Accounting Conservatism, Debt Contracts and Financial Institutions

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ABSTRACT

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This thesis studies the role of accounting conservatism in debt contracting and in financial institutions. In the first setting, I find that the demand for accounting conservatism in debt contracts depends on whether the debt covenant can be renegotiated and the cost of renegotiation. When the covenant is not renegotiable or when renegotiation cost is sufficiently high, more conservative accounting reduces the efficiency of debt contracts. When renegotiation cost is moderate, more conservative accounting may increase the entrepreneur's welfare under certain conditions, especially for firms with less promising investment opportunities and for firms with higher liquidation values. When renegotiation is costless, the degree of accounting conservatism becomes irrelevant and the first best liquidation is always achieved. In the second part, I examine the effectiveness of capital regulation in controlling excessive risk-taking by banks under three different accounting regimes: historical cost accounting, lower-of-cost-or-market accounting and fair value accounting. Given some minimum capital requirement, the bank is more likely to issue equity capital in excess of the minimum required level and implement less risky investment policy under either lower-of-cost-or-market accounting or fair value accounting than under historical cost accounting. But fair value accounting induces more risk-taking compared to lower-of-cost-or-market accounting because of the short term interest of the bank manager. From the regulator's perspective, if the social cost associated with capital regulation is high, lower-of-cost-or-market accounting is the optimal regime; however, if the ex-ante effort by the bank to discover the risky investment is important, the regulator may find it optimal to choose either historical cost accounting or fair value accounting, when the bank manager is very short term oriented.
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To my family
1 Introduction

The conservative principle in accounting, which implies the prudence in the recognition and measurement of income and assets, is a crucial property of financial reporting. However, considerable controversy remains on the desirability of accounting conservatism for different investors and regulators. In this dissertation, I study the role of accounting conservatism in the following two aspects: one is related to the debt contracting, and the second is related to the regulation of financial institutions. I demonstrate that in both settings conservative accounting system can be desirable either to improve the debt contracting efficiency or to improve the social welfare in the bank regulation. However, conservatism is not always the optimal accounting policy in that under certain conditions investors and regulators may prefer other accounting regimes.

In the first chapter, I develop a theoretical model to understand the role of accounting conservatism in debt contracts. The optimal debt contract includes an accounting based covenant that gives the creditor the right to liquidate when accounting information reveals unfavorable news about the firm. I find that the demand for accounting conservatism depends on whether renegotiation occurs and if so, at what cost. When the covenant is not renegotiable or when renegotiation cost is sufficiently high, more conservative accounting actually reduces the efficiency of debt contracts. When renegotiation cost is moderate, on the other hand, more conservative accounting may increase the entrepreneur’s welfare under certain conditions, especially for
firms with less promising investment opportunities and for firms with higher liquidation values. Both are characteristics of "traditional industries" characterized by low growth and high level of tangible assets in place. When renegotiation is costless, the degree of accounting conservatism becomes irrelevant and the first best liquidation is always achieved. These results call for more cross-sectional examinations on the role of accounting conservatism in debt contracts in empirical studies.

In the second chapter, I examine the effectiveness of capital regulation in controlling excessive risk-taking by banks under three different accounting regimes: historical cost accounting, lower-of-cost-or-market accounting and fair value accounting. In the model, the bank's manager maximizes a weighted sum of short term earnings and the long term expected payoff to shareholders. Given some minimum capital requirement, the bank is more likely to issue equity capital in excess of the minimum required level and implement less risky investment policy under either lower-of-cost-or-market accounting or fair value accounting than under historical cost accounting. Fair value accounting, however, may induce more risk-taking compared to lower-of-cost-or-market accounting because recognizing good news gives additional incentives to take more risk due to the short term interest of the bank manager. Considering these effects, the regulator chooses the optimal minimum capital requirement under the respective accounting regimes. Accounting for the cost of capital regulation, social welfare is the highest under lower-of-cost-or-market accounting and the lowest under historical cost accounting. However, if considering the role of ex-ante effort
by the bank manager to discover the risky investment opportunity, I show that the regulator may sometimes prefer historical cost accounting or fair value accounting over lower-of-cost-or-market accounting under certain conditions.
2 Accounting Conservatism and Debt Contracts

In a competitive capital market, debt will be efficiently priced such that risk-neutral debtholders break even in expectation. Although accounting information may help the contracting parties evaluate expected future profitability to determine the ex-ante interest rate, we expect it becomes irrelevant once the debt contract is signed. One role that accounting information can play to improve the contracting efficiency is when it can trigger some real actions such as liquidation.\footnote{Firms can issue new debts to replace old debts when future accounting information reveals better information about underlying economics of the firm. However, in this paper I do not consider the possibility of refinancing in order to focus on the role of accounting information through accounting-based debt covenants.} This is consistent with stylized facts that debt contracts often include debt covenants that are contingent on accounting numbers. These covenants usually define constraints on a firm’s net asset worth, working capital, financial ratio, or leverage. Violation of covenants will restrict the firm from engaging in specified activities such as issuing dividends or investing in new projects, or allow creditors to liquidate the assets and collect the collateral.

Watts (2003) in his influential paper on accounting conservatism argues that debt contracting is one important explanation for the demand for conservatism in financial reports, as debtholders are more interested in the downside risk than the upside potential of the firm’s performance. However, Guay and Verrechia (2006) conjecture that firms can always undo the effect of conservatism by modifying the tightness of debt covenants to the optimal level without altering the informativeness of the accounting measurement system. Therefore it is not clear from a theoretical point of
view how the properties of accounting information affect the debt contracting process. Recently a number of empirical studies have examined the association between the characteristics of accounting information and debt contracts. For example, Ball et al. (2008) find that the demand of accounting conservatism is due to debt markets using cross-country data. Begley and Chamberlain (2005) find that the use of accounting-based covenants is associated with less conservatism using a sample of public debt agreements. Beatty et al. (2008) and Nikolaev (2007) find that the covenant restrictiveness is positively correlated with accounting conservatism using samples of private loan agreements. These findings so far are inconclusive.

Moreover, one important feature of debt contracts is that debt covenants are frequently violated and renegotiated (Smith, 1993). Using a large sample of private debt agreements, Dichev and Skinner (2002) find that 30% of firms in their sample violate the covenants. Roberts and Sufi (2007) document that 75% of long term private credit agreements have a major contract term renegotiated before the stated maturity date. Other studies that examine actual violations of debt covenants, such as Chen and Wei (1993) and Beneish and Press (1993), suggest that a large percentage of firms get waivers after violations (about 50% in the violation sample) and that the most frequently violated covenants are technical violations which usually involve covenants based on accounting numbers. The significance and frequency of renegotiation highlight the importance of incorporating renegotiation into a formal analysis of the debt contracting process.
In this paper I build a model to examine the impact of accounting conservatism on the efficiency of debt contracts, considering both non-renegotiable and renegotiable covenants. In the model an entrepreneur seeks financing from the creditor to invest in a risky project. Both the entrepreneur and the creditor face ex-ante uncertainty about the prospect of the project. The optimal debt contract sets the face value and includes a debt covenant that might trigger liquidation when future accounting information reveals bad news before the maturity of debt. Without the accounting-based covenant, the entrepreneur has no incentive to liquidate the project ex-post as all proceeds from the liquidation will be paid to the creditor. Allowing for possible liquidation induced by the debt covenant in general increases the ex-ante efficiency of the debt contract and the entrepreneur's welfare. However, inefficient liquidation decisions may arise ex post when accounting information does not perfectly reveal the true state of the firm. In general increasing the overall informativeness of the accounting system always increases the entrepreneur's welfare, but as is shown here, the effect of accounting conservatism depends on the specific features of the debt contract.

Contrary to the hypothesis of the debt contracting explanation for accounting conservatism (Watts, 2003), I find that increasing accounting conservatism reduces the

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2 A large body of theoretical research in financial contracting focuses on the contingency and renegotiation of optimal contracts. That literature views debt contracts as dynamic state contingent contracts that often change through a combination of ex-ante contingencies and ex post renegotiation (Aghion and Bolton, 1992; Hart and Moore, 1998; Bolton and Scharfstein, 1990; etc). In this paper I do not model the security design but instead assume that for reasons outside the model debt financing is optimal for the entrepreneur.
efficiency of the liquidation decision and the entrepreneur's expected payoff when the
debt contract includes non-renegotiable accounting-based covenants. The main intu­
tion is that the entrepreneur trades off the expected efficiency loss due to liquidating
good projects and not liquidating bad projects based on accounting information. As
long as the project is ex-ante worth investing, the entrepreneur prefers more liberal
accounting as the expected efficiency loss from liquidating a good project is larger
than the expected loss from not liquidating a bad project.

However, in the model the debt contract is to some degree incomplete as the debt
covenant can only be contingent on the imperfect accounting signal but not on the
realized true state, which is assumed to be unverifiable. Therefore there will be scope
for renegotiation to improve the contract efficiency when the initial contract induces
inefficient liquidation after the true state is realized. Specifically, in the model two
types of inefficiencies arise: liquidation of the good project upon observing a low
signal and continuation of the bad project upon observing a high signal. If ex-post
renegotiation is always efficient and costless, the properties of accounting system
do not affect the outcome. But when renegotiation is costly, accounting information
potentially becomes relevant to the entrepreneur's welfare and the efficient liquidation
decision.

When the renegotiation cost is sufficiently large such that renegotiation is im­
possible for either inefficient case, more conservative accounting decreases the en­
trepreneur's expected payoff, essentially the same as the non-renegotiation result
above. On the other hand, when the renegotiation cost is relatively small, renegotiation occurs in both inefficient cases. The choice of accounting systems then only affects the expected total renegotiation cost. In this case more conservative accounting increases the entrepreneur’s expected payoff when the ex-ante probability of a firm facing positive NPV projects is lower. When the renegotiation cost is moderate, the entrepreneur trades off the expected renegotiation cost (but the efficient liquidation decision) on one type and the efficiency loss from the inefficient liquidation decision on the other type. A key determinant of the welfare effect of conservatism then is the liquidation value, and the preference over conservative accounting is increasing with the liquidation value. The reason is that when the liquidation value increases, the benefit from efficiently liquidating the bad project becomes so attractive that the entrepreneur is willing to bear the loss from inefficiently liquidating a good project as a result of more conservative accounting.

These results provide some empirical implications on the cross-sectional variation of the demand for accounting conservatism in debt contracts. One implication is that the renegotiation cost needs to be taken into account when testing the demand for accounting conservatism in debt contracts. Firms with public debt usually have very high costs of renegotiation, and hence are expected to prefer less conservative accounting than firms with private debt. The investment opportunities and liquidation values are also important factors to be considered in examining the role of accounting conservatism in debt contracts. These cross-sectional effects should be more
prominent at the industry level. Therefore more conservative accounting increases the debt contract efficiency in traditional industries with less promising investment opportunities and more tangible assets and decreases the debt contract efficiency in knowledge based industries with better investment opportunities and fewer tangible assets. These predictions so far have not been tested by empirical studies.

I also derive from the model the relationship between accounting conservatism and the equilibrium face value of the debt, which is usually measured by the implied interest rate in the loan agreement in empirical studies. The results show that even though accounting conservatism may lower the entrepreneur’s payoff, the ex-ante face value of debt may still decrease as the accounting system becomes more conservative. The implied interest rate of debt (or the face value of debt) is, therefore, not sufficient to assess the welfare implications of conservatism, since it ignores the ex-post efficient liquidation decisions. Empirical studies using the interest rate to examine the efficiency role of accounting conservatism in debt contracting need to use caution interpreting the results.

This study is related to several other studies modeling the accounting based debt covenant. Magee and Sridhar (1997) show that it can be ex-ante optimal to design a financial contract that admits debtholders’ discretionary waiving of debt covenants and firms’ opportunistic investments ex-post. Gjesdal and Antle (2001) model the

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3 Indeed for some R&D intensive industries, the practice of immediately recognizing R&D expenditure as expense is consistent with the prediction of the model, as R&D expense is a form of ex-ante conservatism which will preempt ex-post conservatism and requires no recognition of loss when the R&D project fails in the future. The model’s implication is mainly about the ex-post or conditional conservatism when there is new information about the project in the future.
dividend restriction covenant in incomplete market and attempt to examine the role of accounting construction in the optimal dividend constraint. Garleanu and Zwiebel (2009) analyze the design and renegotiation of covenants and show that adverse selection problems lead to the allocation of greater ex-ante decision rights to the uninformed creditor through tighter covenants that are frequently waived upon renegotiation ex-post.

Few studies have directly examined the demand of accounting conservatism in debt contracts. The closest study to mine is Gigler et al. (2008), which also examines the link between accounting conservatism and the efficiency of debt contracting. Their conclusion for the non-renegotiable contract setting is similar to mine in that more conservative accounting always reduces the efficiency of debt contracts, which counters the common debt contracting hypothesis of accounting conservatism. Gigler et al. (2008) consider a more general model in terms of continuous outcomes and endogenous optimal debt covenants. But they do not allow for renegotiation upon observing informative accounting signals at an intermediate date, hence in their model conservatism is never optimal. By allowing for renegotiation conditional on information revealed at the intermediate stage, this paper adds to our understanding of the role of accounting conservatism in debt contracts and generates novel cross-sectional empirical predictions.

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4Gigler et al. (2008) also consider renegotiation but of a very different kind as in my model. They show that any potentially ex-ante suboptimal debt covenant will be renegotiated to the optimal one. That is, the optimal debt covenant in the continuous model is renegotiation proof.
2.1 The Model

I consider a wealth constrained risk-neutral entrepreneur who needs to finance the entire amount of investment $I$ from a creditor to undertake a project. The entrepreneur faces a competitive lending market and he offers the creditor a debt contract that ensures the creditor breaks even. For simplicity, assume the discount rate is zero. Both the entrepreneur and creditor are risk neutral. At time 0, the contract is signed and the project is undertaken. The project generates cash flows only at time 2, the end of project life. The debt contract has a face value of $D$ at time 2 and gives the creditor priority to collect the proceeds from liquidation at time 1. In this model I do not address the more general question whether equity or debt should be issued, instead simply assume that debt is chosen for unmodeled reasons.\(^5\)

The project is risky: in case of success it will pay out cash flows of $X$, otherwise the project fails with zero cash flows. It is easy to see that $D$ must be lower than $X$. The entrepreneur can be either a good type ($G$) or a bad type ($B$). A good type entrepreneur’s project has a higher probability of success ($p_g$) than a bad type ($p_b$). Furthermore, assume that the good type entrepreneur has a positive NPV project and the bad type has a negative NPV project in expectation, i.e.,

\(^5\)The key rationalization for relying on debt contracts is that the entrepreneur can ‘divert’ or ‘hide’ project returns (and liquidation values) from the investor unless the investor actually assumes control during liquidation. Earlier literature (e.g., Hart and Moore, 1998) has shown that under these conditions debt contracts are optimal, i.e., the entrepreneur promises a fixed stream of payments to the investor and, if the entrepreneur defaults, the investor has the right to seize and liquidate the project. I therefore confine attention to debt contracts and ignore alternative contractual arrangements, e.g., to delegate all the decision rights to the entrepreneur, as this would be vulnerable to opportunistic behavior on the part of the entrepreneur who would always claim to have liquidated the project, leaving the creditor empty-handed.
\[ p_g X > I > p_b X \]

If the information about the type is known to both parties, only the good type entrepreneur will seek financing and undertake the project. Ex-ante both the entrepreneur and creditor only have information about the probability \( (\theta) \) of the entrepreneur being a good type. I assume that the ex-ante expected payoff from the project is positive so that the project is worth undertaking without knowing the entrepreneur’s type:

\[
[\theta p_g + (1 - \theta) p_b] X > I
\]

*Liquidation decision:* The liquidation value of the project is exogenously determined as \( K \). The liquidation value can be viewed as the initial investment’s asset value at time 1, which depreciates to zero if the firm waits until time 2 to liquidate the project. If the creditor liquidates the project at time 1, he will collect \( K \); otherwise he waits until time 2 to collect \( D \) if the project succeeds, or gets nothing if the project fails. Success or failure, respectively, are verifiable events.

Assume that the liquidation value satisfies the condition \( p_g X > I > K > p_b X \), i.e., with perfect verifiable information about the true type, the efficient liquidation decision is always to liquidate the bad type project and continue the good type project. Without any information about the project type it is efficient to continue the project.
Therefore only the intermediate information that triggers the liquidation can improve the efficiency of the debt contract.

Accounting system: At time 1 the true type is realized, but the true type is impossible or very costly to describe or verify, so that the ex-ante contract cannot be contingent on $\theta$. However, both parties can perfectly identify which type is realized.\textsuperscript{6} The contract can, however, be contingent upon an accounting signal that is informative about the realized type as in Aghion and Bolton (1992). The accounting signal is observable and verifiable and it can be either low ($S_L$) or high ($S_H$). Therefore the accounting-based covenant is necessary to trigger the liquidation event even though the true type is realized and known to both parties.

In this model the information structure follows Venugopalan (2004), which defines different accounting regimes by varying the conditional probabilities of observing high or low signals for a certain type of entrepreneur. The conditional probabilities are defined as:

\[
\begin{align*}
P(S_H \mid G) &= \lambda + \delta \\
P(S_L \mid G) &= 1 - \lambda - \delta \\
P(S_H \mid B) &= \delta \\
P(S_L \mid B) &= 1 - \delta
\end{align*}
\]

for $\lambda \in [0, 1]$ and $\delta \in [0, 1 - \lambda]$\textsuperscript{6}

\textsuperscript{6}The assumption about the realized state of nature follows the incomplete contract literature since Grossman and Hart (1986).
This specification is consistent with the monotone ratio property (MLRP) as

\[ P(S_H | G) > P(S_H | B) \].

Higher values of \( P(S_H | G) \) and \( P(S_L | B) \) make the accounting system more informative about the true type. If both these values equal 1, the signal is perfectly informative about the true type. As discussed in Venugopalan (2004), the parameters \( \lambda \) and \( \delta \) capture the degree of informativeness and conservatism of accounting system. The posterior probabilities of true type after observing the accounting signal are:

\[
P(G | S_H) = \frac{(\lambda + \delta) \theta}{\lambda \theta + \delta}
\]

\[
P(B | S_L) = \frac{(1 - \delta)(1 - \theta)}{1 - \lambda \theta - \delta}
\]

As \( \lambda \) increases, the above posterior probabilities increase, indicating that the accounting system is more informative. The parameter \( \delta \) is defined within the range of \([0, 1 - \lambda]\), capturing the degree of conservatism. An increase in \( \delta \) makes the accounting system more liberal as the probability of \( P(G | S_H) \) decreases and the probability of \( P(B | S_L) \) increases. More conservative accounting is more informative at the top end (signal \( S_H \)) due to its downward bias. When \( \delta = 0 \), the bad type always produces signal \( S_L \) and the error of misreporting occurs when the good type also produces a low signal. The accounting system then is most conservative. On the other hand, the accounting system is most liberal when \( \delta = 1 - \lambda \) so that the good type always gen-
erates high signal, while the error occurs when the bad type also generates signal $S_H$. The information structure of the accounting system in Venugopalan (2004) allows for a direct examination of the effect of accounting informativeness and conservatism in a simple binary setting. \(^7\)

### 2.2 Optimal debt contract without renegotiation

In this section I model the optimal debt contract in the absence of renegotiation. The optimal contract is designed to maximize the entrepreneur’s expected payoff, subject to the creditor’s participant constraint that the creditor earns zero expected return in the competitive lending market. When there is no accounting information at the intermediate stage, the creditor can not force liquidation at the intermediate date since the realized true states are assumed to be unverifiable. The entrepreneur has no incentive to liquidate the project either, since the proceeds from liquidation will be used to pay the creditor first as specified in the debt agreement. If the debt contract has a face value of $D_0$, the creditor’s expected payoff without liquidation at the intermediate stage would be $[\theta p_g + (1 - \theta) p_b]D_0 - I$. The zero profit constraint gives the creditor a break-even return for lending the amount of $I$:

---

\(^7\)Gigler et al. (2008) introduce an additional notion of conservatism which allows the effect of $\delta$ on the conditional probability to differ for different realized types and find the same conclusion using either form of conservatism definition. It might be worthwhile in the future work to introduce their definition of conservatism in the renegotiable debt contract, as it might affect the tension in the efficient liquidation decision with costly renegotiation and hence generate potentially interesting results.
\[ D_0 = \frac{I}{\theta p_g + (1 - \theta) p_b} \]  

where \( \theta p_g + (1 - \theta) p_b \) is the ex-ante probability that the creditor receives the full face value at the end of project period. In equilibrium the creditor gets compensated for the possibility of default. Because of the competitiveness of the debt market, the whole surplus or the net present value of the project goes to the entrepreneur if the project is financed. Denote the entrepreneur’s expected payoff from the project as \( E_0 \), we have:

\[ E_0 = [\theta p_g + (1 - \theta) p_b] (X - D_0) = [\theta p_g + (1 - \theta) p_b] X - I \]

Since the project has positive expected net present value, i.e., \( [\theta p_g + (1 - \theta) p_b] X - I > 0 \), the entrepreneur will seek financing and invest in the project. The bad project can never be liquidated at the intermediate stage for lack of verifiable accounting information; hence the debt contract in the no-information case is inefficient. But efficiency can be improved through a debt covenant that might induce the efficient liquidation based on an informative signal about the underlying type in the intermediate stage. The next two sections discuss the optimal contract with such covenant in detail.
2.2.1 Contract with perfect information: first best benchmark

When the accounting signal at the intermediate stage perfectly reveals the underlying true type, it is equivalent to assume that $\lambda = 1$ and the information structure in the model becomes $P(G \mid S_H) = 1$ and $P(B \mid S_L) = 1$. Given the verifiable accounting information, the optimal debt contract would include a covenant that allows the creditor to liquidate the project when observing a low accounting signal. At time 1, upon observing a high signal, the creditor knows that the entrepreneur is a good type and continuing the project will yield a higher expected payoff than liquidation. Upon observing a low signal, the creditor knows that the entrepreneur is a bad type and liquidating the project is better for him, since the creditor's expected payoff from continuing the bad type project is lower than the liquidation value $p_bD < p_bX < K$. Thus if the debt contract has a face value of $D$, the ex-ante expected payoff to the creditor at time 0 is given by:

$$\theta \cdot p_gD + (1- \theta) K - I$$

(3)

The optimal debt contract can be solved by applying the creditor's zero profit constraint to equation (3), as stated in proposition 1:

Proposition 1 When the information at time 1 perfectly reveals the entrepreneur's type, the optimal debt contract will include a covenant that gives the creditor the right to liquidate the project when the low signal is observed, and the equilibrium face value
of debt is $D_1 = \frac{I - (1 - \theta) K}{\theta p_g}$. It achieves the first-best performance.

The optimal debt contract with perfect ex-post information can always achieve the socially optimal liquidation decision. The entrepreneur receives a positive return when the project is a good type and zero when the project is a bad type, therefore his expected payoff from the investment is:

$$E_1 \equiv \theta p_g (X - D_1) = \theta p_g X + (1 - \theta) K - I > E_0$$  \hfill (4)

With perfect accounting information, the creditor is strictly better off ex-post through the efficient liquidation of the bad project. However, the surplus from the efficiency improvement goes to the entrepreneur as stated in (4), because the entrepreneur can extract the rent ex-ante by offering a contract with a lower face value.

2.2.2 Contract with imperfect information

I now proceed to the more general case where accounting information is imperfect and reveals the true type with noise. The debt contract contingent on imperfect accounting signals may improve the efficiency of the liquidation decision, however, it may also introduce inefficient liquidations if accounting signals contain errors in revealing the true type. The properties of the accounting system will affect the precision and bias of accounting signals, which in turn will affect the creditor's liquidation decisions.

If the debt contract does not include a covenant that allows the creditor to
liquidate the project, the debt contract remains effectively the same as in the no-information case. Therefore the optimal debt contract includes a debt covenant that gives the creditor the liquidation right only when the low signal is observed. However, given this covenant the creditor may not always want to execute the liquidation right even when the low signal ($S_L$) is observed. Whether the covenant effectively triggers liquidation upon observing a low signal depends on the creditor's tradeoff between the expected payment at time 2 and the liquidation value.

Based on the signal generated by the accounting system, the creditor updates his expectations about the probability of success of the project. Define the posterior probability of success after observing a high signal as $q_h$, and the probability of success after observing a low signal as $q_l$, where $q_h$ and $q_l$ are calculated as:

$$q_h = p_g P(G | S_H) + p_b P(B | S_H) = p_g \frac{\theta (\lambda + \delta)}{\lambda \theta + \delta} + p_b \frac{(1 - \theta) \delta}{\lambda \theta + \delta}$$

$$q_l = p_g P(G | S_L) + p_b P(B | S_L) = p_g \frac{\theta (1 - \lambda - \delta)}{1 - \lambda \theta - \delta} + p_b \frac{(1 - \theta) (1 - \delta)}{1 - \lambda \theta - \delta}$$

When the high signal is observed, the creditor updates his belief so that the posterior probability of dealing with a good type is higher than $\theta$ (this can be shown as $\frac{\lambda + \delta}{\lambda \theta + \delta} > 1$ and $\frac{\delta}{\lambda \theta + \delta} < 1$). On the other hand when the low signal is observed, the creditor updates his belief that the probability of dealing with a bad type is higher
than $1 - \theta$. It can also be easily shown that $q_h > q_l$.

Upon observing a high signal, the creditor cannot take any action but waits until time 2 to collect the face value. Upon observing a low signal, the creditor may liquidate the project if the expected payment at time 2 is smaller than the value he may receive from an early liquidation. Therefore the ex-ante expected payoff for the creditor at time 0 can be expressed as:

$$P(S_H)q_HD + P(S_L)\max\{q_LD, K\} - I$$

(5)

where $P(S_H)$ and $P(S_L)$ represent the unconditional probabilities of observing the signal $S_H$ and $S_L$ respectively. From the assumed information structure, we have $P(S_H) = \lambda\theta + \delta$ and $P(S_L) = 1 - \lambda\theta - \delta$. Compared to the case with perfect accounting information, the creditor now relies on the posterior belief about the true type to make the liquidation decision. It is therefore possible that the debt covenant may not be always effective, in that the creditor may not want to liquidate the project even when the low signal is observed. This is explicitly shown in Proposition 2 below.

**Proposition 2** When the accounting signal at time 1 imperfectly reveals the entrepreneur’s type, there exists some hurdle value of liquidation $K^\ast = \frac{q_l I}{\theta p_g + (1 - \theta) p_b}$, such that:

- If $K \leq K^\ast$, the optimal debt contract does not include any covenant to allow
  the creditor to liquidate the project at time 1, and the equilibrium face value of
debt is \( D_2 = D_0 = \frac{I}{\theta p_g + (1 - \theta) p_b} \).

- If \( K > K^* \), the optimal debt contract includes a covenant that gives the creditor the right to liquidate the project when the low signal is observed at time 1, and the equilibrium face value of debt is

\[
D_2 = \frac{I - P(S_L)K}{q_h P(S_H)} = \frac{I - (1 - \lambda \theta - \delta) K}{\lambda \theta p_g + \delta [\theta p_g + (1 - \theta) p_b]},
\]

and \( D_1 < D_2 < D_0 \).

**Proof.** See Appendix.

\( P(S_L)K \) is the expected liquidation value that the creditor may collect at the intermediate stage when observing a low accounting signal. \( q_h P(S_H) \) is the probability of success at time 2 when the project is allowed to continue upon observing a high signal. When the liquidation value is greater than \( K^* \), the imperfect accounting information allows the liquidation at time 1 and the equilibrium face value of debt is lower than in the no-information case \( D_0 \). Compared to the perfect information case, the imperfect accounting information introduces noise into both the liquidation decision at time 1 and the expected probability of default at time 2, therefore the ex-ante face value of debt is higher than the perfect information case.

Proposition 2 also suggests that the effectiveness of any covenant in the optimal debt contract depends on the exogenous liquidation value. When the liquidation value is relatively small, the creditor may not choose to liquidate the project even when a low signal is observed. The reason is that the creditor wants to avoid the excessive inefficient liquidation when accounting information contains noise and the benefit from an early liquidation becomes less attractive as the liquidation value decreases.
The relation between the liquidation hurdle value and the accounting information is further shown in Corollary 1:

**Corollary 1** The hurdle value of liquidation \( K^* \) is decreasing in the informativeness \( (\partial K^*/\partial \lambda < 0) \) and increasing in the degree of conservatism of the accounting system \( (\partial K^*/\partial \delta < 0) \).

It is intuitive to see that a more informative accounting system increases the parameter space over which the debt covenant is effective. However increasing accounting conservatism has the opposite effect. As the accounting system becomes more conservative \( (\delta \downarrow) \), the low signal contains more noise since increasing conservatism increases the probability of generating a low signal for the good type project; therefore, a debt covenant that allows for liquidation upon observing a low signal may induce more excessive inefficient liquidation of the good type. Indeed when the accounting system is most liberal \( (\delta = 1 - \lambda) \), the critical liquidation value becomes

\[
K^* = \frac{p_h I}{\theta p_g + (1 - \theta) p_b},
\]

which is always less than \( p_h X \). In this case, the bad project is always correctly identified when the low signal is observed. Hence it is always optimal for the debt contract to include a debt covenant that allows liquidation upon observing a low signal.

Consider now the expected payoff of the entrepreneur under the optimal debt contract with an effective debt covenant (i.e., when the liquidation value is sufficiently large, \( K > K^* \)). When the low signal is observed, the creditor liquidates the project and collects the liquidation value. The entrepreneur gets a positive payoff only from
continuing the project given that the high signal is observed. Hence the entrepreneur's expected payoff under the optimal debt contract is:

\[
E_2 = P(S_H) \cdot q_h \cdot (X - D_2)
\]

Substituting the values of \(P(S_H)\), \(q_h\), and \(D_2\) into the above equation, the entrepreneur's expected payoff can be represented as:

\[
E_2 = \frac{\theta p_g X + (1 - \theta) K - I - \theta (1 - \lambda - \delta) (p_g X - K)}{E_1} - \delta (1 - \theta) (K - p_b X) \tag{6}
\]

As shown in equation (6), the entrepreneur's optimal expected payoff with imperfect accounting information can be broken down into three components: first best expected payoff, expected efficiency loss from liquidating the good project, and expected efficiency loss from not liquidating the bad project. The characteristics of the accounting system affect the probability of having these two types of inefficiencies. An increase in accounting conservatism (\(\delta \downarrow\)) has two effects on the efficiency of liquidation:

- It increases the probability of observing a low signal for a good type project, i.e, \(P(G, S_L)\), and therefore increases the expected efficiency loss from liquidating a good project by \(\theta \delta (p_g X - K)\)

- It decreases the probability of observing a high signal for a bad type project, i.e,
P(B, S_H), and therefore reduces the expected efficiency loss from not liquidating a bad project by \((1 - \theta) \delta (K - p_b X)\)

The overall impact of accounting characteristics can be summarized in Proposition 3 below:

**Proposition 3** With imperfect accounting information, the entrepreneur’s expected payoff given the optimal debt contract is increasing in the informativeness of accounting system and decreasing in the degree of accounting conservatism. i.e, \(\partial E_2 / \partial \lambda > 0;\) \(\partial E_2 / \partial \delta > 0\)

**Proof.** See Appendix □

As mentioned above, maximizing the entrepreneur’s welfare is equivalent to the social welfare maximization as the creditor’s welfare is always zero due to the competitive lending market. Proposition 3 hence summarizes a key result of our analysis: more conservative accounting decreases the efficiency of debt contracting and therefore decreases the overall social welfare. This implication, essentially the same conclusion as in Gigler et al. (2008), may seem in contrast to the conventional view on the debt contracting hypothesis of accounting conservatism; however, the intuition is immediate from analyzing the expected payoff function of the entrepreneur. The overall impact of increasing conservatism depends on the relative magnitude of the loss from inefficiently liquidating good projects and the gain from efficiently liquidating bad projects. Since by assumption \([\theta p_g + (1 - \theta) p_b] X > I > K\), more conservative
accounting will reduce the overall benefit to the entrepreneur. In other words, if the project is worth undertaking ex-ante, the entrepreneur prefers as liberal as possible an accounting system so that the good project is liquidated as infrequently as possible. When \( \lambda \to 1 \) (and therefore \( \delta \to 0 \)), the accounting system produces the perfect signal, hence the face value of debt \( (D_2) \) and entrepreneur’s expected benefit \( (E_2) \) will converge to the first best benchmark.

The face value of debt in the model is usually measured by the implied interest rate in the empirical literature. From the model we can derive the impact of accounting conservatism on the implied interest rate as stated in Corollary 2 below:

**Corollary 2** There exists some cutoff value of liquidation,

\[
K^c \equiv \frac{I [\theta p_g + (1 - \theta) p_b]}{\theta p_g + (1 - \theta) p_b + \lambda \theta (1 - \theta) (p_g - p_b)}
\]

with \( K^c > K^* \), such that:

\[
\begin{align*}
\partial D_2 / \partial \delta & > 0, \quad \text{for } K > K^c \\
\partial D_2 / \partial \delta & < 0, \quad \text{for } K^* < K < K^c
\end{align*}
\]

**Proof.** See Appendix. ■

Increasing conservatism affects the face value of debt through increasing the probability of observing a low signal (triggering liquidation) at time 1 and decreasing the probability of collecting the face value of debt at time 2. The creditor accepts a lower face value when he may collect higher expected liquidation value at time 1 and asks for a higher face value when the probability of collecting the face value at time 2 increases. As shown in Corollary 2, the tradeoff between these two effects
depends on the liquidation value $K$. For projects with sufficiently large liquidation value ($K > K^c$), the face value of debt decreases as the accounting system becomes more conservative.

The entrepreneur’s expected payoff is not equivalent to the face value of debt. It is interesting to observe that even though the entrepreneur’s expected payoff decreases as the accounting system becomes more conservative, the implied interest rate of debt financing may not necessarily increase with accounting conservatism. Corollary 2 therefore provides some implications about the empirical test on the relationship between accounting conservatism and cost of debt. These empirical studies often use the interest rate as a proxy for the cost of debt and find that more accounting conservatism is associated with lower interest rate of loan agreements (For example, Zhang, 2008). We need to be careful to interpret the result on the ex-ante interest rate as the evidence of contracting efficiency of accounting conservatism. Zhang (2008) in fact tests the contracting efficiency hypothesis of accounting conservatism using both the ex-ante interest rate and ex-post accelerated covenant violations. However, as shown in this model, the ex-post accelerated covenant violation may not be equivalent to the efficiency of debt contract either. Increasing accounting conservatism always increases the probability of violating covenant and induces early liquidation; however, more conservative accounting may actually reduce the efficiency of the liquidation decision.

In the non-renegotiable debt contract setting discussed in this section, account-
ing conservatism can never be optimal. In the next section I model renegotiable
debt contracts, in which accounting conservatism may improve the efficiency of debt
contracting process under certain conditions.

2.3 Optimal debt contract with renegotiation

The debt contract in the model is incomplete because the debt covenant can only be
contingent on observed accounting signals but not on realized true states. Therefore
the contract may result in inefficient actions ex post when the good type generates
a low signal or when the bad type generates a high signal. In these cases, the con­
tracting parties would want to renegotiate the liquidation decision induced by the
initial covenant so as to increase the efficiency of the contracting arrangement if the
true state is observable. In fact, the empirical evidence documents that renegotia­
tion of debt contracts is both frequent and significant. For example, Roberts and
Sufi (2007) document that 75% of private credit agreements have a major contract
term renegotiated after origination and before the stated maturity date, based on a
random sample of 1,000 private loan agreements between financial institutions and
publicly listed firms. Other studies examine the violation of debt covenants, such
as Chen and Wei (1993) and Beneish and Press (1993). Both of them document a
large percentage of renegotiation and waiver decisions in their samples of covenant
violations (57 out of 128, and 53 out of 91 respectively). They also find that the most
frequent covenant violations are technical violations which usually involve covenants
Introducing the possibility of renegotiation may change the efficiency of the debt contract and the role of accounting information as modeled in Section 3. The major implication of the non-renegotiation model is that the most liberal accounting system minimizes the inefficiencies induced by the covenant based on noisy accounting signals. If ex-post renegotiation is efficient and costless, we expect that the inefficiency due to the incomplete contract will disappear. The Coase Theorem indicates that the initial contractual arrangement does not matter because the ex-post efficient decision can always be achieved; therefore the choice of the accounting system would not affect the ex-post efficiency either. Only when there is some degree of inefficiency in the renegotiation process does accounting information become welfare relevant. One factor that might drive the inefficiency of renegotiation is the existence of renegotiation costs. With costly renegotiation, the arrangement of the ex-ante accounting system will affect the ex-post efficiency of the contract.

2.3.1 Costless renegotiation

Assume that the initial debt contract includes a debt covenant that gives the creditor the right to liquidate the project if the low accounting signal is observed at time 1. At time 1 the contracting parties may want to renegotiate the action to be taken if the initial debt covenant induces an inefficient liquidation decision. I assume for now that renegotiation is costless. Following Aghion and Bolton (1992), it is reasonable to
assume that the creditor can make a take-it-or-leave-it renegotiation offer with the full bargaining power only when the debt covenant is violated; otherwise the entrepreneur can make the renegotiation offer with the full bargaining power. Notice that ex-ante the entrepreneur can always make a take-it-or-leave-it debt contract offer to the creditor as the lending market is competitive. Therefore, as will be shown below, the entrepreneur can always extract the extra bargaining surplus from the creditor through the ex-ante competitive debt contract even when the creditor has the full bargaining power ex post.

At time 1, there are four pairs of combinations of realized true types and accounting signals: \((G, S_H), (G, S_L), (B, S_L), (B, S_H)\). If the realized combination is \((G, S_H)\), the creditor does not have the right to liquidate the project under the initial debt contract with covenant. The continuation decision is efficient for this case. If the combination \((B, S_L)\) is realized, the debt covenant allows the creditor to liquidate the project when the low signal is observed and the creditor will actually liquidate the project, which is also efficient. It is in the other two cases that the initial debt contracts induce inefficient liquidation decisions and there will be scope for renegotiation.

First look at the case when the high signal is observed but the true type is “bad” \((B, S_H)\). The initial debt covenant does not allow for liquidation by the creditor.

---

8 Aghion and Bolton (1992) point out that debt financing can be viewed as a way to allocate the control right in a ‘state-contingent’ fashion with equityholders retaining control in the nondefault state and creditors taking control in the default state. It is a typical assumption that the party with control right has the full bargaining power in the renegotiation process.
Given that the entrepreneur has all the bargaining power, he will offer the creditor the amount of $p_b D$ to liquidate the project and leave himself $K - p_b D$ after liquidation. The creditor will accept the offer because his expected payoff is the same whether he accepts the offer or not. The whole renegotiation surplus goes to the bad type entrepreneur, therefore the entrepreneur is strictly better off by $K - p_b X$ through the renegotiation. Hence renegotiation results in a Pareto improvement and leads to the socially optimal liquidation decision.

In the case when the low signal is observed but the true type is “good” $(G, S_L)$, renegotiation also improves the contract efficiency. Under the initial contract the creditor has the right to liquidate the project when a low signal is realized. Now since the creditor has all the bargaining power when the covenant is violated, he will threaten to liquidate the project and ask for the entire future cash flows $X$ if he allows the project to continue. The entrepreneur gets the same expected payoff zero whether or not he accepts the renegotiation offer. I assume that when the entrepreneur is indifferent in the monetary payoff, the renegotiation will work toward the efficient outcome, i.e, the good type entrepreneur will accept the offer and allow the project to continue. Therefore the creditor gets the expected payoff $p_g X$ instead of $K$ as a result of renegotiation with the good type entrepreneur. In this case, again, renegotiation results in a Pareto improvement.

Table 1 summarizes the expected payoffs for both parties under each scenario in the renegotiable debt contract. The left item in the bracket of each cell represents
the entrepreneur's ex post payoff, and the right item in the bracket represents the creditor's ex post payoff at the end of the operation period.

Table 1: Expected ex post payoffs with renegotiation

<table>
<thead>
<tr>
<th>True Type</th>
<th>Signals</th>
<th>( S_H )</th>
<th>( S_L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Type</td>
<td></td>
<td>No renegotiation ([p_g(X-D), p_yD-I])</td>
<td>Renegotiation ([0, p_gX-I])</td>
</tr>
<tr>
<td>Bad Type</td>
<td></td>
<td>Renegotiation ([K-p_bD, p_bD-I])</td>
<td>No renegotiation ([0, K-I])</td>
</tr>
</tbody>
</table>

The face value of debt can be solved by applying the creditor's zero profit constraint to the creditor's ex-ante expected payoff as calculated by the sum of expected payoffs under four possible realizations in Table 1, denoted as \( D_3 \)

\[
D_3 = \frac{I - (1 - \lambda \theta - \delta) K - \theta (1 - \lambda - \delta) (p_gX - K)}{\lambda \theta p_g + \delta [\theta p_g + (1 - \theta) p_b]} 
\]  

(7)

It is intuitive to compare the face value under costless renegotiation \((D_3)\) with the face value without renegotiation \((D_2)\) to understand the intuition of renegotiation in the debt contract. The difference between these two equilibrium face values is marked as (a) in equation (7), which represents the surplus to the creditor from the efficiency gain by not liquidating the good project when a low signal is observed. However, even though the creditor captures the entire surplus from renegotiation when the debt covenant is violated, the expected gain from renegotiation will be extracted upfront by the entrepreneur through a lower face value of debt. In the
other renegotiation case when the high signal is observed, the entrepreneur has the bargaining power and captures the entire surplus from renegotiation. Therefore when costless renegotiation of debt contract is feasible, the efficient liquidation decision can always be implemented and the entire surplus from efficient renegotiation will go to the entrepreneur, whose payoff will be exactly the same as the first best benchmark.\(^9\)

\[
E_3 = \theta p_y X + (1 - \theta)K - I
\]  

(8)

The next proposition follows immediately from this observation:

**Proposition 4** *In the debt contract with costless renegotiation, the first-best benchmark performance is achieved and the ex-ante properties of the accounting system \((\lambda, \delta)\) do not affect the entrepreneur’s payoff.*

The irrelevance of accounting information is consistent with Coase Theorem. With costless renegotiation, ex-post efficiency can always be achieved. The entrepreneur can freely choose any accounting system and still achieve the first best efficient liquidation. However, the accounting-based covenant is necessary and serves the purpose of a trigger for costless renegotiation ex-post.

\(^9\)The entrepreneur’s payoff can also be derived as follows: in Table 1 the entrepreneur gets non-zero payoff only when the high signal is observed. The entrepreneur’s expected payoff from financing and investment now becomes:

\[
E_3 = P(S_H, G) \cdot p_y (X - D_3) + P(S_H, B) \cdot (K - p_b D_3)
\]

Substituting \(D_3\) into the equation above, we get equation (8)
In addition, from the equilibrium debt contract we can also derive a similar implication on the implicit interest rate of debt financing as in Corollary 3 below:

**Corollary 3** With costless renegotiation, the face value of debt decreases as the accounting becomes more conservative, $\partial D_3/\partial \delta > 0$.

**Proof.** See Appendix □

Therefore even when the accounting information is irrelevant to the expected payoff of the entrepreneur, increasing accounting conservatism reduces the face value of debt in equilibrium. However the lower face value does not necessarily translate into an ex-ante benefit of entrepreneur, as the entrepreneur can extract all the rent from the creditor in the competitive lending market. More conservative accounting shifts the ex-post allocation of the project payoff more to the creditor through the liquidation right, hence ex-ante the entrepreneur will set a lower face value to extract the rent from the creditor.

### 2.3.2 Costly Renegotiation

In this section I consider the debt contract with costly renegotiation. From now on I assume that there is a fixed amount of cost $c$ in the renegotiation process. Some examples of these costs are direct costs paid to lawyers or accountants and personal efforts involved, and others could be indirect costs such as the free-rider or externality costs, arising when multiple creditors are involved. Renegotiation cost varies significantly across different types of lending agreements. Public debts are viewed
to be more costly to renegotiate than private loans since public debts are subject
to more legal restrictions and require the consent of majority bondholders in order
to renegotiate the initial contract (Smith and Warner, 1979). In the private lending
agreement, renegotiation is typically easier as there are fewer lenders involved and
the lenders usually have better means of monitoring or controlling the firm. Within
private loans, renegotiation cost is higher for large syndicated loans with multiple
creditors. Chen and Wei (1993) document that covenant violations and follow-up
waivers or renegotiation decisions occur most frequently in private bank loans with
one creditor, and less likely in private loans with more than one creditor, and very
rarely in public debts. The variation of renegotiation cost will affect the extent of
ex-post efficiency through renegotiation and the role of accounting information.

As in the case of costless renegotiation, renegotiation may improve the two possible
inefficiencies under the initial contract when the low signal is observed for a good type
or when the high signal is observed for a bad type. The surplus from efficiently not
liquidating the good project is $p_g X - K$ and the surplus from efficiently liquidating the
bad project is $K - p_b X$. Whether or not renegotiation occurs depends on the relative
magnitude of the renegotiation cost and these two surplus terms. There are three
possible cases to be considered: when the renegotiation cost is "large", "small" or
"moderate", respectively. Compared to the no-renegotiation case where more liberal
accounting is always preferred by the entrepreneur and the costless renegotiation case
where accounting information is irrelevant, the costly renegotiation provides a role
for conservative accounting in debt contracting, as discussed below.

In the model it is reasonable to assume that the renegotiation cost is paid by the party who makes the renegotiation offer. When the debt covenant is not violated, the entrepreneur makes the renegotiation offer and pays the cost out of the liquidation value if the project is liquidated through renegotiation. When the debt covenant is violated, the creditor makes the renegotiation offer and pays the cost out of his own pocket. Recall that the entrepreneur in the model is wealth constrained, but the creditor is not.

Case I: "Large" renegotiation cost, i.e, $c > \max\{K - p_b X, p_g X - K\}$. In this scenario, the renegotiation cost is greater than any possible surplus from the renegotiation, hence renegotiation is not cost-effective. Then the same conclusion can be reached as for the non-renegotiable contract discussed in section 3, and the entrepreneur still prefers more liberal accounting.

Case II: "Small" renegotiation cost, i.e, $c < \min\{K - p_b X, p_g X - K\}$. When the renegotiation cost is relatively small, it is always worthwhile to renegotiate at time 1 to obtain a Pareto improvement in each of the inefficient states $(G, S_L)$ and $(B, S_H)$, because the surplus from renegotiation in both states $(p_g X - K$ and $K - p_b X$, respectively) is greater than the cost. Case II generalizes the costless renegotiation results in section 4.1, except that the entrepreneur or the creditor now needs to pay an additional cost of $c$ when renegotiation occurs. The payoff functions shown in Table 2 below, therefore, are similar to those in Table 1, adjusted for the cost $c$. 


Table 2: Expected ex-post payoffs with costly renegotiation (Case II)

<table>
<thead>
<tr>
<th>True Type</th>
<th>Signals</th>
<th>$S_H$</th>
<th>$S_L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Type</td>
<td>No renegotiation</td>
<td>$[p_g(X - D), p_gD - I]$</td>
<td>Renegotiation $[0, p_gX - c - I]$</td>
</tr>
<tr>
<td>Bad Type</td>
<td>Renegotiation</td>
<td>$[K - p_bD - c, p_bD - I]$</td>
<td>No renegotiation $[0, K - I]$</td>
</tr>
</tbody>
</table>

The equilibrium face value of debt ($D_4^{II}$) in this case is solved by applying the zero profit constraint to the creditor's ex-ante expected payoff at time 0 given the payoff matrix in Table 2.

$$D_4^{II} = \frac{I - (1 - \lambda \theta - \delta) K - \theta (1 - \lambda - \delta) (p_gX - K - c)}{\lambda \theta p_g + \delta [\theta p_g + (1 - \theta) p_b]}$$

Compared with $D_3$ under costless renegotiation in equation (7), the only difference is the renegotiation cost when the low signal is observed. Even though the entrepreneur only pays the renegotiation cost ex-post when the high signal is observed, his expected payoff is also lowered by the renegotiation cost occurred by the creditor since the ex-ante debt contract needs to compensate the creditor for the cost. Intuitively the first best liquidation decisions can always be achieved through the low cost renegotiation, however the entrepreneur needs to bear the expected renegotiation cost. The entrepreneur's expected payoff ($E_4^{II}$) will be lower than the first best payoff $E_1$, as shown below:

$$E_4^{II} = E_1 - [\theta (1 - \lambda - \delta) + (1 - \theta) \delta] c - I$$
Renegotiation cost occurs in the two inefficient cases induced by the initial contract: \( \theta(1 - \lambda - \delta)c \) when the low signal is generated for the good type project, and \( (1 - \theta)\delta c \) when the high signal is generated for the bad type project. Changing the properties of accounting system \((\lambda, \delta)\) will affect the total expected renegotiation cost. It is easy to observe that when the accounting system becomes more informative, the expected renegotiation cost goes down as the probability of occurring ex-post renegotiation decreases in general. When the accounting system becomes more conservative, the impact on the entrepreneur's expected payoff depends on the ex-ante probability of being a good type \( (\theta) \). Since \( \frac{\partial E^H_4}{\partial \delta} = (2\theta - 1)c \), we can get the following proposition:

**Proposition 5** When the renegotiation cost is small, more conservative accounting increases the entrepreneur's expected payoff if and only if \( \theta < 1/2 \).

Proposition 5 suggests the possibility for accounting conservatism to improve the entrepreneur's welfare, which is in contrast with prior results of no role for accounting conservatism either in the non-renegotiable contract or in the costless renegotiable contract. The intuition is that increasing accounting conservatism increases the probability of generating a low signal for the good type and consequently increases the expected renegotiation cost for the scenario \((S_L, G)\); on the other hand it decreases the probability of generating a high signal for the bad type to the same degree and consequently reduces the expected renegotiation cost for the scenario \((S_H, B)\). The overall outcome of increasing conservatism on the total renegotiation cost depends
on the ex-ante probability of being the good type or bad type. If the project is more likely to be a bad type, then the reduction of expected renegotiation cost in \((S_H, B)\) outweighs the increase of expected renegotiation cost in \((S_L, G)\). Therefore more conservative accounting is preferred by the entrepreneur when ex-ante the entrepreneur is more likely to face a negative NPV project \((\theta < 1/2)\).\(^\text{10}\)

Case III: "Moderate" renegotiation cost, i.e., \(c \in [K - p_bX, p_gX - K]\) or \(c \in [p_gX - K, K - p_bX]\). In this case renegotiation cost prevents the renegotiation for one of the two inefficiencies. The exogenous liquidation value \(K\) determines the relative magnitude of the two surplus terms. Larger liquidation values increase the efficiency gain from liquidating the bad project. Specifically if \(K > K^* \equiv \frac{p_gX + p_bX}{2}\) then \(p_gX - K < K - p_bX\), and vice versa. At \(K^*\), the surplus from renegotiation is the same in the two inefficient states.

When the liquidation value is small \((K < K^*)\), renegotiation in the \((B, S_H)\) state is not cost effective. Hence renegotiation only occurs in the state \((G, S_L)\), and the inefficiency in the state \((B, S_H)\) remains unsolved. Accordingly the entrepreneur's payoff is smaller than the first best benchmark due to two components: 1) the expected renegotiation cost at the state \((G, S_L)\); 2) the loss due to the inefficient liquidation decision at the state \((B, S_H)\).

On the other hand, when the liquidation value is large \((K > K^*)\), liquidating the

\(^{10}\)Some signaling models predict that good firms might commit to more conservative accounting and adopt earnings-based covenants to signal their type when facing credit rationing (Levine and Hughes, 2005), which provides a different explanation for the choice of accounting conservatism in firms with different investment opportunities.
bad project becomes more attractive and the opposite result is obtained. Renegotiation will occur in the state \((B, S_H)\) but not in the state \((G, S_L)\). The entrepreneur’s expected payoff is smaller than the first best benchmark payoff due to: 1) the expected renegotiation cost at the state \((B, S_H)\); 2) the loss due to the inefficient liquidation decision at the state \((G, S_L)\).

The impact of accounting conservatism on the entrepreneur’s payoff depends on the tradeoff between the expected renegotiation cost (yet the efficient liquidation decision) in one state and the efficiency loss due to the inefficient liquidation decision in the respective other state. As the accounting becomes more conservative, the probability of observing state \((G, S_L)\) increases and of observing state \((B, S_H)\) decreases. Therefore the effect of accounting conservatism on the overall outcome depends on the ex-ante probability of being a good type, \(\theta\). In general, there exists a threshold of \(\theta\) below which the entrepreneur will prefer conservative accounting and the threshold of \(\theta\) varies with the exogenous liquidation value \(K\).

The following proposition summarizes the effect of accounting conservatism under moderate renegotiation cost.

**Proposition 6** In the presence of moderate renegotiation cost (Case III), more conservative accounting increases the entrepreneur’s expected payoff if and only if:

\[
\theta \leq \theta^*(K) = \begin{cases} 
\frac{1}{1 + \frac{c}{K - p_k X}}, & \text{for } K < K^* \\
\frac{1}{1 + \frac{p_k X - K}{c}}, & \text{for } K > K^*
\end{cases}
\]
Proof. See Appendix ■

Figure 2 illustrates how the liquidation value $K$ affects the threshold of $\theta$ below which more conservative accounting will increase the entrepreneur's welfare. The preference set of conservative accounting is represented by the shadow area in the graph. As shown in the figure, at $K^s$, the threshold at $K^s$ is $\theta^*(K^s) = \frac{1}{2}$. At this point, the creditor is indifferent between renegotiation and no-renegotiation in both states and renegotiation will occur in either case; therefore the threshold of $\theta$ is coincident with that in Case II (see Proposition 5). In general, we have the following corollary:

**Corollary 4** The threshold of $\theta^*(K)$ below which the entrepreneur prefers more conservative accounting increases with the liquidation value $K$.

As the liquidation value increases, the efficiency improvement from renegotiation in the state $(B, S_H)$ also increases and therefore the entrepreneur is more likely to prefer more conservative accounting.

The results in Proposition 5 and Proposition 6 suggest that increasing accounting conservatism may benefit the entrepreneur under certain circumstances that are determined by a variety of factors such as magnitude of renegotiation cost, ex-ante investment opportunity set, and exogenous liquidation value. In the next section I discuss the empirical implications of these results in detail.
2.4 Discussions and empirical implications

Recently a large body of empirical literature has tested the association between accounting conservatism and some features of debt contracts, especially debt covenants. However, this literature by and large focuses on particular firms or industries and offers limited evidence on cross-sectional differences. Ignoring cross-sectional differences may explain the low statistical power in large sample tests (for example, Frankel and Litov, 2007) or inconclusive results about the role of accounting conservatism. This model may help better understand the driving forces behind the empirical results, and also provide additional implications for further articulating cross-sectional tests of the role of accounting conservatism in debt contracts.

Renegotiation cost: As suggested by the model, renegotiation cost is an important factor that shapes the use of accounting information in debt contracts. Typically
we expect the renegotiation cost to be lower for private bank loans than for public bonds, and also lower for loans with a single creditor than for syndicated loans with multiple creditors. Therefore the model predicts that in public bond issues, the accounting system should be more liberal when debt covenants are based on accounting information. On the other hand, in the private debt agreements, more conservative accounting may be preferred. The model reconciles well with some of the empirical evidences. Begley and Freedman (2004) report that the use of accounting-based debt covenants has declined sharply over the last three decades, which happen to be the period during which financial reporting becomes more conservative (Basu, 1997). Begley and Chamberlain (2005) also find the evidence that the use of accounting-based covenants is associated with less accounting conservatism by examining the public debt market. Earlier literature (Leftwich, 1983) finds that private debt contracts often include provisions based on systematic conservative adjustments from GAAP accounting. Recent empirical evidence using the sample of private bank loans (Zhang, 2008) or syndicated loans (Beatty et al., 2008) also finds more conservative accounting in these lending agreements.

**Investment opportunity set:** Another important implication from the model is that the preference for accounting conservatism depends on the ex-ante investment opportunity set, indicated by $\theta$ in the model. Most empirical studies on the debt contracting hypothesis of accounting conservatism do not consider the interaction between the investment opportunity set and the use of accounting information in the
debt covenants. The model predicts that debt contracts based on more conservative accounting may improve the efficiency of firms' investment and liquidation decisions when firms are more likely to face bad projects ex-ante; and vice versa. Although investment opportunities and growth opportunities are not exactly the same, firms with more positive NPV projects available are more likely to expand and grow in their investment. Therefore we expect growth firms either more likely to adjust accounting system to be more liberal, or less likely to seek debt financing if they cannot adjust accounting system freely.

**Liquidation value:** Liquidation value also plays a role in the use of accounting information in debt contracts. The first implication is from Proposition 2 that accounting-based debt covenants are ineffective for firms with extremely low liquidation values. Therefore we expect to observe less use of accounting-based covenants for firms with more intangible assets, especially in the knowledge-based industries. When liquidation value is relevant and the accounting-based covenant is effective, Proposition 6 predicts that firms are more likely to prefer conservative accounting as the liquidation value increases. This suggests that on average debt contracts demand more conservative accounting for the traditional industries with more tangible assets in place, and more liberal accounting for the new high-tech industries with more intangible assets.

**Interest rate and accounting conservatism:** As stated in Corollaries 2 and 3, the face value of debt usually decreases with accounting conservatism, even though the
social welfare or the entrepreneur's expected payoff may not increase as accounting becomes more conservative. This result has implications for the empirical tests of using interest rates to test the debt contracting hypothesis of accounting conservatism. For example, Zhang (2008) finds a negative relationship between initial interest rate in the lending agreement and accounting conservatism. This evidence, however, cannot be directly used to infer the efficiency implications of accounting conservatism.

Covenant tightness and accounting conservatism: Guay and Verrechia (2006) argue that the covenant tightness can replicate the effect of accounting conservatism in debt contracts. Empirically Beatty et al. (2008) find that conservatism in debt covenants and conservatism in accounting information are complements rather than substitutes. In this model due to the binary setting, I could not examine simultaneously how the choice of debt covenants and the properties of accounting system affect the efficiency of debt contracts. However, since accounting conservatism in the model arises from the potential efficiency improvement induced by ex-post renegotiation, both the tightness of covenant and conservatism in financial reports can be mechanisms to trigger the violation and renegotiation of covenants. One possible way to formally examine the relationship between the covenant tightness and accounting conservatism is to extend the endogenous optimal covenant model in Gigler et al. (2008) to the renegotiation setting in this paper, and it would be interesting to see whether accounting conservatism and covenant conservatism are complement or supplement to each other in the efficient debt contracting process.
2.5 Conclusion

This paper provides a theoretical model to understand the role of accounting information in debt contracts. I model the optimal debt contract with accounting-based covenants when the entrepreneur seeks financing for a risky project. The debt covenant gives the creditor the right to liquidate when accounting information reveals bad news about the project. The impact of accounting information on the entrepreneur's payoff depends on the efficiency of the ex-post liquidation decision triggered by the debt covenant. When the covenant is not renegotiable or the renegotiation cost is very high, conservative accounting actually reduces the welfare of the entrepreneur and the efficiency of debt contracts. When the covenant can be renegotiated at no costs, accounting information becomes irrelevant as ex-post efficiency can be achieved as long as ex-ante debt covenant is based on some accounting information. When the renegotiation cost is relatively small or moderate, conservative accounting can increase the entrepreneur’s welfare under some conditions, especially when the firm has less promising investment opportunities and higher liquidation value.

The model focuses on the ex-ante properties of accounting information system that entrepreneur commits to choose and also truthfully reports the accounting signal generated by the system. One possible deviation is that the entrepreneur can manipulate the signal to avoid the possible debt covenant violation. Empirical studies have documented evidence of earnings management through income increasing accruals when the debt covenant becomes tight. Therefore incorporating the entrepreneur’s manipu-
lation of accounting reports ex-post may affect the preference over ex-ante accounting system.
3 Accounting for Banks, Capital Regulation and Risk-Taking

The current banking crisis has raised much criticism of fair value accounting due to the mandatory adoption of SFAS 157 (*Fair Value Measurement*) in 2007 which resulted in large amounts of write-downs and recognition of credit losses in banks and financial institutions. This criticism has mainly focused on the unreliable value estimation for assets with illiquid markets and the systematic risk induced by excessive volatility under fair value accounting (Andrea et al., 2004; Landsman, 2005), and it has intensified during the current credit crunch.\(^{11}\) Many financial institutions blame fair value accounting for aggravating the financial crisis when the market is extremely illiquid and proper valuation models are unavailable; some even call on FASB to reassess the new fair value standard.\(^ {12}\) Advocates for fair value accounting, on the other hand, emphasize the benefits in terms of improved transparency and disclosure, promoting market discipline and providing relevant information for decision makers.\(^ {13}\)

Given the ongoing debate amid the financial crisis, it is crucial to have a better understanding of the desirability of different accounting regimes for banks so as to provide some ground for policymakers and regulators in the post-crisis regulatory reform. To that end, this paper examines whether different financial reporting

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\(^{11}\)Research on limitations and potential problems of market value accounting dates back to the early 1990s, for example, Berger et al., 1991; Shaffer, 1994; Robert, 1992; etc.

\(^{12}\)See for example “Fair-value Accounting’s Atmosphere of Fear” (CFO.com, May.19, 2008), “Bankers cry foul over fair value accounting rules” (FT.com, March.13, 2008), etc.

\(^{13}\)See for example, Barth, 1994; Bernard et al., 1995, Bies, 2004; Landsman, 2005; and most recently, Ryan, 2008b.
standards for banks provide relevant information for the prudential regulation and discipline of banks. Specifically, in a theoretical model I examine how accounting regimes affect the effectiveness of capital regulation in restricting banks’ risk-taking behaviors.

Banks have incentives to engage in excessive risk-taking as a result of high leverage, as shown by Jensen and Meckling (1976). The incentives for risk-taking are greater when banks’ investment decisions are not observable or verifiable to outsiders. Due to the nature of deposit financing, depositors are typically dispersed and uninformed small investors with deposits insured by the government, therefore they lack both the capability and incentives to monitor banks’ investment decisions. While debtholders in other industries may protect themselves through various instruments such as covenants and close monitoring, banks are subject to the prudential regulation where the regulator serves as the representative of small investors (Dewatripont and Tirole, 1994). An important aspect of the current regulatory system is the explicit minimum capital requirement, which was introduced in Basel Accords as part of the bank regulatory reform in the late 1980s in response to the Savings and Loans (S&L) crisis. By forcing banks to hold more capital, it is expected that risk-taking incentives can be reduced. However, whether or not capital requirement can effectively restrict

\[14\] The deposit insurance is assumed as an inherent feature of the banking sector in this paper. Diamond and Dybvig (1983) model the bank’s function as a liquidity provider in the economy; thus rationalize the deposit insurance as an instrument to prevent bank runs. But as John, et al. (1991) point out, even though banks’ deposits are insured, the root of banks’ risk-taking incentives is not in the deposit insurance (whether or not the insurance premium is risk based); but rather attributable to the convexity of levered equity payoff resulting from limited liability.

\[15\] The role of capital requirement to reduce risk-taking in banks is modeled in Keeley and Furlong, 1989 and 1990; Rochet, 1991; John et al., 1991. However, other papers such as Kim and Santomero
the risk-taking depends crucially on the extent to which the measure of capital is accurate and informative. Therefore capital regulation confers an important role to accounting methods that largely determine how the net worth (capital) is measured.

The move toward market-value based accounting in banks and financial institutions has also been triggered by the S&L crisis, which in part was attributed to lack of transparency under historical-cost based accounting (Benson et al., 1986; Kaufman, 1996). Consistent with the proposal's recommendation, the use of current valuations among banks and financial institutions has increased over the past 20 years, with FASB's issuance of a number of accounting standards related to fair value accounting. Until recently, FASB has been actively promoting a move toward comprehensive or full fair value accounting, in which all financial assets and liabilities are recorded at fair value on the balance sheet and changes in fair value are recorded in earnings. But whether the market-oriented accounting is more desirable for safe and sound banking has not been theoretically examined in the literature.

In this paper three accounting regimes are analyzed: historical cost accounting, lower-of-cost-or-market accounting, and fair value accounting. The practice of lower-of-cost-or-market accounting conforms to the conservatism principle; in the current (1988) and Koehn and Santomero (1980) argue that capital requirement can increase banks' riskiness within a simple portfolio model in an incomplete market setting.

These standards include SFAS 107 (Disclosures about fair values of financial instruments), SFAS 114 (Accounting by creditors for impairment of a loan), SFAS 115 (Accounting for certain investments in debt and equity securities), SFAS 119 (Disclosures about derivatives), SFAS 133 (Accounting for derivative instruments and hedging activities), SFAS 140 (Accounting for transfers and servicing of financial assets and extinguishment of liabilities), SFAS 141 (Accounting and reporting for business combinations), SFAS 157 (Fair value measurements) and SFAS 159 (The fair value option for financial assets and financial liabilities).
accounting framework, it is not the same as ‘one-side’ fair value accounting, since for some assets the book value is written down only when the impairment can be proved to be “other than temporary”. With this caveat in mind, I assume in the model that lower-of-cost-or-market accounting and fair value accounting are equivalent when economic losses are realized; the only difference between these two arises when economic gains are realized.

The basic model in the paper follows John et al. (1991) and John et al. (2000), capturing the key feature of banks’ risk-taking incentives in a simple framework. The investment opportunity appears after raising deposits and equity at the beginning of the operating period. The deposits are fully insured by government insurance agencies such as Federal Deposit Insurance Corporation (FDIC). The bank can choose either a safe investment or a risky investment after privately observing the probability of generating high cash flows for the risky investment. Ex-ante the bank manager determines the investment policy and the level of equity to maximize a weighted average of the short term earnings recognized and the final expected payoff to shareholders, subject to the capital regulation from the regulator. Different accounting regimes determine the expected earnings to be recognized and the expected regulatory cost when the interim capital falls below the regulatory requirement.

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17 SFAS 157 only provides more comprehensive guidance on fair value measurements to estimate fair value more rigorously without changing current framework in banks, which still has mixed features with some assets like bank loans recorded at historical based accounting subject to impairments and other assets such as held-for-sale securities recorded at lower-of-cost-or-market or full fair value.

Under historical cost accounting, no accounting information is revealed in the interim period and thus there is no risk of violating the minimum capital requirement ex post. Therefore the bank will not issue more equity than the minimum requirement and the investment policy will be more risky than the first best investment policy. Under lower-of-cost-or-market accounting, the bank may incur a regulatory cost in face of loss realizations and hence is likely to issue equity capital in excess of the minimum requirement. This will be more pronounced the greater the expected marginal regulatory cost of violating the minimum capital requirement. The optimal investment policy always involves less risk under lower-of-cost-or-market accounting than under historical cost accounting. The short-term attention to earnings induces the bank manager to be less aggressive since only bad news about the future economic conditions can be revealed under lower-of-cost-or-market accounting.

Fair value accounting is also more effective in restricting the bank’s risk-taking behavior than historical cost accounting. However, the concern about the short term earnings makes the bank more risk-taking under fair value accounting than under lower-of-cost-or-market accounting as the upside gain is also recognized. In summary, lower-of-cost-or-market accounting is the most effective regime in controlling the bank’s risk-taking incentive, followed by fair value accounting and historical cost accounting, given the exogenous minimum capital requirement set by the regulator.

However, if the regulator’s sole concern is to control banks’ risk-taking behaviors, the regulator, under any accounting regime, can raise the minimum capital
requirement to the level high enough that the bank always implements the first best investment policy. But it is not optimal for the regulator to do so because in general there are social costs associated with the capital requirement, such as restricting the liquidity provision function of banks (Diamond and Rajan, 2000; Gorton and Worton, 1995). Taking into account these costs related to capital regulation, the lower-of-cost-or-market accounting is the most favorable regime from the regulator's perspective while the historical cost accounting is the least favorable.

In the last part of the model, I also consider the case when the bank manager needs to exert some effort in order to find a risky investment opportunity. I find that in the market when the bank manager is extremely short term oriented, the lower-of-cost-or-market accounting may not be the most desirable regime any more, since it forces the bank's investment choice to be too conservative to induce the sufficient effort ex-ante. Historical cost accounting is a more welfare enhancing regime if the bank's cost of violating capital regulation is very high; otherwise, fair value accounting is preferred to the other two regimes from the regulator's perspective. These results may shed some lights on the recent debates about the desirable accounting regime for banks.

There are also several other studies on the implication of fair value accounting in financial institutions with more emphasis on the criticisms of fair value accounting. O'Hara (1993) examines the effect of market value accounting on the loan maturity in that market value accounting introduces a bias into the valuation of long-term illiquid
assets and hence increases interest rates for long-term loans and induces a shift to short term loans. More recently, Allen and Carletti (2008) show that mark-to-market accounting can lead to contagion between a banking sector and an insurance sector when the bank’s illiquid assets are carried at the market value, while no contagion would occur under historical cost accounting. Plantin et al. (2008) focus on the problem of fire sale induced by the artificial volatility due to mark-to-market for the bank’s long-lived, illiquid and senior assets. These papers all assume that accounting only matters for the ex-post recognition procedure after banks’ decisions have been made. However, Ryan (2008b) argues that although criticisms about fair value accounting are correct in some aspects, ‘the subprime crisis that gave rise to the credit crunch was primarily caused by firms, investors, and households making bad operating, investing, and financing decisions, and managing risks poorly’. This paper provides analytical supports for Ryan (2008b)’s argument by focusing on the ex-ante role of accounting in banks’ decision making process, yet the results also show that moving to full fair value accounting may not be optimal for disciplining banks.

More broadly, this study is also related to prior studies on alternative accounting regimes in other settings. Bachar et al. (1997) compare different accounting valuation approaches in communicating information to investors in a setting with transaction costs and auditing costs. Kirschenheiter (1997) compares the historical cost and market value methods in the valuation of assets. Other papers compare accounting regimes in a contracting setting (Kirschenheiter, 1999) or in a hedge-accounting...
setting (Melumad et al., 1999 and Gigler et al., 2007). This paper adds to the literature by comparing accounting regimes in banks and financial institutions and, in the course of doing so, supporting the role of accounting conservatism in financial reporting.

3.1 The model

The basic model is built on the risk shifting model developed in John et al. (1990) and John et al. (2000), which captures the key feature of the bank's moral hazard problem in a simple framework. I first lay out the analytical framework in a general setting and then analyze and compare the bank's behavior under different accounting regimes. While in John, et al. (1990) the bank's capitalization decision is exogenous, the current model endogenizes both the equity issuance and risk choice of the bank.

3.1.1 The basic model setup

Consider a three-date two-period model. At $t = 0$, the bank issues equity $K$ and collects deposits $D$ to a total amount of $I$. For simplicity, all deposits are assumed to be insured by the government in the case of default. Thus, the pricing of deposits does not incorporate the default risk of the bank. We can normalize the interest rate of deposits to zero and the bank promises to pay $D$ at $t = 2$.

After the bank has raised equity and deposits at date 0, the investment opportunity appears, which represents possible loan portfolios that the bank can choose to
invest in. Following John et al. (1990), I assume that there are basically two types of investments: 1) a safe investment with zero NPV, i.e., the safe investment generates cash flows of \( I \) at \( t = 2 \); and 2) a menu of possible risky investments indexed by \( \bar{q} \). The risky investment generates either high or low cash flows (represented as \( H \) or \( L \)) at \( t = 2 \), with \( H > I > L \). The probability of generating the high cash flow \( H \), denoted by \( \bar{q} \), is observed privately by the bank manager when the investment opportunity appears.\(^{19}\) However, ex-ante all parties know that \( \bar{q} \) is uniformly distributed over the interval [0,1].

The bank manager chooses between the safe and risky investments after observing the value of \( \bar{q} \). At \( t = 2 \), the terminal cash flows are realized, i.e., \( I \) if the safe investment is chosen and \( H \) or \( L \) if the risky investment is chosen. The final realized cash flows are observable and verifiable. The bank will pay the full promised payment \( D \) to depositors if realized cash flows are higher than \( D \) and the partial payment of \( L \) if the bank claims a default if realized cash flows are lower than \( D \). In the case of default, the government insurance agency will pay depositors the remaining amount of unpaid deposits.

**Definition 1** *An investment policy indexed by \( q \) is defined as follows: for a given cutoff value of \( q \), the bank will choose the risky investment for \( \bar{q} \geq q \) and the safe investment for \( \bar{q} < q \).*

\(^{19}\)The unobservable information of \( \bar{q} \) precludes any contract contingent on the value of \( \bar{q} \), and in this sense, the contract is incomplete.
the terminal cash flow distribution as follows: \( H \) with a probability \( \frac{1}{2}(1-q^2) \), \( I \) with a probability \( q \), and \( L \) with a probability \( \frac{1}{2}(1-q)^2 \). The total expected value of terminal cash flows for an investment policy \( q \) is thus given by:

\[
V(q) = qI + \frac{(1-q)^2}{2}L + \frac{1-q^2}{2}H
\]

First-best investment policy: The first best investment policy \((q^b)\) which maximizes \( V(q) \) above is:

\[
q^b = \frac{I-L}{H-L}
\]

The first-best investment policy \((q^b)\) can be implemented if the bank is financed entirely by equity so that the bank's manager maximizes the firm value, or if the information about \( q \) is perfectly observed by all parties. Thus \( q^b \) is a benchmark for comparing the investment distortion caused by risk shifting incentives due to deposit insurance.

If the bank finances the investment by issuing both equity and deposits, then deposit insurance will induce excessive risk-taking. Suppose now the bank simultaneously chooses the level of riskiness of its investment policy \( q \) and the equity issued \( (K) \), and raises the remaining amount of the investment by insured deposits \((D)\). Assume that the bank's manager maximizes the expected future payoff to shareholders,
which is represented by:

\[ \pi(q, K) = q(I - D) + \frac{1}{2} q^2 (H - D) - K \]  

(13)

Solving this maximization problem gives us Lemma 1:

**Lemma 1*** Risk-shifting incentives of deposit insurance: In the absence of capital regulation, the bank will raise the full investment by deposits and implement the most risky investment policy, i.e., \( K^d = 0 \) and \( q^d = 0 \).

In the absence of any regulatory constraint, the bank will always invest in the risky project and not issue any equity capital to finance the investment. It should be noted that even if, in contrast to my model’s assumptions, deposit insurance were fairly priced, the risk shifting problem could not be reduced.\(^{20}\) The reason is that the insurance premium could only reflect the anticipated riskiness of the investment, as the actual realization of \( q \) is privately observed by the bank’s manager. The insurance premium only adds a lump sum to the payoff once the equity issued \( (K) \) is chosen. The excessive risk-taking by banks increases the default probabilities and hence the likelihood of bank failures, which may result in the industry-wide crisis when most banks choose risky investments for their own profit-maximization objectives.

\(^{20}\)See Appendix B for an analysis of the fairly priced deposit insurance premium.
3.1.2 Information and accounting regimes

At date 1 all uncertainty of the risky investment is resolved, i.e., whether the risky investment generates high or low cash flows. However, the information about cash flows to be realized at date 2 is still not directly observable by outsiders. The bank has an information system in place that generates signals about the date 2 cash flows for the risky investment. The signal can be either good \((G)\) or bad \((B)\) conditional on the realized high \((H)\) or low \((L)\) cash flows. When the safe investment is made, no signal is generated by the information system. The following conditional probabilities represent the properties of the information system:

\[
P(G \mid H) = \alpha \\
P(B \mid L) = \beta
\]

\[
\alpha \in [\frac{1}{2}, 1] \quad \text{and} \quad \beta \in [\frac{1}{2}, 1]
\]

When \(\alpha = 1\) and \(\beta = 1\) the information system generates perfect signals about the date 2 cash flows. Given the investment policy of \(q\), the probabilities of generating good and bad signals can be derived as:

\[
P(G) = \alpha \frac{1 - q^2}{2} + (1 - \beta) \frac{(1 - q)^2}{2} \tag{15}
\]

\[
P(B) = (1 - \alpha) \frac{1 - q^2}{2} + \beta \frac{(1 - q)^2}{2}
\]
Let $E[V(q) \mid G]$ and $E[V(q) \mid B]$ denote the expected future cash flows conditional on the signals:

$$E[V(q) \mid G] = \frac{\alpha(1 - q^2)H + (1 - \beta)(1 - q^2)L}{\alpha(1 - q^2) + (1 - \beta)(1 - q)^2}$$

$$E[V(q) \mid B] = \frac{(1 - \alpha)(1 - q^2)H + \beta(1 - q^2)L}{(1 - q^2)(1 - \alpha) + \beta(1 - q^2)}$$

(16)

I also assume that the properties of the information system satisfy the following condition:

$$\frac{1 - \alpha}{\beta} < \frac{I - L}{H + I - 2L}$$

(17)

Overall when the information quality (indicated by $\alpha$ and $\beta$) increases, the above condition is easier to be satisfied. Given the condition in (17), it can be shown that $E[V(q) \mid G] > I$ and $E[V(q) \mid B] < I$ if $q < q^b$. Hence if the bank takes excessive risk, the expected future payoff to the investment given a bad (good) signal represents a loss (gain).

**Accounting regimes** Three accounting regimes of banks are considered in this paper: historical cost accounting, lower-of-cost-or-market accounting and fair value accounting. Accounting earnings to be recognized under different accounting regimes are as follows:

*Historical cost accounting.* No accounting earnings are recognized in all cases, and
accounting earnings do not reflect any new information at \( t = 1 \), i.e:

\[
e_h = 0
\]

*Lower-of-cost-or-market accounting.* Lower-of-cost-or-market accounting is a form of conservative accounting. The common practice is to write down the book asset to its current market value when the market value falls below the historical book value. In this model, I assume that the current market value is measured by the expected future cash flows at \( t = 1 \) conditional on the signals observed. The book value is carried at the initial investment value \( I \) at \( t = 0 \). When the bad signal is generated, the market value \( E[V(q) \mid B] \) is lower than the book value \( I \) and the bank needs to recognize negative earnings. When the good signal is generated, or no signal is observed, the bank recognizes no earnings. Therefore, accounting earnings under lower-of-cost-or-market accounting are:

\[
e_I = \begin{cases} 
0 & \text{if no (or good) signal is generated} \\
e^B = E[V(q) \mid B] - I & \text{if bad signal is generated}
\end{cases}
\]

*Fair value accounting.* Under fair value accounting, the bank has to recognize both the accounting gain (for good signal) and the accounting loss (for bad signal):
\[
\begin{align*}
  e_f &= \begin{cases} 
  0 & \text{if no signal is generated} \\
  e^G = E[V(q) \mid G] - I & \text{if good signal is generated} \\
  e^B = E[V(q) \mid B] - I & \text{if bad signal is generated}
\end{cases}
\end{align*}
\]

3.1.3 Bank capital and regulation

Besides the investment choice, the bank's manager also endogenously chooses the level of equity capital. I assume that the bank can only issue equity at the beginning of the investment period and the bank’s equity balance is subject to changes due to accounting earnings recognized under different accounting regimes. It is reasonable to assume that the new equity issuance is allowed only at the beginning of the investment period in this setting, as the bank faces the investment opportunity only at \( t = 0 \).\(^{21}\)

**Capital regulation:** From the preceding discussion, it is apparent that without capital requirements the bank will prefer to hold no capital at all. An important element of the current capital regulation is the minimum capital adequacy ratio requirement that the bank needs to meet continually.\(^{22}\) I model the role of regulatory constraint in the following two aspects:

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\(^{21}\)However, it is possible that with capital regulation, the bank may need to raise additional equity from the market when its capital falls below the regulatory requirement at the interim stage. This possibility is not directly modeled here. But since the equity issuance in time of breaching capital requirement is often more costly, thereby the equity issuance can be viewed as part of the regulatory cost that the bank may need to incur in breach of regulatory requirements, as modeled in the regulatory cost function.

\(^{22}\)The 1988 Basel Accord (Basel I) requires two levels of minimum capital requirements for banks: minimum Tier 1 capital is set at 4% of risk-weighted assets and minimum Tier 2 capital is set at 8% of risk weighted assets. Banks with at least 5% Tier 1 and 10% Tier 2 capital are considered to be 'well-capitalized'. Basel I was replaced by Basel II in 2004. Basel II better aligns the regulatory capital requirements with 'economic capital' demanded by investors, which allows the use of internal ratings based (IRB) approach of choosing regulatory capital.
1. At $t = 0$, the initial equity issued has to strictly satisfy the capital requirement, which is to hold a minimum capital of $k$ per unit of deposits.

2. At $t = 1$, the bank violates the minimum capital requirement if the new equity balance after recognizing accounting earnings falls below the requirement. The expected regulatory cost of violation is a convex function of the amount of inadequate capital, $C(u_j(k))$, where $u_j(k), \ j \in \{h, f, l\}$, denotes the amount of inadequate capital under different accounting regimes. Suppose that the bank issues equity of $K$ at $t = 0$, the capital balance at $t = 1$ will be $K + e_j$, where $e_j$ is the amount of earnings recognized under different accounting regimes. Then the total amount of inadequate capital $u_j$ at $t = 1$ can be represented as:

$$u_j(k) = \text{Max}\{0, kD - K - e_j\}, \ j \in \{h, f, l\}$$ (18)

I assume that the cost function is convex, i.e., $C' \geq 0$ and $C'' > 0$, with $C''(0) = 0$. Specifically, this cost can be viewed as the regulator's punishment on shareholders when the bank violates the capital requirement. These costs are likely to be marginally increasing in the severity of capital inadequacy. Empirical studies have documented that many banks hold capital above the minimum regulatory requirement, which is consistent with the model in this paper where the level of buffer capital (i.e., the amount of capital in excess of the regulatory requirement) is endogenously determined.\(^{23}\)

\(^{23}\)The capital regulation modeled in this paper is consistent with ex-ante regulation approach in bank capital regulation. Basel I and Pillar I of Basel II are examples of ex ante capital constraint,
To summarize the model setup, Figure 2 illustrates the timeline of events.

![Figure 2: Timeline](image)

3.2 The bank’s problem

Now I consider the bank’s problem with capital regulation under different accounting regimes. Assume that the bank’s manager is interested not only in the long run expected payoff to shareholders, but also in the short term earnings reported under the prevailing accounting system. This assumption is in line with the managerial myopia literature which typically assumes that managers give some weight to the short term earnings in addition to the long-term fundamental value.\(^{24}\) I assume that the bank’s manager will assign a positive weight, denoted as \(\gamma\), on the earnings which imposes a fixed ratio of the minimum capital requirement. However, Pillar II of Basel II introduces some elements of \textit{ex-post regulation}, in which the bank has the freedom to choose capital and portfolio risk. This paper does not attempt to model the feature under the new Basel Accord, but it is a possible future direction for research. See Giammarino et al. (1993) and Kupiec and O’Brien (1997) for more details about the \textit{ex post regulation} approach.

\(^{24}\)See for example Stein, 1989; Narayanan, 1985.
reported in the interim period. Moreover, as assumed in section 3.1.3, the expected regulatory cost of violating capital requirement in the interim period is determined by the probability and amount that the equity capital falls below the required level under each regime, \( E[C(u_j)] \).

In summary, accounting earnings play a dual role in the model: first, it determines the ex-post cost of violating capital regulation; second, it directly affects the bank’s incentive induced by the short term interest. The bank’s manager maximizes the following objective function under each regime, subject to the first-period regulatory constraint of equity capital:

\[
\max_{q, K} \Pi_j(q, K) = \gamma E[e_j] + (1 - \gamma) \pi(q, K) - E[C(u_j)], \quad j \in \{h, l, f\} \quad (19)
\]

\[
st. \quad D + K = I \\
K \geq K_0(k)
\]

Where \( K_0(k) = \frac{k}{k + 1} I \) represents the minimum equity capital that satisfies the regulatory requirement.

Denote the optimal solution to the bank’s problem in (9) as \((q^*_j, E^*_j)\), where \( j \in \{h, l, f\} \), indicating different accounting regimes. The recognized earnings differ under various accounting regimes, affecting both the short term interest in earnings and the expected regulatory cost and thereby altering the bank’s optimal investment.
policy and equity issuance decisions. This section examines the effectiveness of capital regulation in controlling the bank’s risk-taking behavior under these regimes. The capital requirement is taken as an exogenous factor in this section, i.e., it remains the same across accounting regimes. In the next section, I will examine the regulator’s problem of choosing the optimal capital requirement for a given accounting regime in place.

3.2.1 Historical cost accounting

Consider first historical cost accounting. Under historical cost accounting, no accounting earnings are recognized in the interim period. Therefore the book value of equity remains the same as the initial value. The expected regulatory cost \( E[C(u_h)] = 0 \) if the initial equity satisfies the minimum capital requirement constraint. Solving the bank’s problem under historical cost accounting gives the following proposition:

**Proposition 7** Under historical cost accounting, the bank’s optimal investment policy \( (q_h^*) \) and equity issue \( (K_h^*) \) are given by:

\[
\begin{align*}
K_h^* &= K_0(k) \\
q_h^* &= \frac{E_h^*}{H - I + K_h^*}
\end{align*}
\]

As long as the minimum capital requirement is greater than zero, the bank’s investment policy under historical cost accounting is less risky than in Lemma 1 as the bank now invests partially in the safe project as a result of the minimum capital
requirement. The result is consistent with the prior literature that the prudential regulation of bank through minimum capital requirements can reduce the excessive risk-taking by forcing the bank to share the investment’s riskiness to some extent. It is easy to show that \( \frac{\partial q_h^*}{\partial K_h^*} > 0 \), hence the optimal \( q_h^* \) is increasing with the optimal equity issued \( K_h^* \), which is determined by the minimum capital requirement. Another implication of Proposition 7 is that, with historical cost accounting, the bank will issue no more equity than the minimum required level and finance the rest of investment by deposits. Therefore, under historical cost accounting, the regulator can increase the minimum capital requirement so that the bank is forced to raise more capital and lower the excessive risk-taking. In sum, historical cost accounting fails to capture the new information about the investment’s future cash flows and hence accounting information does not affect the effectiveness of capital requirement in controlling the risk-taking by the bank.

### 3.2.2 Lower-of-cost-or-market accounting

Lower-of-cost-or-market accounting constitutes a move toward the forward-looking, market based accounting. It requires the write-down of assets when the asset value is impaired or when its market value falls below the book value. This is consistent with the general conservatism principle in GAAP and other accounting standards. Overall, lower-of-cost-or-market accounting provides more information about the bank’s economic activities, especially when the expected future economic conditions deteri-
In the model, the accounting system reports a loss of $e^B$ when the bad signal is generated and zero when either the good signal is generated or no signal is generated at all. Therefore the expected earnings to be recognized at $t = 1$ are:

$$E[e_t] = P(B)e^B$$

(20)

The expected regulatory cost that may occur under lower-of-cost-or-market accounting depends on the probability of recognizing an accounting loss when the bad signal is generated, $P(B)$, and the amount of inadequate capital conditional on a loss being recognized, $u_t$. The inadequate capital when the bad news is observed is $u_t = \max\{0, kD - K - e^B\}$. Hence the expected regulatory cost is given by:

$$E[C(u_t)] = P(B)C(u_t)$$

(21)

Ignoring for now the constraint for the minimum equity capital requirement at the beginning of period 1, the bank's optimal choices of equity capital and the investment policy are determined by the first order conditions to the objective function in (19).\(^{25}\) Denote the solution to this relaxed maximization problem under lower-of-cost-or-market accounting as $(q_t, \tilde{K}_t)$, which is given by the solution to the maximization problem in (19) without the second constraint $K \geq K_0(k)$. The following equation

\(^{25}\)I show in the proof of Proposition 8 in Appendix that the second order condition is met given the assumption of sufficiently large $C''$.\)
system represents the solution:

\[
\begin{align*}
\frac{\partial}{\partial q} \Pi_i(q_i, \tilde{K}_i) &= 0 \\
\frac{\partial}{\partial K} \Pi_i(q_i, \tilde{K}_i) &= 0
\end{align*}
\]  

(22)

However, the relaxed optimal equity capital ($\hat{K}_i$) is not always feasible as it may be lower than the minimum capital requirement. Before presenting the complete solution to the bank's problem under lower-of-cost-or-market accounting, I also define the minimum capital investment policy as the bank's optimal risk choice conditional on the initial equity level being equal to the minimum capital required:

**Definition 2** A *minimum capital investment policy* ($\hat{q}_j$) is defined as below:

\[
\hat{q}_j \in \max_q \Pi_j(q, \hat{K}), \text{ where } \hat{K} = \frac{k}{k+1} I, \quad j \in \{h, l, f\}
\]

One can easily see that the optimal investment policy under historical cost accounting coincides with the minimum capital investment policy, $q^*_h = \hat{q}_h = \frac{\hat{K}}{H - I + \hat{K}}$. Under lower-of-cost-or-market accounting, the minimum capital investment policy ($\hat{q}_l$) can be derived from the first-order condition of the maximization problem of $\Pi_l(q, \hat{K})$, shown as follows:

\[
\hat{q}_l = \frac{(1 - \gamma)\hat{K} - \frac{\partial P(B)}{\partial q}C(-e^B) + P(B)C'(e^B)\frac{\partial e^B}{\partial q} + \gamma \beta (I - L)}{H - I + (1 - \gamma)\hat{K} - \gamma \alpha (H - I) + \gamma \beta (I - L)}
\]  

(23)
The following lemma compares the minimum capital investment policies under historical cost accounting and lower-of-cost-or-market accounting.

**Lemma 2** The minimum capital investment policy under historical cost accounting is more risky than under lower-of-cost-or-market accounting, i.e., $q_h < \hat{q}_l$.

**Proof.** See Appendix. ■

Lemma 2 suggests lower-of-cost-or-market accounting may alleviate the excessive risk-taking problem. Yet this result is preliminary because it exogenously imposes identical capital structures under different accounting regimes. The bank's risk-taking incentive is potentially mitigated by the fact that increasing risk also increases the bank's expected regulatory cost, since the future equity capital may be reduced through the loss recognition under lower-of-cost-or-market accounting. However, implementing the minimum capital investment policy may not necessarily be optimal for the bank, given that the bank also has the option to raise more equity ex-ante to reduce the expected regulatory cost. The marginal impact of increasing the equity at the minimum capital level can be represented by the following equation:

$$\frac{\partial}{\partial K} \Pi_t(\hat{q}_t, \hat{K}) = - (1 - \gamma) \frac{(1 - \hat{q}_t)^2}{2} + P(B)C'(e^B(\hat{q}_t))$$

As indicated in the equation above, the equity issuance decision involves a tradeoff between the marginal benefit and cost of increasing equity. On the one hand increasing equity capital reduces the expected future regulatory cost of violating the capital
requirement; on the other hand, it reduces the bank's benefit from risk shifting. Therefore the bank's optimal equity issuance depends on two different scenarios:

- **Case I:** $C'(e^B(q_i)) \leq (1 - \gamma)\frac{(1 - \hat{q}_i)^2}{2P(B)}$; in this case the expected marginal regulatory cost is smaller than the benefit of risk-shifting

- **Case II:** $C'(e^B(q_i)) > (1 - \gamma)\frac{(1 - \hat{q}_i)^2}{2P(B)}$; in this case the expected marginal regulatory cost is larger than the benefit of risk-shifting

Given these two different cases, the bank's optimal decisions under lower-of-cost-or-market accounting are characterized in the following proposition:

**Proposition 8** Under lower-of-cost-or-market accounting, the bank's optimal investment choice ($q_i^*$) and equity issue ($K_i^*$) are given by:

- **Case I:** $K_i^* = \hat{K}$ and $q_i^* = \hat{q}_i$

- **Case II:** $K_i^* = \hat{K}_i$ and $q_i^* = \hat{q}_i$

**Proof.** See Appendix. 

To better understand the intuition behind Proposition 8, note that the optimal investment policy ($q_i^*$) always satisfies the first order condition $\frac{\partial}{\partial q} \Pi_i(q_i^*, K) = 0$ for any level of equity capital $K$. However, the optimal equity issuance decision at $t = 0$ involves a tradeoff between the marginal benefit and cost of increasing equity. Only in Case II when the expected marginal regulatory cost is larger than the benefit, the bank has the incentive to increase its equity capital to the relaxed optimal level, which
is above the minimum capital requirement. Hence one would expect to find banks holding excess capital under lower-of-cost-or-market accounting, consistent with the empirical evidence that banks has started to hold more excess capital in 1990s when the accounting regime is moving toward a more market-value based system (Flannery and Rangan, 2008).

Another observation is that it is never optimal for the bank to issue more capital than $kD - e^B$, which is the capital level that fully insures the bank against incurring any regulatory cost. This can be shown following the fact that $\frac{\partial}{\partial K} \Pi_t(q, kD - e^B) < 0$. Given the assumption that $C'(0) = 0$, lowering $K$ slightly, starting from $K = kD - e^B$, only comes at a second-order loss in terms of expected regulatory costs, while yielding a first-order gain in terms of risk shifting benefits. Thus, instead of holding the capital too safe, the bank will always prefer being exposed to some degree of future regulatory cost.

In terms of the investment policy, we compare the optimal investment policy when the bank issues the equity capital in excess of the minimum requirement with the minimum capital investment policy. It turns out that when the bank issues equity above the minimum required level, the investment policy will not become more risky than the minimum investment policy under lower-of-cost-or-market accounting ($\hat{q}_t$), which is shown to be less risky than under historical cost accounting in Lemma 2. Corollary 5 gives the complete comparison of the investment policies under these two accounting regimes:
Corollary 5  The bank's investment policy is always less risky under lower-of-cost-or-market accounting than under historical cost accounting, i.e., \( q_t^* \geq q_t > q_h^* \)

Proof. See Appendix.

Aside from the minimum capital requirement, the short term interest in earnings also acts as another mechanism in reducing the risk-taking incentive of the bank under lower-of-cost-or-market accounting. As the interim accounting information reveals future economic conditions and provides an early signal about the investment decision made, the attention to short-term earnings can also discipline the bank manager’s decision ex-ante. When the bank’s manager puts more attention on the interim earnings reported (i.e., \( \gamma \) increases), the optimal investment policy under lower-of-cost-or-market accounting is less-risky, and the bank is more likely to issue equity in excess of the minimum requirement, and the level of buffer capital is higher.

3.2.3 Fair value accounting

Fair value accounting is a forward looking accounting regime that requires the recognized asset value to incorporate current information about future cash flows in a fully symmetric fashion. The current accounting framework for banks has mixed attributes with some financial instruments like bank loans reported at historical costs (with limited features of lower-of-cost-or-market), while other financial instruments like trading securities and derivatives reported at fair value. The full fair value ac-
counting requires the recognition of both unrealized gains and losses consistently.\textsuperscript{26}

In the context of this model, fair value accounting is identical to lower-of-cost-or-market when there is bad news about future expected cash flows. The only difference between these two regimes arises when there is good news about future cash flows.

Since the initial capital issued needs to meet the regulatory requirement, the only possibility that the bank may incur the regulatory cost is when there is bad news about future cash flows and accounting losses are recognized to decrease the initial capital below the required level. Therefore in this model, due to the binary nature, the bank has the same expected regulatory cost under both lower-of-cost-or-market accounting and fair value accounting, which is given in (21). However, the expected earnings recognized under fair value accounting are different from lower-of-cost-or-market accounting, as they are now given by the expected NPV of the risky investment:

\[
E[e_f] = P(B)e^B + P(G)e^G \\
= \frac{1-\bar{q}^2}{2}(H - I) + \frac{(1-\bar{q})^2}{2}(L - I)
\]

This transparency property is the main advantage of fair value accounting. Note in particular that the properties of the accounting system do not affect the expected earnings to be recognized under fair value accounting. Since fair value accounting

\textsuperscript{26}SFAS 157 provides an extensive practical guidance regarding how to measure fair values, however, it does not require fair value accounting for any position (Ryan, 2008a). SFAS 159 offers the fair value option to measure certain financial assets and liabilities at fair value, with changes in fair value recognized in current earnings.
provides full recognition of both gains and losses symmetrically, there is no distortion in the recognized earnings with respect to the expected future cash flows.

Given (21) and (24), the bank’s problem can be solved under fair value accounting. Following a similar procedure as under lower-of-cost-or-market accounting, I first characterize the relaxed solution to the objective function, ignoring the constraint of the minimum capital requirement at the beginning of the period. The following system of equations summarizes the solution:

\[
\begin{align*}
    \frac{\partial}{\partial q} \Pi_f(q_f, K_f) &= 0 \\
    \frac{\partial}{\partial K} \Pi_f(q_f, K_f) &= 0
\end{align*}
\] (25)

Again, the relaxed optimal equity capital \(K_f\) is not always feasible as it may be lower than the minimum capital required. Therefore we also need to consider the minimum capital requirement policy under fair value accounting, \(q_f\), which is derived from the first order condition of the maximization problem of \(\Pi_f(q, K)\), shown as follows:

\[
q_f = \frac{(1 - \gamma)K - \frac{\partial P(B)}{\partial q} C(-e^B) + P(B)C'(-e^B)\frac{\partial e^B}{\partial q} + \gamma(I - L)}{H - I + (1 - \gamma)K + \gamma(I - L)}
\] (26)

The following lemma compares the minimum capital investment policy under fair value accounting with those under the other two accounting regimes.
Lemma 3  The bank's minimum capital investment policy under fair value accounting is less risky than under historical cost accounting, but more risky than under lower-of-cost-or-market accounting, i.e., \( q_h < q_f < q_i \).

Proof. See Appendix. □

Lemma 3 suggests that although the bank's minimum capital investment policy is less risky under fair value accounting than under historical cost accounting, it is more risky than under lower-of-cost-or-market accounting. Now we can finalize the optimal decisions of the bank \((q^K_f, K_f)\) given the above relaxed optimal solution and the minimum investment policy under fair value accounting. The bank's choice of optimal equity capital also depends on two different scenarios under fair value accounting, which are parallel to Case I and Case II under lower-of-cost-or-market accounting:

- Case I': \( C'(\gamma f') \leq (1 - \gamma) \frac{(1 - \hat{q}_f)^2}{2P(B)} \); in this case the expected marginal regulatory cost is smaller than the benefit of risk-shifting

- Case II': \( C'(\gamma f') > (1 - \gamma) \frac{(1 - \hat{q}_f)^2}{2P(B)} \); in this case the expected marginal regulatory cost is larger than the benefit of risk-shifting

Similar to lower-of-cost-or-market accounting, the optimal equity issuance decision depends on the trade off of the marginal benefit and marginal cost of increasing equity. We have the following Proposition 9 that characterizes the bank's optimal decisions under fair value accounting:
Proposition 9 Under fair value accounting, the bank’s optimal investment policy \( (q_f^*) \) and equity issuance \( (K_f^*) \) are given by:

- **Case I'**: \( K_f^* = \hat{K} \) and \( q_f^* = \hat{q_f} \)

- **Case II'**: \( K_f^* = \hat{K}_f \) and \( q_f^* = \hat{q}_f \)

**Proof.** Similar to the proof of Proposition 8. ■

Under fair value accounting the bank is also likely to hold capital in excess of the minimum requirement level when the expected marginal regulatory cost is high enough. Moreover, we can also derive a conclusion similar to Corollary 1 that under fair value accounting the bank’s investment policy is no more risky than its minimum capital investment policy, i.e., \( q_f^* \geq \hat{q}_f \). Therefore fair value accounting always induces less risky investment than historical cost accounting, i.e.:

\[
q_f^* \geq q_h^*
\]  

(27)

Now we focus on a comparison of the optimal decisions under fair value accounting and lower-of-cost-or-market accounting as shown in Corollary 6.

**Corollary 6** Under fair value accounting the bank’s investment policy is more risky than under lower-of-cost-or-market accounting, i.e., \( q_f^* < q_l^* \); Moreover, the bank is less likely to issue capital in excess of the minimum requirement and the level of capital issued is also lower, i.e., \( K_f^* \leq K_l^* \).
Proof. See Appendix. ■

Therefore, overall fair value accounting is less effective in controlling the bank’s risk-taking behavior than lower-of-cost-or-market accounting. The bank’s concern about the regulatory cost is identical under these two accounting regimes, but the short term interest in earnings makes the bank’s manager more aggressive under fair value accounting as the upside gain recognized adds to the incentive to choose the risky investment ex-ante. In terms of the equity issuance, the result in Corollary 6 means that when the bank’s marginal regulatory cost is high enough so that the optimal decision is to issue equity in excess of the minimum requirement under lower-of-cost-or-market accounting, the same level of marginal regulatory cost will also drive the issuance of equity in excess of the minimum requirement under fair value accounting. The opposite, however, does not hold. Therefore the likelihood of observing excess capital is larger under lower-of-cost-or-market accounting.

3.3 The regulator’s problem

In the previous analysis the capital requirement was assumed exogenous and the bank’s optimal decisions under different accounting regimes are compared given the same degree of the minimum capital requirement. In this section I consider the regulator’s problem when the regulator can adjust the capital requirement to maximize its own objective function, which is to maximize social welfare.

When there is no cost associated with capital regulation, the regulator can freely
adjust the capital requirement for banks. In this case the sole objective of the regulator is to maximize the investment return to all stakeholders, including shareholders, depositors, the insurance agency and the regulator. Social welfare is then purely determined by the investment policy, as the cost to the insurance agency in default is offset by the benefit to shareholders regardless of the insurance premium scheme; and the regulatory cost is a wealth transfer between the regulator and the bank's shareholders. Hence the regulator solves the following problem:

\[
\max_{k, q_j, K_j} V(q_j(k)) \\
\text{s.t. } q_j, K_j \in \arg \max_{q, K} \Pi_j(q, K|k)
\]  

(28)

The regulator's objective is to eliminate the bank's excessive risk-taking to implement the first best investment policy, \(q^{fb}\), which is also the social optimal investment policy. Given the results in Section 3, the regulator can always adjust the minimum capital requirement under each accounting regime so that the bank's induced investment decision replicates the first best investment policy \(q^{fb}\). Denote the regulator's optimal capital requirement when capital regulation is costless as \(\bar{k}_j\), \(j \in \{h, l, f\}\).

Then the solution to the problem in (28) is characterized by Proposition 10:

---

27Note that if we assume the regulatory cost comes from the costly new equity issuance, which represents a deadweight loss, the objective function of the regulator will change accordingly. In this case, the assumption of costless capital regulation does not hold, and the results will be close to those with costly capital regulation.
Proposition 10 When capital regulation is costless, there exists an optimal minimum capital requirement under each accounting regime, $\bar{k}_j$:

$$\bar{k}_l < \bar{k}_f < \bar{k}_h = \frac{I - L}{L}$$

such that the first best investment policy is implemented by the bank:

$$V(q^*_l(\bar{k}_l)) = V(q^*_f(\bar{k}_f)) = V(q^*_h(\bar{k}_h)) = V(q^{fb})$$

Proof. The proof follows by setting the optimal investment policy $q^*_j(k)$ under each regime equal to $q^{fb}$. ■

The regulator's optimal capital requirements under lower-of-cost-or-market accounting and fair value accounting are lower than under historical cost accounting. Under historical cost accounting, when the capital requirement is $\bar{k}_h$, the bank issues only safe deposits as $D = L$. In fact for any capital requirement above this level, the bank's investment policy will also achieve the first best level under historical cost accounting as the bank internalizes the default risk when only safe deposits are issued. Under the other two accounting regimes, the requirement for issuing safe deposits cannot induce the first best investment policy, as the bank is also subjected to the regulatory cost.

Proposition 10 might suggest that accounting does not matter from the social welfare perspective, as the first best investment policy can always be implemented
under each accounting regime. However, the assumption of costless capital regulation is crucial for this result; yet the assumption is clearly unrealistic. In the real economy, the regulator also needs to consider social costs associated with the capital requirement. One such cost of increasing the bank’s capitalization is the restriction of liquidity creation provided by the bank to investors through deposits. When the regulator is also concerned with the cost associated with capital requirement, then the regulator will prefer the accounting regime that requires the lowest optimal capital requirement to induce the first best investment policy. Therefore the social welfare at the optimal capital requirement level will be the highest under lower-of-cost-or-market accounting, and the lowest under historical cost accounting. The conservative bias under lower-of-cost-or-market accounting reduces the excessive risk-taking incentives in banks, thereby allowing the regulator to set more lenient capital requirements that improve social welfare, in face of opportunity costs of imposing capital requirements.

3.4 The role of ex-ante effort

The regulator’s preference over different accounting regimes in the discussion so far is primarily concerned of the excessive risk-taking incentive of the bank when the

\footnote{Banks’ function as liquidity provider has been extensively studied in the literature following Diamond and Dybvig (1983). For example, Diamond and Rajan (2000) study the consequences of regulatory capital requirements in trading off credit and liquidity creation functions with the possibility of financial distress. Gorton and Winton (1995) also show in a general equilibrium framework to that bank capital is costly because of the restriction on the liquidity provision. Other types of costs associated with capital regulation involve the supervision and compliance costs in general. In a recent study, Van den Heuvel (2008) quantifies the social welfare cost of capital requirements as the percentage of consumption by comparing the benefit of limiting the moral hazard problem and the cost of reducing liquidity creation.}
investment opportunity is available. Therefore the regulator prefers to choose the regime which is most effective in controlling the bank’s risk-taking incentive given the investment opportunity set. In this section, I consider another scenario in which the bank manager needs to exert some effort ex-ante in order to discover a risky investment opportunity. The bank can only generate positive NPV through investing in the risky investment, as the safe investment is always a zero NPV investment. Therefore the risky investment opportunity itself is desirable, despite the fact that the bank may choose an investment policy suboptimal to the regulator in the presence of a risky investment opportunity. In this scenario, the regulator needs to balance the incentives to control the bank risk-taking behavior ex-post and to motivate the bank manager exerting effort ex-ante.

To formally analyze the bank and the regulator’s problems in this case, I consider the following simple model. At \( t = -1 \), one period before the beginning of the timeline of events in Figure 1, the bank manager may spend some effort \( a \) to discover a risky investment opportunity. Assume that \( a \in [0, 1] \) and the cost of effort to the bank manager is \( g(a) = \frac{1}{2}a^2 \). The probability of a risky investment appears at \( t = 0 \) depends on the effort level, which I simply assume to be \( P(\text{Risk}) = a \). The risky investment is still indexed by \( \tilde{q}, \tilde{q} \sim U[0, 1] \), which is the probability of generating the high cash flow and privately known to the manager at \( t = 0 \). Now the bank manager will choose between the safe and risky investments as before if a risky investment appears at \( t = 0 \); otherwise, the bank manager can only invest in the safe investment.
When the bank manager's effort and investment choice are not contractible, he chooses the optimal level of ex-ante effort and ex-post investment decisions to maximize the bank's own utility under each accounting regime. Assuming the minimum capital requirement is exogenously set by the regulator, the bank's problem now becomes:

\[
\max_{a, q_j, K_j} a \Pi_j(q_j, K_j, k) - g(a)
\]

\[
s.t. \quad q_j, K_j \in \arg\max_{q, K} \Pi_j(q, K | k)
\]

The bank's subproblem under each accounting regime in choosing the optimal investment policy and the equity issuance at \( t = 0 \) is still the same as the problem without ex-ante effort. The optimal level of effort is then determined by the bank's payoff at the optimal decisions ex-post and the marginal cost of effort:

\[
a_j^*(k) = \frac{m}{2} \Pi_j(q_j^*(k), K_j^*(k))
\]

The regulator now needs to solve the welfare maximizing problem which requires taking into consideration both the bank's ex-ante and ex-post incentives under each accounting regime. Put aside the social cost of the minimum capital requirement, the optimal capital requirement that achieves the first best investment policy in the previous setting without ex-ante effort cannot remain as optimal for the regulator.
The regulator's problem now becomes:

\[
\max_{k,a_j,q_j} a_j V(q_j(k)) - g(a_j(k))
\]

\[
s.t. \quad a, q_j, K_j \in \arg \max_{a,q_j,K_j} a \Pi_j(q_j, K_j, k) - g(a)
\]

\[
q_j, K_j \in \arg \max_{q_j,K_j} \Pi_j(q, K|k)
\]  \quad (31)

In general the optimal capital requirement to the regulator's problem above will be lower than the level that induces the first best investment policy, since slightly lowering the capital requirement at this point has a positive marginal effect on the ex-ante effort while the marginal effect on the investment policy is zero. Under lower-of-cost-or-market accounting the bank's effort level is lower than the other two, however, the regulator may lower the capital requirement so that a comparison of the overall effect on the social welfare becomes ambiguous. Therefore I focus only on a special case which can generate some interesting results compared with no effort setting. Proposition 11 below characterizes this special case:

**Proposition 11** When the bank manager's short term interest is extremely high (\(\gamma \to 1\)), lower-of-cost-or-market accounting is the least preferred regime by the regulator; when the bank's cost of violating capital regulation is very high, historical cost accounting results the highest welfare; otherwise fair value accounting can result the highest welfare.
Proof. See Appendix. ■

Therefore Proposition 11 shows that it is possible that the regulator may prefer historical cost accounting or fair value accounting to other regimes under certain conditions. This is in contrast with the previous results with no ex-ante effort in that the regulator always prefers the most conservative accounting regime when the capital regulation bears social costs. If the ex-ante effort plays an important role in discovering the bank’s investment opportunity, the conservative accounting regime will discourage the ex-ante incentive too much so that regulator may find other accounting regimes more favorable.

3.5 Conclusion

This paper examines banks’ risk-taking incentives in the presence of minimum capital regulation under three different accounting regimes: historical cost accounting, lower-of-cost-or-market accounting and fair value accounting. Lower-of-cost-or-market accounting, which requires banks to recognize economic losses earlier when information becomes known to the market, is shown to be more effective than the other two regimes in controlling risk-taking behaviors by banks. Moreover, banks are more likely to hold buffer capital to avoid future costly violation of capital regulation when the accounting system incorporates more market-based information. Compared to lower-of-cost-or-market accounting, fair value accounting may be less effective in controlling the risk-taking, because recognizing positive news gives banks additional incentives to
be more aggressive ex-ante in risk-taking when bank managers also care about short
term earnings recognized in addition to the expected final payoff to shareholders.

When the regulator may adjust the minimum capital requirement optimally under
each accounting regime, the social welfare is the highest under lower-of-cost-or-market
accounting and the lowest under historical cost accounting if increasing the capital
requirement also increases the social cost. On the other hand, when the role of ex-
ante effort by the bank in discovering the investment opportunity is more important,
I show that the above preference order may reverse if the bank is sufficiently short
term oriented.

The results taken together provide policy implications for bank regulators and
accounting standard setting bodies. In terms of safe and sound banking, lower-of-
cost-or-market accounting provides better risk control than other accounting regimes.
Banks will be more cautious in making investment decisions being aware of potential
costs of violating capital regulation and negative market responses to earnings in
the future. While the results support for incorporating market information into the
accounting system, they also suggest that moving toward a full fair value accounting
should be carefully considered by policymakers.

Another relevant concern for standard setters is the recognition versus disclosure
of fair value. The model in this paper can provide indirect implications about this
concern from the following two aspects. First, for the effective capital regulation,
recognition of economic losses are essential to get an accurate measure of the capital;
disclosure of fair value itself can not bring into regulator’s attention about the declining economic value of banks’ capital. Second, the manager’s short term interest in earnings likely depends on the market’s reaction to accounting information. Given that the degree of market reaction is larger for recognized earnings than for disclosed numbers, the recognition of upside gains may induce more risk-taking by banks than pure disclosure; however the recognition of downside losses can better discipline the risk-taking as shown in the model. Therefore, this paper suggests that lower-of-cost-or-market accounting with disclosure of full fair value is a better combination for the accounting framework in banks.
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Appendix

Appendix A: Proof

Proof. Proposition 2

i). If $q_l D > K$, the zero profitability constraint of creditor’s payoff in (4) becomes:

$$P(S_H) q_h D_2 + P(S_L) q_l D_2 - I = 0$$

Substitute $P(S_H)$, $P(S_L)$, $q_l$ and $q_h$ into the equation, we can get:

$$[\theta p_g + (1 - \theta) p_b] D_2 - I = 0 \Rightarrow D_2 = \frac{I}{\theta p_g + (1 - \theta) p_b}$$

Next substitute the equilibrium face value of debt into the condition $q_l D > K$, we can get $K < K^*$, where $K^* = \frac{q_l I}{\theta p_g + (1 - \theta) p_b}$

ii). If $q_l D > K$, the zero profitability constraint of creditor’s payoff in (4) becomes:

$$P(S_H) q_h D + P(S_L) K - I = 0$$
Substitute $P(S_H)$, $P(S_L)$, $q_l$ and $q_h$ into the equation, we can get:

$$(\lambda \theta + \delta) \cdot \left[p_g \frac{\theta(\lambda + \delta)}{\lambda \theta + \delta} + p_b \frac{(1 - \theta)\delta}{\lambda \theta + \delta}\right]D + (1 - \lambda \theta - \delta)K - I = 0$$

$$\Rightarrow \lambda \theta p_g + \delta[p_g + (1 - \theta)p_b]D + (1 - \lambda \theta - \delta)K - I = 0$$

$$\Rightarrow D_2 = \frac{I - (1 - \lambda \theta - \delta)K}{\lambda \theta p_g + \delta[p_g + (1 - \theta)p_b]}$$

Substitute $D_2$ into the condition $q_lD > K$, we can get $K > K^*$, where $K^*$ is the same as in (i).

Now examine the properties of $K^*$. Take the partial derivative of $q_l$ with respect to $\lambda$ and $\delta$ separately:

$$\frac{\partial q_l}{\partial \lambda} = \frac{\theta(1 - \theta)(1 - \delta)(p_b - p_g)}{(1 - \lambda \theta - \delta)^2} < 0$$

$$\frac{\partial q_l}{\partial \delta} = \frac{\lambda \theta(1 - \theta)(p_b - p_g)}{(1 - \lambda \theta - \delta)^2} < 0$$

Therefore $\partial K^*/\partial \lambda < 0$ and $\partial K^*/\partial \delta < 0$. ■

**Proof. Proposition 3** Without the effective accounting based-covenant, $\partial E_2/\partial \lambda = 0$ and $\partial E_2/\partial \delta = 0$. With the accounting-based debt covenant, from equation (5), the entrepreneur's expected payoff can be written as:

$$E_2 = \lambda \theta p_g X + (1 - \lambda \theta)K + \delta[p_g + (1 - \theta)p_b]X - K$$
Take the partial derivative of $E_2$ with respect to $\lambda$ and $\delta$ respectively, we get:

$$\frac{\partial E_2}{\partial \lambda} = \theta(p_gX - K)$$

$$\frac{\partial E_2}{\partial \delta} = [\theta p_g + (1 - \theta)p_b]X - K$$

Given the assumption $p_gX - K > 0$ and $[\theta p_g + (1 - \theta)p_b]X - K > 0$, we have $\partial E_2/\partial \lambda > 0$ and $\partial E_2/\partial \delta > 0$.

**Proof. Corollary 2**

From proposition 2, take the partial derivative of $D_2$ with respect to $\delta$ if $K > K^*$, we get:

$$\frac{\partial D_2}{\partial \delta} = \frac{K[\lambda\theta p_g + (1 - \lambda\theta)[\theta p_g + (1 - \theta)p_b]] - I[\theta p_g + (1 - \theta)p_b]}{\{\lambda\theta p_g + \delta[\theta p_g + (1 - \theta)p_b]\}^2}$$

Therefore $\partial D_2/\partial \delta > 0$ iff

$$K > K^c = \frac{I[\theta p_g + (1 - \theta)p_b]}{\lambda\theta p_g + (1 - \lambda\theta)[\theta p_g + (1 - \theta)p_b]}$$

Next check whether $K^c$ is greater or less than $K^*$. Since $\partial K^*/\partial \delta < 0$, we only compare $K^c$ with $K^*_{\delta=0}$:

$$K^c - K^*_{\delta=0} = \frac{\lambda^2\theta^2 p_g(1 - \theta)(p_g - p_b)}{(1 - \lambda\theta)[\theta p_g + (1 - \theta)p_b][\theta p_g + (1 - \theta)p_b + \lambda\theta(1 - \theta)(p_g - p_b)]} > 0$$
\[ K^*_\delta = \frac{[\theta p_g + (1 - \theta)p_b] - \lambda \theta p_g}{(1 - \lambda \theta)[\theta p_g + (1 - \theta)p_b]} \]

Therefore for \( K > K^c \), we have \( \partial D_2 / \partial \delta > 0 \); and for \( K^* < K < K^c \), we have \( \partial D_2 / \partial \delta < 0 \)

\[ \textbf{Proof. Corollary 3} \]

Take the partial derivative of \( D_3 \) with respect to \( \delta \) as in equation (7):

\[ \frac{\partial D_3}{\partial \delta} = \frac{[\theta p_g + (1 - \theta)p_b][\theta p_g X + (1 - \theta)K - I] + \lambda \theta p_g (1 - \theta)(K - p_b X)}{\{\lambda \theta p_g + \delta[\theta p_g + (1 - \theta)p_b]\}^2} \]

Since \( \theta p_g X + (1 - \theta)K - I > 0 \) and \( K - p_b X > 0 \), we have \( \partial D_3 / \partial \delta > 0 \)

\[ \textbf{Proof. Proposition 6} \]

When \( K < K^* \), the renegotiation occurs only in state \((G, S_L)\) and not in \((B, S_H)\).

The expected payoffs to both parties are summarized in the table below.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{True Type} & \textbf{Signals} & \textbf{\( S_H \)} & \textbf{\( S_L \)} \\
\hline
Good Type & No renegotiation \([p_g(X - D), p_gD - I]\) & Renegotiation \([0, p_gX - c - I]\) & \\
\hline
Bad Type & No renegotiation \([p_b(X - D), p_bD - I]\) & No renegotiation \([0, K - I]\) & \\
\hline
\end{tabular}
\caption{Expected payoffs with costly renegotiation (Case III)}
\end{table}
The face value of debt can be solved by the zero profit constraint:

\[ D^{IIIa}_4 = \frac{I - (1 - \theta) (1 - \delta) K - \theta (1 - \lambda - \delta) (p_g X - c)}{\lambda \theta p_g + \delta [\theta p_g + (1 - \theta) p_b]} \]

The entrepreneur's payoff is therefore:

\[ E^{IIIa}_4 = \theta p_g X + (1 - \theta) K - \theta (1 - \lambda - \delta) c - \delta (1 - \theta) (K - p_b X) \]

Take the partial derivative of \( E^{IIIa}_4 \) with respect to \( \delta \):

\[ \frac{\partial E^{IIIa}_4}{\partial \delta} = \theta c - (1 - \theta) (K - p_b X) \]

\[ \Rightarrow \frac{\partial E^{IIIa}_4}{\partial \delta} < 0 \text{ iff } \theta < \frac{1}{1 + \frac{c}{K - p_b X}} \tag{32} \]

When \( K > K^* \), the renegotiation occurs only in state \((B, S_H)\) and not in \((G, S_L)\).

Similarly the entrepreneur's expected payoff will be:

\[ E^{IIIb}_4 = \theta p_g X + (1 - \theta) K - \theta (1 - \lambda - \delta) (p_g X - K) - \delta (1 - \theta) c \tag{33} \]

Take the partial derivative of \( E^{IIIb}_4 \) with respect to \( \delta \):

\[ \frac{\partial E^{IIIb}_4}{\partial \delta} = \theta (p_g X - K) - (1 - \theta) c \]
Combine (11) and (13) we have Proposition 6.

\[ \Rightarrow \frac{\partial E_4^{III}}{\partial \delta} < 0 \text{ iff } \theta < \frac{1}{1 + \frac{\ln X - K}{c}} \]  

Proof. Lemma 2 Compare the minimum capital investment policy under historical cost accounting and lower-of-cost-or-market accounting:

\[ \hat{q}_h = \frac{\hat{K}}{H - I + \hat{K}} \]

\[ \hat{q}_l = \frac{(1 - \gamma)\hat{K} + \gamma \beta (I - L) - \frac{\partial P(B)}{\partial q} C(\gamma + \beta) + P(B)C'(\gamma + \beta)^2}{H - I + (1 - \gamma)\hat{K} - \gamma \alpha (H - I) + \gamma \beta (I - L)} \]

Let \( a = \frac{(1 - \gamma)\hat{K} + \gamma \beta (I - L)}{H - I + (1 - \gamma)\hat{K} - \gamma \alpha (H - I) + \gamma \beta (I - L)} \) and \( b = \frac{\hat{K}}{H - I + \hat{K}} \)

Then using assumption in (7), it can be shown that:

\[ a - b = \frac{\gamma (H - I) [\beta (I - L) - (1 - \alpha)\hat{K}]}{[H - I + (1 - \gamma)\hat{K} - \gamma \alpha (H - I) + \gamma \beta (I - L)] \cdot [H - I + \hat{K}]} \]

\[ \gamma (H - I) \beta (I - L) [1 - \frac{\hat{K}}{H + I - 2L}] \]

\[ \frac{\gamma (H - I) \beta (I - L) [H - L + D - L]}{[H - I + (1 - \gamma)\hat{K} - \gamma \alpha (H - I) + \gamma \beta (I - L)] \cdot [H - I + \hat{K}]} \]

\[ \gamma (H - I) \beta (I - L) \cdot \frac{H - L + D - L}{H + I - 2L} \]

\[ > 0 \quad (\text{risky debt is issued, } D > L) \]
In addition, for any \( q \), the following conditions hold:

\[
\frac{\partial P(B)}{\partial q} = -[q(1 - \alpha) + (1 - q)\beta] < 0
\]

\[
\frac{\partial e^B}{\partial q} = \frac{2\beta(1 - \alpha)(H - L)}{[(1 + q)(1 - \alpha) + (1 - q)\alpha]^2} > 0
\] (36)

Hence combine (22) and (23), we have \( \hat{q}_h < \hat{q}_l \)

\[ \blacksquare \]

**Proof. Proposition 8**

To solve the objective function in (9) subject to the capital requirement constraint, first look at the case when \( u = 0 \), i.e., \( K \geq kD - e^B \). Since \( e^B < 0 \), \( K \geq kD \) is automatically satisfied. Now the objective function becomes:

\[ \Pi_l(q, K) = \gamma P(B)e^B + (1 - \gamma)[qK + \frac{1-q^2}{2}(H - I + K) - K] \]

Take the first order derivative with respect to \( K \), we get:

\[ \frac{\partial}{\partial K}\Pi_l(q, K) = -(1 - \gamma)\frac{(1 - q)^2}{2} < 0 \]

Hence it is never optimal to issue equity more than \( kD - e^B \).

Now we examine the case when the equity issuance level is less than \( kD - e^B \):

If \( K < kD - e^B \), \( u = kD - K - e^B > 0 \), the objective function becomes:
\[ \Pi_i(q, K) = \gamma P(B)e^B + (1 - \gamma)[qK + \frac{1-q^2}{2}(H - I + K) - K] - P(B)C(kD - K - e^B) \]

Take the first order derivative of the above function with respect to \( K \) and \( q \), we get:

\[
\frac{\partial}{\partial K} \Pi_i(q, K) = -(1 - \gamma) \frac{(1-q)^2}{2} + P(B)C'(u)
\]

\[
\frac{\partial}{\partial q} \Pi_i(q, K) = \gamma[\beta(1-q)(H-I) - q(1-\alpha)(H-I)] + (1 - \gamma)[K - q(H-I + K)]
- \frac{\partial P(B)}{\partial q} C(u) + P(B)C'(u) \frac{\partial e^B}{\partial q}
\]

The second order derivatives and cross partial derivative with respect to \( K \) and \( q \) are given by:

\[
\frac{\partial^2}{\partial K^2} \Pi_i(q, K) = -P(B)C''(kD - K - e^B) < 0
\]

\[
\frac{\partial^2}{\partial q^2} \Pi_i(q, K) = \gamma[(1-\alpha)(H-I) - \beta(I-L)] - (1 - \gamma)(H-I + K)
\begin{align*}
&\text{By assumption (7)}
&\frac{\partial^2 P(B)}{\partial q^2} C(u) + 2 \frac{\partial P(B)}{\partial q} C'(u) \frac{\partial e^B}{\partial q} - P(B)C''(u) \left( \frac{\partial e^B}{\partial q} \right)^2
\end{align*}
\[
+ P(B)C'(u) \frac{\partial^2 e^B}{\partial q^2}
\]

\[
\Rightarrow \frac{\partial^2}{\partial q^2} \Pi_i(q, K) < 0
\]
Check whether the Hessian Matrix is positive definite, i.e.,

$$\frac{\partial^2 \Pi}{\partial K^2} \frac{\partial^2 \Pi}{\partial q^2} - \left( \frac{\partial^2 \Pi}{\partial K \partial q} \right)^2 > 0$$

It turns out that as long as the $C''$ is sufficiently large, the above condition always holds. Therefore the second order condition for maximizing $\Pi_I(q, K)$ without the second constrained is satisfied.

Now define the solution that satisfies the first order condition as $\hat{K}_{fcm}$ and $\hat{q}_{fcm}$, which are given as follows:

$$\begin{align*}
\frac{\partial}{\partial q} \Pi_I(\hat{q}_I, \hat{K}_I) &= 0 \\
\frac{\partial}{\partial K} \Pi_I(\hat{q}_I, \hat{K}_I) &= 0
\end{align*}$$

Considering the capital requirement constraint that $K \geq kD$, let $\hat{K} = kD$. The following scenarios are considered:

- If $\frac{\partial}{\partial K} \Pi_I(\hat{q}_I, \hat{K}_I) \leq 0$, i.e., $P(B)C'(-e^B) \leq (1 - \gamma) \frac{(1 - \hat{q}_I)^2}{2}$, then the bank would want to further decrease the equity capital to the relaxed optimal $K$ which is below the capital requirement level, but couldn’t do so because of the capital requirement. Hence, given the capital requirement constraint the bank’s optimal equity level is $\hat{K}^*_l = \hat{K}$.

- If $\frac{\partial}{\partial K} \Pi_I(\hat{q}_I, \hat{K}_I) > 0$, i.e., $P(B)C'(-e^B) > (1 - \gamma) \frac{(1 - \hat{q}_I)^2}{2}$, then the bank could further increase the equity capital to the relaxed optimal level, which is
\[ K_i^* = \hat{K}_i. \]

Given the optimal level of the equity capital \( K_i^* \), the optimal investment policy \( q_i^* \) is always determined by the first order condition \( \frac{\partial}{\partial q} \Pi_i(q, K_i^*) = 0 \). Therefore, when \( K_i^* = \hat{K}_i \), it is the minimum capital investment policy \( q_i^* = \hat{q}_i \); when \( K_i^* = \hat{K}_i \), it is the relaxed optimal investment policy \( q_i^* = \hat{q}_i \).

**Proof. Corollary 5**

First we need to show that the investment policy under lower-of-cost-or-market accounting is always no more risky than the minimum capital investment policy, i.e, \( q_i^* \leq \hat{q}_i \).

Define the function \( \Gamma \) as:

\[
\Gamma = \frac{\partial}{\partial q} \Pi(q_i, \hat{K}_i) \]
\[
= \gamma[\beta(1 - \hat{q}_i)(I - L) - \hat{q}_i(1 - \alpha)(H - I)] + (1 - \gamma)[\hat{K}_i - \hat{q}_i(H - I + \hat{K}_i)]
\]
\[
- \frac{\partial P(B)}{\partial q_i} C(u) + P(B) C'(u) \frac{\partial e^B}{\partial q_i}
\]
\[
= -(1 - \gamma) \frac{(1 - \hat{q}_i)^2}{2} + P(B) C'(u(\hat{K}_i)) = 0
\]

Substitute \( P(B) C'(u) \) from (25) into the function of \( \Gamma \) in (24), we have:
\[ \Gamma = \gamma [\beta (1 - \hat{q}_i)(I - L) - \hat{q}_i (1 - \alpha)(H - I)] + (1 - \gamma)[\hat{K}_i - \hat{q}_i (H - I + \dot{K}_i)] \]

\[ -\frac{\partial P(B)}{\partial \hat{q}_i} C(u) + (1 - \gamma)\frac{(1 - \hat{q}_i)^2}{2} \frac{\partial e^B}{\partial \hat{q}_i} \]

(39)

Now take the partial derivative of \( \Gamma \) with respect to \( \dot{K}_i \), we have:

\[ \frac{\partial \Gamma}{\partial \dot{K}_i} = (1 - \gamma)(1 - \hat{q}_i) + \frac{\partial P(B)}{\partial \hat{q}_i} C'(u) \]  

(40)

Then substitute the function of \( C'(u) \) from (25) into (27), and also substitute \( P(B) \) and \( \frac{\partial P(B)}{\partial \hat{q}_i} \) into (27), we have the following result:

\[ \frac{\partial \Gamma}{\partial \dot{K}_i} = (1 - \gamma)(1 - \hat{q}_i) + \frac{\partial P(B)}{\partial \hat{q}_i} \frac{(1 - \hat{q}_i)^2}{2 P(B)} \]

\[ = (1 - \gamma)(1 - \hat{q}_i)\left[ 1 - \frac{\hat{q}_i(1 - \alpha) + (1 - \hat{q}_i)\beta}{(1 + \hat{q}_i)(1 - \alpha) + (1 - \hat{q}_i)\beta} \right] > 0 \]  

(41)

Then take the total derivative of the function \( \Gamma \) with respect to \( \dot{K}_i \), we have:

\[ \frac{\partial \Gamma}{\partial \dot{K}_i} + \frac{\partial \Gamma}{\partial \hat{q}_i} \frac{\partial \hat{q}_i}{\partial \dot{K}_i} = 0 \]

Given the second order condition in the proof of Proposition 2, we have \( \frac{\partial \Gamma}{\partial \hat{q}_i} < 0; \) and \( \frac{\partial \Gamma}{\partial \dot{K}_i} > 0 \) from (28), therefore we have:

\[ \frac{\partial \hat{q}_i}{\partial \dot{K}_i} > 0 \]  

(42)
Hence at the relaxed optimal solution, the higher equity capital always induces the less risky investment. Since $\hat{K}$ and $\hat{q}_i$ is also a set of solution that satisfies the FOC, thereby it is easy to see that $q_i^* \geq \hat{q}_i$ given $K_i^* > \hat{K}$.

Then combined with Lemma 2, which suggests that $\hat{q}_i > \hat{q}_h = q_h^*$, we can show that:

$$q_i^* > q_h^*$$

\[\boxed{}
\]

**Proof. Lemma 3**

Following a similar proof of Lemma 2, we can easily show that $\hat{q}_f > \hat{q}_h$. Now we need to compare $\hat{q}_f$ with $\hat{q}_i$. Compare the partial derivative of the objective function with respect to $q$ at $\hat{K}$:

$$\frac{\partial}{\partial q} \Pi_i(q, \hat{K}) = \gamma[\beta(1 - q)(I - L) - q(1 - \alpha)(H - I)] + (1 - \gamma)[\hat{K} - q(H - I + \hat{K})]$$

$$- \frac{\partial P(B)}{\partial q} C(u) + P(B)C'(u) \frac{\partial e^B}{\partial q}$$

$$\frac{\partial}{\partial q} \Pi_f(q, \hat{K}) = \gamma[(1 - q)(I - L) - q(H - I)] + (1 - \gamma)[\hat{K} - q(H - I + \hat{K})]$$

$$- \frac{\partial P(B)}{\partial q} C(u) + P(B)C'(u) \frac{\partial e^B}{\partial q}$$

The only difference in the partial derivative functions is the underlined part. Com-
pare these two underlined parts:

\[
[(1 - q)(L - L) - q(H - I)] - [\beta(1 - q)(L - L) - q(1 - \alpha)(H - I)]
\]

\[
= (I - L)(1 - q)(1 - \beta) - \alpha q(H - I)
\]

\[
< \frac{H - L}{H - I + K} [(I - L)(1 - \beta) - \alpha K]\quad \text{(since } \hat{q}_{l,f} > \frac{\hat{K}}{H - I + K}\text{ holds)}
\]

\[
< 0 \quad \text{(by the assumption in (7))}
\]

\[
\Rightarrow \frac{\partial \Pi_f}{\partial q} < \frac{\partial \Pi_l}{\partial q}, \quad \forall q
\]

Therefore the optimal solution must satisfy \(\hat{q}_f < \hat{q}_l\)

\[\blacksquare\]

**Proof. Corollary 6**

Following the proof of Lemma 3, we can also show that for any given equity capital \(K\), the optimal investment policy under fair value accounting is always more risky than under lower-of-cost-or-market accounting, i.e, \(q^*_f(K) > q^*_l(K)\)

If under both regimes, the bank issues the minimum capital capital, then \(q^*_f < q^*_l\) holds.

If under both regimes, the bank issues the capital in excess of the minimum requirement, we need to compare \(\hat{K}_l\) and \(\hat{K}_f\) and the corresponding optimal investment policies.
Now since \( \hat{q}_f \) and \( \hat{K}_f \) satisfy the FOC condition for \( K \), we have:

\[
\frac{\partial}{\partial \hat{K}_f} \Pi_f(\hat{q}_f, \hat{K}_f) = -(1 - \gamma) \frac{(1 - \hat{q}_f^2)}{2} + P(B)C'(u) = 0
\]

Under LCM, we also have the same form of FOC condition for \( K \):

\[
\frac{\partial}{\partial \hat{K}_l} \Pi_l(\hat{q}_l, \hat{K}_l) = -(1 - \gamma) \frac{(1 - \hat{q}_l^2)}{2} + P(B)C'(u) = 0
\]

From the proof in Corollary 1, we have the following condition for the FOC solution under fair value accounting:

\[
\frac{\partial^2}{\partial \hat{K}_f \partial \hat{q}_f} \Pi_f(\hat{q}_f, K) > 0
\]

In addition \( q_l^*(\hat{K}_f) > \hat{q}_f(\hat{K}_f) \) by (29), therefore \( \frac{\partial}{\partial \hat{K}_f} \Pi_f(q_l^*(\hat{K}_f), \hat{K}_f) > 0 \)

Given that FOC functions under FV and LCM have the same form:

\[
\frac{\partial}{\partial \hat{K}_l} \Pi_l(q_l^*(\hat{K}_f), \hat{K}_f) > 0 \Rightarrow \hat{K}_l > \hat{K}_f, \quad \hat{q}_l > \hat{q}_f
\]

The only question remains about the likelihood of issuing equity capital in excess of the minimum requirement under two regimes. Suppose under fair accounting, the minimum capital \( \hat{K} \) also satisfies the FOC, i.e,

\[
\Lambda_f(\hat{K}, \hat{q}_f) = -(1 - \gamma) \frac{(1 - \hat{q}_f^2)}{2} + P(B)C'(-e^B(\hat{q}_f)) = 0
\]  \hspace{1cm} (43)
From the proof of Proposition 2, we know that at the optimal solution, the cross partial derivative \( \frac{\partial^2 \Pi_f}{\partial q \partial K} > 0 \), therefore we can get:

\[
\Lambda_t(K, q_i) > 0, \quad \text{as} \quad q_i > q_f
\]

This means under lower-of-cost-or-market accounting, the optimal solution for the bank is to issue equity in excess of the minimum requirement. Therefore, the bank is more likely to issue buffer capital under lower-of-cost-or-market accounting than under fair value accounting.

\[ \ast \]

**Proof. Proposition 11**

To solve the problem in (31), substitute the bank’s solution to his own problem in (30) to get the optimal social welfare under each accounting regime for any exogenous \( k \):

\[
W_j(k) = \frac{m}{2} \Pi_j(q_j^*(k), K_j^*(k), k) [V(q_j^*(k)) - \frac{1}{2} \Pi_j(q_j^*(k), K_j^*(k), k)] \quad (44)
\]

The maximum welfare under each accounting regime is given by \( W_j(k_j^*) \), where \( k_j^* \) is the optimal capital requirement for the regulator. The first step is to prove that \( W_t(k_t^*) < W_h(k_t^*) \) and \( W_l(k_l^*) < W_f(k_l^*) \) when \( \gamma \to 1 \). For any given \( k \), we will show that \( W_t(k) < W_h(k) \). Then it is easy to conclude that \( W_t(k_l^*) < W_h(k_l^*) \leq W_h(k_h^*) \).
Under historical cost accounting, the welfare is:

\[ W_h(k) = \frac{m}{2} (1 - \gamma) \pi(q_h^*(k), K_h^*(k)) [V(q_h^*(k)) - \frac{1 - \gamma}{2} \pi(q_h^*(k), K_h^*(k))] \] (45)

Under lower-of-cost-or-market accounting, define \( \Delta_l = E[e_i] - E[C(u_i)] \), then the welfare function becomes:

\[ W_l(k) = \frac{m}{2} (1 - \gamma) \pi(q_l^*(k), K_l^*(k)) [V(q_l^*(k)) - \frac{1 - \gamma}{2} \pi(q_l^*(k), K_l^*(k))] - \frac{m}{2} \Delta_l [(1 - \gamma) \pi(q_l^*(k), K_l^*(k)) - V(q_l^*(k))] \] (46)

Define \( U(q, K) = \pi(q, K) [V(q) - \frac{1 - \gamma}{2} \pi(q, K)] \), and take derivative with respect to \( q \) and \( K \). It can be shown that for any \( q_h^* \leq q < q_{fb} \), the following holds when \( \gamma \to 1 \):

\[ \frac{\partial U(q, K)}{\partial K} \leq 0, \quad \frac{\partial U(q, K)}{\partial q} \leq 0 \]

Therefore since \( q_l^*(k) > q_h^*(k) \) and \( K_l^*(k) \geq K_h^*(k) \), we have

\[ U(q_l^*, K_l^*) < U(q_h^*, K_h^*) \] (47)

In addition, under lower of cost or market accounting, we have \( \Delta_l < 0 \). And for any \( q \), we can show that \( \pi(q, K) < V(q) \). Therefore in (46), we have \( \Delta_l [(1 - \gamma) \pi(q_l^*(k), K_l^*(k)) - V(q_l^*(k))] > 0 \). Combined with the result in (47), we have for any given \( k \),
To compare the welfare under fair value accounting and historical cost accounting, define \( \Delta_f = E[e_f] - E[C(u_f)] \), then the result depends on the sign of \( \Delta_f \). When the cost and marginal cost of violating regulatory constraint is sufficiently high, \( \Delta_f < 0 \); otherwise, \( \Delta_f > 0 \). In the former case, comparing fair value accounting to historical cost accounting is similar to the proof shown above for the lower-of-cost-or-market accounting, i.e., \( W_f(k^*_f) < W_h(k^*_h) \). In the later case, the result will be opposite, we can show that \( W_f(k) > W_h(k) \) following the same process. Therefore under these conditions, we have \( W_h(k^*_h) < W_f(k^*_f) \).

\[ W_f(k) < W_h(k) \quad (48) \]

Appendix B: Fairly priced deposit insurance

In the model, I assume that deposits are fully insured by the insurance agency and the insurance agency may demand an insurance premium from the bank for each dollar of deposit raised. Will the fairly priced (risk-sensitive) deposit insurance premium solve the problem of risk taking? In the analysis of the main body, the bank’s payment for the insurance premium is not included in the objective function. The following analysis explains why the bank’s optimal decisions are not altered by the existence of a fairly priced insurance system, even if the bank incorporates the insurance premium cost in the objective function.

In this appendix, I analyze the bank’s problem in Lemma 1 considering fairly
priced deposit insurance. Suppose that the insurance agency now prices the insurance
of deposits $D$ based on the expected default cost when the bank chooses its investment
policy of $q$. A fairly priced insurance premium is specified as follows:

$$ p(D, q) = \frac{(1 - q)^2}{2}(D - L) $$  \hspace{1cm} (49) $$

Ideally, if the bank internalizes the insurance cost in the objective function, the
bank faces the problem as stated below:

$$ \max_q \pi_h(q) = q(I - D) + \frac{1 - q^2}{2}(H - D) - p(D, q) - K $$

The investment policy that solves the above problem is $\frac{I - L}{H - L}$, which equals the
first best investment choice $q^{fb}$. However, since the bank’s investment riskiness is
not observable to the regulator, the regulator can not enforce or monitor the bank’s
investment decision once deposits are raised. If the bank issues deposits with the
insurance premium priced as $p(D, q^{fb})$, it will always have the incentive to deviate
from $q^{fb}$ so as to maximize the expected payoff in the following equation:

$$ \max_q \pi'_h(q) = q(I - D) + \frac{1 - q^2}{2}(H - D) - p(D, q^{fb}) - K $$

Then the optimal solution to the above problem is given by $q^* = \frac{I - D}{H - D}$, which
yields the same investment policy as in Lemma 1. Essentially the risk-shifting problem
of the bank in my model is driven by the incomplete contractable investment choice,
which can not be solved through the fairly pricing of insurance premium.

The insurance agency can, nonetheless, still set a fairly priced insurance premium based on the predicted bank’s optimal decisions under different accounting regimes. As specified below, the insurance premium depends on the capital structure and the anticipated investment policy of the bank:

\[ \pi(D, q^*_j) = \frac{(1 - q^*_j)^2}{2}(D - L), \quad \text{where } j \in \{h, l, f\} \]

(50)

With the fairly priced insurance premium, the bank’s shareholders actually pay the cost of the sub-optimal investment choice induced by the deposit financing. The bank’s investment riskiness can only be controlled through the effective capital regulation or other mechanisms not examined in this paper.