PRUDENTIAL REGULATION AND BANK ACCOUNTING

A Dissertation

Presented to

The Faculty of the C.T. Bauer College of Business

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

By

Yan (Lanyi) Zhang

May 1st, 2019

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ABSTRACT

This study focuses on how to design a mechanism that coordinates prudential regulation and bank accounting. I study a setting in which a bank chooses its loan quality and makes its asset substitution decision. The social planner sets the regulatory leverages for banks, and the accounting regime (either fair value accounting or historical cost accounting) for banks to report on loan performance. Using the ex ante bank value as the criterion, I find that the historical cost regime dominates the fair value regime for medium values of asset substitution risk; medium values of asset substitution constraint; low values of asset specificity; low values of fundamental risk of loans; high values of marginal benefit or low values of marginal cost of loan quality; and high values of the liquidity benefit of bank debtholders. Fair value accounting dominates for other values of these parameters. This study contributes to the theoretical literature on the debate about bank opacity by incorporating *both the asset side and the liability side* of bank's balance sheets in designing a mechanism to coordinate prudential regulation and bank accounting. The paper makes important policy implications on prudential regulation and bank accounting such as cycle-contingent regulations, asset risk class-contingent regulations and country-contingent accounting standard.

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CHAPTER 1

INTRODUCTION

Debates are ongoing on alternative financial accounting standards for banks, especially financial reporting opacity, in the context of prudential regulation of banks (Laux and Leuz 2009). Prudential regulations are reformed period by period, such as Basel I\Basel II\Basel III and mandatory stress test under Dodd-Frank Act, especially after the 2007-2009 financial crisis, which spawned a vigorous debate on the role of bank regulation (Admati and Hellwig 2013, Gale 2010). Such prudential regulation is accounting-based, for example prudential leverage ratios, which is defined as the ratio of liability over asset of banks. Therefore, naturally a coordination of prudential regulation and bank accounting is necessary to enhance social welfare.

Some argue for the importance of the *asset* side of bank's balance sheets. For example, Morgan (2002, p. 874) states that "the opacity of banks exposes the entire financial system to bank runs, contagion, and other strains of 'systemic' risk. Take away opacity and the whole story unravels." Similarly, Nier and Bauman (2006, p. 337) believe that "a bank that discloses its risk profile exposes itself to market discipline and will therefore be penalized by investors for choosing higher risk." Therefore, this type of views support *fair value* accounting, which reports timely interim performance of bank's loan portfolios, thereby making it feasible for the prudential regulators to fine-tune the regulatory target leverages to precisely control the bank's asset substitution (or risk shifting) decisions. That is, fair value accounting makes it feasible for regulator to discipline bank's excessive risk taking, which may eventually result in systemic risk.

However, others argue for the importance of the *liability* side of bank's balance sheets. They emphasize the role of banks in the economy in creating highly liquid, money-like debt claims (for example, demand deposits and the associated banking services). Such claims are collateralized to make them information-insensitive. To further make them information-insensitive, they argue, banks should be "secret keepers," and thus governmental guarantees, and regulation and supervision should not force banks to publicly reveal information (Dang et al. 2014; Holmstöm 2015). Therefore, this type of views support *historical cost* accounting, which does not report the interim performance of bank's loan portfolios on a timely basis, thereby avoiding triggering interim insolvency risk and thus safeguarding debtholders' deposits and enhancing the debtholders' liquidity benefits.

I incorporate both the asset side and the liability side of bank's balance sheets to investigate how the social planner coordinates prudential regulations and bank accounting to enhance the ex ante bank value (the sum of the bank's ex ante debt value and equity value). How should the optimal regulatory leverages be set, given a particular accounting regime (fair value accounting versus historical cost accounting) in place? Under what conditions will one accounting regime dominate the other? I address these questions in a setting in which a representative bank chooses its loan quality and makes its asset substitution decision.

Banks are plagued with debt overhang problems, including both asset substitution (or risk shifting) and underinvestment in loan quality. Banks may increase the risk of its loan portfolios to gamble for the upside potential at the expense of the debtholders, and the expected net present value suffers as a result. For example, they may undertake negative net present value projects (Jensen and Meckling 1976; Dewatripont and Tirole 1993; Gron and Winton 2001; Admati and Hellwig 2013), or they may construct derivatives for speculations based on the loan portfolios, or reduce the frequency of filed inspection to the facility of borrowers in the hope of achieving upside potential. Banks with excessive leverage may forgo positive net present value projects and thus lead to under investment in the quality of the loan portfolios (Myers 1977; Admati et al. 2012).

I incorporate these two debt overhang problems in a two-period model characterized by maturity mismatch, a prominent feature in the banking industry: The bank finances its long-term investment in loans (its largest asset items) using short-term deposits (its largest liability items). Specifically, the bank chooses the quality of its loan portfolios in period 1 and makes its asset substitution decision in period 2. Asset substitution in period 2 may enhance the bank's equity value in period 2; Anticipating this, the bank is incentivized to choose a higher quality level for its loan portfolios in period 1. Put it the other way, if the bank's period 2 asset substitution is constrained, its period 1 incentive for quality will be dampened (Lu, Sapra, and Subramanian 2019).

Apparently, the higher the bank leverage, the more incentivized the bank will engage in asset substitution. Thus, it may seem naturally that the regulator may want to lower the regulatory target leverage in period 2 to constrain asset substitution. However, this will reduce the bank's incentive for quality, as discussed above. To counteract this effect, the regulator may lower the regulatory target leverage in period 1 to reduce the debt overhang on the bank with respect to loan quality. If so, the regulatory target leverages in both periods are lowered and thus the bank's debt capacity is reduced, which implies lower liquidity benefits for the debtholders (Bryant 1980; Diamond and Dybvig 1983; Calomiris and Kahn 1991; Gale 2010).

I capture such economic tradeoffs in my model, and more importantly, I introduce an accounting tradeoff (fair value accounting versus historical cost accounting). Under fair value accounting in which the interim loan performance is reported, the bank regulator can tie her interim prudential leverage to the fair value report and therefore can precisely curb or forbear bank's asset substitution (Giammarino, Lewis, and Sappington 1993; Kahn and Winton 2004; Allen, Carletti, ad Marquez 2011; Bulow, Goldfield, and Klemperer 2013). However, the interim fair value report introduces the interim volatility into the market value of bank debt and equity, thereby entailing interim insolvency risk. Under historical cost accounting in which the loan performance is not reported on a timely basis, the bank regulator cannot precisely control bank's asset substitution due to the less informative accounting report. However, the absence of timely fair value reports implies no interim volatility in the market value of bank debt and equity, which suppresses the interim insolvency risk. [1]

The main ingredients of the model are (1) bank's asset substitution and quality of loan portfolios (the asset side of the bank's balance sheet) and (2) the bank debtholders' liquidity benefit (the liability side of the balance sheet), (3) the regulatory target leverages for banks (prudential regulation), and (4) historical cost accounting versus fair value accounting (bank accounting).

In my paper, bank value is defined as the sum of debt value plus equity value, hence, both bank assets and bank liabilities are important for bank value. Therefore, my main results are on the conditions under which one accounting regime dominates the other in terms of the parameters of bank assets and liabilities, using the ex ante bank value as the criterion. I find that the historical cost accounting regime dominates the fair value accounting regime for the following parameter values of bank assets: medium values of asset substitution risk; medium values of asset substitution constraint; low values of asset specificity; high values of marginal benefit or low values of marginal cost of loan quality; low values of fundamental risk of loan portfolios. Historical cost accounting also dominates fair value accounting for the following parameter value of bank liabilities: high values of the liquidity benefit of bank debtholders. For other parameter values, the fair value accounting regime dominates the historical cost accounting regime.

My investigation contributes to the *public policy* debate on *prudential regulation*

[1] This paper study two pure accounting regime for bank loans, Fair value accounting and historical cost accounting. The fair value of bank loan is level 3 fair value, which is determined by bank's private information. Therefore, under historical cost accounting, as private information about loans is not incorporated into loan interim fair value and accounting report, accounting report on bank loans is less informative than that under fair value accounting. Here, I don't consider any manager's discretion, because I study accounting standard setting.

and bank accounting.

(1) The social planner may condition her regulatory leverages and accounting choice on the asset substitution *risk classes of bank loans* and/or the *strength of bank's corporate governance.* For bank loans with extremely low or extremely high asset substitution risk, fair value accounting is preferable, whereas for loans with medium risk, historical cost accounting is called for. Furthermore, to the extent that the asset substitution risk varies with the phases of business and credit cycles, my result argues for *cycle-contingent regulation*, if practical. Specifically, to the extent that the asset substitution risk is high in peak, low in trough and medium in contraction or expansion, it is optimal to implement fair value accounting in the peak and trough phases of the cycle and historical cost accounting in the expansion and contraction phases. With respect to corporate governance, my results argue for *corporate governance contingent regulation,* if practical. Specifically, to the extent that the asset substitution constraint is high for banks with good corporate governance, for banks with bad corporate governance and medium for banks with medium corporate governance, it is optimal to implement fair value accounting for banks with good or bad corporate governance and historical cost accounting for banks with medium corporate governance.

(2) Fair value accounting is optimal for bank assets with high specificity or high illiquidity and historical cost accounting is optimal for generic assets or liquid assets. Plantin, Sapra, and Shin (2008) generate an opposite result in a setting of premature asset sales triggered by higher-order beliefs. Therefore, I identify another rationale regarding the desirability of historical cost accounting versus fair value accounting in terms of specificity of bank assets.

(3) One of my results sheds light on impairment accounting (or lower-of-cost-or-market rule). To the extent that the marginal benefit (cost) of loan quality is high (low) in good times and the converse is true in bad times, it is socially optimal to

mandate historical cost accounting in good times and fair value accounting in bad times. This is what impairment accounting prescribes. Therefore, I adds benefit of the impairment accounting to the literature (Göx and Wagenhofer 2009; Li 2017), which identify the benefits of impairment accounting to borrowers by exploring that impairment accounting is beneficial to lenders (banks).

(4) Another result is on liquidity benefits to bank depositors. To the extent that depositors in *developing countries* value liquidity benefits relatively more than those in developed countries, my result implies that *historical cost accounting* is better for developing countries while *fair value accounting* is better for developed countries. This implication warns developing countries against their rush to converge their local accounting standards to the International Financial Reporting Standards, which are taking great strides towards fair value accounting.

Overall, my study identifies the characteristics of bank assets and liabilities that should be taken into account in the mechanism design of prudential regulation and bank accounting. In addition, it provides specific examples of how the two regulations should be optimally coordinated.

My study contributes to the theoretical literature on bank accounting. (1) This study incorporates *both the asset side and the liability side* of bank's balance sheets to shed light on the debate over bank opacity. (2) This study focuses on regulatory coordinations: How are *prudential regulation and bank accounting* optimally coordinated?

Li (2017) and Bertomeu, Mahieux, and Sapra (2018) also study the coordination of prudential regulation and bank accounting. Their focuses are different from mine. Li (2017) introduces capital issuance decision whereas Bertomeu, Mahieux, and Sapra (2018) introduce accounting information system design, and both papers study the loan risk decision. In contrast, I introduce bank's loan quality decision, which affect both the mean and variance of loan fundamental.

Several papers focus on prudential regulation under fair value accounting only, leaving out historical cost accounting. Heaton, Lucas, and McDonald (2010) investigate how to design capital requirements under mark-to-market regime. Lu, Sapra, and Subramanian (2018) study a setting in which the bank can misreport its performance under fair value accounting. In contrast, I extend and modify their model and study historical cost accounting as well as fair value accounting, and thus provide a full picture regarding the optimal accounting choices for banks under different conditions.

Most existing accounting studies do not introduce or endogenize prudential regulation. Allen and Carletti (2008) focus on historical cost versus fair value accounting as well. In contrast to this study, they are interested in contagion from the insurance sector to the banking sector. Plantin, Sapra, and Shin (2008) also focus on historical cost versus fair value accounting for banks. They are interested in bank's asset sales decision. Burkhardt and Strausz (2009) focus on historical cost versus impairment accounting on asset substitution. In contrast, I introduce bank's quality decision as well as asset substitution decision, thereby introducing the tradeoff between the two. Corona, Nan, and Zhang (2018) focus on historical cost versus fair value accounting for assets in place. They are interested in bank's lending decision as opposed to bank's asset substitution and quality decisions, which are the key ingredients of my study. In addition, they investigate bank's voluntary choice of accounting regimes whereas I study mandatory accounting. Bleck and Gao (2018) compare the two accounting regimes and study the loan selling decision assuming the prudential regulation (capital requirement) is exogenous.[2]

My paper makes some empirical predictions. For example, the cycle-contingent or asset risk class contingent regulations, corporate governance contenting regulations, asset specificity contingent accounting method, loan quality contingent accounting

[2]Some papers focus on other attributes of accounting as opposed to historical cost versus fair value accounting. For example, Corona, Nan, and Zhang (2015) focus on accounting quality.

method, country conditional accounting method. By developing proper proxy for the parameters in my model, future empirical research can practically test my theoretical results.

Section 2 describes the model setup. Section 3 analyzes the historical cost regime and Section 4 analyzes the fair value regime. Section 5 compares the two regimes. The proofs of Propositions are contained in the Appendix. Section 6 discusses potential research extensions and summarizes this study.

CHAPTER 2

MODEL

I study a banking setting in which (i) a representative bank chooses the quality (q) of its loan portfolios in period 1 and makes its asset substitution decision (a) in period 2; (ii) a social planner chooses regulatory target leverages (equivalently, capital requirements) for period 1 (L_1) and period 2 (L_2)[3] and an accounting regime (fair value accounting versus historical cost accounting). I modify and extend the model in Lu, Sapra, and Subramanian (2018).

2.1 Loan Portfolio

At date 0, a representative bank originates a loan portfolio whose terminal cash flow V will be realized at date 2, $V = XZ$. Bank's two decisions will affect V: a date 0 quality decision $q \in \{q_H, q_L\}$ that will affect X and a date 1 asset substitution decision $a \in \{0, 1\}$ that will affect Z.

At date 0, the bank can engage in costly loan screening processes to filter its loan applications. The cost of quality is $C(q)$ where $C(q) = c$ if $q = q_H$ and $C(q) = 0$ if $q = q_L$. The higher quality q_H will generate a higher interim loan performance X and thus a higher net present value. Hence, q_H is more desirable than q_L from the perspective of the size of the pie. Specifically, $X \sim Lognormal(q, \sigma_X^2)$ with density $g(X)$ and cumulative distribution function $G(X)$. Equivalently, $X = e^{q+\sigma_X \varepsilon}$ where $\varepsilon \sim N(0, 1)$. σ_X captures the fundamental risk of loan portfolio, that is: how volatile the loan fundamental is. For example, the loan financing on firm's R&D project is more risky than the loan on other projects. I assume $(e^{q_H} - e^{q_L})\, e^{\frac{1}{2}\sigma_X^2} > c$, which implies that the marginal benefit of the higher quality q_H relative to q_L exceeds the marginal cost. Naturally, the higher quality q_H increases both the mean and the

[3] This is not a dynamic model to deal with multiple periods leverages, but rather ideally propose leverages bundle as the socially optimal choice. The two leverages in my model represent the different prices for deposits in two different periods; Practically, regulators do implement different capital requirement for different economic conditions when needed, for example in recession period.

variance of X, which captures the idea that a higher expected return comes together with a higher volatility.

At date 1, after privately learning the realized value of the interim loan performance X, the bank can engage in asset substitution, for example, reducing the frequency of its on-site inspections at borrower's facilities or increasing the riskiness of the loan portfolio using derivatives. Specifically, $Z \sim Lognormal(-ak, a^2\sigma_Z^2)$ with density $f(Z)$ and cumulative distribution function $F(Z)$. Equivalently, $Z = e^{a(\sigma_Z \eta - k)}$ where $\eta \sim N(0,1)$. σ_Z captures the asset substitution risk, that is: the opportunity of the asset substitution or the upside potential for engaging in asset substitution. For example, in peak, the opportunity of derivatives for speculation is relatively more than in trough. k captures the constraint on asset substitution. For example, the frequency of stress test, the soundness of corporate governance. I assume $k > \frac{1}{2}\sigma_Z^2$, which implies that asset substitution is very costly. Naturally, asset substitution decreases the mean of Z and increases its variance and skewness, implying that asset substitution on average is value-destroying.

2.2 Prudential Regulation and Bank Accounting

Bank industry has a very important feature, maturity mismatching. That is: banks normally issue short-term deposits on the liability side and originate long-term loans on the asset side of bank's balance sheet. On the asset side of the balance sheet, because banks are highly levered, they are plagued with asset substitution and underinvestment in loan quality. Specifically, because of high leverage, banks have an incentive to use depositors' money to gamble for the upside potential, thereby aggravating the asset substitution problem, which may damage loan NPV. In addition, because of high leverage, the bulk of potential profits from loan origination will be accrued to depositors, but the cost of loan screening is borne by shareholders. Therefore, banks are disincentivized to engage in costly loan quality investment, which will also damage loan NPV. On the liability side of the balance sheet, banks' role of providing liquidity benefits to depositors is crucial to social welfare. The higher leverage, the more deposits will be issued, and the more associated liquidity benefits will be. Hence, the insolvency risk of banks threatens the receipts of liquidity benefits and deposits by depositors.[4] Due to their weak bargaining power, individual depositors cannot directly contract with banks to discipline bank's risk taking which will affect the insolvency risk of banks. Bank regulator then steps in to represent individual depositors to discipline bank's risk taking. Therefore, the banking industry is characterized by strict regulations. For example, implement capital requirement and stress test. Because neither asset substitution nor quality choice is verifiable, in this paper, i focus on the leverage ratio, which is invoked by prudential regulation and is well identified in the literature to be the root of asset substitution problem and loan quality incentive problem.

Because the bank chooses its loan quality in period 1 and makes its asset substitution decision in period 2, a social planner will ideally set a prudential leverage for each period, $\{L_1, L_2\}$. Moreover, because of the maturity mismatching, that is, banks use short-term deposits to finance its long-term loans, the size of the deposits (or the price of deposits) in periods 1 and 2 may be different.[5] This further enhances the desirability of time-varying leverage ratios (as opposed to a fixed ratio for all periods).

Because prudential leverage ratios are based on bank's balance sheet data, bank accounting plays a critical role in bank regulations. The ongoing debate on historical cost accounting versus fair value accounting is a case in point. Specifically, at date 1, fair value accounting mandates interim loan performance reports, that is, the bank's private information of the realized value of X.[6] Thus, the social planner can tie pe-

[4] Deposit insurance by the Federal Deposit Insurance Corporation covers only a limited amount of deposits. My model setup is relevant as long as the depositors' loss exceeds this limit, which is especially acute in financial crises in which systemic risk threatens the whole banking sector.

[5] My assumption of short-term deposits is purely to highlight the maturity mismatch between bank's assets and liabilities. All my results hold with a mixture of long-term and short-term deposits.

[6] Because of the long-term nature of loans, the date 1 realized value of X is the bank's private

riod 2 prudential leverage L_2 to the accounting report X. In contrast, historical cost accounting does not mandate a report of X at date 1. Therefore, the prudential leverage for period 2 cannot be tied to the bank's interim performance. In a nutshell, fair value accounting provides more information than historical cost accounting.[7] However, because of the multiple frictions in the economy, that is, the interactions of asset substitution, underinvestment, and liquidity benefit provisions, it is not always true that "the more, the merrier," as to be shown in later sections.[8]

2.3 Timeline

Given the social planner's choices of prudential regulation $\{L_1, L_2\}$ and bank accounting (historical cost or fair value), the game plays out as follows:

Date 0:

(i) The bank finances the initial investment I via short term debt, D_0, and equity, E_0. The debt matures at date 1 with maturity value L_1.

(ii) The bank chooses the loan quality, $q \in \{q_H, q_L\}$, and incurs quality cost $C(q)$.

Date 1:

(i) The interim loan performance X is realized and is privately known to the bank. It is disclosed under fair value accounting but not under historical cost accounting.

(ii) Denote the market values of the bank's debt and equity at date 1 before L_1 is paid as D_1 and E_1, respectively. If the bank is insolvent, i.e., $D_1 + E_1 < L_1$, the bank is

information rather than cash flows. The loan portfolio's cash flow is not X but $V = XZ$, which will be realized at date 2. In addition, because the realized value of X is hidden information, the fair value report of X is a Level 3 input in the fair value hierarchy.

[7] The only difference between the two accounting regimes is that fair value accounting reports interim loan performance on a timely basis while historical cost accounting does not. Both accounting regimes report the loan origination value at date 0 and loan realized value at date 2.

[8] To focus on bank's quality choice and asset substitution decision, I take the bank's scale of lending as given, that is, I assume a fixed amount of investment I in place at the beginning of the game. The literature has investigated the scale of investment thoroughly (e.g., Corona, Nan, and Zhang (2018)). As a consequence, I cannot deal with hybrid accounting regimes in this model. For example, an impairment accounting will mandate the disclosure of $min\{I, X\}$ at date 1. To make it interesting enough, my model must endogenize I before addressing the merits and demerits of impairment accounting. However, Proposition 9 in Section 5 does imply the desirability of impairment accounting, which is also summarized in the Introduction.

bankrupt and the liquidation value of the loan portfolio is normalized to be 0 because the pre-mature project is low valued. If the bank is solvent, i.e., $D_1 + E_1 \geq L_1$, the bank makes the required debt payment L_1 by issuing new debt and (if necessary) equity.[9] The debt issued at date 1 will mature at date 2 with maturity value L_2.

(iii) The bank makes its asset substitution decision $a \in \{0, 1\}$.

Date 2:

(i) The terminal cash flow of the bank's loan portfolio will be realized as $V = XZ$.

(ii) If the bank is insolvent, i.e., $V < L_2$, the bank is bankrupt and the liquidation value of the loan portfolio is αV where $\alpha \in (0, 1)$ and thus $1 - \alpha$ represents asset specificity that causes the deadweight loss in liquidation. If the bank is solvent, i.e., $V \geq L_2$, the bank makes the required debt payment L_2.[10]

2.4 Payoffs

At date 0, bank's depositors lend D_0 to the bank, and the bank's shareholders receive it and incur the cost of quality investment $C(q)$, therefore, the net proceeds received will be: $D_0 - C(q)$.

Because bank's depositors value the liquidity benefits, their payoffs consist of not only the pecuniary amount (cash flows from the bank) but also a non-pecuniary benefit, which is normally called liquidity benefits (also called "convenience spread" in finance literature). Hence, at date 1, if the bank is solvent ($D_1 + E_1 \geq L_1$), the period 1 depositors' payoff is $L_1(1 + \lambda)$, where λ represents the liquidity benefit per dollar deposits.[11] The period 2 depositors lend D_1 to the bank. Thus, bank shareholders'

[9] If the amount of new debt raised exceeds the required payment of the old debt, that is, if $D_1 > L_1$, I assume that the bank will use the surplus as new equity. For example, the bank may issue restricted stocks whose vesting date is date 2. The reason why I am assuming so is to make thing easy. In practice, bank can pay dividends with the extra money. However, the paid dividend will decrease the equity of bank. Therefore, the equity value after paying dividend at date 1 will have to deduct the paid dividend, which is a constant number assumed. Deducting a constant number won't change the essence of my story. Therefore, I normalize the dividend paid as 0 to make my model mathematically easier.

[10] If loans are prematurely liquidated at date 1, their liquidate value will be much lower than at the loan maturity date (date 2). To capture this difference, I normalize the date 1 liquidate value to 0 and assume a positive liquidation value αV at date 2.

[11] Subramanian and Yang (2018) document that on average $\lambda = 25\%$ with a standard error of 0.08

payoff is $D_1 - L_1$. If the bank is insolvent, both depositors and shareholders will receive nothing.

At date 2, if the bank is solvent ($V \geq L_2$), the period 2 depositors' payoff is $L_2(1+\lambda)$. Thus, bank shareholders' payoff is $V - L_2$. If the bank is insolvent, depositors' payoff is $\alpha V(1+\lambda)$ and shareholders will receive nothing. I assume that $\alpha(1+\lambda) < 1$ to avoid the unrealistic scenario in which the liquidation at date 2 generates a higher social value ($\alpha V(1+\lambda)$) than the cash flow without deadweight loss (V).

2.5 Endogenous and Exogenous Variables

I focus on the bank's date 0 loan quality choice $q \in \{q_H, q_L\}$ and its date 1 asset substitution decision $a \in \{0, 1\}$. I assume that the social planner's objective is to maximize the date 0 bank value, that is, $\pi_0 \equiv D_0 + E_0$, the sum of the date 0 debt value and equity value of the bank, and the bank's objective is to maximize equity value at each date. Given these objectives, I investigate the social planner's optimal choices of prudential leverages for periods 1 and 2, that is, $\{L_1, L_2\}$, under an accounting regime in place, historical cost accounting or fair value accounting, to induce bank's decision on loan quality and asset substitution. I will identify the conditions under which one accounting regime dominates the other. Eventually, I will show how to design the optimal coordination mechanisms for prudential regulation and bank accounting to enhance bank value.

I am interested in several parameters in economic environments that shed light on the optimal coordination of prudential regulation and bank accounting. On the asset side of the bank's balance sheet, I am interested in two sets of parameters:

(i) those that affect the bank's quality decisions: σ_X (fundamental risk of the loan portfolio); q_H relative to q_L (the incremental benefit of loan quality); and c (the incremental cost of loan quality).

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for banks in the U.S. over the period of 1991 to 2008.

(ii) those that affect the bank's asset substitution decision: σ_Z (asset substitution risk); k (asset substitution constraint); and $1 - \alpha$ (the deadweight loss due to the date 2 insolvency caused by asset specificity).

On the liability side of the bank's balance sheet, I am interested in the parameter λ (liquidity benefit to depositors).

CHAPTER 3

PRUDENTIAL REGULATIONS UNDER HISTORICAL COST ACCOUNTING

Under historical cost accounting, interim loan performance X is not publicly disclosed at date 1. However, the bank has private knowledge about X. At date 1, the bank chooses its asset substitution decision to maximize its date 2 expected payoff, given its private knowledge of the realized interim loan performance X:

$$\max_{a} \mathbb{E}\left[1_{V \geq L_2} \bullet (V - L_2)|X\right], \tag{1}$$

where the bank will be solvent when its date 2 bank value V exceeds its date 2 obligation L_2 and $1_{V \geq L_2}$ is an indicator function that equals 1 if $V \geq L_2$ and 0 otherwise.

The following proposition confirms the conventional wisdom that high leverage leads to asset substitution.

Proposition 1. *(a) At date 1, the bank will choose asset substitution ($a = 1$) over no asset substitution ($a = 0$) if and only if the leverage is high enough ($L_2 > \gamma_0 X$).*

(b) At date 1, the date 2 insolvency risk is $F\left(\frac{L_2}{X}\right)$.

In the above, γ_0 is defined by

$$1 - \gamma_0 = \int_{\gamma_0}^{\infty} (Z - \gamma_0) f(Z) dZ. \tag{2}$$

At date 1, market values of equity and debt are, respectively,

$$\begin{array}{c} E_1 = \mathbb{E}\left[1_{V \geq L_2} \bullet (V - L_2)\right] \\ D_1 = \mathbb{E}\left[1_{V \geq L_2} \bullet L_2(1+\lambda) + 1_{V < L_2} \bullet \alpha V (1+\lambda)\right] \end{array}, \tag{3}$$

where the debtholders will receive the maturity value of debt L_2 along with its liquidity benefit λL_2 when the bank is solvent at date 2 and receive the liquidation value of loans αV along with its liquidity benefit $\lambda\alpha V$ when the bank is insolvent.

If the interim loan performance X were known to the capital market, the market would know precisely whether the bank will engage in asset substitution or not: Asset substitution will take place if and only if $X < \frac{L_2}{\gamma_0}$ (Proposition 1(a)). If X were known, I denote the market value of the bank (the sum of equity and debt market values) $XB_0\left(\frac{L_2}{X}\right)$ given no asset substitution and $XB_1\left(\frac{L_2}{X}\right)$ given asset substitution, where

$$\begin{array}{c} B_0\left(\frac{L_2}{X}\right) \equiv 1 + \frac{L_2}{X}\lambda \\ B_1\left(\frac{L_2}{X}\right) \equiv \int_{\frac{L_2}{X}}^{\infty}\left(Z + \frac{L_2}{X}\lambda\right) f(Z)dZ + \int_0^{\frac{L_2}{X}} \alpha Z(1+\lambda)f(Z)dZ \end{array}. \tag{4}$$

However, under historical cost accounting, the interim loan performance X is not disclosed. Therefore, the market must assess the distribution of X. Thus, the date 1 market value of the bank (the sum of debt and equity market values) before the payment of L_1 to the period 1 depositors is

$$\pi_1(q, L_2) \equiv \int_{\frac{L_2}{\gamma_0}}^{\infty} XB_0\left(\frac{L_2}{X}\right) g(X;q)dX + \int_0^{\frac{L_2}{\gamma_0}} XB_1\left(\frac{L_2}{X}\right) g(X;q)dX. \tag{5}$$

At date 0, the bank chooses its quality to maximize its equity value:

$$E_0 \equiv \max_q \; - C(q) + \mathbb{E}\left[1_{\pi_1(q,L_2)\geq L_1} \bullet (\pi_1 - L_1)\right], \tag{6}$$

where the bank will be solvent when its date 1 bank value π_1 exceeds its date 1 obligation L_1.

Analogously, the date 0 market values of debt is

$$D_0 = \mathbb{E}\left[1_{\pi_1(q,L_2)\geq L_1} \bullet L_1(1+\lambda)\right], \tag{7}$$

where the debtholders will receive the maturity value of debt L_1 along with its liquidity benefit λL_1 when the bank is solvent at date 1.

The following proposition confirms the conventional wisdom that debt overhang leads to underinvestment in loan quality.

Proposition 2. *[historical cost accounting] (a) At date 0, the bank will choose the low quality (q_L) if and only if the leverage is high enough ($L_1 > \pi_1(q_H, L_2) - c$).*

(b) The bank will be insolvent at date 1 if and only if $L_1 > \pi_1(q, L_2)$.

Proposition 1 and 2 highlight the frictions plagued in banking industry, debt overhang problems (asset substitution and loan quality underinvestment)and insolvency problems due to high leverages.

Friction 1: A high period 2 prudential leverage L_2 leads to bank's asset substitution incentives and high insolvency risk. With a high leverage L_2 in period 2, the bank has an effective call option, that is, the bank can reap the full extent of the upside potential without worrying about the downside risk. Thus, the bank is incentivized to use depositors' money to gamble, or engage in asset substitution. This is demonstrated by Proposition 1(a): The bank will choose asset substitution ($a = 1$) over no asset substitution if and only if the leverage is high enough ($L_2 > \gamma_0 X$). In addition, even though a high leverage may generate a high liquidity benefit for depositors, it may also lead to a high insolvency risk at date 2, which will damage damage the chance of realizing liquidity benefit. Indeed, if the bank is bankrupt, the promised cash flow to depositors and the associated liquidity benefit will be curtailed. This is demonstrated by Proposition 1(b): The date 2 insolvency risk ($F\left(\frac{L_2}{X}\right)$) is high with a high leverage L_2.

Friction 2: A high period 1 prudential leverage L_1 leads to bank's quality underinvestment incentives and high insolvency risk. With a high leverage L_1 in period 1, the bulk of the future benefit from the high quality investment will accrue to debtholders. Thus, the bank is disincentivized to choose a costly quality investment. This is demonstrated by Proposition 2(a): The bank will choose the low quality (q_L) over the high quality if and only if the leverage is high enough ($L_1 > \pi_1(q_H, L_2) - c$). In addition, even though a high leverage may generate a high liquidity benefit for depositors, it may also lead to a high insolvency risk at date 1, which will damage the chance of realizing liquidity benefit. This is demonstrated by Proposition 2(b): The bank will be insolvent if and only if $L_1 > \pi_1(q, L_2)$.

Given the above trade-offs embedded in the bank's private incentives, a social planner sets $\{L_1, L_2\}$ to maximize the date 0 bank value $\pi_0 \equiv D_0 + E_0$, the sum of the date 0 debt value and equity value of the bank, as depicted in the following proposition 3.

Proposition 3. *[historical cost accounting] The social planner sets the optimal leverages $\{L_1^{HC}, L_2^{HC}\}$ as follows:*

(a) $L_1^{HC} = \pi_1(q_H, L_2^{HC}) - c$ and L_2^{HC} is characterized by

$$\int_{\frac{L_2^{HC}}{\gamma_0}}^{\infty} B_0'\left(\frac{L_2^{HC}}{X}\right) g(X; q_H) dX + \int_0^{\frac{L_2^{HC}}{\gamma_0}} B_1'\left(\frac{L_2^{HC}}{X}\right) g(X; q_H) dX = 0, \tag{8}$$

which induces the equilibrium bank decisions:

(b) $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$;

(c) $q^{HC} = q_H$;

and the equilibrium date 0 bank value:

(d) $\pi_0^{HC} = [\pi_1(q_H, L_2^{HC}) - c](1 + \lambda)$.

The social planner sets the period 2 prudential leverage L_2 to balance the trade-offs described above in Friction 1. A high period 2 leverage will directly generate a higher liquidity benefit; however, it will also increase the date 2 insolvency risk, thereby damaging the chance of realizing the liquidity benefit in the first place. In addition, a higher leverage will induce a higher incidence of asset substitution, which will decrease the date 1 bank value. The balancing of these forces yields the optimal choice of L_2 (equation (8)), which, in turn, determines the incidence of asset substitution targeted by the social planner ($Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$).

The social planner also sets the period 1 prudential leverage L_1 to balance the trade-offs described above in Friction 2. A high period 1 leverage will directly generate a higher liquidity benefit; however, it will also increase the date 1 insolvency risk, thereby damaging the chance of realizing the liquidity benefit in the first place. In addition, a higher leverage will discourage the bank from choosing the high quality. The balancing of these forces yields the optimal choice of L_1, which, in turn, induces the bank to choose the high quality ($q^{HC} = q_H$).

Because the social planner sets the prudential regulations $\{L_1, L_2\}$ at the same time at date 0, they are naturally optimally combined. Specifically, the social planner sets L_2 to maximize the date 1 bank value π_1 before the payment of L_1 to the period 1 depositors. Because a higher date 1 bank value encourages the bank's quality investment, the period 1 debt overhang problem is mitigated, and thus the social planner can push L_1 up to enhance the period 1 liquidity benefit to the fullest extent, only constrained by the requirement that no interim insolvency will be triggered.[12]

[12] Under historical cost accounting, X is not disclosed, therefore, social planner cannot precisely induce the socially desirable bank's choice of asset substitution, but rather an optimal incidence of asset substitution. In this regard, regulation is less efficient compared to second-best regulation under fair value accounting. With this third-best regulation on asset substitution, a social planner has to make sure high quality is first induced to enhance ex-ante bank value. This is why high quality is always induced under historical cost accounting.

CHAPTER 4

PRUDENTIAL REGULATIONS UNDER FAIR VALUE ACCOUNTING

The bank's asset substitution decision at date 1 is based on its knowledge of the interim loan performance X and the prevailing prudential leverage L_2 for period 2. Therefore, the bank will engage in asset substitution at date 1 if and only if $\frac{L_2}{X} > \gamma_0$, as stated in Proposition 1.

Under fair value accounting, the interim loan performance X is disclosed at date 1. Therefore, the social planner can tie the prudential leverage L_2 for period 2 to X and set $\frac{L_2}{X} = \gamma$ to precisely induce no asset substitution ($a = 0$) by setting $\gamma \leq \gamma_0$ or asset substitution ($a = 1$) by setting $\gamma > \gamma_0$. Then, the market value of the bank at date 1 is $\pi_1 = XB_a(\gamma)$ where $\pi_1 = XB_0(\gamma)$ given no asset substitution ($a = 0$) and $\pi_1 = XB_1(\gamma)$ given asset substitution ($a = 1$). Note that because the interim loan performance X is disclosed at date 1, the market value of the bank at date 1 is unlike its counterpart (5) under historical cost accounting, which randomizes over the possible values of X.

At date 1, the bank will be solvent if and only if its date 1 value π_1 exceeds its date 1 obligation L_1, or equivalently, $X \geq \frac{L_1}{B_a(\gamma)}$. At date 0, the bank chooses its quality q to maximize its date 0 expectation of equity value:

$$E_0 \equiv \max_q \; -C(q) + \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[XB_a(\gamma) - L_1\right] g(X;q)dX, \tag{9}$$

and the date 0 debt value is

$$D_0 = \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} L_1(1+\lambda)g(X;q)dX, \tag{10}$$

where the debtholders will receive the maturity value of debt L_1 along with its associated liquidity benefit λL_1 when the bank is solvent at date 1. The following proposition 4 describes the decision rule of loan quality choice for the bank.

Proposition 4. *[fair value accounting] (a) At date 0, the bank will choose the low quality (q_L) if and only if the leverage is high enough ($L_1 > \overline{L}_1(\gamma)$).*

(b) At date 0, the date 1 insolvency risk is $G\left(\frac{L_1}{B_a(\gamma)}\right)$.

In the above, $\overline{L}_1(\gamma)$ is characterized by

$$\int_{\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}}^{\infty}\left[X-\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}\right]g(X;q_H)dX-\int_{\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}}^{\infty}\left[X-\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}\right]g(X;q_L)dX=\frac{c}{B_a(\gamma)}. \quad (11)$$

Similarly, Proposition 4 along with proposition 1 highlights the frictions plagued in banking industry, which is debt overhang problems (asset substitution and loan quality underinvestment)and insolvency problems due to high leverages. The first two frictions are similar to their counterparts Friction 1 and Friction 2 under historical cost accounting, whereas the third one here is unique to the fair value accounting regime:

Friction 3: Eliminating asset substitution may damage the bank's incentive to choose the high quality. Specifically, when asset substitution yields a higher interim (date 1) bank value under some conditions, eliminating asset substitution will decrease equityholders' date 0 expectation for future payoff, thereby damaging its date 0 incentive to choose a costly high quality level. This friction is first identified in Lu, Sapra, and Subramanian (2018). This is the interaction between asset substitution and loan quality, and thus may affect social planner's mechanism design.

Given the above trade-offs embedded in the bank's private incentives, a social planner sets $\{L_1, L_2\}$ to maximize the date 0 bank value $\pi_0 \equiv D_0 + E_0$, the sum of the date 0 debt value and equity value of the bank. The following proposition 5 describes social planner's optimal choice of leverages to induce socially desirable bank's decision on asset substitution and loan quality.

Proposition 5. *[fair value accounting] The social planner sets the optimal leverages $\{L_1^{FV}, L_2^{FV}\}$ as follows:*

(i) If

$$A\left(\frac{\overline{L}_1(\gamma_a)}{B_a(\gamma_a)}, q_H\right) - A\left(e^{q_L+S}, q_L\right) \geq \frac{c}{B_a(\gamma_a)}, \tag{12}$$

$L_1^{FV} = \overline{L}_1(\gamma_a)$ *and* $L_2^{FV} = \gamma_0 X$ *if* $B_0(\gamma_0) \geq B_1(\gamma_1)$ *and* $L_2^{FV} = \gamma_1 X$ *if* $B_1(\gamma_1) > B_0(\gamma_0)$,

which induces the equilibrium bank decisions:

$q^{FV} = q_H$;

$a^{FV} = 0$ *if* $B_0(\gamma_0) \geq B_1(\gamma_1)$ *and* $a^{FV} = 1$ *if* $B_1(\gamma_1) > B_0(\gamma_0)$;

the equilibrium date 0 bank value $\pi_0^{FV} = B_a(\gamma_a) A\left(\frac{\overline{L}_1(\gamma_a)}{B_a(\gamma_a)}, q_H\right) - c$.

(ii) If $A\left(\frac{\overline{L}_1(\gamma_a)}{B_a(\gamma_a)}, q_H\right) - A\left(e^{q_L+S}, q_L\right) < \frac{c}{B_a(\gamma_a)}$,

$L_1^{FV} = e^{q_L+S} B_a(\gamma_a)$ *and* $L_2^{FV} = \gamma_0 X$ *if* $B_0(\gamma_0) \geq B_1(\gamma_1)$ *and* $L_2^{FV} = \gamma_1 X$ *if* $B_1(\gamma_1) > B_0(\gamma_0)$,

which induces the equilibrium bank decisions:

$q^{FV} = q_L$;

$a^{FV} = 0$ *if* $B_0(\gamma_0) \geq B_1(\gamma_1)$ *and* $a^{FV} = 1$ *if* $B_1(\gamma_1) > B_0(\gamma_0)$;

the equilibrium date 0 bank value $\pi_0^{FV} = B_a(\gamma_a) A\left(e^{q_L+S}, q_L\right)$.

In the above, $A\left(\frac{L_1}{B_a(\gamma)}, q\right) \equiv \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X + \frac{L_1}{B_a(\gamma)}\lambda\right] g(X;q)dX$

and $B_a(\gamma_a) = max\{B_0(\gamma_0), B_1(\gamma_1)\}$, *where*

$$\begin{array}{c} B_0(\gamma_0) \equiv 1 + \gamma_0\lambda \\ B_1(\gamma_1) \equiv \int_{\gamma_1}^{\infty} (Z + \gamma_1\lambda) f(Z)dZ + \int_0^{\gamma_1} \alpha Z(1+\lambda) f(Z)dZ \end{array}, \tag{13}$$

and

$$\gamma_1 \equiv e^{T-k}, \tag{14}$$

where T is defined by $h(T/\sigma_Z)/\sigma_Z = \frac{\lambda}{(1+\lambda)(1-\alpha)}$ *and S is defined by* $h(S/\sigma_X)/\sigma_X = \frac{\lambda}{1+\lambda}$, *in which $h()$ is a hazard rate function for a standard normal distribution.*

Under fair value accounting, to balance the trade-offs in Friction 1, the social planner can tie its period 2 prudential leverage L_2 to the interim loan performance X, thereby precisely inducing no asset substitution or asset substitution, whichever yields a higher interim (date 1) bank value. Specifically, if the planner wants to induce no asset substitution, she will set $L_2^{FV} = \gamma_0 X$, thereby enhancing the liquidity benefit to the fullest. If she wants to induce asset substitution instead, she can set a leverage higher than γ_0. The higher period 2 leverage will directly generate a higher liquidity benefit; however, it will also increase the date 2 insolvency risk, thereby damaging the chance of realizing the liquidity benefit in the first place. The balancing of liquidity benefits and insolvency risk will yield the optimal $L_2 = \gamma_1 X$.

The social planner also sets the period 1 prudential leverage L_1 to balance the trade-offs in Friction 2. A high period 1 leverage will directly generate a higher liquidity benefit; however, it will also increase the date 1 insolvency risk, thereby damaging the chance of realizing the liquidity benefit in the first place. In addition, a higher leverage will disincentivize the bank's choice of the high quality. Furthermore, the induced asset substitution may indirectly incentivize bank's loan quality. The balancing of these forces yields the optimal L_1, which, in turn, induces a targeted date 1 insolvency risk $G\left(\frac{L_1^{FV}}{B_a(\gamma)}\right)$.

Remark 1. Contrasts between Historical Cost Accounting and Fair Value Accounting.

(i) Under fair value accounting, the interim loan performance X is disclosed at date 1. Therefore, the social planner can tie its period 2 prudential leverage L_2 to X, thereby precisely inducing asset substitution or no asset substitution, whichever she wants.

In contrast, under historical cost accounting, X is not reported at date 1 and thus the planner can only sets L_2 to induce a target incidence of asset substitution, which balances the trade-offs described in Friction 1.

(ii) Under historical cost accounting, the interim loan performance X is not disclosed at date 1 and thus no volatility in the interim (date 1) market value of the bank exists. Therefore, even at date 0, the social planner can for certain induce the interim solvency without any uncertainty. To do so, she sets her period 1 prudential leverage L_1 to induce the bank to choose the high quality to boost the date 1 bank value.

In contrast, under fair value accounting, X is reported at date 1 and therefore the interim (date 1) market value of the bank will be volatile, thereby potentially triggering interim insolvency. Because at date 0 the social planner cannot know the exact value of X to be disclosed at date 1, she sets L_1 to induce a target incidence of interim insolvency, which balances the trade-offs described in Friction 2 and 3.

(iii) As a consequence of (i) and (ii), under historical cost accounting, the social planner sets her prudential leverages to induce a target incidence of asset substitution and the high quality level, whereas under fair value accounting, she sets her prudential leverages to induce her desired level of asset substitution and a target incidence of interim insolvency, which may engender the high or low quality level.

In particular, under fair value accounting, it is not surprising that under certain parameter values, a combination of $\{a = 0, q = q_H\}$ which maximizes the net cash flow may occur in equilibrium. However, more interestingly, under other parameter values, Friction 3 described above may take force: that is, eliminating asset substitution may endanger the bank's quality investment (that is, a combination of $\{a = 0, q = q_L\}$), or on the other direction, forbearing asset substitution in order to boost the bank's quality investment (that is, a combination of $\{a = 1, q = q_H\}$) may occur in equilibrium.[13]

[13] In my model, a social planner simultaneously chooses two optimal regulatory leverages to induce socially desirable bank's choice of asset substitution in period 2 and loan quality in period 1. Therefore, asset substitution and loan quality are organically interacted with each other by two leverages. To isolate how leverage induces desirable loan quality without considering the effect of asset substitution on loan quality, that is, the effect of friction 3 described above, in the appendix, I will illustrate the incremental effect of asset substitution on loan quality in a hypothetical accounting

CHAPTER 5

HISTORICAL COST ACCOUNTING VERSUS FAIR VALUE ACCOUNTING

Which accounting regime, historical cost or fair value, induces a larger date 0 bank value π_0? I answer this question along the dimensions of parameters on the asset side and the liability side of bank's balance sheets.

5.1 Asset Substitution Risk and Constraint

Proposition 6. *(i) Under fair value accounting, when σ_Z is increasing from 0 or when k is decreasing towards 0,*

L_2^{FV} is decreasing first ($L_2^{FV} = \gamma_0 X$) and increasing later ($L_2^{FV} = \gamma_1 X$), and L_1^{FV} is decreasing first (from $L_1^{FV} = \overline{L}_1(\gamma_0)$ to $L_1^{FV} = e^{q_L+S}B_0(\gamma_0)$) and increasing later (from $L_1^{FV} = e^{q_L+S}B_1(\gamma_1)$ to $L_1^{FV} = \overline{L}_1(\gamma_1)$). Such a pattern of change induces $a = 0$ first and $a = 1$ later, and induces q_H first, followed by q_L, and eventually q_H later again.

(ii) Under historical cost accounting, when σ_Z is increasing from 0 or when k is decreasing towards 0,

L_2^{HC} and L_1^{HC} are increasing, which induce $q^{HC} = q_H$ and an increasing $Prob(a^{HC} = 1)$.

(iii) Historical cost accounting dominates fair value accounting for medium values of σ_Z and k, whereas fair value accounting dominates historical cost accounting for extremely high or low values of σ_Z and k.

regime, which is called "Baseline Fair value accounting regime", in which high quality is induced for sure by leverage in period 1 without being affected by the induced future asset substitution decision in period 2. Hence, readers can see the magnitude of the effect of friction 3 on loan quality. That will imply the incremental efficiency of leverages regulation.

A higher asset substitution risk σ_Z or a looser asset substitution constraint k motivates bank's asset substitution incentives. Therefore, in the following, I focus on the intuition of Proposition 6 in terms of σ_Z with the understanding that the same intuition applies for k. The frictions I introduced before feature strongly in Proposition 6.

Under *fair value accounting*, when asset substitution risk σ_Z is extremely low, asset substitution is not quite attractive to the bank in the first place. Therefore, the social planner can comfortably set high prudential leverage L_2^{FV} to induce no asset substitution without ever compromising liquidity benefits to depositors. The high leverage in period 2 with induced no asset substitution will boost the interim bank value, which will give social planner ample room to set a high leverage L_1^{FV} to induce high quality of loans.

When asset substitution risk σ_Z is increasing, the bank's asset substitution incentive is increasing. Therefore, to curb bank's increasing incentive of asset substitution, the social planner lowers the period 2 prudential leverage L_2^{FV}. However, because of the trade-off described in Friction 3, a dampened asset substitution incentive will disincentivize the bank's quality investment. To restore the high quality, the social planner will lower the period 1 prudential leverage L_1^{FV} to reduce debt overhang. Although both no asset substitution and high quality are induced, it comes at the expense of lower liquidity benefits implied by lower prudential leverages. Therefore, the date 0 bank value decreases.

When asset substitution risk σ_Z increases further, the induced low quality incentive alluded to above becomes even stronger. Further decreasing leverage L_1^{FV} to induce high quality becomes too costly. Therefore, the social planner has to tolerate the low quality, which leads to a high chance of the interim (date 1) insolvency risk. To control this heightened risk, the social planner further lowers the period 1 prudential leverage L_1. The low quality q_L in conjunction with low leverages further decreases the date 0 bank value.

When asset substitution risk σ_Z increases even further, lowering L_2 further would sacrifice too many liquidity benefits. Therefore, the social planner increases L_2 to forbear asset substitution. At the same time, a higher level of L_2 implies a higher level of liquidity benefits and thus a higher interim (date 1) bank value. A higher bank value at date 1 reduces the interim insolvency risk and thus gives the social planner ample room to increase the period 1 prudential leverage L_1 to enhance the period 1 liquidity benefit. For these reasons, the date 0 bank value reverses its downward slip and starts to increase.

When asset substitution risk σ_Z continues to increase further, the force of Friction 3 works to its fullest extent: An ever-increasing period 2 asset substitution incentive will eventually induce the bank to choose the high quality in period 1. This gives the social planner ample room to increase the period 1 prudential leverage L_1 to enhance the period 1 liquidity benefit. For these reasons, the date 0 bank value increases even more.

Under *historical cost accounting*, because the interim loan performance X is not disclosed, the social planner cannot eliminate asset substitution for certain because it cannot fine-tune its period 2 prudential leverage L_2 to X. In other words, she has to allow for a probability of asset substitution. Therefore, the higher the value of σ_Z, the higher incentive of asset substitution, and then the high incidence of asset substitution. To induce an increasing optimal incidence of asset substitution, the higher the level of L_2^{HC} will be set by the social planner. At the same time, a higher level of L_2 implies a higher level of liquidity benefits and thus a higher interim (date 1) bank value. A higher bank value at date 1 reduces the interim insolvency risk and thus gives the social planner ample room to increase the period 1 prudential leverage L_1 to enhance the period 1 liquidity benefit. For these reasons, the date 0 bank value increases.

Which accounting regime, historical cost or fair value, induces a higher date 0 bank value?

Proposition 6(iii) provides the answer: Historical cost accounting dominates fair value accounting for medium values of asset substitution risk and constraint, and fair value accounting dominates for extremely high or low values. The intuition behind this result hinges crucially upon Frictions 1, 2, and 3 described before and the fact that the prudential leverages L_1 and L_2 are optimally coordinated by the social planner.

When asset substitution risk σ_Z is extremely low, the curbed asset substitution with high leverage L_2 results in the higher interim bank value and the lower interim insolvency risk under fair value accounting than under historical cost accounting; the social planner can thus take advantage of it to boost L_1 to enhance liquidity benefits. Therefore, the date 0 bank value under fair value accounting is higher than under historical cost accounting in this σ_Z area.

By the same token, when asset substitution risk σ_Z is extremely high, the tolerated asset substitution with high leverage L_2 results in the higher interim bank value and the lower interim insolvency risk under fair value accounting than under historical cost accounting; the social planner can thus take advantage of it to boost L_1 to enhance liquidity benefits. Therefore, the date 0 bank value under fair value accounting is also higher than under historical cost accounting in this σ_Z area.

For medium values of σ_Z, things are dramatically different. In these cases, under fair value accounting, because of the trade-off between asset substitution and quality described in Friction 3 earlier, the low quality is chosen in equilibrium, which works against the desirability of fair value accounting relative to historical cost accounting, in which the high quality is always chosen in equilibrium. Because the social planner tolerates the low quality for the benefit of no asset substitution, she sets a lower level of L_2 than its counterpart under historical cost accounting, yielding a lower liquidity benefit for period 2 debtholders. Because the two prudential leverages are coordinated, L_1 is also lower under fair value accounting. Moreover, there is an added benefit under historical cost accounting: Because of no insolvency risk at date 1 and thus the high quality will be chosen in equilibrium, the social planner can further boost the period 1 leverage L_1 to further enhance liquidity benefits. Therefore, the date 0 bank value is higher under historical cost accounting than under fair value accounting in this σ_Z area.

σ_Z captures the opportunity or risk of asset substitution. I conjecture that σ_Z is different for bank assets with different risk classes. For example, the bank has more opportunity to engage in asset substitution (constructing derivatives for speculation) for high risk assets. In addition, I can also conjecture that σ_Z is different for different business cycle stages. For example, in the troughs stage, the opportunity to engage in asset substitution is relatively low while in the peaks, the opportunity is relatively high. Similarly, I can conjecture that k, asset substitution constraint is different for banks with different strength of corporate governance, or is different for different tightness of stress test. Proposition 6 then has the following important policy implications.

(1) It may be socially beneficial to impose prudential leverages contingent on the risk classes (σ_Z) of bank assets and the strength (k) of bank's corporate governance. Proposition 6 implies that, the social planner may require *historical cost accounting for bank assets subject to medium asset substitution risk and/or for banks with medium strength of corporate governance*; however, fair value accounting is preferred for the least and the most risky bank assets and/or for banks with weak or strong corporate governance.

(2) It may be socially beneficial to switch accounting methods contingent on the phase of business cycles. In the troughs or peaks of business cycles when asset substitution risk is the least or greatest, fair value accounting is called for; however, *in the expansion or contraction phases of business cycles, historical cost accounting* is

preferred.

(3) Prudential regulations are contingent on the particular bank accounting in place. For medium values of asset substitution risk σ_Z and corporate governance strength k, the social planner should set higher prudential leverages under historical cost regime than under fair value regime. However, for extremely low values of σ_Z and high value of k, the social planner should set higher prudential leverages under fair value regime than under historical cost regime. Furthermore, for extremely high values of σ_Z and low value of k, even though prudential regulations should be set at high levels in both regimes, the social planner should set higher leverages under fair value regime than under historical cost regime. In this regard, fair value accounting may result in both counter-cyclical and pro-cyclical prudential regulation, while historical cost accounting may result in pro-cyclical prudential regulation.

5.2 Asset Specificity

Proposition 7. *(i) Under fair value accounting, when $1-\alpha$ is decreasing from 1,*

L_2^{FV} is constant first ($L_2^{FV} = \gamma_0 X$) and increasing later ($L_2^{FV} = \gamma_1 X$), and L_1^{FV} is constant first ($L_1^{FV} = e^{q_L+S}B_0(\gamma_0)$) and increasing later (from $L_1^{FV} = e^{q_L+S}B_1(\gamma_1)$ to $L_1^{FV} = \overline{L}_1(\gamma_1)$). Such a pattern of change induces $a=0$ first and $a=1$ later, and induces q_L first and q_H later.

(ii) Under historical cost accounting, when $1-\alpha$ is decreasing from 1,

L_2^{HC} and L_1^{HC} are increasing, which induce $q^{HC} = q_H$ and increasing $Prob(a^{HC} = 1)$.

(iii) Historical cost accounting dominates fair value accounting for low values of $1-\alpha$, whereas fair value accounting dominates historical cost accounting for high values of $1-\alpha$.

Because the liquidation value of loans at the terminal date (date 2) is αV where

$\alpha \in (0, 1)$, $1 - \alpha$ represents the deadweight loss caused by liquidation due to factors such as asset specificity.

When asset is not specific, deadweight loss is low, then asset specificity is not a big issue (that is, when $1 - \alpha$ is low), in which case, fair value accounting is inferior to historical cost accounting for two reasons. First, because the deadweight loss due to liquidation is small, the opportunity of fine-tuning the period 2 prudential leverage L_2 to the interim performance report X does not generate much benefit. Second, however, fair value accounting triggers the interim insolvency risk at date 1, which hurts the chance of receiving the date 2 value. This damage will become even bigger when the liquidation value is bigger (that is, when α is higher), while under historical cost accounting, because no information is updated at date 1, interim insolvency risk can be avoided. Both the benefits of fine-tuning leverage and avoiding interim insolvency risk will contribute to the enhancement of bank value. Therefore, the social planner will trade off between these two aspects for assets with different asset specificity.

I conjecture that generic assets are less specific, and assets are normally less liquid in the trough or contraction phase of business cycle. Therefore, proposition 7 has the following important policy implications.

(1) It may be socially beneficial to impose prudential leverages contingent on the specificity $(1 - \alpha)$ of bank assets. That is, social planners may require fair value accounting for specific assets whose values are low in the second-hand markets; however, *historical cost accounting is preferred for generic assets.*

(2) It may be socially beneficial to switch accounting methods contingent on the phase of business cycles. That is, in the trough or contraction phase of business cycles characterized by illiquid markets, fair value accounting is called for; however, *in the peak or expansion phase of business cycles, historical cost accounting* is preferred.

The above two implications are in contrast with Plantin, Sapra, and Shin (2008), who arrive at an opposite conclusion in a different setting in which banks make "sell versus hold" decisions in Keynesian beauty contests.

5.3 Fundamental Risk

Proposition 8. *Historical cost accounting dominates fair value accounting for lower values of σ_X whereas fair value accounting dominates historical cost accounting for higher values of σ_X.*

When the fundamental risk does not exist ($\sigma_X = 0$), that is, when the interim loan performance X is known even at date 0, no difference exists between the two accounting regimes, because both regimes report the same information at date 1. However, when σ_X is sufficiently large, the public reporting of the interim loan performance under fair value accounting eliminates the fundamental risk at date 1, whereas this cannot be achieved under historical cost accounting. This is exactly the reason cited by fair value proponents. In my paper, the conventional wisdom that reporting the interim loan performance is good holds when the volatility of fundamental performance is a significant concern for the social planner. When fundamental performance is not very volatile, exposure of risk by fair value accounting does not generate too many benefits. However, fair value accounting may result in volatile bank value and thus trigger interim insolvency, which can be avoided under historical cost accounting. Therefore, under different conditions, the social planner will trade off such two aspects to design the optimal regulations.

5.4 Quality Level and Quality Cost

Proposition 9. *(i) Under fair value accounting, when q_H is increasing from q_L or when c is decreasing towards* 0*,*

L_2^{FV} and L_1^{FV} are increasing, which induces q_L first and q_H later.

(ii) Under historical cost accounting, when q_H is increasing from q_L or when c is decreasing towards 0*,*

L_2^{HC} and L_1^{HC} are increasing, which induce $q^{HC} = q_H$ and increasing $Prob(a^{HC} = 1)$.

(iii) Historical cost accounting dominates fair value accounting for high values of q_H or low values of c, whereas fair value accounting dominates historical cost accounting for low values of q_H or high values of c.

A higher quality level q_H , which approximately captures the marginal benefits of high quality or a lower marginal cost c of quality investment motivates bank's high quality incentives. Therefore, in the following, I focus on the intuition of Proposition 9 in terms of q_H with the understanding that the same intuition applies for c.

When q_H is increasing from q_L, naturally the date 0 bank value increases in both accounting regimes. For high values of q_H, the interim bank value will be high, and an interim (date 1) insolvency will entail a big social loss. In this case, historical cost accounting dominates fair value accounting because the former regime avoids the interim insolvency. However, this benefit of historical cost accounting is low when the value of q_H is low, in which case, fair value accounting can fine-tune the period 2 prudential leverage to the interim loan performance report, thereby enhancing bank value. That is the advantage of fair value accounting.

I conjecture that the marginal benefits of high quality for heterogeneous loan is higher than homogeneous loan, the marginal cost for special types of loans is higher than commonplace types of loans and the quality level is relatively higher in good times than in bad times. Therefore, proposition 9 has the following policy implications.

(1) It may be socially beneficial to mandate accounting regimes based on the characteristics of bank loan applications. For loan applications of heterogeneous qualities (high q_H relative to q_L), historical cost accounting is called for; however, for loan applications of homogeneous quality (low q_H relative to q_L), fair value accounting

is preferred. In addition, for loan applications of commonplace types (low value of screening cost c), historical cost accounting is called for; however, for loan applications of special types (high value of c), fair value accounting is preferred.

(2) It may be socially beneficial to switch accounting methods contingent on the phase of business cycles. To the extent that high quality levels and/or low marginal cost of quality is featured in good times and the converse is featured in bad times, Proposition 9 implies that, historical cost accounting is called for in good times and fair value accounting is preferred in bad times. This is exactly what *impairment accounting* prescribes. Göx and Wagenhofer (2009) explain why impairment accounting may benefit borrowers. Adding to the literature, I explain why impairment accounting may benefit lenders (banks).

5.5 Liquidity Benefit

Proposition 10. *(i) Under fair value accounting, when λ is increasing from 0, the patterns of changes in L_2^{FV}, L_1^{FV}, a^{FV}, q^{FV}, and π_0^{FV} follow the same trend as what is described in Proposition 6 for an increasing value of σ_Z.*

In particular, L_2^{FV} and L_1^{FV} are increasing in λ.

(ii) Under historical cost accounting, when λ is increasing,

L_2^{HC} and L_1^{HC} are increasing, which induces $q^{HC} = q_H$ and increasing $Prob(a^{HC} = 1)$.

(iii) Historical cost accounting dominates fair value accounting for high values of λ, whereas fair value accounting dominates historical cost accounting for low values of λ.

The date 0 bank value π_0 consists of two parts: one is the net present value of loan cash flows determined by bank's quality q and asset substitution choice a; the other is the liquidity benefits to depositors determined by leverages L_2 and L_1.

When the liquidity benefit λ is increasing, the social planner has more incentives to increase leverage to enhance liquidity benefits. Therefore, the social planner naturally increases the prudential leverages L_2 and L_1 in both accounting regimes. For low values of λ, liquidity benefits are relatively low, then the social planner's focus will focus more on enhancing the net present value of loan cash flows, in which case fair value accounting is more attractive because the social planner can tie her period 2 leverage with the interim performance report X, thereby managing bank's asset substitution decision more efficiently. For high values of λ, liquidity benefit is higher, and then the social planner will focus more on enhancing liquidity benefits, in which case historical cost accounting is more attractive because it avoids the interim insolvency risk, thereby safeguarding debtholders' deposits and the associated liquidity benefits. Therefore, for different values of λ, the social planner will trade off these two aspects.

I conjecture that liquidity benefits are more significant for citizens in developing country than in developed country, and are cherished differently in different business cycles, proposition 10 has the following important policy implications.

(1) To the extent that liquidity benefits are more significant to citizens in developing countries than in developed countries, social planners may require *historical cost accounting for developing countries*. The International Financial Reporting Standards are advocating fair value accounting, and more and more developing countries are accepting those standards. My result warns against blindly accepting fair value accounting for banks in developing countries without a consideration of liquidity benefits of their domestic depositors.

(2) It may be socially beneficial to switch accounting methods contingent on the phase of business cycles. To the extent that liquidity benefits are more cherished in difficult times, proposition 10 implies that, in the peak or expansion phase of business cycles, fair value accounting is called for; however, *in the trough or contraction phase*

of business cycles, historical cost accounting is preferred.

CHAPTER 6

CONCLUSIONS

This study focuses on the bank's decisions (asset substitution and quality of loan portfolios) and on the regulatory coordination (prudential regulation and bank accounting). I identify several key parameters related to bank assets and bank liabilities and investigates their effects on bank decisions and regulatory decisions, and ultimately, on bank value. By incorporating both asset side and liability side of bank's balance sheet items into my model, my paper identifies the conditions under which historical cost accounting dominates fair value accounting, and the conditions for optimal prudential regulation as described in above propositions.

My paper contributes to the public policy making in several aspects. For example, the prudential regulation may be cycle-contingent. Fair value accounting is optimal for the stage of peak or trough, while historical cost accounting is optimal for the stage of contraction or expansion. In addition, in different economic times, accounting method may be different. Specifically, historical cost accounting is for good time while fair value accounting is for bad time. With respect to country perspective, my paper argues for historical cost accounting preferable for developing country while fair value accounting preferable for developed country.

My paper also contributes to theoretical research. I explore the coordination of prudential regulation and bank accounting in full accounting regimes by focusing on the loan quality decision and asset substitution decision while other papers in the literature study different decisions. I introduce many interesting parameters to capture the characteristics of bank loans and deposits, which makes it more feasible for the future empirical examination of my theoretical results.

I contrast a pure fair value accounting regime and a pure historical cost accounting regime in this paper. In practice, however, a mixed-attributes accounting regime is used. For example, impairment accounting mixes both the feature of a pure historical cost accounting regime and the feature of a pure fair value accounting regime. Therefore, the two pure regimes can serve as benchmarks for a future extension of the model in this study to incorporate mixed-attributes regimes. My paper assumes exogenous lending amounts. Future research can endogenize lending decision to study how the prudential regulation with respect to capital ratios under BASEL III should be optimally designed to enhance social value.

APPENDIX

PROOF OF PROPOSITION 1

If the bank chooses $a = 1$, the bank will be solvent at date 2 if and only if $V \geq L_2 \Leftrightarrow Z = e^{\sigma_Z \eta - k} \geq \frac{L_2}{X}$, and the bank's expected date 2 payoff in (1) will be $X \int_{\frac{L_2}{X}}^{\infty} \left(Z - \frac{L_2}{X}\right) f(Z)dZ$. This payoff equals $Xe^{\frac{1}{2}\sigma_Z^2 - k} < 1$ at $\frac{L_2}{X} = 0$ and approaches 0 when $\frac{L_2}{X}$ approaches ∞. In addition, its derivative with respect to $\frac{L_2}{X}$ is $-X\left[1 - F\left(\frac{L_2}{X}\right)\right]$.

If the bank chooses $a = 0$, the bank will be solvent at date 2 if and only if $V \geq L_2 \Leftrightarrow 1 \geq \frac{L_2}{X}$, and the bank's expected date 2 payoff in (1) will be $X\left(1 - \frac{L_2}{X}\right)$ if $\frac{L_2}{X} \leq 1$ and 0 otherwise. Its payoff given solvency equals X at $\frac{L_2}{X} = 0$ and 0 when $\frac{L_2}{X} = 1$. In addition, its derivative with respect to $\frac{L_2}{X}$ is $-X$.

Therefore, the bank's expected date 2 payoff given $a = 1$ and that given $a = 0$ intersect at $\frac{L_2}{X} = \gamma_0$, where γ_0 is defined by $1 - \gamma_0 = \int_{\gamma_0}^{\infty} (Z - \gamma_0) f(Z)dZ$. And the bank will choose asset substitution ($a = 1$) over no asset substitution if and only if the leverage is high enough ($L_2 > \gamma_0 X$).

By (3), if X were known to the capital market, the bank's market value of equity at date 1 given $a = 0$ is $X\left(1 - \frac{L_2}{X}\right)$ and the bank's market value of debt at date 1 given $a = 0$ is $X\frac{L_2}{X}(1 + \lambda)$, which sum up to $XB_0\left(\frac{L_2}{X}\right)$, where $B_0\left(\frac{L_2}{X}\right) \equiv 1 + \frac{L_2}{X}\lambda$.

Similarly, by (3), if X were known to the capital market, the bank's market value of equity at date 1 given $a = 1$ is $X \int_{\frac{L_2}{X}}^{\infty} \left(Z - \frac{L_2}{X}\right) f(Z)dZ$ and the bank's market value of debt at date 1 given $a = 1$ is $X\left[\int_{\frac{L_2}{X}}^{\infty} \frac{L_2}{X}(1 + \lambda) f(Z)dZ + \int_0^{\frac{L_2}{X}} \alpha Z(1 + \lambda) f(Z)dZ\right]$, which sum up to $XB_1\left(\frac{L_2}{X}\right)$, where

$$B_1\left(\frac{L_2}{X}\right) \equiv \int_{\frac{L_2}{X}}^{\infty} \left(Z + \frac{L_2}{X}\lambda\right) f(Z)dZ + \int_0^{\frac{L_2}{X}} \alpha Z(1 + \lambda) f(Z)dZ.$$

■

PROOF OF PROPOSITION 2

Note that $\pi_1(q, L_2)$ is increasing in q and therefore $\pi_1(q_L, L_2) < \pi_1(q_H, L_2)$. Thus, there are three cases to discuss:

(i) When $L_1 \leq \pi_1(q_L, L_2)$, the bank's expected payoff in (6) is $-c + \pi_1(q_H, L_2) - L_1$ given q_H and $\pi_1(q_L, L_2) - L_1$ given q_L. Because $\pi_1(q_H, L_2) - \pi_1(q_L, L_2) > c$, the bank will choose q_H.

(ii) When $L_1 \in (\pi_1(q_L, L_2), \pi_1(q_H, L_2)]$, the bank's expected payoff in (6) is

$$-c + \pi_1(q_H, L_2) - L_1$$

given q_H and 0 given q_L, and thus the bank will choose q_H if and only if $L_1 \leq \pi_1(q_H, L_2) - c$.

(iii) When $L_1 > \pi_1(q_H, L_2)$, the bank's expected payoff in (6) is $-c$ given q_H and 0 given q_L and thus the bank will choose q_L.

To summarize, the bank will choose q_H if and only if $L_1 \leq \pi_1(q_H, L_2) - c$.

Define $\pi_0 \equiv D_0 + E_0$ as the ex ante bank value. When $L_1 > \pi_1(q_H, L_2) - c$, $E_0 = 0$ by (6) and $D_0 = 0$ by (7) and thus $\pi_0 \equiv D_0 + E_0 = 0$. When $L_1 \leq \pi_1(q_H, L_2) - c$, $E_0 = -c + \pi_1(q_H, L_2) - L_1$ by (6) and $D_0 = L_1(1 + \lambda)$ by (7) and thus $\pi_0 = -c + \pi_1(q_H, L_2) + L_1\lambda$. ■

PROOF OF PROPOSITION 3

The social planner sets $\{L_1, L_2\}$ to maximize the date 0 bank value $\pi_0 \equiv D_0 + E_0$, which is $\pi_0 = -c + \pi_1(q_H, L_2) + L_1\lambda$ when $L_1 \leq \pi_1(q_H, L_2) - c$, as stated at the end of the proof of Proposition 2. Thus, in this case, the optimal value of L_1 is $\pi_1(q_H, L_2) - c$ and then $\pi_0 = [\pi_1(q_H, L_2) - c](1 + \lambda)$, which is greater than 0, which is the value of π_0 when $L_1 > \pi_1(q_H, L_2) - c$. Thus, $q^{HC} = q_H$.

Therefore, the optimal value of L_2 is characterized by the first-order condition of

$$\pi_0 = [\pi_1(q_H, L_2) - c](1 + \lambda)$$

with respect to L_2, which is given in (8) in the statement of the proposition. As a consequence, $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$, $L_1^{HC} = \pi_1(q_H, L_2^{HC}) - c$, and $\pi^{HC} = [\pi_1(q_H, L_2^{HC}) - c](1 + \lambda)$. ■

PROOF OF PROPOSITION 4

By (9), $\frac{\partial E_0}{\partial L_1} = -B_a(\gamma)[1 - \Phi\left((ln\frac{L_1}{B_a(\gamma)} - q)/\sigma_X\right)] < 0$, which implies that the slope of E_0 given q_H is steeper than that given q_L. Moreover, at $L_1 = 0$, E_0 given q_H equals $B_a(\gamma)\mathbb{E}[X|q_H] - c$ and E_0 given q_L equals $B_a(\gamma)\mathbb{E}[X|q_L]$, and the former exceeds the latter by the assumption that $\mathbb{E}[X|q_H] - \mathbb{E}[X|q_L] > c$ and by the fact that $B_a(\gamma) \geq 1$. Furthermore, when $L_1 \to \infty$, E_0 given q_H approaches $-c$ and E_0 given q_L approaches 0. Thus, E_0 given q_H exceeds E_0 given q_L if and only if $L_1 \leq \overline{L}_1$ where $\overline{L}_1$ is the value of L_1 where the two equity values equal and is characterized in (11) in the statement of the proposition.

Thus, when $L \leq \overline{L}_1$, the bank will choose q_H, and its date 0 equity value will be

$$-c + \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X B_a(\gamma) - L_1 \right] g(X; q_H) dX$$

by (9) and its date 0 debt value will be

$$D_0 = \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} L_1(1+\lambda) g(X; q_H) dX$$

by (10), and therefore the date 0 bank value is

$$\pi_0(L_1, q_H) = -c + \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X B_a(\gamma) + L_1 \lambda \right] g(X; q_H) dX.$$

Similarly, when $L > \overline{L}_1$, the bank will choose q_L, and its date 0 equity value will be $\int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X B_a(\gamma) - L_1 \right] g(X; q_L) dX$ by (9) and its date 0 debt value will be

$$D_0 = \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} L_1(1+\lambda) g(X; q_L) dX$$

by (10), and therefore the date 0 bank value is

$$\pi_0(L_1, q_L) = \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X B_a(\gamma) + L_1 \lambda \right] g(X; q_L) dX.$$

■

PROOF OF PROPOSITION 5

Recall from the proof of Proposition 4 that when $L \leq \overline{L}_1$, the date 0 bank value is $\pi_0(L_1, q_H) = -c + B_a(\gamma) A\left(\frac{L_1}{B_a(\gamma)}, q_H\right)$ where $A\left(\frac{L_1}{B_a(\gamma)}, q\right) \equiv \int_{\frac{L_1}{B_a(\gamma)}}^{\infty} \left[X + \frac{L_1}{B_a(\gamma)}\lambda\right] g(X; q) dX$.

Because $\frac{\partial \pi_0(L_1, q_H)}{\partial B_a(\gamma)} = A - \frac{\partial A}{\partial\left(\frac{L_1}{B_a(\gamma)}\right)} \frac{L_1}{B_a(\gamma)} > 0$, the social planner will pick the value of $\frac{L_2}{X} = \gamma$ to maximize $B_a(\gamma)$. By (4), $B_0\left(\frac{L_2}{X}\right)$ attains its maximal value at $\frac{L_2}{X} = \gamma_0$ and $B_1\left(\frac{L_1}{X}\right)$ attains its maximal value at $\frac{L_2}{X} = \gamma_1$ where $\gamma_1 = e^{T-k}$ where T is characterized by $h(T/\sigma_Z)/\sigma_Z = \frac{\lambda}{(1+\lambda)(1-\alpha)}$. Thus, the social planner will set $\frac{L_2}{X} = \gamma_0$ if $B_0(\gamma_0) \geq B_1(\gamma_1)$ and set $\frac{L_2}{X} = \gamma_1$ if $B_1(\gamma_1) > B_0(\gamma_0)$.

In addition,

$$
\begin{gathered}
\frac{\partial \pi_0(L_1,q_H)}{\partial L_1} = \frac{\partial A}{\partial(\frac{L_1}{B_a(\gamma)})} = \\
[1-\Phi\left((ln\frac{L_1}{B_a(\gamma)}-q)/\sigma_X\right)][\lambda-(1+\lambda)h\left((ln\frac{L_1}{B_a(\gamma)}-q)/\sigma_X\right)/\sigma_X].
\end{gathered}
\tag{15}
$$

Note that $A = \mathbb{E}[X|q_H]$ at $\frac{L_1}{B_a(\gamma)} = 0$ and approaches 0 when $\frac{L_1}{B_a(\gamma)} \to \infty$. In addition, it reaches its maximal value at $\frac{L_1}{B_a(\gamma)} = e^{q+S}$ where S is defined by $h(S/\sigma_X)/\sigma_X = \frac{\lambda}{1+\lambda}$. Furthermore, it is concave for lower values of $\frac{L_1}{B_a(\gamma)}$ and convex for higher values of $\frac{L_1}{B_a(\gamma)}$. Therefore, $A - \frac{\partial A}{\partial(\frac{L_1}{B_a(\gamma)})}\frac{L_1}{B_a(\gamma)} > 0$.

Again from the proof of Proposition 4, when $L > \overline{L}_1$, the date 0 bank value is $\pi_0(L_1,q_L) = B_a(\gamma)A\left(\frac{L_1}{B_a(\gamma)}, q_L\right)$. A similar analysis again generates the same decision rule for L_2.

Recall from the above that by (15), $\pi_0(L_1,q)$ attains its maximal value at $\frac{L_1}{B_a(\gamma)} = e^{q+S}$. When $\frac{\overline{L}_1}{B_a(\gamma)} > e^{q_L+S}$, however, this ideal value is not attainable for a social planner who considers to induce q_L, and so she has to set $L_1 = \overline{L}_1$, which violates my assumption that when indifferent between q_H and q_L, the bank will choose q_H. Thus, it must be the case that $\frac{\overline{L}_1}{B_a(\gamma)} \le e^{q_L+S}$, which implies the following:

(i) If the social planner wants to induce q_L, she sets $L_1 = e^{q_L+S}B_a(\gamma)$ and thus

$$\pi_0(e^{q_L+S}, q_L) = B_a(\gamma)A\left(e^{q_L+S}, q_L\right).$$

(ii) If she wants to induce q_H, she sets $L_1 = \overline{L}_1(\gamma)$ because $L_1 = e^{q_H+S}B_a(\gamma)$ is infeasible and thus $\pi_0(\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}, q_H) = -c + B_a(\gamma)A\left(\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}, q_H\right)$. Overall, the above results imply that the social planner will induce q_H if and only if

$$A\left(\frac{\overline{L}_1(\gamma)}{B_a(\gamma)}, q_H\right) - A\left(e^{q_L+S}, q_L\right) \ge \frac{c}{B_a(\gamma)}.$$

■

PROOF OF THE INCREMENTAL EFFECT OF ASSET SUBSTITUTION ON LOAN QUALITY

Under fair value accounting, the anticipated asset substitution decision induced will incentivize/disincentivize bank's loan quality. Therefore, when inducing desirable loan quality, the social planner will incorporate such interaction mechanism into her decision rule, which complicates both the bank's decision on loan quality and the social planner's decision on leverage L_1, as proved and illustrated in proposition 4 and proposition 5. Now, I will isolate such complicated mechanism of asset substitution on loan quality by hypothetically inducing the high quality for sure at date 0. That is, the high quality is induced for certain by leverage in period 1 no matter what asset substitution decision will be induced in period 2. In other words, future induced asset substitution decision will not affect it. I denote this case as a hypothetical case under fair value accounting, and I call it as "baseline case fair value accounting regime", which will be used to compare with "historical cost accounting regime" and "real case fair value accounting regime" thereafter. By doing so, I can compare the ex-ante social pie in this baseline case fair value accounting regime with the ex-ante social pie in the historical cost accounting regime and real case fair value accounting regime. The difference between each regime will imply different inefficiency or efficiency, one of which will be the effect of asset substitution on loan quality and thus on social pie.

In the baseline case fair value accounting regime ("Baseline FV"): how to make sure high quality is induced? The mechanism is similar to that in historical cost accounting regime.

As indicated in proposition 2, $\pi_1(q, L_2) = B_a(\gamma)X$ is increasing in q and therefore $\pi_1(q_L, L_2) < \pi_1(q_H, L_2)$. Thus, there are three cases to discuss:

(i) When $L_1 \leq \pi_1(q_L, L_2)$, the bank's expected payoff in (is $-c + \pi_1(q_H, L_2) - L_1$ given q_H and $\pi_1(q_L, L_2) - L_1$ given q_L. Because $\pi_1(q_H, L_2) - \pi_1(q_L, L_2) > c$, the bank will choose q_H.

(ii) When $L_1 \in (\pi_1(q_L, L_2), \pi_1(q_H, L_2)]$, the bank's expected payoff in is

$$-c + \pi_1(q_H, L_2) - L_1$$

given q_H and 0 given q_L, and thus the bank will choose q_H if and only if $L_1 \leq \pi_1(q_H, L_2) - c$.

(iii) When $L_1 > \pi_1(q_H, L_2)$, the bank's expected payoff in is $-c$ given q_H and 0 given q_L and thus the bank will choose q_L.

To summarize, the bank will choose q_H if and only if $L_1 \leq \pi_1(q_H, L_2) - c$.

Define $\pi_0 \equiv D_0 + E_0$ as the ex ante bank value. When $L_1 > \pi_1(q_H, L_2) - c$, $E_0 = 0$ and $D_0 = 0$ and thus $\pi_0 \equiv D_0 + E_0 = 0$.

When $L_1 \leq \pi_1(q_H, L_2) - c$, $E_0 = -c + \pi_1(q_H, L_2) - L_1$ and $D_0 = L_1(1 + \lambda)$ and thus $\pi_0 = -c + \pi_1(q_H, L_2) + L_1\lambda$.

How to purposely induce high quality q_H by L_1?

The social planner sets $\{L_1, L_2\}$ to maximize the date 0 bank value $\pi_0 \equiv D_0 + E_0$, which is $\pi_0 = -c + \pi_1(q_H, L_2) + L_1\lambda$ when $L_1 \leq \pi_1(q_H, L_2) - c$. Thus, in this case, the optimal value of L_1 is $\int_0^{\propto}[B_a(\gamma)X(q_H) - c]g(X)dX$ and then $\pi_0 =$

$\int_0^\propto [B_a(\gamma)X(q_H) - c](1+\lambda)g(X)dX$, which is greater than 0, the value of π_0 when $L_1 > \int_0^\propto [B_a(\gamma)X(q_H) - c]g(X)dX$. Thus, $q^{HC} = q_H$.

Therefore, the optimal value of L_2 is characterized by the first-order condition of

$$\pi_0(L_1, q_H) = \int_0^\propto [B_a(\gamma)X(q_H) - c](1+\lambda)g(X)dX.$$

Because $\frac{\partial \pi_0(L_1,q_H)}{\partial B_a(\gamma)} = \int_0^\propto (1+\lambda)X(q_H)g(X)dX > 0$, the social planner will pick the value of $\frac{L_2}{X} = \gamma$ to maximize $B_a(\gamma)$. $B_0\left(\frac{L_2}{X}\right)$ attains its maximal value at $\frac{L_2}{X} = \gamma_0$ and $B_1\left(\frac{L_1}{X}\right)$ attains its maximal value at $\frac{L_2}{X} = \gamma_1$ where $\gamma_1 = e^{T-k}$ where T is characterized by $h(T/\sigma_Z)/\sigma_Z = \frac{\lambda}{(1+\lambda)(1-\alpha)}$. Thus, the social planner will set $\frac{L_2}{X} = \gamma_0$ if $B_0(\gamma_0) \geq B_1(\gamma_1)$ and set $\frac{L_2}{X} = \gamma_1$ if $B_1(\gamma_1) > B_0(\gamma_0)$.

Therefore, in the equilibrium, the social planner will choose optimal $\{L_1, L_2\}$to surely induce q_H and induce desirable asset substitution as following:

$L_1^{FV\_baseline} = \int_0^\propto [B_a(\gamma)X(q_H) - c]g(X)dX$, $L_2^{FV\_baseline} = \gamma_0 X$ if $B_0(\gamma_0) \geq B_1(\gamma_1)$ and $L_2^{FV\_baseline} = \gamma_1 X$ if $B_1(\gamma_1) > B_0(\gamma_0)$

Which induces the equilibrium bank decisions:

$q^{FV\_baseline} = q_H$;

$a^{FV\_baseline} = 0 \ if \ B_0(\gamma_0) \geq B_1(\gamma_1)$ and $a^{FV\_baseline} = 1 \ if \ B_1(\gamma_1) > B_0(\gamma_0)$

The equilibrium date 0 bank value$\pi_0^{FV_baseline} = \int_0^\propto [B_a(\gamma)X(q_H) - c](1+\lambda)g(X)dX$.

Now, let's compare the ex-ante bank value under three regimes: Historical cost accounting regime, Baseline Fair value accounting regime and Real Fair value accounting regime.

HC: $\pi_0^{HC} = [\pi_1(q_H, L_2) - c](1+\lambda)$

Baseline FV:$\pi_0^{FV\_baseline} = \int_0^\propto [B_a(\gamma)X(q_H) - c](1+\lambda)g(X)dX$

Real FV:$\pi_0^{FV\_real} = -c + B_a(\gamma)A\left(\frac{L_1(\gamma)}{B_a(\gamma)}, q_H\right)$,

where $A\left(\frac{L_1(\gamma)}{B_a(\gamma)}, q\right) \equiv \int_{\frac{L_1(\gamma)}{B_a(\gamma)}}^\infty \left[X + \frac{L_1(\gamma)}{B_a(\gamma)}\lambda\right] g(X;q)dX$.

Proof: $\pi_0^{HC} < \pi_0^{FV\_baseline} >? < \pi_0^{FV\_real}$

$\pi_1(q_H, L_2)$ under HC is the weighted average $\pi_1$for all possible $B_a(\gamma)$, while under base-line$B_a(\gamma)$ is the $\max\{B_1(\gamma_1), B_0(\gamma_0)\}$, so $\pi_0^{FV\_baseline} > \pi_0^{HC}$

$L_1^{FV\_baseline} = \int_0^\propto [B_a(\gamma)X(q_H) - c]g(X)dX$

$\pi_0^{FV\_baseline} = \int_0^\propto \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c\right] g(X;q_H)dX$

$\pi_0^{FV\_real} = \int_{\frac{L_1^{FV\_Real}}{B_a(\gamma)}}^\infty \left[X(q)B_a(\gamma) + \lambda L_1^{FV\_Real} - c\right] g(X;q)dX = -c + B_a(\gamma)A\left(\frac{L_1^{FV\_Real}}{B_a(\gamma)}, q_H\right)$

As proved in proposition 5,$A\left(\frac{L_1^{FV\_Real}}{B_a(\gamma)}, q\right)$ is concave in $L_1^{FV\_Real}$, while

$\pi_0^{FV\_baseline} = \int_0^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX$ is increasing in $L_1^{FV\_baseline}$,but I assume that $L_1^{FV\_baseline} = \pi_1(q_H, L_2) - c$ to induce q_H for sure. That is, at $L_1^{FV\_baseline}$, $\pi_0^{FV\_baseline}$ is maximized.

Now let's discuss the following cases:

Case I: $L_1^{FV\_Real} = L_1^{FV\_baseline}$

$\pi_0^{FV\_baseline} = \int_0^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX$

$\pi_0^{FV\_real}|q_H = \int_{\frac{L_1^{FV\_Real}}{B_a(\gamma)}}^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_Real} - c \right] g(X;q_H)dX$

$= \int_{\frac{L_1^{FV\_baseline}}{B_a(\gamma)}}^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX$

$> \int_0^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX = \pi_0^{FV\_baseline}$

Case II: $L_1^{FV\_Real} > L_1^{FV\_baseline}$

$\pi_0^{FV\_real}|q_H = \int_{\frac{L_1^{FV\_Real}}{B_a(\gamma)}}^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_Real} - c \right] g(Xq_H;q)dX$

$> \int_{\frac{L_1^{FV\_baseline}}{B_a(\gamma)}}^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX$

$> \int_0^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX = \pi_0^{FV\_baseline}$

Case III: $L_1^{FV\_Real} < L_1^{FV\_baseline}$

$\pi_0^{FV\_real}|q_L = \int_{\frac{L_1^{FV\_Real}}{B_a(\gamma)}}^{\infty} \left[X(q_L)B_a(\gamma) + \lambda L_1^{FV\_Real} - c \right] g(X;q_L)dX$

$< \int_{\frac{L_1^{FV\_baseline}}{B_a(\gamma)}}^{\infty} \left[X(q_L)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_L)dX$

$< \int_0^{\infty} \left[X(q_H)B_a(\gamma) + \lambda L_1^{FV\_baseline} - c \right] g(X;q_H)dX = \pi_0^{FV\_baseline}$

Therefore, I proved $\pi_0^{FV\_baseline} > \pi_0^{FV\_real}|q_L$ or $\pi_0^{FV\_baseline} < \pi_0^{FV\_real}|q_H$

■

PROOF OF PROPOSITION 6

Fair Value Accounting:

By (2), $\frac{\partial \gamma_0}{\partial \sigma_Z} < 0$. By (13), $\frac{\partial B_0(\gamma_0)}{\partial \sigma_Z} < 0$. In contrast, by (14), $\frac{\partial \gamma_1}{\partial \sigma_Z} > 0$. By (13), $\frac{\partial B_1(\gamma_1)}{\partial \sigma_Z} > 0$. Therefore, $B_0(\gamma_0) > B_1(\gamma_1)$ for lower values of σ_Z and vice versa.

Then, for lower values of σ_Z, the social planner will set $L_2 = \gamma_0 X$ to induce $B_0(\gamma_0)$. In these cases, a higher value of σ_Z will lead to a lower value of $B_0(\gamma_0)$, which in turn will lead to a lower value of $\overline{L}_1(\gamma_0)$ by (11). Furthermore, a lower value of $\overline{L}_1(\gamma_0)$ will lead to a lower value of the left-hand side of (12), which implies that it will become less beneficial for the planner to induce q_H.

By a similar reasoning, for higher values of σ_Z, the social planner will set $L_2 = \gamma_1 X$ to induce $B_1(\gamma_1)$. In these cases, a higher value of σ_Z will lead to a higher value of $B_1(\gamma_1)$, which in turn will lead to a higher value of $\overline{L}_1(\gamma_1)$ by (11). Furthermore, a higher value of $\overline{L}_1(\gamma_1)$ will lead to a higher value of the left-hand side of (12), which implies that it will become more beneficial for the planner to induce q_H.

The above results imply that when σ_Z is increasing from 0, L_2^{FV} is decreasing first ($L_2^{FV} = \gamma_0 X$) and increasing later ($L_2^{FV} = \gamma_1 X$). Such a pattern induces $a = 0$ first and $a = 1$ later.

By Proposition 5, when σ_Z is increasing from 0, L_1^{FV} is decreasing first (from $L_1^{FV} = \overline{L}_1(\gamma_0)$ to $L_1^{FV} = e^{q_L+S}B_0(\gamma_0)$) and increasing later (from $L_1^{FV} = e^{q_L+S}B_1(\gamma_1)$ to $L_1^{FV} = \overline{L}_1(\gamma_1)$). Such a pattern induces q_H first, followed by q_L, and eventually q_H later again.

By the above results and by Proposition 5, when σ_Z is increasing from 0, the equilibrium date 0 bank value changes from $\pi_0^{FV} = B_0(\gamma_0)A\left(\frac{\overline{L}_1(\gamma_0)}{B_0(\gamma_0)}, q_H\right) - c$ to $\pi_0^{FV} = B_0(\gamma_0)A\left(e^{q_L+S}, q_L\right)$, then to $\pi_0^{FV} = B_1(\gamma_1)A\left(e^{q_L+S}, q_L\right)$, and eventually to $\pi_0^{FV} = B_1(\gamma_1)A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$.

Historical Cost Accounting:

By (8), $\frac{\partial L_2^{HC}}{\partial \sigma_Z} > 0$. And because $\frac{\partial \gamma_0}{\partial \sigma_Z} < 0$, $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$ is increasing in σ_Z.

By (5), $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial \sigma_Z} > 0$ and therefore $\frac{\partial L_1^{HC}}{\partial \sigma_Z} > 0$ and $\frac{\partial \pi_0^{HC}}{\partial \sigma_Z} > 0$.

Comparison of Fair Value Accounting and Historical Cost Accounting:

I first show that when σ_Z is sufficiently large, $\pi_0^{FV} > \pi_0^{HC}$.

Note that $\frac{\partial \pi_0^{HC}}{\partial \sigma_Z} = \int_0^{\frac{L_2^{HC}}{\gamma_0}} X \frac{\partial B_1\left(\frac{L_2^{HC}}{X}\right)}{\partial \sigma_Z} g(X; q_H)dX$ by the expression for π_0^{HC} in Proposition 3. Note that when $\sigma_Z \to \infty$, $L_2^{HC} \to \infty$ and $\gamma_0 \to 0$, and thus

$$\frac{\partial \pi_0^{HC}}{\partial \sigma_Z} \to \int_0^{\infty} X \frac{\partial B_1\left(\frac{L_2^{HC}}{X}\right)}{\partial \sigma_Z} g(X; q_H)dX.$$

Next note that when σ_Z is sufficiently large, $\pi_0^{FV} = B_1(\gamma_1)A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$ according to Proposition 5. Therefore,

$$\begin{aligned}\frac{\partial \pi_0^{FV}}{\partial \sigma_Z} &= (1+\lambda)\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)^2 g\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)\frac{\partial B_1(\gamma_1)}{\partial \sigma_Z} + \int_{\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}}^{\infty} X \frac{\partial B_1(\gamma_1)}{\partial \sigma_Z} g(X; q_H)dX \\ &\quad + \frac{\partial \overline{L}_1(\gamma_1)}{\partial \sigma_Z}\left[1 - G\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)\right]\left[\lambda - (1+\lambda)h\left(\left(ln\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)} - q_H\right)/\sigma_X\right)/\sigma_X\right].\end{aligned} \tag{16}$$

Note that when $\sigma_Z \to \infty$, $\gamma_1 \to \infty$ and $B_1(\gamma_1) \to \infty$, and thus

$$\begin{array}{l} \frac{\partial \pi_0^{FV}}{\partial \sigma_Z} \to (1+\lambda)\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)^2 g\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)\frac{\partial B_1(\gamma_1)}{\partial \sigma_Z} + \int_0^\infty X\frac{\partial B_1(\gamma_1)}{\partial \sigma_Z} g(X;q_H)dX \\ +\frac{\partial \overline{L}_1(\gamma_1)}{\partial \sigma_Z}\left[1 - G\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right)\right]\left[\lambda - (1+\lambda)h\left(\left(ln\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)} - q_H\right)/\sigma_X\right)/\sigma_X\right]. \end{array} \tag{17}$$

Because the second and third terms of the preceding expression are both positive and because its first term equals $\frac{\partial \pi_0^{HC}}{\partial \sigma_Z}$ in the limit, when $\sigma_Z \to \infty$, $\frac{\partial \pi_0^{FV}}{\partial \sigma_Z} > \frac{\partial \pi_0^{HC}}{\partial \sigma_Z}$. Because when $\sigma_Z \to \infty$, both π_0^{FV} and π_0^{HC} go to ∞ and $\frac{\partial \pi_0^{FV}}{\partial \sigma_Z} > \frac{\partial \pi_0^{HC}}{\partial \sigma_Z}$, it must be the case that when σ_Z is sufficiently large, $\pi_0^{FV} > \pi_0^{HC}$.

Next I show that when σ_Z is sufficiently low, $\pi_0^{FV} > \pi_0^{HC}$ where

$$\pi_0^{FV} = B_0(\gamma_0)A\left(\frac{\overline{L}_1(\gamma_0)}{B_0(\gamma_0)}, q_H\right) - c$$

according to Proposition 5.

Note that when $\sigma_Z \to 0$, $L_2^{HC} \to 0$ and $\gamma_0 \to 1$, and thus $\pi_1 \to \mathbb{E}[X|q_H]$. Thus, when $\sigma_Z \to 0$, $\pi_0^{HC} \to (1+\lambda)\mathbb{E}[X|q_H] - (1+\lambda)c$. Moreover, when $\sigma_Z \to 0$, $\gamma_0 \to 1$ and thus $B_0(\gamma_0) \to 1+\lambda$, which in turn implies that $\pi_0^{FV} \to (1+\lambda)\int_{\frac{\overline{L}_1(\gamma_0)}{1+\lambda}}^{\infty}\left[X + \frac{\overline{L}_1(\gamma_0)}{1+\lambda}\lambda\right]g(X;q_H)dX - c$. Because $\int_y^\infty [X + y\lambda]\, g(X;q_H)dX$ is increasing in y for $y < e^{q_H+S}$, it must be the case that when σ_Z is sufficiently low, $\pi_0^{FV} > \pi_0^{HC}$.

Overall, because π_0^{FV} is a U-shaped curve of σ_Z and π_0^{HC} is an increasing function of σ_Z, and because $\pi_0^{FV} > \pi_0^{HC}$ for both extremely low values and extremely high values of σ_Z, it must be the case that $\pi_0^{HC} > \pi_0^{FV}$ for medium values of σ_Z and the converse is true for extreme values of σ_Z.

The proof of the results regarding k follows the similar reasoning above and is omitted. ■

PROOF OF PROPOSITION 7

Fair Value Accounting:

By (2), $\frac{\partial \gamma_0}{\partial \alpha} = 0$. By (13), $\frac{\partial B_0(\gamma_0)}{\partial \alpha} = 0$. In contrast, by (14), $\frac{\partial \gamma_1}{\partial \alpha} > 0$. By (13), $\frac{\partial B_1(\gamma_1)}{\partial \alpha} > 0$. Therefore, $B_0(\gamma_0) > B_1(\gamma_1)$ for lower values of α and vice versa.

Then, for lower values of α, the social planner will set $L_2 = \gamma_0 X$ to induce $B_0(\gamma_0)$, and for higher values of σ_Z, the social planner will set $L_2 = \gamma_1 X$ to induce $B_1(\gamma_1)$. In the latter case, a higher value of α will lead to a higher value of $B_1(\gamma_1)$, which in turn will lead to a higher value of $\overline{L}_1(\gamma_1)$ by (11). Furthermore, a higher value of $\overline{L}_1(\gamma_1)$ will lead to a higher value of the left-hand side of (12), which implies that it will become more beneficial for the planner to induce q_H.

The above results imply that when α is increasing from 0, L_2^{FV} is constant first ($L_2^{FV} = \gamma_0 X$) and increasing later ($L_2^{FV} = \gamma_1 X$). Such a pattern induces $a = 0$ first and $a = 1$ later.

By Proposition 5, when α is increasing from 0, L_1^{FV} is constant first ($L_1^{FV} = e^{q_L+S}B_0(\gamma_0)$) and increasing later (from $L_1^{FV} = e^{q_L+S}B_1(\gamma_1)$ to $L_1^{FV} = \overline{L}_1(\gamma_1)$). Such a pattern induces q_L first and q_H later.

By the above results and by Proposition 5, when α is increasing from 0, the equilibrium date 0 bank value changes from $\pi_0^{FV} = B_0(\gamma_0)A\left(e^{q_L+S}, q_L\right)$ to $\pi_0^{FV} = B_1(\gamma_1)A\left(e^{q_L+S}, q_L\right)$, and eventually to $\pi_0^{FV} = B_1(\gamma_1)A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$.

Historical Cost Accounting:

By (8), $\frac{\partial L_2^{HC}}{\partial \alpha} > 0$ and therefore $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$ is increasing in α.

By (5), $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial \alpha} > 0$ and therefore $\frac{\partial L_1^{HC}}{\partial \alpha} > 0$ and $\frac{\partial \pi_0^{HC}}{\partial \alpha} > 0$.

Comparison of Fair Value Accounting and Historical Cost Accounting:

I first show that when α is sufficiently large, $\pi_0^{HC} > \pi_0^{FV}$.

Note that when $\alpha = 1$, $B_1'\left(\frac{L_2^{HC}}{X}\right) > 0$ and thus $L_2^{HC} \to \infty$, which implies that $B_1\left(\frac{L_2^{HC}}{X}\right) = \mathbb{E}[Z](1+\lambda)$ and $\pi_1 = \mathbb{E}[X|q_H]\mathbb{E}[Z](1+\lambda)$. Thus, $\pi_0^{HC} = \mathbb{E}[X|q_H]\mathbb{E}[Z](1+\lambda)^2 - c(1+\lambda)$.

Next note that when $\alpha = 1$, $\pi_0^{FV} = B_1(\gamma_1)A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$ according to Proposition 5. Because $\gamma_1 \to \infty$ and $B_1(\gamma_1) \to \mathbb{E}[Z](1+\lambda)$ when $\alpha = 1$,

$$\pi_0^{FV} \to \int_{\frac{\overline{L}_1(\gamma_0)}{\mathbb{E}[Z](1+\lambda)}}^{\infty} \left[X\mathbb{E}[Z](1+\lambda) + \overline{L}_1(\gamma_1)\lambda\right] g(X; q_H)dX - c.$$

By (11), $\pi_0^{HC} > \pi_0^{FV}$ if and only if

$$\mathbb{E}[X|q_H]\mathbb{E}[Z](1+\lambda)^2 >$$
$$\int_{\frac{\overline{L}_1(\gamma_0)}{\mathbb{E}[Z](1+\lambda)}}^{\infty} X\mathbb{E}[Z](1+\lambda)^2 g(X; q_H)dX - \lambda\mathbb{E}[Z](1+\lambda)\int_{\frac{\overline{L}_1(\gamma_0)}{\mathbb{E}[Z](1+\lambda)}}^{\infty} \left[X - \frac{\overline{L}_1(\gamma_0)}{\mathbb{E}[Z](1+\lambda)}\right] g(X; q_L)dX,$$

which always holds.

A similar reasoning demonstrates that when α is sufficiently low, $\pi_0^{FV} > \pi_0^{HC}$ due to (i) $B_0(\gamma_0) > B_1(\gamma_1)$ and (ii) c is sufficiently high.

Overall, both π_0^{FV} and π_0^{HC} are increasing functions of α and in particular π_0^{HC} is linear in α. In addition, because $\pi_0^{FV} > \pi_0^{HC}$ when $\alpha = 0$ and $\pi_0^{HC} > \pi_0^{FV}$ when $\alpha = 1$, it must be the case that $\pi_0^{HC} > \pi_0^{FV}$ for large values of α and vice versa. ■

PROOF OF PROPOSITION 8

Fair Value Accounting:

By Proposition 5, it is straightforward to show that $\pi_0^{FV} = B_a(\gamma_a)A\left(e^{q_L+S}, q_L\right)$ or $\pi_0^{FV} = B_a(\gamma_a)A\left(\frac{\overline{L}_1(\gamma_a)}{B_a(\gamma_a)}, q_H\right) - c$ is increasing in σ_X.

Historical Cost Accounting:

For lognormal distributions, their density is decreasing in σ_X for $X \in (e^{q-\sigma_X}, e^{q+\sigma_X})$ and is increasing in σ_X otherwise. Therefore, $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial \sigma_X} > 0$ for lower values of σ_X and $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial \sigma_X} < 0$ for higher values of σ_X. Thus, π_0^{HC} follows the same pattern.

Comparison of Fair Value Accounting and Historical Cost Accounting:

At $\sigma_X = 0$, $\pi_0^{HC} = \pi_0^{FV}$. Because π_0^{FV} is increasing in σ_X and π_0^{HC} is increasing for lower values of σ_X and decreasing for higher values of σ_X, $\pi_0^{HC} > \pi_0^{FV}$ for lower values of σ_X and vice versa. ■

PROOF OF PROPOSITION 9

Fair Value Accounting:

A higher value of q_H will lead to a higher value of the left-hand side of (12), which implies that it will become more beneficial for the planner to induce q_H.

By Proposition 5, when q_H is increasing from q_L, L_1^{FV} is constant first ($L_1^{FV} = e^{q_L+S}B_a(\gamma_a)$) and increasing later ($L_1^{FV} = \overline{L}_1(\gamma_a)$). Such a pattern induces q_L first and q_H later.

By the above results and by Proposition 5, when q_H is increasing from q_L, the equilibrium date 0 bank value is constant first ($\pi_0^{FV} = B_a(\gamma_a)A\left(e^{q_L+S}, q_L\right)$) and increasing later ($\pi_0^{FV} = B_a(\gamma_a)A\left(\frac{\overline{L}_1(\gamma_a)}{B_a(\gamma_a)}, q_H\right) - c$).

Historical Cost Accounting:

By (8), $\frac{\partial L_2^{HC}}{\partial q_H} > 0$ and therefore $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$ is increasing in q_H.

By (5), $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial q_H} > 0$ and therefore $\frac{\partial L_1^{HC}}{\partial q_H} > 0$ and $\frac{\partial \pi_0^{HC}}{\partial q_H} > 0$.

Comparison of Fair Value Accounting and Historical Cost Accounting:

I first show that when q_H is sufficiently large, $\pi_0^{HC} > \pi_0^{FV}$ where

$$\pi_0^{FV} = B_1(\gamma_1)A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$$

according to Proposition 5.

By (11), $\pi_0^{HC} > \pi_0^{FV}$ if and only if

$$\begin{aligned}&\int_{\frac{L_2}{\gamma_0}}^{\infty} XB_0\left(\tfrac{L_2}{X}\right)(1+\lambda)g(X;q_H)dX + \int_0^{\frac{L_2}{\gamma_0}} XB_1\left(\tfrac{L_2}{X}\right)(1+\lambda)g(X;q_H)dX > \\ &\int_{\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}}^{\infty} XB_1(\gamma_1)(1+\lambda)g(X;q_H)dX - \lambda B_1(\gamma_1)\int_{\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}}^{\infty}\left[X - \tfrac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right]g(X;q_L)dX.\end{aligned} \quad (18)$$

The preceding inequality holds for sufficiently large values of q_H, because as $q_H \to \infty$, $L_2^{HC} \to \infty$ and $\overline{L}_1(\gamma_a) \to \infty$.

A similar reasoning demonstrates that when $q_H = q_L$, $\pi_0^{FV} > \pi_0^{HC}$.

Thus, it must be the case that $\pi_0^{HC} > \pi_0^{FV}$ for large values of q_H and vice versa.

The proof of the results regarding c follows the similar reasoning above and is omitted. ■

PROOF OF PROPOSITION 10

Fair Value Accounting:

By (13), $B_0(\gamma_0) = 1$ at $\lambda = 0$ and is linearly increasing in λ. By (13), $B_1(\gamma_1) = \mathbb{E}[Z] < 1$ at $\lambda = 0$ and is increasing and convex in λ. Therefore, $B_0(\gamma_0) > B_1(\gamma_1)$ for lower values of λ and vice versa.

Then, for lower values of λ, the social planner will set $L_2 = \gamma_0 X$ to induce $B_0(\gamma_0)$, and for higher values of λ, the social planner will set $L_2 = \gamma_1 X$ to induce $B_1(\gamma_1)$. In the latter case, a higher value of λ will lead to a lower value of the left-hand side of (12), which implies that it will become less beneficial for the planner to induce q_H.

The above results imply that when λ is increasing from 0, the patterns of changes in L_2^{FV}, L_1^{FV}, a^{FV}, q^{FV}, and π_0^{FV} follow the same trend as what is described in Proposition 6 for an increasing value of σ_Z.

Historical Cost Accounting:

By (8), $\frac{\partial L_2^{HC}}{\partial \lambda} > 0$ and therefore $Prob(a^{HC} = 1) = G\left(\frac{L_2^{HC}}{\gamma_0}\right)$ is increasing in λ.

By (5), $\frac{\partial \pi_1(L_2^{HC}, q_H)}{\partial \lambda} > 0$ and therefore $\frac{\partial L_1^{HC}}{\partial \lambda} > 0$ and $\frac{\partial \pi_0^{HC}}{\partial \lambda} > 0$.

Comparison of Fair Value Accounting and Historical Cost Accounting:

I first show that when λ is sufficiently large, $\pi_0^{HC} > \pi_0^{FV}$, where

$$\pi_0^{FV} = B_1(\gamma_1) A\left(\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}, q_H\right) - c$$

according to Proposition 5.

By (11), $\pi_0^{HC} > \pi_0^{FV}$ if and only if

$$\begin{aligned} &\int_{\frac{L_2}{\gamma_0}}^{\infty} X B_0\left(\tfrac{L_2}{X}\right)(1+\lambda) g(X; q_H) dX + \int_0^{\frac{L_2}{\gamma_0}} X B_1\left(\tfrac{L_2}{X}\right)(1+\lambda) g(X; q_H) dX > \\ &\int_{\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}}^{\infty} X B_1(\gamma_1)(1+\lambda) g(X; q_H) dX - \lambda B_1(\gamma_1) \int_{\frac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}}^{\infty} \left[X - \tfrac{\overline{L}_1(\gamma_1)}{B_1(\gamma_1)}\right] g(X; q_L) dX, \end{aligned} \tag{19}$$

which holds for sufficiently large values of λ.

A similar reasoning demonstrates that when $\lambda = 0$,

$$\pi_0^{FV} = \pi_0^{HC} = \mathbb{E}[X|q_H] - c$$

and $\frac{\partial \pi_0^{FV}}{\partial \lambda} > \frac{\partial \pi_0^{HC}}{\partial \lambda}$ because q_H is sufficiently high.

Overall, both π_0^{FV} and π_0^{HC} are increasing functions of λ. In addition, when $\lambda = 0$, $\pi_0^{FV} = \pi_0^{HC}$ and $\frac{\partial \pi_0^{FV}}{\partial \lambda} > \frac{\partial \pi_0^{HC}}{\partial \lambda}$. Furthermore, when λ is sufficiently large, $\pi_0^{HC} > \pi_0^{FV}$. Thus, it must be the case that $\pi_0^{HC} > \pi_0^{FV}$ for large values of λ and vice versa. ■

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