loan loss provisioning to smooth earnings.

costs as follows:

$$\mathcal{TC}_{FV} = \underbrace{q^2[2(1-P_H)D_F]}_{\text{both receive } H} + \underbrace{(1-q)^2\,[2(D_F-\delta P_L R)]}_{\text{both receive } L} + \underbrace{2q(1-q)[D_F - P_L R + EC_A]}_{\text{one } H \text{ and one } L}$$

The first term is decreasing in λ because the information content of H increases, which means the healthy bank is less likely to default. Nonetheless, the second and third term are both increasing in λ, because the information content of L also increases, suggesting that credit deterioration becomes more severe. As a result, the salvage value of the insolvent bank's assets decreases regardless of the resolution method. In summary, too informative accounting may distort banks' incentives to issue extra equity, and diminish the benefit of regulatory intervention since banks' distressed assets becomes worthless by the time of intervention.

Corollary 2 sheds light on the debate between the bank regulator and accounting standards setters over the goals of banks' financial reporting. The mission of prudential regulation is to enhance financial stability and to reduce systemic risk, whereas the purpose of financial reporting is to provide decision-useful information to existing and potential investors. These tasks often overlap, but are not the same. However, bank regulators often criticize that some accounting standards, such as fair value accounting, could have impaired financial stability even though they provide more relevant information. In response to these criticisms, Robert H Herz, the former chairman of the Financial Accounting Standard Board (FASB), recommended that the setting of accounting standards and the setting of regulatory capital and reserves should be decoupled.[26] Even though bank regulators are able to adjust GAAP number with so-called prudential filters, banks' financial reporting remains a crucial factor in calculating regulatory capital. For example, the informative of accounting is determined by the bank's measurement rules, loan loss provision models, etc., which are determined by the FASB's accounting standards rather than bank regulators. As

[26] In the FASB's Conceptual Framework, they explicitly state that, the regulator's information needs and maintaining financial stability are *not* their primary objective, because "Handcuffing regulators to GAAP or distorting GAAP to always fit the needs of regulators is inconsistent with the different purposes of financial reporting and prudential regulation."

a result, bank regulators may be better off deviating from accounting numbers. In this simple model, I potentially find conditions in which the mission of prudential regulation and the objective of financial reporting may not coincide, and thus call for effective coordination between the two parties.

Lastly, I decompose total resolution costs into two parts: The expected immediate costs incurred at date 3 are defined as short-term costs, i.e., $\mathcal{ST}$. Meanwhile, the expected future obligations that will be incurred at date 4 are defined as long-term costs, i.e., $\mathcal{LT}$.

Corollary 3. *$\mathcal{ST}_{LCM} > \mathcal{ST}_{FV} > \mathcal{ST}_{HC}$; $\mathcal{LT}_{HC} > \mathcal{LT}_{FV} > \mathcal{LT}_{LCM}$.*

Corollary 3 links accounting measurement to myopia of bank regulators. In reality, bank regulators may care more about short-term than long-term costs because they are resource constrained and are concerned about maintaining the deposit insurance fund (Gallemore, 2016). Corollary 3 suggests that fair value accounting saves short-term costs vis-à-vis LCM, because the regulator avoids inefficient liquidation with probability $2q(1-q)$. Meanwhile, historical cost can further reduce short-term costs as there is no interim costs at date 3. However, short-term benefits also come with long-term costs. Historical cost *delays*, rather than eliminate short-term costs, because those insolvent institutions that could have been closed earlier are likely to fail anyway. In that regard, LCM and fair value accounting can prevent the accumulation by unraveling deterioration of asset quality immediately. Meanwhile, LCM can alleviate financial contagion and thus lead to the lowest long-term costs. Therefore, the above results provide a plausible solution to mitigate regulatory myopia, i.e., adopting more conservative accounting measurement regimes such as LCM.

2.4.2 Social Costs of Bank Failures

A bank failure occurs when it is unable to meet the obligations to its depositors because of insolvency or illiquidity. The literature has documented two types of costs associated with a bank failure: the direct monetary costs paid from insurance funds to depositors; and the nonmonetary costs incurred to the society. The social costs could arise because: (i) A bank failure decreases the availability of banking services, especially to smaller communities, and thus disturbs real economic activities. (ii) Depositors lose confidence in the financial system as a whole, leading to panic-driven runs on other healthy institutions. (iii) A nontransferable charter is required by the legislation for a bank to take deposits and make loans, and becomes forfeited upon the failure. Endogenizing these social costs requires a general equilibrium model or a coordination game among investors (Gao and Jiang, 2018; Goldstein and Sapra, 2014), which is beyond the scope of this paper. For simplicity, I assume that any incidence of failure will impose a fixed costs $\mathcal{F}$ on the regulator, and the expected social costs are denoted as $\mathcal{SC}$ (Corona, Nan, and Zhang, 2016).

Under historical cost accounting, a bank failure only occurs at date 4 when its investment fails, so $\mathcal{SC}_{HC} = 2(1-q)\mathcal{F}$.

Under LCM, a bank could fail at date 3 due to insolvency, or at date 4 when its investment fails, i.e.,

$$\mathcal{SC}_{LCM} = 2\left[(1-q) + q(1-P_H)\right]\mathcal{F} \tag{2.7}$$

Lastly, under fair value accounting, the insolvent bank's service is protected if the conglomerate does not default at date 4. In contrast, if the conglomerate defaults, both banks fail and their services are lost. Define $Pr(Con)$ as the probability of default for the conglomerate.

$$\mathcal{SC}_{FV} = \left[2(1-q)^2 + 2q^2(1-P_H) + 2q(1-q) \times 2Pr(Con)\right]\mathcal{F} \tag{2.8}$$

Proposition 7. *1. Historical cost accounting always leads to the lowest social costs.*

2. Fair value accounting leads to higher social costs than LCM if and only if $R < 2D$ and λ is intermediate.

First, historical cost always leads to lower social costs than fair value and LCM accounting because noisy accounting signals inevitably result in type Ierror: a bank fails at the interim date due to insolvency even though it could have survived without intervention. Second, the comparison between LCM and fair value accounting depends on circumstances: In the coinsurance case, an interbank acquisition not only saves the banking services of the troubled institution, but also reinforces the stability of the healthy bank, thereby leading to positive net effect. In contrast, the acquisition protects the troubled bank's service while put excessive risk on the healthy bank's service in the contagion case. As a result, the net effect could be negative if the λ is smaller and sufficiently close to $1 - \dfrac{R - D_F}{qR}$, i.e., when the informativeness of accounting is intermediate.

Conclusion

3.1 Discussion

3.1.1 Marking up in Practice

The interaction between fair value accounting and financial contagion has received much attention by accounting researchers in the last decade. The empirical evidence, however, remains mixed. For example, Bhat, Frankel, and Martin (2011) and Khan (2010) find supporting evidence that fair value accounting is associated with an increase in contagion among banks. Laux and Leuz (2009, 2010) and Xie (2016) find no evidence that fair value accounting has contributed to the financial crisis in 2007. A typical argument is that many types of banks' assets are not recorded at the fair value; in addition, for certain types of assets that are recorded at fair value, unrealized gains or losses will directly enter other comprehensive income and thus have no impact on regulatory capital (Laux and Leuz, 2009, 2010). Since the main contribution of this paper is the novel trade-off of marking up, the following question would naturally arise: Does marking up exist under current accounting standards?

The answer is positive and I will give two examples. First, banks hold a large amount of investment securities classified as held to maturity, available for sale or trading assets. In practice, held to maturity securities are measured at historical cost while the other two categories are measured at fair value; furthermore, unrealized gains or losses for trading assets will directly affect banks' net income and consequently regulatory capital. As for large banks, trading assets constitute around 8% of their total assets, which are economically significant. Second, fair value option (ASU

Subtopic 825-10 or IAS 39) allows business entities to elect to measure most financial instruments and many other items at fair value. Subsequently, unrealized gains and losses on items for which the fair value option has been elected are reported in net income. In reality, fair value option is not widely used by banks possibly because it leads to excessive volatility of earnings or because banks face competition in the deposit market (Corona et al., 2017). Nevertheless, the economic consequence could have been huge had banks chosen to use fair value option for all assets and liabilities.

More importantly, accounting has recently moved towards more fair value based, for example, the change of loan loss provision models, therefore marking up may become more prevalent in the future. In that regard, my results imply that marking up *can* lead to significant losses for bank regulators, which has not been shown in prior literature.

3.1.2 Regulation and Commitment

A crucial assumption in the model is that prudential regulation entails regulators' commitment to intervene with troubled banks. In this section, I justify this assumption from several perspectives.

First, there is a time inconsistency issue with respect to commitment: Even though commitment seems inefficient ex post, it could be optimal from an ex ante standpoint because banks' capital structure decisions become different without commitment. The issue of time inconsistency is a common feature in other studies on policy making and accounting standards setting. For example, Arya and Glover (2006) find a principal's ex post optimal bailout policy can decrease the incentive of agents to exert effort ex ante. I only discuss a special case in the text and leave detailed proofs to Appendix B. Suppose the regulator lacks commitment power and forbearance is ex post optimal for any signal realization; in return, banks will anticipate the regulator's sequential rationality and thus always raise the maximum deposits. Therefore, the lack of commitment can *dampen* the disciplinary effect resulting from marking down.

Second, managers of distressed banks have incentives to take a "gambling for resurrection" strategy without intervention, because downside risk is completely borne by depositors. This moral hazard issue has been broadly studied in the literature (Corona et al., 2017, 2014; Lu et al., 2016); one notorious example is the S&L crisis in the 1980s. Due to lack of regulatory supervision and virtually nonexistent market discipline, many insolvent institutions adopted *go-for-broke* strategies or took fraudulent practices, such as absconding money from the bank. Widespread malpractices finally led to catastrophic losses, which could have been reduced had regulators closed the insolvent thrifts.

Third, the bank regulator faces reputation losses and market monitoring. In a dynamic world, forbearing troubled banks impairs the regulator's reputation because banks believe the regulator is likely lenient. As a response, banks will engage in more intensive risk taking. In addition, since the bank's insolvency status is publicly observable, the regulator will face great pressure from the public for failing to fulfill its obligation.

Lastly, other mechanisms also exist in reality to ensure the commitment: (i) Formal interventions, such as enforcement actions, are always legally enforceable. As a result, unsound banks are subject to supervision by a prudential regulator. (ii) The Federal Deposit Insurance Corporation Improvement Act of 1991 requires the regulator to take "prompt corrective actions" (PCA) when the depository institutions are critically undercapitalized: the objective of PCA is to restrict the regulator's ability to delay intervention. (iii) Various public disclosures, such as banks' financial statements, call reports, etc., increase bank's transparency and make it more difficult for the regulator to exercise forbearance. For example, Gallemore (2016) finds that bank financial reporting opacity, measured by delayed loan loss recognition, is negatively associated with regulatory intervention. Furthermore, the association is not driven by opacity that inhibits the effectiveness of monitoring, but driven by providing an information environment within which to practice forbearance.

3.1.3 Capital Regulation

Under current capital regulation in the U.S., there are five levels of capital adequacy: a bank is (i) well capitalized if the capital ratio is above 8%; (ii) adequately capitalized if above 6%; (iii) undercapitalized if below 6%; (iv) significantly undercapitalized if below 4%; (v) critically undercapitalized if below 2%. For simplicity, I assume banks do not incur monetary costs when they are undercapitalized but not critically undercapitalized (2%-6%). In reality, banks that fail to meet minimum capital requirement are subject to regulatory scrutiny, such as cease and desist orders. In addition, banks' operations are also restricted until the problem is solved; for example, banks must reduce asset growth, increase earnings retention, etc. Because of these restrictions, banks' profit will decline significantly, even though they may still be able to continue to operate. In that regard, a possible extension of this model is to include partial liquidation, but the main trade-off should not change.

More importantly, one caveat of this paper is that the exogenous prudential regulation cannot be justified within the model. Nevertheless, I will separately discuss how bank closure and minimum capital requirement become optimal by adding some more components in the model.

First, any bank closure before asset maturity decreases social surplus because outsiders are always less inefficient in generating profits. In other words, from the social planer's perspective, depositors (or equivalently the regulator) should never have the decision right as they are too keen to liquidate. Nevertheless, this argument does not hold if banks also face the moral hazard problem described in Section 6.2 (Lu et al., 2016). Specifically, if insolvent banks are allowed to continue, managers' "gamble for resurrection" strategy can further aggravate welfare losses, suggesting that bank closure is also optimal for the social planer.

In addition, the FDIC, who aims to reduce expected resolution costs, is delegated as the bank regulator in my model. However, why banks are not required to be more, or even completely equity financed if that is the only objective for the regulator? The answer is unfortunately outside of the model: bank regulators, such as the Federal Reserve and the Office of Currency and Comptroller, have other missions than to reduce resolution costs. For example, banks can provide liquid, information-insensitive securities such as demand deposits that are valuable to investors. Gorton and Winton

(2017) build a general equilibrium model and find that raising the capital requirement reduces short-term debts, because the equity holders will substitute for debt holders. Dang, Gorton, Holmström, and Ordonez (2017) find that banks keep the details of their loans secret to produce safe and money-like liquidity. Furthermore, the minimum capital requirement is converging to a uniform standard globally, primarily designated by the Basel Committee on Banking Supervision, and even bank regulators such as the FDIC have limited discretion in determining ϕ. Therefore, the optimal minimum capital requirement will be interior after taking into account liquidity provision role, which is also consistent with reality.

3.2 Concluding Remarks

At the center of criticism of fair value accounting is the vicious circle of falling prices during recessions, and how it leads to financial contagion and, in turn, destabilizes the economy. The basis for this argument is that when the market is illiquid and distressed, marking down to such an inefficient market could result in more failures of otherwise healthy institutions. In this paper, I deviate from the prior literature and focus on the costs and benefits of marking up.

I develop a simple model to examine how fair value accounting can lead to financial contagion and thus increase resolution costs for the bank regulator. By forcing banks to mark assets down, the regulator obtains an early signal of credit deterioration to take early intervention, thereby preventing further damages. Meanwhile, by marking its assets up, a healthy bank obtains additional free capital to absorb a failed bank, which is also a double-edged sword. On the one hand, the regulator avoids liquidating the failed bank's assets in a less efficient secondary market, and thus saves resolution costs. On the other hand, the acquisition may also impose excessive default risk on the otherwise healthy bank and leads to contagion. Therefore, the net effect of marking up is unclear. I find that marking up increases overall resolution costs when banks' investments are less profitable, banks are highly leveraged and accounting signal is not adequately informative. As a remedy, lower of cost or market accounting can prevent financial contagion, because it forbids a healthy bank from obtaining capital through marking up. Therefore, the healthy bank must raise external equity to acquire the troubled bank, which protects depositors and reduces resolution costs. After introducing LCM, I find that the regulator prefers fair value accounting only when the liquidity discount in the secondary market is intermediate.

In addition, this paper also provide interesting policy implications. I find that more informative accounting information not only distorts banks' incentives to raise more equity, but may also diminish the value of regulatory intervention. As a result, bank regulators may prefer less informative but potentially more timely information, which helps to explain the debate over the objective of financial reporting between bank regulators and accounting standard setters. Finally, contrary to the popular view that the CECL model strictly dominates the incurred loss model, I find that financial contagion may emerge after introducing and CECL model and bank regulators' resolution costs may increase.

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Appendix A

A.1 Proofs

Proof of Lemma 1

Proof. If accounting is not informative, i.e., $\lambda < 1 - \frac{D_F}{qR} \doteq \lambda_C$, the bank will choose $D_B = D_F$.

If accounting is sufficiently informative and $D > P_L R$, the expected payoff is $qP_H(R-D)-(I-D)$. Since it is strictly increasing in D, the bank chooses $D_B = D_F$. If $D < P_L R$, the expected payoff is $q(R-D)-(I-D)$. Since it is increasing in D, the bank chooses $D_B = P_L R$. So the bank's problem becomes

$$\max_{D=\{D_F, P_L R\}} \Pi_B(D) = \begin{cases} qP_H(R-D_F)-(I-D_F) & \text{if } D = D_F \\ q(R-P_L R)-(I-P_L R) & \text{if } D = P_L R \end{cases}$$

Therefore, the bank chooses $D_B = P_L R$ if and only if

$$qP_H(R-D_F)-(I-D_F) < q(R-P_L R)-(I-P_L R) \Leftrightarrow \lambda < 1 - \frac{D_F}{2qR - qD_F}$$

Denote the RHS as λ_B. I have

$$\Rightarrow D_B = \begin{cases} P_L R & \text{if } \lambda_C < \lambda < \lambda_B \\ D_F & \text{otherwise} \end{cases}$$

□

Proof of Lemma 2

Proof. I prove that the capital ratio after the acquisition is above ϕ.

$$\frac{E_i^H}{P_H R + P_L R} = \frac{P_H R - D_i}{P_H R + P_L R} \geq \phi$$
$$\Leftrightarrow (1-\phi)P_H R - \phi P_L R \geq D_i$$

The LHS is strictly increasing in λ, and the minimum must be reached at $\lambda = 1 - \frac{D_j}{qR}$, which leads to

$$\Leftrightarrow q(1-\phi)R > qD_i + D_j(2q\phi - q + \phi + 1)$$

The RHS is strictly increasing in D_i and D_j, so a sufficient condition is that when $D_i = D_j = (1-\phi)I$, the above inequality still holds.

$$\Leftrightarrow \phi < \frac{qR - I}{(2q-1)I}$$

By assumption that $\phi < \bar{\phi}$, the above inequality always holds. □

Proof of Lemma 3

Proof. I only need to prove $\Delta^M > P_H(R - D_i)$.

$$P_H P_L(2R - P_L R - D_i) + (P_H + P_L - 2P_H P_L)max\{0, R - P_L R - D_i\}$$
$$> P_H(R - D_i)$$
$$\Leftrightarrow P_H(1-P_L)(P_L R - R + D_i) + (P_H + P_L - 2P_H P_L)max\{0, R - P_L R - D_i\} > 0$$

(i) If $R - P_L R - D_i < 0$, the above inequality $\Leftrightarrow P_H(1-P_L)(P_L R - R + D_i) > 0$.

(ii) If $R - P_L R - D_i \geq 0$, the above inequality $\Leftrightarrow 2P_L(P_H - 1)(P_L R - R + D_i) > 0$.

Therefore, the healthy bank is always better off after acquiring the insolvent bank. □

Proof of Lemma 5

Proof. Bank i chooses the maximum deposits if and only if the following inequality is satisfied.

$$\begin{gathered}\Pi_1^M(D_F,\hat{D}_j) > \Pi_2^M(P_LR,\hat{D}_j) \\ D_F + q^2P_H(R-D_F) - [(1-q)P_L + q^2P_H](R-P_LR) - P_LR \\ -q(1-q)(\Delta^M(P_LR) - \Delta^M(D_F)) > 0\end{gathered} \tag{A.1}$$

The objective is to show that equation (A.1) increases in λ. By equation (1.3), we also have

$$\begin{gathered}\Delta^M(D_F) = P_HP_L(2R-P_LR-D_F) + (P_H+P_L-2P_HP_L)\max\{R-P_LR-D_F,0\} \\ \Delta^M(P_LR) = P_HP_L(2R-2P_LR) + (P_H+P_L-2P_HP_L)\max\{R-2P_LR,0\}\end{gathered}$$

Case 1: $R > 2D_F$. In this case, the intermediate return is always positive, so $\Delta^M(P_LR) - \Delta^M(D_F) = P_HP_L(D_F-P_LR) + (P_H+P_L-2P_HP_L)(D_F-P_LR)$ which is equal to

$$(1-q)\Big\{(\lambda-1)qR\left((1-\lambda)^2(q^3-q^2)+2\right) + D_F\left((1-\lambda)^2(q^3-q^2)-\lambda q+q+1\right)\Big\}$$

Define the equation as $G_1(\lambda) \Rightarrow$

$$\begin{aligned}G_1'(\lambda) &= q(1-q)\big[D_F\left(2(\lambda-1)(q^2-q)-1\right) + R(3(\lambda-1)^2(q^3-q^2)+2\big)\big] \\ &> q(1-q)\big[\frac{R}{2}\left(2(\lambda-1)(q^2-q)-1\right) + R(3(\lambda-1)^2(q^3-q^2)+2\big)\big] \\ &= \frac{q(1-q)R}{2}\big[6(\lambda-1)^2q^3 - 2\left(3\lambda^2-7\lambda+4\right)q^2 - 2(\lambda-1)q + 3\big] > 0\end{aligned}$$

Therefore, $G_1(\lambda)$ is strictly increasing in λ, and $\hat{D}_j > P_LR \Rightarrow 1 > \lambda > 1 - \dfrac{\hat{D}_j}{qR} > \lambda_C$. Now I just need to check the two corners: When $\lambda \to 1$, $G_1(1) \to (1-q)D_F > 0$; when $\lambda \to \lambda_C$, $G_1(\lambda_C) \to \dfrac{(1-q)D_F(D_F-R)}{R} < 0$. So there exists a $\lambda_F \in (\lambda_C, 1)$, such that $G_1(\lambda) > 0$ if and only if $\lambda > \lambda_F$.

Case 2: $R < 2D_F$. In this case, the intermediate return could be negative.

(i) If $R - P_L R < P_L R \Rightarrow \Delta^M(P_L R) - \Delta^M(D_F) = P_H P_L(D_F - P_L R)$. Equation (A.1) is equivalent to

$$\Pi_1^M(D_F, \hat{D}_j) - \Pi_2^M(P_L R, \hat{D}_j) = G_1(\lambda) + (P_H + P_L - 2P_H P_L)(D_F - P_L R)$$

Define this equation as $G_2(\lambda)$. Because both $P_H + P_L - 2P_H P_L$ and $D_F - P_L R$ are strictly increasing in λ, $G_2^{'}(\lambda) > 0$. In addition, when $\lambda \to \lambda_C$, $G_2(\lambda_C) \to \dfrac{D_F(1-q)^2(D_F - R)}{R} < 0$.

(ii) If $R - D_F < P_L R < R - P_L R \Rightarrow \Delta^M(P_L R) - \Delta^M(D_F) = P_H P_L(D_F - P_L R) + (P_H + P_L - 2P_H P_L)(R - 2P_L R)$. Equation (A.1) is equivalent to

$$\Pi_1^M(D_F, \hat{D}_j) - \Pi_2^M(P_L R, \hat{D}_j) = G_1(\lambda) + (P_H + P_L - 2P_H P_L)(R - P_L R - D_F)$$

Define the equation as $G_3(\lambda)$. Since $(P_H + P_L - 2P_H P_L)$ and $(R - P_L R - D_F)$ are both increasing in λ, $G_3^{'}(\lambda) > 0$. In addition, when $\lambda \to \lambda_B$, $G_3(\lambda_B) > 0$.

(iii) If $P_L R > R - P_L R$, we are back to case 1, and when $\lambda \to 1$, $G_1(1) > 0$.

Therefore, $\Pi_1^M(D_F) - \Pi_2^M(P_L R)$ is increasing in λ. When $\lambda \to \lambda_C, \Pi_1^M(D_F) < \Pi_2^M(P_L R)$, when $\lambda \to 1, \Pi_1^M(D_F) > \Pi_2^M(P_L R)$. Therefore, there exists a threshold λ_F such such that $\Pi_1^M(D_F) > \Pi_2^M(P_L R)$ if and only if $\lambda > \lambda_F$.

Next I compare the two thresholds λ_B and λ_F.

$$G_1(\lambda_B) = \frac{(D_F)^3(1-q)(R - D_F)}{(D_F - 2R)^3} < 0$$
$$G_2(\lambda_B) = \frac{2D_F(1-q)(R - D_F)^2(2qR - D_F)}{(2R - D_F)^3} > 0$$

To simplify notation, I define $\dfrac{R}{D_F} \doteq \alpha$.

1. If $\alpha \geq 2$, because $G_1(\lambda_B) < G_1(\lambda_F) = 0 \Rightarrow \lambda_B < \lambda_F$.

2. If $\alpha < 2$ and λ_B is such that $R - D_F > P_L R$, i.e., $1 - 4\alpha + 2\alpha^2 > 0$, for the same reason above, we have $\lambda_B < \lambda_F$. The inequality of α is equivalent to

$\alpha > \frac{2+\sqrt{2}}{2}$.

3. If $\alpha < 2$ and λ_B is such that $\lambda_B < 1 - \frac{1}{2q}$, i.e., $\alpha < \frac{3}{2}$, we have $G_2(\lambda_B) > G_1(\lambda_F) = 0 \Rightarrow \lambda_B > \lambda_F$.

4. If $\alpha < 2$ and λ_B is such that $R - D_F < P_L R < R - P_L R$, i.e., $\frac{3}{2} < \alpha < \frac{2+\sqrt{2}}{2}$, we have $G_3(\lambda_B) \propto -8\alpha^4 q + 4\alpha^3(6q+1) - 2\alpha^2(9q+7) + \alpha(q+13) - 2$. After some algebra, I find that the RHS is strictly decreasing in α. When $\alpha \to \frac{3}{2}$, the RHS equals $\frac{(3q-1)}{2} > 0$; when $\alpha \to \frac{2+\sqrt{2}}{2}$, the RHS equals $-\frac{(1-q)}{\sqrt{2}} < 0$. So there exists a threshold α_1^*, such that $G_3(\lambda_B) < 0$ if and only if $\alpha > \alpha_1^*$.

In summary, $\lambda_B < \lambda_F$ if and only if $\alpha > \alpha_1^*$.

The comparative statics are straightforward by the implicit function theorem. Suppose $G_k(\lambda_F) = 0$ and $k \in \{1, 2, 3\}$.

$$\frac{\mathbf{d}\lambda_F}{\mathbf{d}\alpha} = -\left(\frac{\partial G_k(\lambda)}{\partial \alpha}\right) \Big/ \left(\frac{\partial G_k(\lambda)}{\partial \lambda}\right) > 0$$

Lastly, I rule out the strategy of raising extra capital to be able to acquire j even if $Y_i = L$. To achieve that goal, bank i needs to further lower its leverage such that $D_i \leq P_L R - 2\phi P_L R \doteq D_S$. The expected payoff is

$$\Pi_3^M(D_i) = \underbrace{q^2(R - D_i)}_{j \text{ receives } H} + \underbrace{q(1-q)\Delta^M(D_i)}_{i \text{ receives } H,\ j \text{ receives } L} + \underbrace{(1-q)^2\Delta_1^M(D_i)}_{i \text{ receives } L,\ j \text{ receives } L} - (I - D_i)$$

where $\Delta_1^M(D_i) = (P_L)^2(2R - D_i - P_L R) + 2P_L(1-P_L)\max\{(R - D_i - P_L R), 0\}$. I prove that $\Pi_3^M(D_S) < \Pi_2^M(P_L R)$ as long as $\phi < \bar{\phi}$.

$$\begin{aligned}
\Pi_2^M(P_L R) - \Pi_3^M(D_S) &= [(1-q)P_L + q^2 P_H](R - P_L R) + 2\phi P_L R - q^2(R - D_S) \\
&\quad - q(1-q)(\Delta^M(D_S) - \Delta^M(P_L R)) - (1-q)^2\Delta_1^M(D_S) \\
&= (1-q^2)(2\phi P_L R) + (1-q)^2(P_L(R - P_L R) - \Delta_1^M(D_S)) \\
&\quad - q(1-q)(\Delta^M(D_S) - \Delta^M(P_L R))
\end{aligned}$$

Since $\Delta_1^M(D_S) - P_L(R - P_L R) > 0$ and $\Delta^M(D_S) - \Delta^M(P_L R) > 0$, I only need to prove the inequality when both terms reach the maximum, i.e., if $R > 2P_L R$. In this case,

$$\begin{aligned}\Pi_2^M(P_L R) - \Pi_3^M(D_S) &\propto -\lambda(3-2\phi) - 2(\lambda-1)^2 q^3 + (\lambda-1)q^2(4\lambda+2\phi-7) \\ &-q\left(2\lambda^2 + 2\lambda(2\phi-5) - 4\phi + 9\right) - 4\phi + 5 \doteq G_4(\lambda) \\ &\Rightarrow G_4^{'}(\lambda) \propto -(1-q)^2(4(\lambda-1)q - 2\phi + 3) < 0 \\ &\Rightarrow G_4(\lambda) > G_4(1) = 2 - q - 2\phi > 0\end{aligned}$$

Therefore, bank i will never choose D_S in equilibrium. □

Proof of Proposition 2

Proof. Case 1: $\lambda_F > \lambda_B$. If $\lambda > \lambda_F$, it is a dominant strategy to choose the maximum deposits regardless of the conjecture. If $\lambda < \lambda_B$, it is a dominant strategy to issue extra equity. However, if $\lambda_B < \lambda < \lambda_F$, suppose bank i believes $\hat{D}_j = D_F$, the optimal capital structure is $D_i = P_L R$. On the other hand, given bank j believes $\hat{D}_i = P_L R$, the best response is $D_j = D_F$. Therefore, the conjecture is consistent with the actual decisions for both i and j, suggesting the rational expectation condition is satisfied. Alternatively, suppose bank i believes $\hat{D}_j = P_L R$, $D_i = D_F$, it is optimal for bank j to choose $D_j = P_L R$.

Case 2: $\lambda_F < \lambda_B$. In a similar fashion, if $\lambda > \lambda_B$, the dominant strategy is $D = D_F$, and if $\lambda < \lambda_F$, the dominant strategy is $D = P_L R$. If $\lambda_F < \lambda < \lambda_B$, suppose bank i believes $\hat{D}_j = D_F$, it will choose $D_i = D_F$, which in turn supports $D_j = D_F$ for bank j given rational expectation. Nonetheless, suppose bank i believes $\hat{D}_j = P_L R$, the best response is $D_i = P_L R$, which in turn supports $D_j = P_L R$ given rational expectation. □

Proof of Proposition 3

Proof. When both banks receive L, the regulator prefers to intervene if and only if

$$2(1 - P_L)D_F > 2(D_F - \delta P_L R) \Leftrightarrow \delta > \frac{D_F}{R}$$

Therefore, marking downs leads to net benefit if and only if $\delta > \dfrac{D_F}{R}$. □

Proof of Proposition 4

Proof. Assume bank i acquires bank j so the balance sheet after acquisition becomes:

$$\underbrace{P_H R + P_L R}_{\text{Investments}} + \underbrace{D_j - P_L R}_{\text{Subsidy}} = \underbrace{D_i + D_j}_{\text{All deposits}} + \underbrace{E_i + (P_H R - I)}_{\text{Capital}}$$

which is equivalent to bank i absorbing only a proportion of depositors and the rest being directly paid off by the regulator.

$$\underbrace{P_H R + P_L R}_{\text{Total ssets}} = \underbrace{D + P_L R}_{\text{Proportion of deposits}} + \underbrace{E + (P_H R - I)}_{\text{Capital}}$$

Obviously, $D - P_L R < (1 - P_L)D_F$, so marking up reduces costs of resolving the insolvent bank. However, $EC_A > (1 - P_L)(1 - P_H)(D + P_L R) > (1 - P_H)D_F$, marking up increases costs of resolving the healthy bank after the acquisition.

To understand the overall effect, I further decompose total resolution costs. In the coinsurance case

$$\underbrace{D_F - P_L R}_{\text{resolving insolvent bank}} + \underbrace{(1 - P_L)(1 - P_H)P_L R}_{\text{absorbed depositors in the healthy bank}} + \underbrace{(1 - P_L)(1 - P_H)D_F}_{\text{original depositors in the healthy bank}}$$

It is obvious that the original depositors face less risk, i.e., $(1 - P_L)(1 - P_H)D_F < (1 - P_H)D_F$. In addition, combine unabsorbed and absorbed depositors and we have

$$D_F - P_L R + (1 - P_L)(1 - P_H)P_L R < (1 - P_L)D_F$$
$$\Leftrightarrow (P_H + P_L - P_H P_L)R > D_F$$

In other words, all depositors including the original depositors face less risk after the acquisition and the overall effect must be positive.

However, in the contagion case, EC_A can be decomposed as follows

$$\underbrace{(1-P_L)(1-P_H)P_LR+(P_H+P_L-2P_HP_L)(D_F+P_LR-R)\frac{P_LR}{P_LR+D_F}}_{\text{absorbed depositors in the healthy bank}}$$
$$+\underbrace{(1-P_L)(1-P_H)D_F+(P_H+P_L-2P_HP_L)(D_F+P_LR-R)\frac{D_F}{P_LR+D_F}}_{\text{original depositors in the healthy bank}}$$

In this equation, suppose only one investment succeeds, the shortfall to pay off depositors is P_LR+D_F-R and the original depositors need a proportion $\frac{D_F}{P_LR+D_F}$. We can show that under certain conditions, costs of protecting original depositors is higher than $(1-P_H)D_F$ because of the acquisition.

In the next step, I formally prove part two of Proposition 4. Marking up decreases overall costs if and only if

$$(1-P_L-P_H)D_F+P_LR>EC_A \tag{A.2}$$

where $EC_A=(1-P_H)(1-P_L)(D_F+P_LR)+(P_L+P_H-2P_LP_H)(D_F+P_LR-R)$ in the contagion case.

$$\Leftrightarrow (P_L+P_H-2P_LP_H+P_H(P_L)^2)R>(P_L+P_H-P_LP_H)D_F$$
$$\Leftrightarrow \alpha\left[\lambda+(1-\lambda)^3q^3+(\lambda-2)(1-\lambda)^2q^2+2(1-\lambda)^2q\right]$$
$$-\left[(1-\lambda)^2q^2-\left(\lambda^2-3\lambda+2\right)q-\lambda\right]>0$$

Define the above as $F_1(\lambda)\Rightarrow F_1^{''}(\lambda)=2q\left(2\alpha+3\alpha(1-\lambda)q^2+q(\alpha(3\lambda-4)+1)-1\right)$, which is increasing in λ. When $\lambda\to\lambda_C=1-\frac{1}{q\alpha}$, $F_1^{''}(\lambda_C)\to 2q(2\alpha-(\alpha-4)q-4)>0$. Therefore, $F_1(\lambda)$ is a convex function in λ, and $F_1^{'}(\lambda)$ is increasing in λ.

$$F_1^{'}(\lambda_C)=\alpha+\frac{5-5q}{\alpha}+3q-5<0$$
$$F_1^{'}(1-\frac{\alpha-1}{q\alpha})=-\frac{\alpha+\left(\alpha^2-3\alpha+1\right)q-1}{\alpha}\doteq F_2(\alpha,q)$$

(i) If $F_2(\alpha,q)<0$, then $F_1(\lambda)$ is strictly decreasing in λ, and $F_1(\lambda)>F_1(1-$

$\frac{\alpha-1}{q\alpha}) = \alpha + \frac{1}{\alpha} - 2 > 0$. So the regulator prefers to intervene for all λ.

(ii) If $F_2(\alpha, q) > 0$, $F_1(\lambda)$ is first decreasing and then increasing in λ, and the minimum value is reached at $F_1^{'}(\lambda) = 0$. Since $F_1^{'}(\lambda)$ is a quadratic function, I can get the analytical solution μ as follows. If the minimum value $F_1(\mu) > 0$, $F_1(\lambda) > F_1(\mu) > 0$. If instead $F_1(\mu) < 0$, for λ in a particular region, $F_1(\lambda) < 0$.

$$\mu = \frac{3\alpha q^3 + (1-4\alpha)q^2 + (2\alpha-1)q - q\sqrt{(\alpha^2 - \alpha + (\alpha^2+\alpha+1)\,q^2 - (\alpha^2+2)\,q + 1)}}{3\alpha(q-1)q^2}$$

Now I just need to solve $F_1(\mu) < 0$, which involves some tedious algebra. The first step is to show that $F_1(\mu)$ is strictly increasing in α; next, when α reaches its minimum at $\frac{1}{q}$, $F_1(\mu) < 0 \Leftrightarrow q > q_1^*$, in other words, a necessary condition for $F_1(\mu) < 0$ is that $q > q_1^*$; finally, when $q > q_1^*$, denote α_2^* as the solution for $F_1(\mu) = 0$, so a necessary condition for $F_1(\mu) < 0$ is that $\Rightarrow \alpha < \alpha_2^*$.

In summary, upon observing H and L, the regulator prefers not to intervene if and only if $q > q_1^*, \alpha < \alpha_2^*$, and $\lambda^*(\alpha, q) < \lambda < \lambda^{**}(\alpha, q)$.[1] □

Proof of Proposition 5

Proof. First, I study the case in which only one bank chooses the partial capital structure. Without loss of generality, I assume bank i raises D_F and j raises $P_L R$. Since bank j issues extra equity, only bank i will be closed at L. If bank j receives L as well, it will be under regulatory scrutiny although not yet intervened, and a deposit payoff is the only resolution method. However, if bank j receives H, it will acquire i. The following table presents the expected resolution costs conditional on signal realization.

Table A.1: Expected Costs When Only One Bank Raise Extra Equity

[1]The analytical solutions are obtained by solving polynomial equations. Specifically, q_1^* is the third root of $4 - 43x + 138x^2 - 195x^3 + 122x^4 - 18x^5 - 12x^6 + 5x^7 = 0$, and $q_1^* \approx 0.769$; and α_2^* is the second root of $-1 + 8q - 18q^2 + 16q^3 - 5q^4 + (2 - 14q + 18q^2 - 2q^3 - 4q^4)x + (-1 - 2q + 57q^2 - 92q^3 + 38q^4)x^2 + (12q - 90q^2 + 130q^3 - 56q^4)x^3 + (-4q + 32q^2 - 48q^3 + 23q^4)x^4 = 0$. Lastly $\lambda^*(\alpha, q)$ and $\lambda^{**}(\alpha, q)$ are the second and third root of $(\alpha q^3 - \alpha q^2)\,x^3 + (-3\alpha q^3 + 4\alpha q^2 - q^2 - 2\alpha q + q)x^2 + (-\alpha + 3\alpha q^3 - 5\alpha q^2 + 2q^2 + 4\alpha q - 3q + 1)x - \alpha q^3 + 2\alpha q^2 - q^2 - 2\alpha q + 2q = 0$. Furthermore, it is easy to verify that $\lambda_B < \lambda^{**}(\alpha, q)$ so the problem is not trivial.

$\tilde{Y}_i, \tilde{Y}_j$	Probability	FV: $\mathbb{E}(\widehat{\mathcal{C}}_I \vert \{\tilde{Y}_i, \tilde{Y}_j\})$
H, H	q^2	$(1-P_H)(D_F + P_L R)$
H, L	$q(1-q)$	$(1-P_H)D_F + (1-P_L)P_L R$
L, H	$q(1-q)$	$(D_F - P_L R) + EC_B$
L, L	$(1-q)^2$	$(D_F - \delta P_L R) + (1-P_L)P_L R$

where EC_B represents the expected resolution cost for the conglomerate, and $EC_B = (1-P_H)(1-P_L)(2P_L R) + (P_H + P_L - 2P_H P_L)\max\{2P_L R - R, 0\}$. Therefore, the regulator prefers fair value to historical cost accounting if and only if

$$
\begin{gathered}
2(1-q)D_F - \Big\{q^2(1-P_H)(D_F + P_L R) + q(1-q)[(1-P_H)D_F + (1-P_L)P_L R] \\
+q(1-q)[(D_F - P_L R) + EC_B] + (1-q)^2[(D_F - \delta P_L R) + (1-P_L)P_L R]\Big\} > 0 \\
D_F(1-(1-\lambda)q) - q(EC_B + (1-\lambda)(1-q)R(1+(\lambda-1)q-\delta)) > 0
\end{gathered}
$$

From Proposition 1, a necessary (but not sufficient) condition for $\lambda_F > \lambda_B$ is that $\alpha > \frac{3}{2}$, i.e., $2P_L R - R < 0$. So $EC_B = (1-P_H)(1-P_L)(2P_L R)$, and the term in the curly bracket becomes $\propto (1-\lambda)(1-q)\alpha q[\delta + 2(\lambda-1)^2 q^2 + (\lambda-1)q - 1] + \lambda q - q + 1 \doteq F_2(\lambda)$

$$
\begin{gathered}
\Rightarrow F_2''(\lambda) = 2\alpha(1-q)q\left[6(1-\lambda)q^2 - q\right] > 0 \\
\Rightarrow F_2'(\lambda) > F_2'(\lambda_C) \propto \alpha^2(1-\delta) + 3\alpha + q\left(\alpha^2(\delta-1) - 2\alpha + 6\right) - 6 \\
> (2\alpha-3)(1-q) + \alpha + 3q - 3 > 0
\end{gathered}
$$

So $F_2(\lambda)$ is strictly increasing in λ. In addition,

$$
F_2(\lambda_C) = \frac{\alpha^2\delta - 2\alpha + q\left[\alpha^2(1-\delta) + \alpha - 2\right] + 2}{\alpha^2} > \frac{(\alpha-1)[(\alpha+2)q-2]}{\alpha^2} > 0
$$

which suggests that $\Rightarrow F_2(\lambda) > 0$. Therefore, the regulator prefers fair value to historical cost accounting in the presence of partial disciplinary effect.

Next, I examine the case in which both banks choose the maximum deposits. Fair value accounting reduces expected resolution costs if and only if

$$(1-q)^2[2(D_F-\delta R)]P_L - 2q(1-q)[(1-P_L-P_H)D_F + P_LR - EC_A] < 0$$

Obviously this LHS is decreasing in δ, so there exists a threshold δ_2 such that the inequality is satisfied if and only if $\delta > \delta_2$, i.e., $\mathcal{TC}_{FV} < \mathcal{TC}_{HC} \Leftrightarrow \delta > \delta_2$. Apparently, $\dfrac{\partial \delta_2}{\partial \alpha} < 0$ but $\dfrac{\partial \delta_2}{\partial \lambda}$ is unclear.

(i) If $R \geq D_F + P_LR \Rightarrow$

$$\delta_2 = \frac{\lambda q - q + 1 - (\lambda-1)q^2 + \alpha\left[(\lambda-1)^2q^3 - (\lambda-2)(\lambda-1)q^2 - \lambda q\right]}{\alpha(1-q)}$$
$$\Rightarrow \frac{\partial \delta_2}{\partial \lambda} \propto \alpha(2(1-\lambda)q-1)+1$$

So $\dfrac{\partial \delta_2}{\partial \lambda} < 0 \Leftrightarrow \lambda > 1 - \dfrac{\alpha-1}{2q\alpha}$.

(ii) If $R < D_F + P_LR \Rightarrow$

$$\delta_2 = \frac{1 + (q-q^2)(1-\lambda)^2 + [q(1-\lambda)^2((\lambda-1)q^2 - (\lambda-2)q - 2) - \lambda]}{\alpha(1-q)(1-\lambda)}$$

$\Rightarrow \dfrac{\partial \delta_2}{\partial \lambda} \propto 1-\alpha+2\alpha(1-\lambda)^3q^3+(1-\lambda)^2q^2(\alpha(2\lambda-3)+1)+(2\alpha-1)(\lambda-1)^2q$ and I denote this equation as $F_3(\lambda)$. It is easy to show that $F_3'(\lambda) \propto 1-2\alpha+3\alpha(\lambda-1)q^2+q(\alpha(4-3\lambda)-1) < 0$. So $F_3(\lambda)$ is decreasing in λ, when $\lambda \to 1 - \dfrac{R-D_F}{qR}$, $F_3(\lambda) \propto \alpha - 2\alpha q + q - 1 < 0$. When $\lambda \to \lambda_B$, $F_3(\lambda_B) \propto 4\alpha^2 - 6\alpha - 2\left(4\alpha^4 - 10\alpha^3 + 10\alpha^2 - 6\alpha + 1\right)q + 1$, and the sign is ambiguous. □

Proof of Proposition 6

Proof. First, since there is no acquisition under LCM, the total costs $\mathcal{TC}_{LCM}$ are equal to

$$\underbrace{(1-q)^2\left[2(D_F-\delta P_LR)\right]}_{\text{both receive } L} + \underbrace{2q(1-q)[(2-P_H)D_F - \delta P_LR]}_{\text{one } H \text{ and one } L} + \underbrace{q^2[2(1-P_H)D_F]}_{\text{both receive } H}$$

Apparently, $\mathcal{TC}_{HC} > \mathcal{TC}_{LCM} \Leftrightarrow \delta > \delta_1$, and I just need to compare LCM with fair value accounting.

$$\mathcal{NC}_{FV} > \mathcal{NC}_{LCM} \Leftrightarrow P_L R - EC_A + (1 - P_H) D_F < \delta P_L R$$

The inequality is more likely to satisfy with a large δ. Meanwhile, when $\delta \to 1$, we have $\mathcal{NC}_{FV} > \mathcal{NC}_{LCM}$, because $EC_A > (1 - P_H) D_F$; while when $\delta \to 0$, we have $\mathcal{NC}_{FV} < \mathcal{NC}_{LCM}$, because $P_L R - EC_A + (1 - P_H) D_F > 0$. So there exists a unique $0 < \delta_3 < 1$, such that $\mathcal{NC}_{FV} > \mathcal{NC}_{LCM}$ if and only if $\delta > \delta_3$.

At last, I rank the order of δ_1, δ_2 and δ_3.

$$(1 - q)\delta_2 + q\delta_3 = \delta_1$$

From the proof of Proposition 4, we know that

$$\delta_2 > \delta_1 \Leftrightarrow P_L R + (1 - P_H - P_L) D < EC_A \Leftrightarrow \text{marking up leads to overall costs}$$

The rest of the proof is in the text. □

Proof of Corollary 2

Proof. If $D_i = D_j = P_L R$, $\mathcal{TC}_{FV} = 2(1 - q) P_L R$, which is strictly decreasing in λ. If one bank chooses D_F and the other chooses $P_L R$, by Proposition 4,

$$2(1 - q) D_F - \mathcal{TC}_{FV} = (1 - q) D_F \times F_3(\lambda) \Rightarrow \frac{\partial \mathcal{TC}_{FV}}{\partial \lambda} = -(1 - q) D_F \times F_3^{'}(\lambda) < 0$$

Therefore, in each of the intervals in which banks are at least partially disciplined, more informative accounting reduces the expected resolution costs. However, the result is different when banks raise the maximum deposits.

(i) If $R > D_F + P_L R \Rightarrow \mathcal{TC}_{FV} = 2(1-q) D_F \{ (1-\lambda)^2 (q-1) q^2 - \lambda q + q + 1 + q\alpha(1-\lambda)[(\lambda-1)^2 q^3 - (\lambda^2 - 3\lambda + 2) q^2 + q(\delta - \lambda) - \delta] \} \Rightarrow \frac{\partial \mathcal{TC}_{FV}}{\partial \lambda} \propto 2(\lambda-1) q^2 - 2\lambda q + 2q - 1 + \alpha[\delta - 3(\lambda - 1)^2 q^3 + (3\lambda^2 - 8\lambda + 5) q^2 - q(\delta - 2\lambda + 1)]$. Denote the equation as $F_4(\alpha)$ and it is easy to show that $F_4(\alpha)$ is increasing in δ. When $\delta \to 1$, $F_4'(\alpha) > 0$. Therefore, $F_4(\alpha) > F_4(\frac{1}{q}) \propto (3\lambda^2 - 8\lambda + 5)\, q^2 + 2(\lambda - 1)q + 1 > 0$.

(ii) Similarly, if $R < D_F + P_L R$, I just need to show that the additional costs $F_5(\lambda) \doteq q(1-q)(P_H + P_L - 2P_H P_L)(D_F + P_L R - R)$ is also increasing in λ. To see that, $\Rightarrow F_5''(\lambda) \propto 2q + \alpha\,(6(1-\lambda)q^2 + 6(\lambda-1)q + 1) > 0$. Therefore, $F_5'(\lambda) > F_5'(\lambda_C) \propto (\alpha^2 + 3\alpha - 16)\, q + 6 - 2\alpha - (\alpha^2 - 10)\, q^2 > 0$.

In sum, if both banks choose D_F, and δ is sufficiently large, $\mathcal{TC}_{FV}$ is increasing in λ.

Lastly, I show how each component in EC_A changes with λ. First, it is obvious that $2(1-P_H)D_F$ is decreasing in λ and $D_F - \delta P_L R$ is increasing in λ. Now I just examine the last term $R > D_F + P_L R$.

(i) Suppose $R > D_F + P_L R$, denote $D_F - P_L R + EC_A$ as $F_6(\lambda) \Rightarrow F_6(\lambda) = (1-\lambda)(1-q)(\lambda q + 1 - q)(\lambda q R - qR - D_F) + D_F - (1-\lambda)qR$. So $F_6'(\lambda) = D_F(q-1)(2q\lambda - 2q + 1) + qR[2\lambda - 3(1-\lambda)^2 q^2 + (3\lambda^2 - 8\lambda + 5)\, q - 1] > 0$.

(ii) Similarly, if $R < D_F + P_L R$, $D_F - P_L R + EC_A$ is also increasing in λ, because the additional term $F_5(\lambda)$ is increasing in λ.

$\square$

Proof of Corollary 3

Proof. First, I decompose total costs into short-term and long-term costs.

$$\mathcal{ST}_{FV} = (1-q)^2\,[2(D_F - \delta P_L R)] + 2q(1-q)(D_F - P_L R)$$
$$\mathcal{ST}_{LCM} = (1-q)^2\,[2(D_F - \delta P_L R)] + 2q(1-q)(D_F - \delta P_L R)$$

Apparently, $\mathcal{ST}_{LCM} - \mathcal{ST}_{FV} = 2q(1-q)(1-\delta)P_L R > 0$. In addition, to compare long-term costs,

$$\mathcal{LT}_{HC} - \mathcal{LT}_{LCM} = 2q(1-q)(1-P_L)D_F + (1-q)^2(2(1-P_L)D_F) > 0$$
$$\mathcal{LT}_{FV} - \mathcal{LT}_{LCM} = 2q(1-q)\,[EC_A - (1-P_H)D_F]$$
$$\mathcal{LT}_{HC} - \mathcal{LT}_{FV} = 2q(1-q)((2 - P_L - P_H)D_F - EC_A) + (1-q)^2(2(1-P_L)D_F)$$

(i) If $R > D_F + P_L R$

$$EC_A - (1-P_H)D_F = (1-P_H)P_L[(1-P_L)R - D_F] > 0$$

$$(2-P_L-P_H)D_F - EC_A > (1-P_HP_L)D_F - (1-P_H)(1-P_L)D_F > 0$$

(ii) If $R < D_F + P_L R$

$$EC_A - (1-P_H)D_F = (P_H - P_HP_L)D_F + (1-P_H)(1-P_L)P_L R > 0$$

$$(2-P_L-P_H)D_F - EC_A = (1-P_L)(1-P_H)D_F + P_H(P_L^2 + 1 - 2P_L)R > 0$$

In summary, $\mathcal{ST}_{HC} < \mathcal{ST}_{FV} < \mathcal{ST}_{LCM}$, $\mathcal{LT}_{LCM} < \mathcal{LT}_{FV} < \mathcal{LT}_{HC}$. □

Proof of Proposition 7

Proof. Apparently, the social costs are the lowest under historical costs accounting. In addition,

$$\mathcal{SC}_{LCM} - \mathcal{SC}_{FV} = 2q(1-q)[2 - P_H - 2Pr(Con)]\mathcal{F}$$

(i) If $R > P_L R + D_F$. $Pr(Con) = (1-P_H)(1-P_L) \Rightarrow \mathcal{SC}_{LCM} - \mathcal{SC}_{FV} = 2q(1-q)(P_H + 2P_L - 2P_HP_L) > 0$.

(ii) If $R < P_L R + D_F$. $Pr(Con) = 1 - P_HP_L \Rightarrow \mathcal{SC}_{LCM} - \mathcal{SC}_{FV} = 2q(1-q)P_H(2P_L - 1)$. Since $2P_L - 1$ is strictly decreasing in λ, when $\lambda \to \lambda_C$, $2P_L - 1 = \frac{2D_F}{R} - 1 > 0$; when $\lambda \to 1 - \frac{R-D_F}{qR}$, $2P_L - 1 = 1 - \frac{2D_F}{R} < 0$. Therefore, there exists a $\lambda_{BF} = 1 - \frac{1}{2q}$ such that, $\mathcal{SC}_{LCM} < \mathcal{SC}_{FV}$ if and only if $1 - \frac{R-D_F}{qR} > \lambda > \lambda_{BF}$.

Therefore, fair value accounting leads to higher social costs than LCM if and only if $R < 2D_F$ and $\lambda_{BF} < \lambda < 1 - \frac{R-D_F}{qR}$. □

A.2 Robustness

A.2.1 Commitment: Time Inconsistency

In this section, I prove that the bank will change its capital structure accordingly if there is no commitment of intervention. For simplicity, I only consider a particular set of parameters, that is q is sufficiently large and α is sufficiently small.[2]

Case 1: $\delta > \delta_1$ and $\lambda^* < \lambda < \lambda^{**}$. The regulator intervenes only when both banks receives L. In response, the bank faces the following problem:

$$\max_{D=\{D_F, P_L R\}} \Pi_1(D) = \begin{cases} [qP_H + q(1-q)P_L](R - D_F) - (I - D_F]) & \text{if } D = D_F \\ q(R - P_L R) - (I - P_L R) & \text{if } D = P_L R \end{cases}$$

$$\Rightarrow D_1 = \begin{cases} D_F & \text{if } \lambda > \lambda_1 \\ P_L R & \text{if } \lambda < \lambda_1 \end{cases}$$

where $\lambda_1 = 1 - \dfrac{D_F}{q(2R - D_F + qD_F - qR)}$. It is easy to verify that $\lambda_1 < \lambda_B$ and $\lambda_1 < \lambda^*$ so the equilibrium is sustained in $\lambda^* < \lambda < \lambda^{**}$.

Case 2: $\delta > \delta_1$ and λ is either greater than λ^{**} or less than λ^*, it is optimal to close the insolvent bank regardless of the resolution method. Therefore, the bank chooses the maximum deposits when $\lambda > \lambda^*$, and issues extra equity when $\lambda < \lambda^*$.

Figure A.1 summarizes the two cases: The disciplinary effect is weaker in the region $\lambda^* < \lambda < \lambda_B$.

Case 3: $\delta < \delta_1$ and $\lambda^* < \lambda < \lambda^{**}$. The regulator never close troubled banks, and in response, banks raise the maximum deposits.

Case 4: $\delta < \delta_1$ and and λ is either greater than λ^{**} or less than λ^*. The Regulator closes the insolvent bank only if there is a healthy bank to take it over. Suppose bank

[2] These conditions ensures that $q > q_1^*$, $\alpha < \alpha_2^*$ and $\lambda_B > \lambda_1$. The last condition $\lambda_B > \lambda_1$ requires q to be large and α to be small as shown below. I ignore the multiple equilibria from Proposition 2.

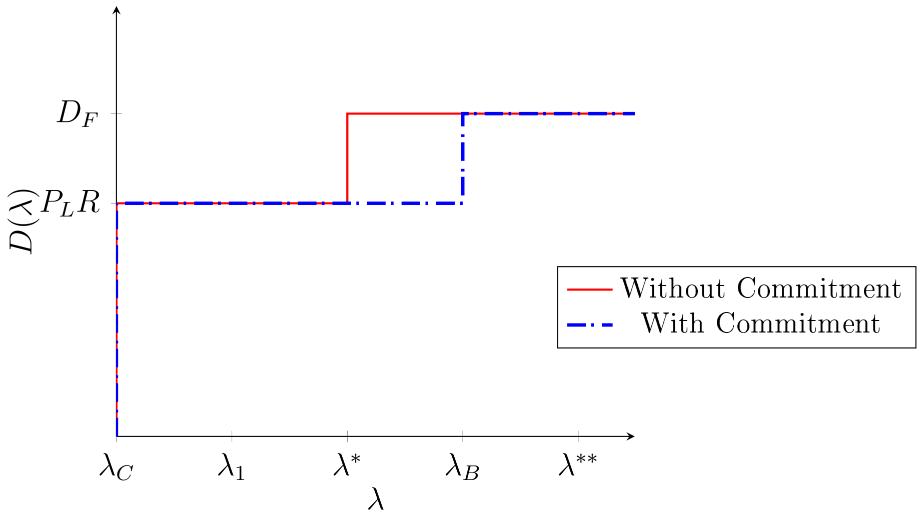

Figure A.1: Commitment and Time Inconsistency
The Bank's Capital Structure: $\delta > \delta_1$

i conjecture $\hat{D}_j > P_L R$, banks maximizes Π_2 which is equal to

$$\begin{cases} [q^2 P_H + (1-q)^2 P_L](R - D_F) + q(1-q)\Delta^M(D_F) - (I - D_F) & \text{if } D = D_F \\ [q^2 P_H + (1-q) P_L](R - P_L R) + q(1-q)\Delta^M(P_L R) - (I - P_L R) & \text{if } D = P_L R \end{cases}$$

$$\Rightarrow D_2 = \begin{cases} D_F & \text{if } \lambda > \lambda_2 \\ P_L R & \text{if } \lambda < \lambda_2 \end{cases}$$

When $\lambda < \lambda_2$, the bank issues extra equity, and when $\lambda > \lambda_B$, the bank chooses maximum deposits. There could be multiple equilibria in $\lambda_2 < \lambda < \lambda_B$. Therefore, the disciplinary effect must be weaker in $\max\{\lambda^*, \lambda_2\} < \lambda < \lambda_B$, and may be weaker in $\min\{\lambda^*, \lambda_2\} < \lambda < \max\{\lambda^*, \lambda_2\}$, as shown in Figure A.2.

In summary, the lack of commitment *dampens* the disciplinary effect.

A.2.2 Alternative Benchmark

In the main model, I assume that the acquisition cannot be completed if the healthy bank does not have adequate regulatory capital. As an alternative benchmark, healthy bank can issue additional equity, and I will show that financial contagion could be alleviated as well. Therefore, financial contagion and aggravated resolution costs are

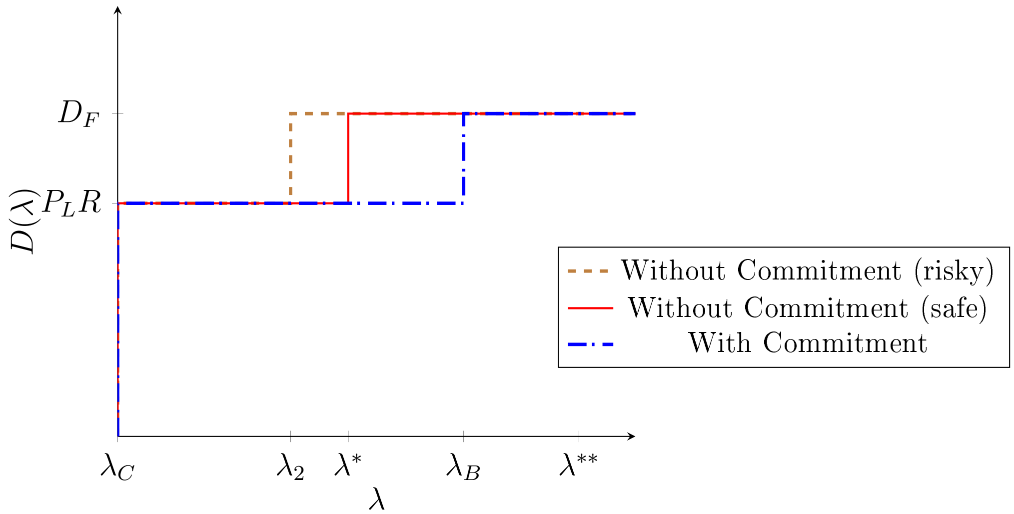

Figure A.2: Commitment and Time Inconsistency, Alternative Case
The Bank's Capital Structure: $\delta < \delta_1$

both driven by accounting measurement issues.

To illustrate this point, I only study the extreme case of LCM regime and assume banks always raise D_F. The healthy bank needs to issue at least $\phi P_L R$ equity, and the balance sheet becomes:

$$\underbrace{I + P_L R}_{\text{risky investments}} + \underbrace{D_F - P_L R}_{\text{subsidy}} + \underbrace{\phi P_L R}_{\text{additional equity}} = \underbrace{(D_F + D_F)}_{\text{total deposits}} + \underbrace{E + (\phi P_L R)}_{\text{capital}}$$

Therefore, if only one investment succeeds, the conglomerate will fail if and only if $R - P_L R + \phi P_L R < D_F$, i.e., financial contagion happens less frequently. Furthermore, the regulator's costs will always decrease relative to the main model because of the additional equity $\phi P_L R$.

If this is the full story, marking up seems to unambiguously increase the regulator's costs. However, the above argument misses an important point: the healthy bank may not have the appropriate incentive given additional equity is required. We have observed in reality (see, for example, the S&L crisis in footnote 2) that massive bank failures can lead to capital crunch for healthy banks; as a result, the regulator must provide stronger incentives to healthy banks.

A.2.3 Capital Structure under LCM

In this section, I examine the bank's capital structure decision under LCM. Similar to the main model, if bank i believes $\hat{D}_j \leq P_L R$, it will follow a switching strategy at λ_B because there is no opportunity to engage in risk-shifting. In contrast, if $\hat{D}_j > P_L R$, bank i anticipates that j will be closed at L. However, because mark-up is not allowed under LCM, bank i will not have enough capital to absorb j unless it has raised extra capital at date 1. Specifically, the balance sheet must satisfy $\dfrac{I - D_i}{I + P_L R} \geq \phi$ to complete the acquisition, i.e., $D_i \leq D_F - \phi P_L R$. Denote $D_T \doteq D_F - \phi P_L R$, and bank i chooses among D_F, $P_L R$, or D_T.

Proposition 8. *Given the conjecture $\hat{D}_j > P_L R$,*

1. *$D_i = D_F$ if and only if λ is sufficiently large.*

2. *Otherwise, $D_i = D_T$ or $D_i = P_L R$ are both possible, depending on the parameters.*

Proof. First, I compare D_T with $P_L R$: $P_L R < D_T \Leftrightarrow \lambda > \lambda_L = 1 - \dfrac{D_F}{qR + qR\phi}$. It is easy to verify that $\lambda_L < \lambda_B$.

Case 1: $\lambda > \lambda_L$. bank i can already acquire j at $D_i = P_L R \Rightarrow$

$$\Pi_1^L(D_F) = qP_H(R - D_F) - (I - D_F)$$
$$\Pi_2^L(P_L R) = [(1-q)P_L + q^2 P_H](R - P_L R) + q(1-q)\Delta^M(P_L R) - (I - P_L R)$$
$$\Pi_3^L(D_T) = q^2 P_H(R - D_T) + q(1-q)\Delta^M(D_T) - (I - D_T)$$

(i) First, $\Rightarrow \Pi_1^L(D_F) - \Pi_2^L(P_L R) = D_F - P_L R + qP_H(R - D_F) - [(1-q)P_L + q^2 P_H](R - P_L R) - q(1-q)\Delta^M(P_L R)$. This equation is always increasing in λ. When $\lambda \to 1$, the equation is positive; when $\lambda \to \lambda_F$, the equation is negative if and only if α is sufficiently small. Define the threshold above which $\Pi_1^L(D_F) > \Pi_2^L(P_L R)$ as λ_1^*.

(ii) Next, I compare $\Pi_2^L(P_L R)$ with $\Pi_3^L(D_T)$: If $R > 2P_L R$, $\Pi_2^L(P_L R) - \Pi_3^L(D_T)$ is decreasing in λ. When $\lambda \to \lambda_F$, the equation is positive; when $\lambda \to 1$, it is negative. In a similar manner, I prove that $\Pi_2^L(P_L R) - \Pi_3^L(D_T)$ is decreasing in λ in case of $R < D_T + P_L R$ or $D_T + P_L R < R < 2P_L R$. So I can define the threshold below which $\Pi_2^L(P_L R) > \Pi_3^L(D_T)$ as λ_2^*.

(iii) Lastly, I compare $\Pi_1^L(D_F)$ with $\Pi_3^L(D_T)$. $\Pi_1^L(D_F) - \Pi_3^L(D_T) \propto L_1(\lambda)$, where $L_1(\lambda)$ is a quadratic function and $L_1^{''}(\lambda) > 0$. When $\lambda \to 1$, $L_1(1) > 0$, so there exists a λ_3^* such that $\Pi_3^L(D_T)$. $\Pi_1^L(D_F) - \Pi_3^L(D_T) > 0 \Leftrightarrow \lambda > \lambda_3^*$.

Case 2: $\lambda < \lambda_L$, bank i must further lower its leverage to D_T to be able to j.

$$\Pi_4^L(P_L R) = q(R - P_L R) - (I - P_L R)$$
$$\Pi_5^L(D_T) = [(1-q)P_L q^2 P_H](R - D_T) + q(1-q)\Delta^M(D_T) - (I - D_T)$$

According to lemma 1, because $\lambda < \lambda_B$, $\Pi_4^L(P_L R) > \Pi_1^L(D_F)$ and I only need to compare the two equations above. $\Pi_4^L(P_L R) - \Pi_5^L(D_T)$ is strictly decreasing in λ. At $\lambda = \lambda_L$ or $\lambda = \lambda_C$, the sign is ambiguous.

In sum, given $\hat{D}_j > P_L R$, $D_i = D_F$ if λ is sufficiently large. It depends on the parameters when bank i will choose $D_i = D_T$ and $D_i = P_L R$.

□

Proposition 8 is similar to Proposition 2. When accounting is too informative, holding extra capital to prevent closure becomes too costly. In addition, the benefit from acquiring j also declines, as chances are slim that the impaired assets will succeed. In response, the bank forfeits the option of risk-shifting and raises the maximum deposits. However, when accounting is not very informative, the bank may choose $D_i = D_T$ or $D_i = P_L R$ depending on the parameters. The problem becomes intractable, because there are too many moving parts. In summary, even though the equilibrium cannot be solved analytically, I confirm that the assumption $D_i = D_j = D_F$ is indeed reasonable.

A.3 Historical Data

Table A.2: Summary of Resolution Costs to the FDIC, 1986-2017

	P&A agreement	Depositor Payoff	Assistance
Number of Failure	2,307	215	116
Average Assets (thousands)	552,110	197,063	164,581
Average Cost (thousands)	71,693	70,145	16,112
Average Cost-to-Asset Ratio	13.0%	35.5%	9.8%
Total Costs (billions)	165.40	15.03	1.87

[a] Source: FDIC, Historical Statistics on Banking.`https://www5.fdic.gov/hsob/`

[b] Notes: The table only includes resolutions for which estimated costs were available and excludes transactions where it was not determined.

[c] The first column includes Purchase and Assumption, Insured Deposit Transfer and MGR. The second column includes direct payout. The third column includes bridge bank, open bank assistance and reprivatization.

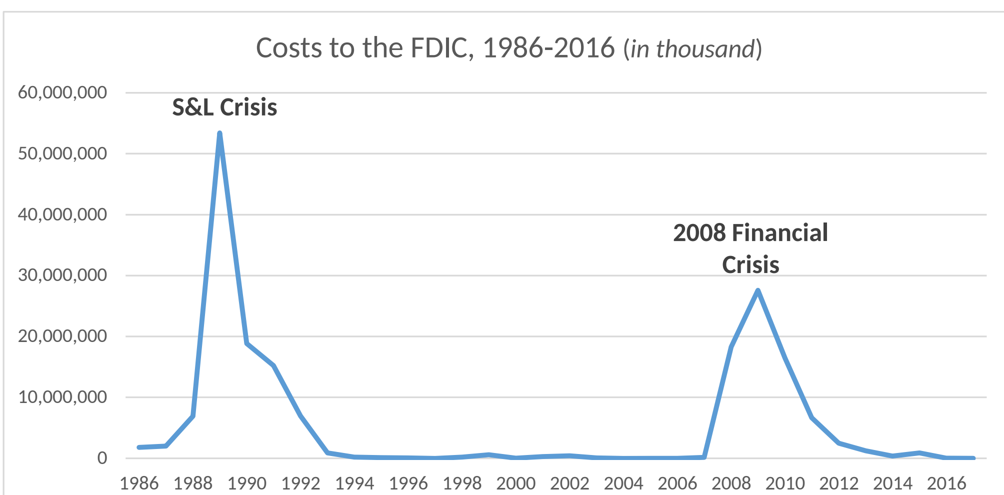

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Figure A.3: Resolution Costs to the FDIC by Year, 1986-2017
Data Source: *FDIC, Historical Statistics on Banking*

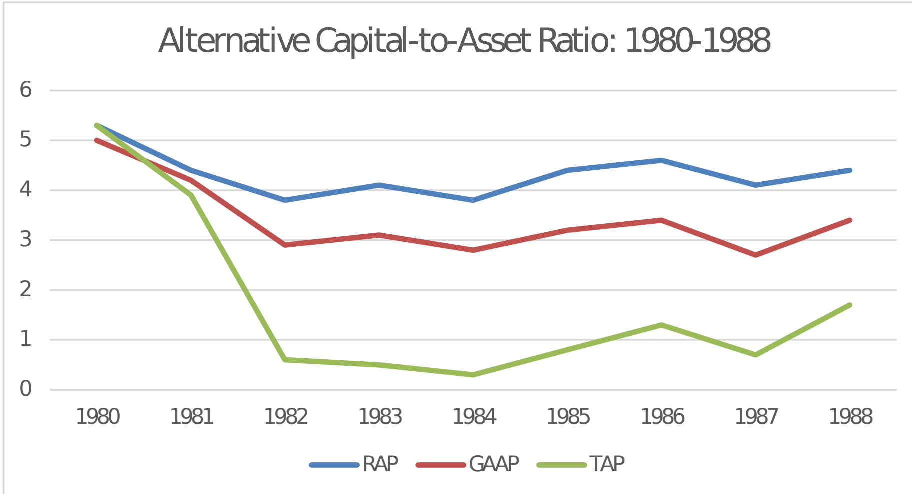

Figure A.4: The S&L Crisis: Capital-to-Asset Ratio for the Savings and Loan Industry

Source: *The Great Savings and Loan Debacle* by J. Barth 1991. GAAP capital consists of permanent, preferred and common stock and returned earnings. TAP(tangible) capital equals GAAP capital minus goodwill and other intangibles. RAP capital essentially equals GAAP capital plus deferred loan losses, appraised equity capital, regulatory forbearance such as the amortization of goodwill over peiords longer than those prescribed by GAAP, etc.

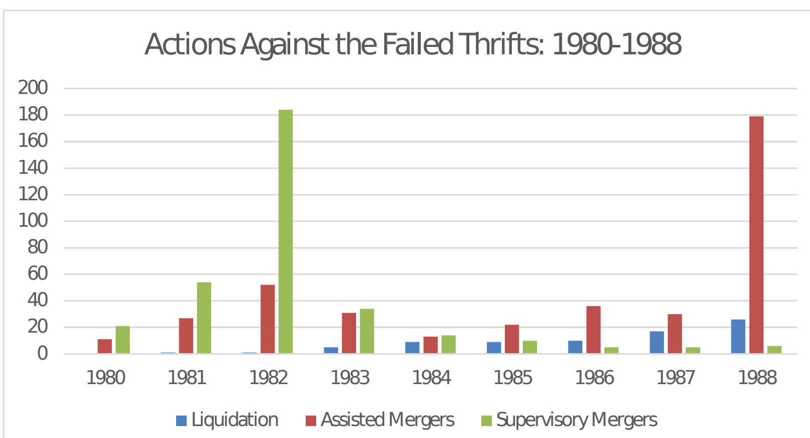

Figure A.5: The S&L Crisis: Regulatory Actions Against Failed Thrifts

Source: *The Great Savings and Loan Debacle* by J. Barth 1991. Liquidation and assisted mergers, generally referred to as resolutions, were meant to be final and impose costs on the FSLIC. A supervisory merger was also meant to be final and not to impose cost on FSLIC.