



# Market Transparency and the Accounting Regime

ALEXANDER BLECK\* AND XUEWEN LIU\*

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## ABSTRACT

We model the interaction of financial market transparency and different accounting regimes. This paper provides a theoretical rationale for the recently proposed shift in accounting standards from historic cost accounting to marking to market. The paper shows that marking to market can provide investors with an early warning mechanism while historical cost gives management a “veil” under which they can potentially mask a firm’s true economic performance. The model provides new explanations for several empirical findings and has some novel implications. We show that greater opacity in financial markets leads to more frequent and more severe crashes in asset prices (under a historic-cost-accounting regime). Moreover, our model indicates that historic cost accounting can make the financial market more rather than less volatile, which runs counter to conventional wisdom. The mechanism shown in the model also sheds light on the cause of many financial scandals in recent years.

## 1. Introduction

Market transparency is generally believed to be a key mechanism that reduces the information asymmetry among market participants thereby guaranteeing market efficiency. In fact, the opacity of markets was blamed for

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the cause of many recent scandals such as Enron, Worldcom, and Fannie Mae. In cases like these, investors and regulators often discover pertinent information too late to be able to take measures to prevent a potential crisis from happening. The *Sarbanes-Oxley Act* of 2002 may be seen as a direct response of regulators to such criticism. Moreover, as a central piece of the infrastructure of financial markets aimed at enhancing market transparency, accounting standards have become a key area of proposed reform over the last couple of years. One such proposal and central issue of the debate is the shift of the accounting regime from historic cost (HC) accounting to marking to market (MTM) with the objective of improving market transparency.

However, there are many voices against such a reform. The main reason for the objections focuses on the infeasibility of implementing the marking-to-market regime. That is, the so-called “fair value” is seldom available in reality. Ideally, if the true value of an asset or liability could be observed, we would use this as the accounting measure. Marking to market would then lead to first-best efficiency. In reality, however, market frictions prevent us from determining a fair value. Most markets are too illiquid to allow for timely and accurate valuation. The debate does not put into question whether marking to market *itself* is optimal. The issue is rather whether it is possible to implement such a regime. That is, the center of the debate is the *feasibility* of marking to market, not its *validity*. Plantin, Sapra, and Shin [2004, p. 2] (hereafter, PSS) write

[...] a rapid shift to a full mark-to-market regime may be detrimental [...]. This is not to deny that such a transition is a desirable long-run aim. In the long run, large mispricings in relatively illiquid secondary markets would likely trigger financial innovations in order to attract new classes of investors. This enlarged participation would in turn enhance liquidity, a situation in which our analysis shows that marking to market becomes more efficient.

The difficulty or infeasibility of *fully* implementing a marking-to-market scheme makes a mixed compromise unavoidable, whereby some items are recorded at historic cost while others are marked to market. The decision by the European Commission last November to endorse a mixed reporting scheme<sup>1</sup> is evidence of a similar thought process. The prerequisite for finding an *optimal* compromise, however, is to understand the advantages and disadvantages of different accounting regimes and their effects on market transparency. While understanding that the main difficulty of marking to market lies in its *infeasibility*, both academics and practitioners are not yet very clear about what the problems of historic cost accounting and the mechanisms are by which these problems are produced. The main motivation for this paper is to investigate these problems and their mechanisms.

In studying the accounting regimes and their economic implications, the first natural question to ask is what the difference between the accounting

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<sup>1</sup> “A Question of Measurement,” *The Economist*, October 23, 2004, p. 83.

regimes is and why the shift from one regime to another matters. In fact, although the proposal to shift the accounting regime to MTM is a recent one, various forms of MTM accounting have already been practiced for centuries, particularly in the form of the so-called lower-of-cost-or-market (LCM) rule.

However, the implementation of the conservative principle like LCM, which is a “rule” rather than a “law,” depends on several factors: industry, market, and country. First, LCM is seldom used in the financial industry, which has been a particular target of accounting regulation in recent years. Even in the manufacturing industry, the LCM rule is not applicable to long-term, illiquid assets. For other assets, LCM is not implemented with high frequency (e.g., only seasonally or annually). In the interim, it is still pure HC accounting that is used. Second, a liquid market is necessary for the implementation of LCM, a rare situation in reality. In fact, the lack of liquidity is the very source of difficulty of implementing MTM in the first place. Third, as Ball, Robin, and Sadka [2005] show, the conservative accounting practice varies across countries. In many countries, it is hard to strictly implement LCM. In order to highlight and study the difference between MTM and HC accounting, HC accounting in this paper is interpreted as HC accounting in the strict sense (i.e., without the LCM element).<sup>2</sup>

The main insight of this paper is that marking to market can provide investors with an early warning mechanism while historical cost gives the manager a “veil” to potentially mask the firm’s true performance. That is, historical cost accounting is equivalent to granting a free call option to the manager. If the firm’s performance is good (i.e., its market price is high), the manager can choose to sell, making the book value reflect the asset’s market price. On the contrary, if the asset’s market value is low, he can hold the asset and report a book value equal to the asset’s initial cost. Hence, however low the market value is, the manager has a “floor” in the book value—the project’s initial cost. At the same time, he can fully benefit from the project’s upside. This “convexity” in the book value is the typical feature of a call option. In practice, as accounting-value-based compensation, such as profit-based bonuses, is widely used, the manager has an incentive to maximize the accounting numbers. Hence he has an incentive to use his free option. We will essentially show that historic cost accounting will not only “incentivize” but also “enable” the manager to mask the firm’s true performance. The manager has an incentive because he would like to keep

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<sup>2</sup> In fact, even if we don’t interpret HC accounting as its pure form, HC accounting with LCM still differs from MTM; they have quite different economic consequences. HC accounting with LCM can only reveal a decrease and not an increase in the asset value (conservative principle). Specifically, a company (and its investors) may well consider a project that earns a low positive return a failure. The investors may want it liquidated and have the resources redeployed. However, under HC accounting with LCM, the investors cannot distinguish a low positive return from a very high positive return. Hence they cannot tell that the asset is earning a substandard return. With MTM accounting, they would be able to. In other words, even if LCM is applied stringently, it provides managers a veil in some cases whereas MTM never does.

a bad project “alive” in order to secure the convex payoff next period. He is also able to because he can hide the project’s poor performance by setting the book value equal to the asset’s initial cost.

Our main findings are two. First, our model implies a relationship between market transparency and asset price crashes under historic cost accounting. Myers and Jin [2004] document that countries where firms are more opaque to outside investors have a higher frequency of crashes in asset prices. Our model can provide an explanation for such evidence. The idea is as follows: In a more transparent market, the shareholder is able to distinguish good from bad projects and hence achieve a first-best outcome by liquidating poor projects. However, in more opaque financial markets, the shareholder may have to let a poor project continue as the manager can use historic cost accounting to pool good with bad projects. Failure of the shareholder to discriminate good from bad projects at an early stage allows bad projects to be kept alive and to potentially worsen in quality over time. The poor performance of these projects can thus accumulate and only eventually materialize at their final maturity, leading to a crash in the asset price. This theory also sheds light on the cause of many recent financial scandals and their link to the different accounting regimes. In fact, such a link has already been suggested by a recent report of the Bank of England (Michael [2004], p.120). As an example, the author cites the crisis of U.S. Savings and Loans, which

[...] stemmed in part from the fact that the (variable) interest rates on their deposit liabilities rose above the (fixed) rates earned on mortgage assets. The application of traditional accounting meant that this showed up initially only gradually through negative net interest income. While it eventually became clear that many S&Ls were insolvent, a fair value approach would have highlighted much earlier that, as a result of changes in interest rates, the true economic value of their fixed-rate mortgage assets was below that of their deposit obligations. Had fair value accounting been used, it is likely that the S&Ls’ difficulties would have been recognised and addressed earlier, and perhaps at lower fiscal cost.

Second, our model will help clarify the debate about the effect of different accounting regimes on asset price volatility. Opponents of a marking-to-market regime often claim that this accounting regime would lead to greater asset price fluctuations than would be the case under historic cost accounting. At first glance, this statement might seem consistent with intuition. But is this statement necessarily true? To the best of our knowledge, no theoretical model or empirical evidence has so far been presented that shows the impact of accounting regimes on asset price volatility. As our model shows, the claim that a historic cost accounting regime makes financial markets less volatile is not strictly true. Historic cost accounting indeed stabilizes asset prices in the short term. Under the veil of this apparent stability, volatility actually accumulates only to hit the market at a later date. Put differently, historic cost accounting not only transfers volatility across time but also increases asset price volatility overall. This result sits in stark contrast with the common opinion about historic cost accounting’s effect on volatility.

Moreover, the model can, to some extent, provide a new explanation for the “Black” effect (Black [1976]). Under the historic-cost-accounting regime, we show that a low book value is followed by high uncertainty and hence high volatility of the next-period return.

Despite the current hot debate and the practical importance of the issue of accounting reform, there is surprisingly little theoretical and empirical work done on the economic consequences of different accounting regimes for the financial market. The leading article on this topic is the PSS paper. The authors study the basic trade-off between historic cost accounting and marking to market. In their model, the main problem of marking to market comes from the illiquidity of the secondary market. In such a market, the asset price is endogenous and the true and fair value of the asset is hence unavailable. The paper mainly concentrates on the position of a financial institution. It sheds light on why the opposition of marking to market is led by the banking and insurance industries. While we agree with PSS on the main problem of marking to market being its infeasibility, our paper mainly concentrates on the modeling of the economic consequences of the historic-cost-accounting regime, particularly its effect on asset prices, its link to market crashes, and its interplay with market transparency. Other papers that study the effects of marking to market on financial institutions include Strausz [2004] and Freixas and Tsomocos [2004].

Myers and Jin [2004] is one of the few papers to model the relationship between market transparency and asset price crashes as well as stock price co-movement while providing evidence in support of their theory. In their paper, using different proxies for transparency, the authors find that countries where firms are more opaque to outside investors exhibit a higher frequency of crashes. In comparison with their model, our paper builds on quite different premises and provides a new theory that explains the existing empirical evidence. Moreover, besides making explicit the effect of market transparency on crashes, our paper models the relationship between the accounting regime and asset price crashes.

Bushman, Piotroski, and Smith [2004] examine the factors that determine corporate transparency at the country level. They find that financial transparency is lower in countries with a high share of state-owned enterprises. In addition, their findings show that corporate governance is more transparent in countries with higher levels of judicial efficiency and a common-law background as well as in countries where stock markets are more active and well developed.

Morck, Yeung, and Yu [2000] and Campbell et al. [2001] study the relationship between the characteristics of financial markets and stock price variation. They show that  $R^2$  and other measures of stock market synchronicity are higher in countries with relatively low per-capita gross domestic product (GDP) and less-developed financial markets. Bushee and Noe [2000] analyze the link between corporate disclosure and stock price volatility. Compared with this literature, our paper analyzes the effect of the accounting regime on asset price volatility.

## 2. The Model

### 2.1 THE FIRM

Consider a firm that is owned by one representative shareholder. The shareholder employs the manager to run the firm. The firm has only one exogenously given project (or asset). The project lasts two periods from  $T_0$  until  $T_2$  when it will be liquidated by the shareholder. The whole life of the project spans across the dates  $T_0, T_1, T_{2-}$  to  $T_2$ .  $T_{2-}$  slightly precedes  $T_2$ . We use  $T_{2-}$  to model our assumption that the manager is shorter lived than the firm.<sup>3</sup> The initial acquisition cost (or the market value at  $T_0$ ) of the project is normalized to unity. The project yields no intermediate cash flows over its life. However, the manager can choose to sell any proportion of the project at  $T_1$  and  $T_{2-}$ .<sup>4</sup> The selling price is the market value of the project at those dates. The market value at  $T_1$  for the whole project is equal to  $1 \cdot (1 + \tilde{g}_1)$ , where  $\tilde{g}_1$  denotes the project's growth rate over the first period. Similarly, the market value at  $T_2$  (or  $T_{2-}$ ) is given by  $1 \cdot (1 + \tilde{g}_1) \cdot (1 + \tilde{g}_2)$ , where  $\tilde{g}_2$  is the growth rate in the second period. Moreover, we assume that the growth rates  $\tilde{g}_1$  and  $\tilde{g}_2$  are positively autocorrelated. Specifically, the setup for  $\tilde{g}_1$  and  $\tilde{g}_2$  is  $\tilde{g}_1 = \tilde{\varepsilon}_1$  and  $\tilde{g}_2 = \rho \tilde{g}_1 + \tilde{\varepsilon}_2$ , where  $\tilde{\varepsilon}_1$  and  $\tilde{\varepsilon}_2$  are independent and both follow uniform distributions:  $\tilde{\varepsilon}_1 \sim Unif[-a, a]$  and  $\tilde{\varepsilon}_2 \sim Unif[-b, b]$  with  $a > 0, b > 0, \rho > 0$ .

Two remarks about the growth rates  $\tilde{g}_1$  and  $\tilde{g}_2$  deserve mention. First, they are private information. The project is firm specific. Its intrinsic worth, and hence its market value, is only known to the manager; it is hidden from the outsider or only available to him at a prohibitive cost. Secondly, we use the assumption of positive autocorrelation mainly to illustrate the feature that the firm's performance in the first period is a signal of its performance in the following period.<sup>5</sup>

### 2.2 THE AGENTS

There are two types of agents in our model: the shareholder and the manager. The first assumption about the manager is that he is shorter lived

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<sup>3</sup> At the same time, this timing setup highlights the fact that a longer-dated model is unsuitable for our purposes (we explain the last two points later on). This timing setup is thus the most tractable one.

<sup>4</sup> We assume this project is divisible. Take the example of a supermarket chain that operates outlets in different locations. Should the company decide to part with some or all of its branches, the latter could be sold off as a whole, in groups, or individually. An outsider would only be able to see the total transaction value but be unable to put a price on the individual branches. He would simply lack the expertise (firm-specific project) or find it uneconomical to do so (high cost).

<sup>5</sup> The assumption of positive autocorrelation can also be justified by empirical evidence (e.g., GDP growth, as an aggregate performance measure of numerous small projects, over the business cycle) and on theoretical grounds (e.g., stage financing in the venture capital industry as an optimal contract due to sequential information revelation).

than the project. Upon receiving his compensation at  $T_{2-}$ , he resigns and leaves the firm while the project remains alive until  $T_2$ . We believe the manager's shorter life relative to that of the project is a fundamental reason for the inefficiency caused by historic cost accounting. Since the project is liquidated at the later date  $T_2$ , its market value is unobservable to the outsider (including the shareholder) when the manager leaves the firm at  $T_{2-}$ . Hence market-value-based compensation is not available to incentivize the manager to maximize firm value (the shareholder's objective). Conversely, suppose the manager was longer lived than the project. Then the shareholder would be able to offer a compensation scheme linking the project's liquidation value to the manager's pay. In this case, first-best efficiency can be achieved.<sup>6</sup> Second, we assume that the manager is risk averse with utility displaying constant absolute risk aversion defined over wealth at time  $T_2$  given by  $U(\tilde{W}) = 1 - e^{-k \cdot \tilde{W}}$ , where  $k$  denotes the coefficient of risk aversion. The shareholder is assumed to be risk neutral for simplicity.

*2.2.1. The Information Structure.* The agency problem in this model arises from the information asymmetry between the shareholder and the manager. The manager as the insider knows the intrinsic value<sup>7</sup> of the project at any point in time even if the project is not brought to the market to be sold. However, the shareholder as the outsider knows the intrinsic value of the project only when it is liquidated in the market at  $T_2$ . Prior to liquidation, the shareholder must rely on the firm's book value from the manager's accounting report, which depends on the particular accounting regime used, to infer the firm's market value. Under historic cost accounting, the firm's book value contains two parts. The portion of the project the manager chooses to sell is transferred to cash and therefore shown at its market price. The remaining part of the project that the manager chooses to hold is recorded at its initial cost. However, under marking to market, the book value of the firm is the market price of the whole project. If there exists a deep and liquid secondary market for the project, as we assume, its market price is exogenous (i.e., the firm is a price-taker unlike in the setup of the PSS model). In this case, first-best efficiency can be achieved under the marking-to-market regime since the book value is just equal to the market value of the firm. There is no information asymmetry between the manager and the shareholder.

*2.2.2. The Compensation Structure.* The objective function of the shareholder is to maximize the final liquidation value of the project at  $T_2$ . As for the manager's compensation structure, we consider different schemes. At this stage, we assume that the manager's objective is to maximize the book

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<sup>6</sup> The shorter lifetime of the manager is also one of the reasons for the inefficiency of historic cost accounting in Plantin, Sapra, and Shin [2004].

<sup>7</sup> The intrinsic value is the value realized if the project is liquidated in the market.

value at  $T_{2-}$ . We show later on that this objective is equivalent to the manager being given accounting-number-based compensation—a base salary plus a profit bonus (the profit at  $T_{2-}$  is the book value at  $T_{2-}$  less the book value at  $T_0$  (the initial cost of the asset)).<sup>8</sup> We believe the assumption of accounting-number-based compensation, particularly profit-based compensation, to be quite reasonable.<sup>9</sup> In fact, such compensation structures are widely used in practice, particularly in firms outside the United States. This is partly due to market inefficiency and illiquidity of some stock markets. Equity-based compensation may therefore cause even greater inefficiency not only in these countries. Even in the United States, where equity-based compensation is common, we still have good reason to believe that the stock price is significantly affected by accounting information. The assumption that the manager tries to maximize the accounting value does therefore not appear extreme.<sup>10</sup> Besides the monetary compensation, we assume that the manager derives some private benefit from running the project. Hence he prefers to continue operating over liquidating the project, all else equal. This assumption is the same in spirit as in Jensen [1986]. The manager prefers to have more and bigger projects despite their being value destroying (negative net present value).

*2.2.3. The Agents' Actions.* In this model, the manager's action is to choose  $\alpha$  ( $\in [0, 1]$ ), the proportion of the project he decides to sell at  $T_1$  and  $T_{2-}$ . At  $T_1$ , conditional on the specific  $\alpha$  the manager chooses, the book value of the project is equal to  $BV_1 = \alpha \cdot (1 + g_1) + (1 - \alpha) \cdot 1 = 1 + \alpha \cdot g_1$ , where  $g_1$  is the realized growth rate of the project in the first period. The first term  $\alpha(1 + g_1)$  is the book value of the part of the project that the manager chooses to sell, which equals its market price. The second term  $(1 - \alpha)$  is the book value of the remaining part of the project the manager chooses to hold, which is recorded at its initial cost. Based on the book value  $BV_1$ , the shareholder makes the decision to either continue with or liquidate the *whole* project by trying to infer the fundamentals  $g_1$ . That is, the shareholder's action is *action*<sup>S</sup>, where *action*<sup>S</sup>  $\in \{\text{liquidate}, \text{continue}\}$ . Suppose the shareholder decides to continue with the project at  $T_1$ . Then the manager has another round of trading at  $T_{2-}$  just before leaving. Again, he can choose to sell any proportion of the remaining project at that date. The reason that we limit the shareholder's action to liquidating or continuing is because the manager's action is unverifiable and hence noncontractable. That is, the shareholder cannot force the manager to hold or sell a certain amount of the project. He can only passively choose to continue or liquidate the whole project.

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<sup>8</sup> In the extension part of this paper, we consider share-price-based compensation.

<sup>9</sup> However, if the shareholder decides to liquidate the whole project at  $T_1$ , we assume that the manager is paid based on the profit at  $T_1$ , which equals the liquidation value less the initial cost.

<sup>10</sup> The PSS paper also assumes that the agent's aim is to maximize the accounting value.

It is important to emphasize that the outsider can only observe the *total* book value  $1 + \alpha \cdot g_1$ . He cannot observe its two components separately: the sold part  $\alpha \cdot (1 + g_1)$  and the unsold part  $\alpha \cdot g_1$ . In fact, no outsider, including the shareholder, can discern the project's growth rate  $g_1$  by telling apart the cash  $\alpha(1 + g_1)$  from the noncash item  $(1 - \alpha)$ . We use this setup to capture the fundamental difference between historic cost accounting and marking to market, namely that the shareholder cannot perfectly infer the market value from the book value.<sup>11</sup> Otherwise, there would be no difference between historic cost accounting and marking to market and the choice of which accounting regime is employed becomes irrelevant. If this is the case, there is no need to debate the accounting regime reform.<sup>12</sup>

2.3 THE TIMELINE OF EVENTS

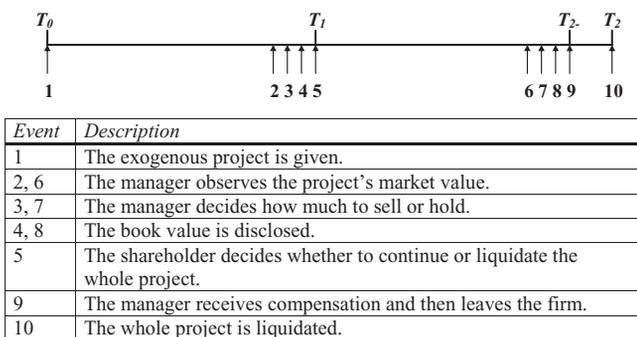


FIG. 1.—Timeline.

2.4 THE DECISION RULES

Our analysis mainly concentrates on the agents' decisions at time  $T_1$ . Figure 2 describes the agents' decision rules at date  $T_1$ . Figure 2 also summarizes all the key information of the setup outlined so far.

<sup>11</sup> It is worth noting that even if these two items could be disentangled on the balance sheet, this can only occur when  $\alpha \neq 0$ . Therefore, if the manager's strategy in the equilibrium is to choose  $a = 0$  for a very low  $g_1$ , then shareholders cannot infer  $g_1$  even under the assumption that the balance sheet reports cash separately.

<sup>12</sup> In our context, the unobservability of the project's market value for the shareholder is due to its firm-specific nature and the heterogeneity of its parts. Take the example of the supermarket chain. In the case of a sale of a number of outlets that are regionally dispersed, for instance, the unit sale values are not known to the outsider, only the total sale value is. Although the outlets are likely to be identically equipped, the location factor is likely to drive a wedge between their individual sale values. Knowing or determining these values is not realistically possible for the outsider or only at a prohibitive cost. The inseparability of the proportion of the project sold and its growth rate, and thus the unobservability of the project's market value, is the crucial difference between historic cost accounting and marking to market. If the outsider could observe the growth rate and the proportion of the project sold individually, historic cost accounting would be just as informative as marking to market, making them identical.

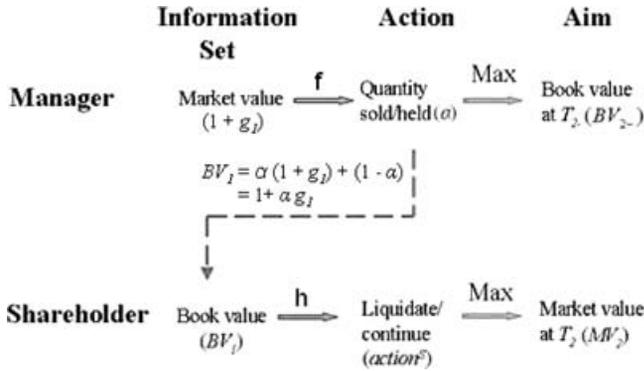


FIG. 2.—The agents’ decision rules at time  $T_1$ . The manager observes the market value of the project. Based on this information, he decides how much to sell/hold to maximize his payoff linked to the book value at time  $T_2$ . However, when making his decision, the manager also needs to take the shareholder’s possible response to his action into account. If the manager’s action (forming a book value) results in the shareholder’s decision to liquidate the whole project, the manager is no longer able to go ahead with the project and hence cannot maximize his payoff based on the book value at time  $T_2$ . He is then remunerated based on the liquidation value at time  $T_1$ . The shareholder uses the book value, which is a function of the fundamentals  $r_1$  as well as the manager’s action, as an (imperfect) signal to infer the firm’s true performance  $r_1$ . Hence he makes the decision whether to continue or liquidate the whole project. His aim is to maximize the market value of the project at time  $T_2$ .

### 2.5 THE FINANCIAL MARKET

In our model, different financial markets are characterized by different degrees of transparency. To each financial market corresponds an “uninformed window” as shown in figure 3. The more transparent the financial market is, the smaller the “uninformed window.” In our setup, where the project’s return is uniformly distributed over the interval  $[-a, a]$ , we define the uninformed window as the subset  $[-a', a']$  ( $0 < a' < a$ ). We assume that the outsider can perfectly observe the true value of states in the case of extreme return realizations (very high or very low) that fall outside the uninformed window. However, the shareholder cannot distinguish any given ex post return sampled inside the uninformed window from other returns in the uninformed window. The shareholder thus has to rely on the manager’s accounting report for more information. The idea of defining an uninformed window can be described as follows. In every financial market, we can classify two kinds of communication channels between shareholders and management: accounting and nonaccounting reports. The nonaccounting channel is more powerful in transparent markets than in opaque ones. In fact, in more transparent financial markets like the United States, there is a greater analyst and media coverage through such institutions as investment banks and rating agencies for instance. All these nonaccounting channels make the shareholder less dependent on the manager’s accounting report. Hence, the uninformed window, within which the shareholder has to rely

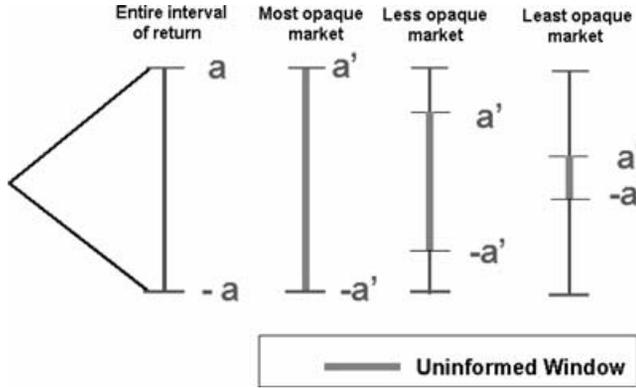


FIG. 3.—The financial market with different degrees of transparency. For the same project whose return is uniformly distributed in the interval  $[-a, a]$ , the less opaque financial market has a shorter uninformed window  $[-a', a']$ , within which the shareholder has to rely on the accounting statement (the book value). Outside the uninformed window, the shareholder knows the true state.

on the manager’s accounting report, is shorter.<sup>13</sup> We also use figure 3 to illustrate the setup of the financial market. Without loss of generality, we normalize the risk-free interest rate in the economy to zero.

### 3. The Equilibrium

As figure 2 shows, the agents’ actions are not independent but there indeed exists a strategic dimension to their decision-making process. In fact, the interplay of their actions constitutes a sequential game between the shareholder and the manager. Solving for the equilibrium of the game is equivalent to finding the equilibrium strategy profile of the agents  $(f, h)$ . We formalize the agents’ strategies in definition 1.

**DEFINITION 1 (Strategies).** *The manager’s strategy at time  $T_1$  is the function  $f$ , which is a map from the first period’s return  $g_1$  to the proportion of the asset he chooses to sell  $\alpha$ , that is,  $\alpha = f(g_1)$ . The shareholder’s strategy is given by the function  $h$ , which maps the book value at time  $T_1$  to the set  $\{\text{liquidate, continue}\}$ . That is,  $\text{action}^S = h(BV_1)$ , where  $\text{action}^S \in \{\text{liquidate, continue}\}$ .*

It is important to note that the equilibrium does not only depend on the accounting scheme but also on the degree of transparency of the financial market. The degree of transparency determines the length of the

<sup>13</sup> Further, as the referee pointed out, we can also interpret the opaqueness measure  $a'$  as an LCM hurdle under the historic cost accounting regime in reality.

uninformed window, which in turn determines the manager’s capability to mask the firm’s true performance. Recall that the shareholder is perfectly informed, that is, his action does not depend on the disclosure of accounting information, when the economic fundamentals are recorded outside the uninformed window. Theorem 2 states the first type of equilibrium—a pooling equilibrium, which occurs in sufficiently opaque financial markets where the uninformed window is large. The proof of the theorem is provided later on.

**THEOREM 2 (Pooling Equilibrium).** *When  $a' > a^*$  ( $b, \rho, k$ ), the strategy profile  $s = (f, h)$  at time  $T_1$  constitutes a Nash equilibrium, where  $f$  and  $h$  satisfy*

$$f(g_1) = \begin{cases} \arg \operatorname{Max}_{\alpha \in [0,1]} E(U(\max(1 + \alpha g_1, \alpha(1 + g_1) & \text{when } g_1 \geq 0 \\ + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2))) & \\ 0 & \text{when } g_1 < 0 \end{cases}$$

and

$$h(BV_1) = \begin{cases} \text{continue when } BV_1 \geq 1 \\ \text{liquidate when } BV_1 < 1 \end{cases}.$$

In this equilibrium, the manager sells nothing (i.e.,  $f(g_1) = 0$ ) if and only if  $g_1$  falls in two extreme intervals, this is  $g_1 \in [-a', \underline{a}] \cup [\bar{a}, a']$ . In the middle interval  $[\underline{a}, \bar{a}]$ , the manager partially liquidates the project, where  $a^* = [\frac{3}{4}(\bar{a}^2 - \underline{a}^2) + \frac{1}{2}(\bar{a}^3 - \underline{a}^3)]^{\frac{1}{3}}$ ,  $\bar{a}$  solves  $\{e^{-k(1+\bar{a})(1+\rho\bar{a}+b)} \cdot [1 + k(1+\bar{a})(\bar{a}\rho + b)] - e^{-k(1+\bar{a})(1+\rho\bar{a}-b)} \cdot [1 + k(1+\bar{a})(\bar{a}\rho - b)]\} \times \frac{1}{2bk(1+\bar{a})} = 0$  and  $\underline{a}$  satisfies  $-k\underline{a}e^{-k\rho\underline{a}^2 + (1+\rho)\underline{a}-b(1+\underline{a})} + \frac{1}{2b(1+\underline{a})}[e^{-k(1+\underline{a})(1+\rho\underline{a}+b)} - e^{-k + k(1+\underline{a})(\rho\underline{a} + b)} \cdot e^{-k(1+\underline{a})(1+\rho\underline{a}+b)} + k\underline{a} \cdot e^{-k}] = 0$ .

It is worth noting that the pooling equilibrium here is to be interpreted in the sense that the shareholder always continues the project, as opposed to the result in theorem 3 below where the firm is efficiently liquidated when  $g_1 < 0$ . The basic idea of the pooling equilibrium can be explained as follows. When the project’s return in the first period  $g_1$  is non-negative, the manager does not need to worry that the shareholder will liquidate the project. The manager can maximize his own expected utility without giving any consideration to the shareholder’s interference. However, when the project’s return  $g_1$  is negative, the manager knows that the shareholder will definitely liquidate the whole project if the manager sells only a tiny fraction. It is thus optimal for the manager to set  $\alpha = 0$ . This is the manager’s strategy. As for the shareholder, if he observes a book value strictly higher (lower) than unity, he can perfectly infer the project’s return being positive (negative). Hence his dominant strategy is to continue (liquidate). Observing a book value of unity, he knows the project could be either

very good or very bad. But if the uninformed window is sufficiently large (i.e.,  $a' > a^*(b, \rho, k)$ ), as we assume in theorem 2, the gain of continuing potentially good projects dominates the loss of not liquidating bad projects. The shareholder's optimal strategy is then to continue resulting in bad and good projects being pooled. In summary, the shareholder continues the whole project if the book value is not less than unity. Otherwise he liquidates the project.

Before proceeding to the proof of theorem 2, we use some diagrams created via numerical simulations of the agents' optimal strategies to help us understand the intuition behind the equilibrium. First, consider the manager's strategy. In figure 4, the bottom diagram represents the manager's strategy, the optimal sale  $\alpha$  as a function of the fundamentals  $g_1$ . This is a nonmonotonic function. The manager sets  $\alpha = 0$  (i.e., holds everything) when  $g_1$  is very low or very high, selling partially when  $g_1$  is fairly high. It is worth noting that the optimal  $\alpha$  is the result of two different considerations by the manager. When  $g_1 \geq 0$ ,  $\alpha$  is the solution to the manager's utility maximization problem. In this case, he needs not be concerned with the shareholder's liquidating the firm, as we show later. When  $g_1 < 0$ , the manager's decision to sell nothing is given by his strategic consideration. The reason for his action is that he must otherwise fear the firm's forced liquidation by the shareholder, which would thwart the manager's chance of upside compensation at time  $T_2$ . Following the manager's action (i.e.,

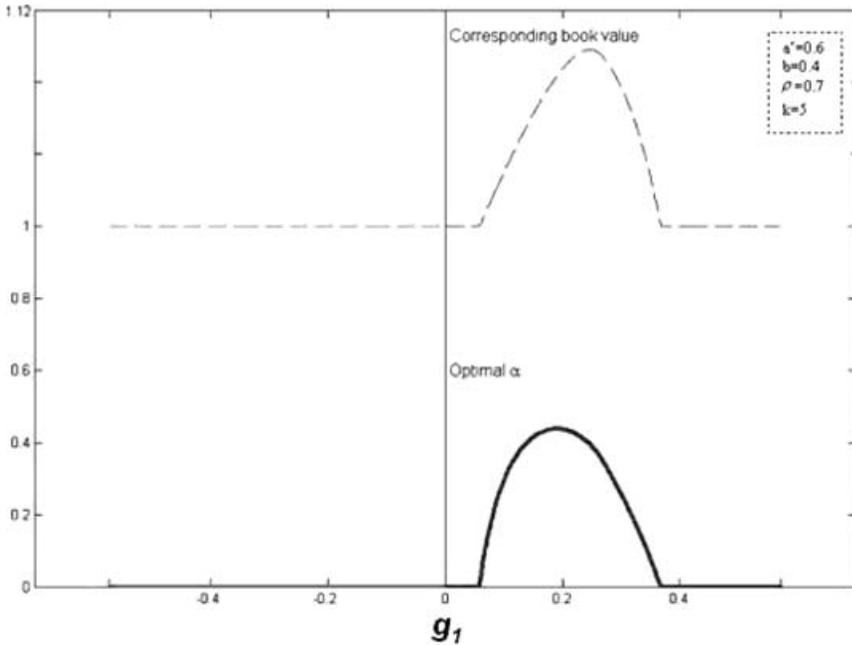


FIG. 4.— The manager's strategy in the pooling equilibrium.



the project dominates the decision to liquidate the firm early. However, if  $g_1$  falls in the interval  $[-a', 0]$ , liquidation is the dominant strategy. Faced with uncertainty, the shareholder's strategy is to compare the potential gain (the area  $\Delta DHIE + \Delta ABC$ ) with the potential loss (the area  $\Delta ALM$ ) of a given strategy. The result of the comparison depends on the length of the uninformed window. The bigger the uninformed window ( $a'$ ) is, the higher the possibility that *continue* becomes the dominant strategy.  $a^*$  is the threshold. If  $a' > a^*$ , the shareholder lets the project continue, which corresponds to the pooling equilibrium in the sense that both bad and good projects are kept alive. If the shareholder observes a book value different from unity, continuation is the shareholder's dominant strategy as the diagram shows.

The above explanation forms the basic intuition for the pooling equilibrium in theorem 2. Now we can proceed with the formal proof.

*Proof of Theorem 2.* In essence, proving that the strategy profile  $(f, h)$  constitutes a Nash equilibrium is equivalent to proving that the strategy of each agent is the best response to that of the other agent (i.e.,  $f$  and  $h$  are the best mutual responses). To aid comprehension, we organize the proof into a number of steps.

Step 1: If  $g_1$  doesn't fall into the uninformed window (that is,  $g_1 \in [-a, -a'] \cup [a', a]$ ), the shareholder knows  $g_1$  perfectly. Hence, there is no inefficiency due to market opaqueness or the accounting regime. Hence, it suffices to focus the discussion only on  $g_1 \in [-a', a']$ .

Step 2: Consider the shareholder's strategy. Essentially the shareholder's decision to continue or liquidate is about the trade-off between liquidating the project at date  $T_1$  and delaying liquidation until time  $T_2$ . Thus he needs to compare the time- $T_1$  market value of the project with its expected time- $T_2$  market value. The project's market value at  $T_1$  is  $MV_1 = 1 \cdot (1 + g_1) = 1 + g_1$ . If the manager delays liquidation until time  $T_2$ , the project's  $T_2$ -market value includes two parts. The first part is the portion of the project the manager liquidated at  $T_1$ . This is in the form of cash, which was converted before  $T_2$ . Its value is  $\alpha (1 + g_1)$ . The other part is the one the manager chooses to hold. Its value at  $T_2$  is  $(1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)$ . Hence, the total market value at  $T_2$  is  $MV_2 = \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)$ . Therefore, the expectation of the difference in payoff between the two alternative choices is

$$E[MV_2 - MV_1] = E[(1 - \alpha)(1 + g_1)\tilde{g}_2] = (1 - \alpha)(1 + g_1)\rho g_1. \quad (1)$$

From equation (1), we can see that the shareholder's decision exclusively depends on the fundamentals  $g_1$ . However, while the manager knows the fundamental value of the firm, the shareholder merely receives some information about it through the disclosure of accounts (i.e., the book value). The book value thus serves as a signal of the fundamentals. It reflects the decision of the manager, which in turn is a function of the fundamentals. Specifically, the book value is given by

$$BV_1 = \alpha(1 + g_1) + (1 - \alpha) = 1 + \alpha g_1. \tag{2}$$

Now we can discuss the shareholder’s strategy, the function  $action^S = h(BV_1)$ . There are three cases for  $BV_1$ : (1)  $BV_1 > 1$ , (2)  $BV_1 < 1$ , and (3)  $BV_1 = 1$ . In cases (1) and (2), the shareholder can perfectly infer the sign of the economic fundamentals from the book value. Given that  $\alpha$  is non-negative, we have

$$BV_1 > 1 \implies g_1 > 0, \tag{3}$$

$$BV_1 < 1 \implies g_1 < 0. \tag{4}$$

Substituting equations (3) and (4) into equation (1) and considering the manager’s equilibrium strategy  $\alpha = f(g_1) \neq 1$ , we obtain

$$BV_1 > 1 \implies E[MV_2 - MV_1] > 0, \tag{5}$$

$$BV_1 < 1 \implies E[MV_2 - MV_1] < 0. \tag{6}$$

From equations (5) and (6), we can get the shareholder’s optimal strategy (i.e., his best response to the manager’s strategy) in cases (1) and (2). That is,  $continue = h(BV_1)$  when  $BV_1 > 1$  and  $liquidate = h(BV_1)$  when  $BV_1 < 1$ .

The more complicated part is case (3) when the book value equals unity. In this case, there are two things that can happen, either  $g_1 = 0$  or  $\alpha = 0$ . In fact, whatever the fundamentals are, the book value will equal unity if the manager holds fully. The shareholder cannot perfectly infer the fundamentals. However, given the manager’s strategy, the shareholder knows that the manager chooses  $\alpha = 0$  if and only if  $g_1 \in [-a', a'] \cup [\bar{a}, a']$ . Hence, the expected net payoff from continuing the project conditional on a book value of unity is

$$\begin{aligned} E[MV_2 - MV_1 \mid BV_1 = 1] &= E[(1 + g_1)\rho g_1 \mid BV_1 = 1] \\ &= \frac{1}{2a' + \underline{a} - \bar{a}} \left( \int_{g_1=-a'}^{g_1=a'} (1 + g_1)\rho g_1 \, dg_1 + \int_{g_1=\bar{a}}^{g_1=a'} (1 + g_1)\rho g_1 \, dg_1 \right) \\ &= \frac{1}{2a' + \underline{a} - \bar{a}} \left[ \frac{2}{3}a'^3 - \frac{1}{3}(\bar{a}^3 - \underline{a}^3) - \frac{1}{2}(\bar{a}^2 - \underline{a}^2) \right]. \tag{7} \end{aligned}$$

From equation (7), we get the condition for the manager to continue the project conditional on the book value equal to unity. That is,

$$E[MV_2 - MV_1 \mid BV_1 = 1] > 0 \iff a' > a^*$$

where

$$a^* = \left[ \frac{3}{4}(\bar{a}^2 - \underline{a}^2) + \frac{1}{2}(\bar{a}^3 - \underline{a}^3) \right]^{\frac{1}{3}}. \tag{8}$$

In theorem 2, we assume  $a' > a^*$ , hence the shareholder continues with the project, which results in the pooling equilibrium. So far, we have shown that  $action^S = h(BV_1)$  is indeed the shareholder’s best response to the manager’s strategy.

Step 3: Now consider the manager’s strategy. The manager’s information is the fundamental return  $g_1$ . Suppose the realized return is non-negative,  $g_1 \geq 0$ , then the book value  $BV_1 = 1 + \alpha g_1$  is greater or equal to unity since  $\alpha$  is non-negative. The analysis shows that the book value will be at least unity whatever the non-negative  $\alpha$  the manager chooses when  $g_1 \geq 0$ . Considering that the shareholder’s strategy is to continue the project if the book value is not less than unity, the manager needs not be concerned with the shareholder’s liquidation of the project. The manager’s objective is equivalent to maximizing expected utility, which is a function of his bonus at  $T_{2-}$ . The bonus is proportional to the firm’s profit, which is the difference between the book value at  $T_{2-}$  and  $T_0$  (i.e., the initial cost). We begin by analyzing the book value at  $T_{2-}$ , denoted  $BV_{2-}$ . As we have already shown in step 2, the market value of the project at  $T_2$  is  $MV_2 = \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)$ . Moreover, we know that the market value of the project at  $T_{2-}$  is  $MV_{2-} = MV_2$ . We must have

$$\begin{aligned} BV_{2-} &= \text{Max}(BV_1, MV_{2-}) \\ &= BV_1 + \text{Max}(0, MV_{2-} - BV_1). \end{aligned} \tag{9}$$

The intuition behind equation (9) is as follows. At  $T_{2-}$  when the manager leaves the firm, he has another opportunity to trade. He can choose to sell or hold the remainder of the project that is still “alive” (i.e., the portion of project that was not liquidated at  $T_1$ ). At that date, if he chooses not to sell, the book value  $BV_{2-}$  is equal to the book value at the previous date (i.e.,  $BV_1$ ). This means the manager can report a book value at  $T_{2-}$  of at least  $BV_1$ . This is his “floor.” The manager chooses not to sell at  $T_{2-}$  when the market value at that date,  $MV_{2-}$ , is lower than  $BV_1$ . It is then optimal for him to hold everything. Alternatively, if the market value  $MV_{2-}$  is higher than  $BV_1$ , he sells the remainder of the project to realize its market value. Hence, we can express the book value  $BV_{2-}$  as shown in equation (9). This equation also highlights the feature that the historic-cost-accounting regime gives the manager a free call option (i.e., a floor plus a call option). The idea behind the option feature of historic cost accounting is as in our analysis above: The manager can choose to sell (i.e., exercise the option) to make the book value reflect the market value when the market price is high. In addition, he can choose to hold (i.e., not exercise the option) to keep the book value unchanged when the market price is low.

Substituting  $MV_{2-}$  and  $BV_1$  into (9), we obtain

$$\begin{aligned} BV_{2-} &= \text{Max}(BV_1, MV_{2-}) \\ &= \text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)). \end{aligned} \tag{10}$$

Therefore, the profit of the firm at  $T_{2-}$  is

$$PF_{2-} = BV_{2-} - BV_0$$

$$= \text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)) - 1. \quad (11)$$

Since we are concerned with the situation  $g_1 \geq 0$ , from equation (11) we have

$$PF_{2-} \geq 0. \quad (12)$$

It is worth noting that the compensation structure has the characteristic of “limited-liability,” which means that the shareholder cannot pay a negative bonus in the case of a loss. Fortunately, however, we can see from equation (12) that the profit is always non-negative in our model. Hence, the limited-liability constraint is never binding.

Suppose the manager’s bonus is a proportion  $\beta > 0$  of the profit. The bonus is then equal to

$$BN = \beta \cdot PF_{2-} = \beta \cdot [\text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)) - 1]. \quad (13)$$

Substituting equation (13) into the manager’s utility function, we obtain his expected utility

$$EU = E(U(BN))$$

$$= E(U(\beta \cdot PF_{2-}))$$

$$= E(U(\beta \cdot [\text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)) - 1])). \quad (14)$$

Recall that the manager’s utility function is  $U(\tilde{W}) = 1 - e^{-k \cdot \tilde{W}}$ . In order to save parameters, we can use an equivalent optimization scheme to replace the original one by replacing  $k$  with  $k\beta$

$$\begin{aligned} \text{Max}_{\alpha \in [0,1]} EU &\iff \text{Max}_{\alpha \in [0,1]} E(U(\beta \cdot [\text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)) - 1])) \\ &\iff \text{Max}_{\alpha \in [0,1]} E(U(\text{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)))) \end{aligned} \quad (15)$$

where  $k$  is scaled up by  $\beta$ .

Basically, equation (15) shows that the manager’s maximizing utility based on his bonus is equivalent to his maximizing utility based on book value.

Hence, we obtain the optimal strategy for the manager when  $g_1 \geq 0$ , that is,

$$f(g_1) = \arg \operatorname{Max}_{\alpha \in [0,1]} E(U(\operatorname{Max}(1 + \alpha g_1, \alpha(1 + g_1) + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2)))) \text{ when } g_1 < 0.$$

Finally, we need to show that the manager's optimal strategy is to sell nothing when  $g_1 < 0$ . By  $BV_1 = 1 + \alpha g_1$ , if the manager sets  $\alpha$  to be positive,  $BV_1 < 1$ . Following the argument in step 2, the shareholder liquidates the firm immediately after observing  $BV_1 < 1$ . If this situation happens, the market value of the firm is realized and the manager's bonus is paid based on the firm's liquidation value. The liquidation value however is  $MV_1 = 1 + g_1 < 1$ , which means that the manager receives no bonus. This is not the manager's optimal strategy. In fact, he can do better by setting  $\alpha = 0$ , which makes the book value at  $T_1$  equal unity. In this case, the shareholder lets the project continue according to his optimal strategy. The manager prefers this strategy of holding (i.e.,  $\alpha = 0$ ) for two reasons. First, if he can make the shareholder continue with the project, the manager receives a valuable "call option" and his bonus is non-negative. The option comes from the fact that there is a positive probability of the project's "recovery" at date  $T_{2-}$ . If recovery does occur, the manager can sell the project at that date, thus making a profit and earning a bonus. Even if "recovery" does not transpire and the firm's performance worsens, the shareholder can choose to hold the project at  $T_{2-}$ , setting the book value to at least unity. Therefore, the manager has an incentive to keep the project "alive." The second reason follows from the assumption that the manager derives some private benefit from continuing the project. This means that even though the manager knows perfectly that the project will not recover and may even worsen, he still prefers not to divest the project early since he can reap the private benefit in this case. He is also employed for another year and receives his guaranteed base salary. In sum, the manager's strategy is to set  $\alpha = 0$  when  $g_1 < 0$ , that is,

$$f(g_1) = 0 \quad \text{when } g_1 < 0.$$

Step 4: In this step, we show  $\underline{a}$  and  $\bar{a}$  do exist so that the manager indeed holds fully when  $g_1$  is high enough (i.e.,  $g_1 > \bar{a}$ ) and sells partially when  $g_1$  is fairly high. That is, we need to show there do exist such optimal  $a$ s that make the book value a bell-shaped function of  $g_1$ . The mechanism can be explained as follows. As we showed in step 2, the manager holds fully when  $g_1 < 0$  due to his strategic concern that the shareholder would liquidate the project if he were to sell. However, we would ideally like to know the intuition for his choice to hold fully even when the return is very high. There are two reasons. One is the growth opportunity. The high return in the first period means that the expected return in the second period will be high. Second, as we argue in step 3, the manager has an option at date  $T_{2-}$ . However, only if he holds the project can he keep this option alive. Hence, he has an incentive to hold the project. However, why does the manager prefer to sell partially rather than hold fully when the fundamentals are

fairly good? This is due to another two factors that make the decision tend in the opposite direction (i.e., favor selling). One is that the manager is risk averse. His decision to hold or sell is equivalent to making a portfolio choice. Selling the asset increases his position in the risk-free asset (i.e., cash), while holding the project is analogous to investing in the risky asset. The standard trade-off induces the manager to sell partially (i.e., investing some amount in the risk-free asset) when  $g_1$  (the expected return of the risky asset) is not very high. The second force, which makes the manager sell a bit more, is the “floor,” which is analyzed in step 3. The more the manager sells, the higher the book value the manager has at  $T_1$ . This increases the floor in the book value at  $T_{2-}$ , which is valuable to the manager.

This concludes the proof of theorem 2. ■

Theorem 2 presents the pooling equilibrium that occurs in less transparent markets. However, the more transparent the financial market is, the more independent the shareholder is of the manager’s accounting report. The manager has less opportunity to mask the firm’s performance by pooling the bad with the good project. This change could lead to the second kind of equilibrium—a separating equilibrium. We state this result in theorem 3.

**THEOREM 3 (Separating Equilibrium).** *When  $\bar{a} < a' \leq a^*(b, \rho, k)$ , the strategy profile  $s = (f, h)$  constitutes a Nash equilibrium, where  $f$  and  $h$  are given by*

$$f(g_1) = \begin{cases} \left\{ \begin{array}{l} \text{Max}(\arg \text{Max}_{\alpha \in [0,1]} (E(U(\max(1 + \alpha g_1, \alpha(1 + g_1) \\ + (1 - \alpha)(1 + g_1)(1 + \tilde{g}_2))))), \varepsilon) \\ 0 \end{array} \right. & \begin{array}{l} \text{when } g_1 > 0 \\ \text{when } g_1 \leq 0 \end{array} \end{cases}$$

and

$$h(BV_1) = \begin{cases} \text{continue when } BV_1 > 1 \\ \text{liquidate when } BV_1 \leq 1 \end{cases}$$

where  $\varepsilon$  is a small positive number infinitely close to zero (we can also define it by  $\frac{1}{\varepsilon} = +\infty$ ),  $a^* = [\frac{3}{4}(\bar{a}^2 - \underline{a}^2) + \frac{1}{2}(\bar{a}^3 - \underline{a}^3)]^{\frac{1}{3}}$ ,  $\bar{a}$  solves

$$\left\{ \begin{array}{l} e^{-k(1+\bar{a})(1+\rho\bar{a}+b)} \cdot [1 + k(1 + \bar{a})(\bar{a}\rho + b)] - \\ e^{-k(1+\bar{a})(1+\rho\bar{a}-b)} \cdot [1 + k(1 + \bar{a})(\bar{a}\rho - b)] \end{array} \right\} \times \frac{1}{2bk(1 + \bar{a})} = 0$$

and  $\underline{a}$  satisfies  $-k\underline{a}e^{-k\frac{\rho\underline{a}^2 + (1+\rho)\underline{a} - b(1+\underline{a})}{2b(1+\underline{a})}} + \frac{1}{2bk(1+\underline{a})} [e^{-k(1+\underline{a})(1+\rho\underline{a}+b)} - e^{-k(1+\underline{a})(1+\rho\underline{a}-b)}] + k\underline{a}e^{-k} = 0$ .

The emergence of the separating equilibrium is due to the uninformed window being shorter now. The manager can no longer pool the bad with the good project. It is worth noting that both the shareholder’s strategy and the manager’s strategy change in the separating equilibrium compared with their actions in the pooling equilibrium. As for the shareholder, he now

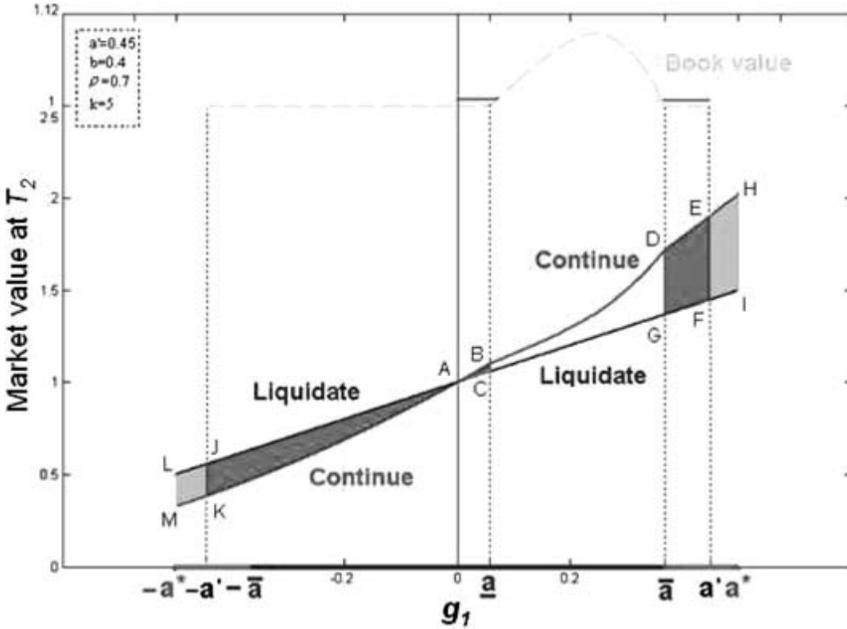


FIG. 6.— The shareholder’s strategy in the separating equilibrium.

liquidates rather than continues the project after observing a book value of unity. The manager changes his strategy to selling a tiny proportion of the project to signal to the shareholder that the project is good when it is indeed good.

Figure 6 describes the result of the separating equilibrium. The top diagram is the shareholder’s book value information. Suppose the manager still adopts his optimal strategy from the pooling equilibrium (i.e., sending no signal to the shareholder). The book value then corresponds to the dashed line in the diagram. If this is the case, conditional on the book value of unity, the shareholder’s potential gain from continuation (the area of  $\triangle ABC$  plus  $\triangle DEFG$ ) is dominated by the potential loss from early liquidation (the area  $\triangle AJK$ ). This is due to the uninformed window being shorter now ( $a' \leq a^*$ ). Note that  $a^*$  is the threshold (i.e.,  $\triangle ABC + \triangle DHIG = \triangle ALM$ ). Therefore, the shareholder’s optimal strategy is to liquidate the project conditional on a book value of unity. The manager’s strategy changes as well. He signals to the shareholder by showing a book value infinitesimally higher than unity when the economic fundamentals are positive. The solid line in the top diagram represents the manager’s signal in terms of the book value. Now the shareholder can perfectly distinguish the bad from the good project and first-best efficiency can be achieved.

*Proof of Theorem 3.* The proof of theorem 3 is rather easy as we only need to compare the agents’ strategies in the separating equilibrium with those in the pooling equilibrium. The change of the shareholder’s strategy in the

separating equilibrium is his action deviation when he observes a book value of unity. Since the uninformed window is shorter now (i.e.,  $a' \leq a^*(b, \rho, k)$ ), condition (8) is no longer satisfied. The shareholder liquidates the project. The idea behind this argument is as follows. Although the shareholder knows the project may be very good conditional on a book value of unity, the loss from a poor project dominates the gain from a promising project. Hence, it is optimal for the shareholder to liquidate the project. It is very important to note that the manager's strategy also changes when the shareholder's strategy does. Conditional on the manager's selling nothing giving rise to a book value of unity, the manager knows that the shareholder will liquidate the project even if there is a chance of it being good. Hence the manager has to adapt his strategy in order to maximize his payoff: He sends an inimitable signal to the shareholder that the project is good when indeed the economic fundamentals are good by selling a tiny fraction  $\varepsilon$  of the project to push the book value slightly above unity. Hence,  $f(g_1)$  is the best response of the manager to the shareholder's strategy. Now we can go back and check that the shareholder's strategy is still the best response to the manager's updated strategy. This is in fact obvious. Given the manager's strategy, the shareholder knows the book value equals unity if and only if  $g_1 < 0$ . Now it is even more certain that the shareholder liquidates the project in this case. ■

#### 4. *The Implications*

In this section, we analyze the model implications by a series of propositions. From theorems 2 and 3, we know that in more opaque financial markets the manager is better able to use historic cost accounting to pool bad with good projects. This hinders the shareholder from discerning the bad project at an early stage. The bad project can then potentially worsen in quality over time. The poor performance can accumulate and only eventually surface, leading to a big crash in the asset price. This is the relationship between market transparency and the asset price crash.

**PROPOSITION 4.** *Under the historic-cost-accounting regime, a higher degree of opaqueness leads to more frequent and more severe asset price crashes.*

The result of Proposition 4 is consistent with the findings in Myers and Jin [2004]. Our contribution is that we provide a new mechanism that explains the cause of the empirical evidence. In other words, the historic-cost-accounting regime can provide a tool for the manager to hide the firm's true performance, a scenario that can potentially lead to a crash.

Figure 7 gives a numerical example. On the horizontal axis we plot  $a'$  (i.e., the width of the uninformed window) and on the vertical axis  $\Delta s$  (i.e., the degree of the crash in the book value). The graph shows that more opaque financial markets exhibit a higher intensity of book value crashes, both in frequency and magnitude.

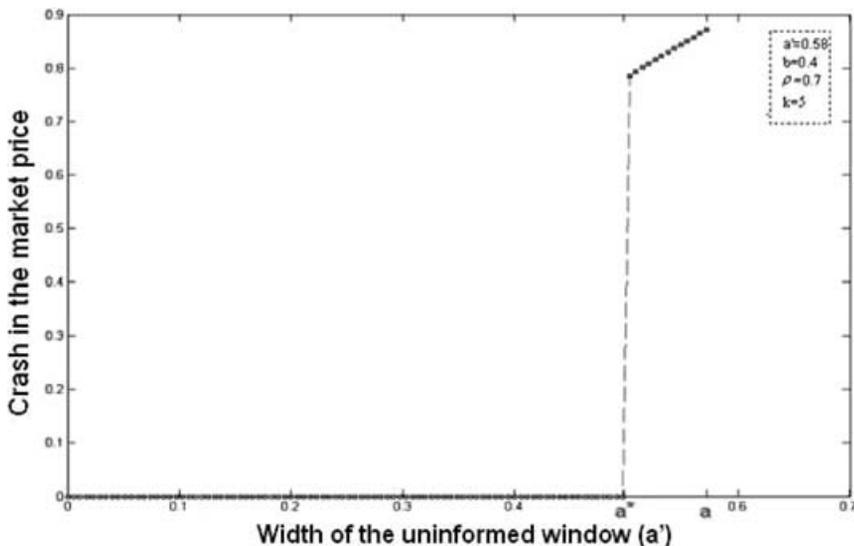


FIG. 7.— The crash in the asset price.

*Proof of Proposition 4.* See appendix.

Now consider what happens if the marking-to-market regime can be implemented (in the sense that the fair value is observable). In this case, the shareholder can see through the firm’s performance. He liquidates the firm if  $\varepsilon_1 = -a'$  and no crash can happen. Yet there is a crash under historic cost accounting if the financial market is sufficiently opaque. This is Proposition 5: the relationship between the accounting regime and the asset price crash.

**PROPOSITION 5.** *In an opaque financial market (i.e.,  $a' > a^*$ ), more severe and more frequent asset price crashes result under historic cost accounting than under marking to market.*

Proposition 5 is in the same spirit as Proposition 4. We therefore omit its proof.

In fact, some practitioner reports have provided evidence in support of the implication of Proposition 5. As a Bank of England survey states, under historic cost accounting the shareholder cannot distinguish the bad from the good project at an early stage and hence is unable to prevent a bad project from being kept alive and potentially worsening in quality. This is the reason for the crash under the historic-cost-accounting regime, while no such crash can happen under marking to market. The above argument underlines the intuition of Proposition 5.

As marking to market can lead to more efficient liquidation, the bad project will have a lower probability of survival over time. The asset price at  $T_2$  is less volatile under marking to market than under historic cost accounting.

PROPOSITION 6. *The unconditional volatility of the asset price at  $T_2$  is higher under historic cost accounting than under marking to market.*

Moreover, the historic-cost-accounting regime not only increases the asset price volatility overall but it also transfers it across time in a pattern similar to the “Black” effect. As figure 4 shows, under historic cost accounting, the lower (higher) the book value at  $T_1$ , the higher (lower) the uncertainty (volatility) about the liquidation value at  $T_2$ .

PROPOSITION 7. *Under historic cost accounting, the asset price exhibits a pattern similar to the “Black” effect in the book value.*

## 5. Conclusion and Discussion

This paper analyzes the economic consequences of historic cost accounting for the financial market. Using a theoretical model we can (partially) answer the following two questions: What kind of inefficiency can a historic-cost-accounting regime cause and what is the mechanism that produces these inefficiencies? Our model shows that under historic cost accounting the opaqueness of the financial market can lead to the inefficient continuation of the project by the shareholder, which in turn leads to more pronounced asset price crashes, both in frequency and magnitude. However, under the marking-to-market regime, if the fair value is indeed available, these crashes do not happen. Our model also shows that historic cost accounting can change the asset price volatility. In fact, it transfers asset price volatility across time while increasing volatility overall. The mechanism of historic cost accounting to produce the above effects lies in the book value’s convexity in the economic fundamentals. However low the market price is, the manager can make the book value equal to the initial cost (the floor) by holding the asset. At the same time, he can participate in the upside of the market valuation by selling. The convexity in the book value is equivalent to granting the manager a free-call option. When accounting-value-based compensation is used (which is quite common in reality), the manager has both the capability and the incentive to use this option. This leads to inefficiencies.

Finally, we admit that our results should be interpreted with caution since our results are based on a specific setup. It is impossible for us to explore all aspects of the features of historic cost accounting and all aspects of the effects of historic cost accounting. Notably, in the analysis of the equilibria and their implications, we assume that the manager’s compensation structure is composed of a base salary plus a profit-based bonus. We use this assumption because such a compensation structure is widely used in practice, particularly in some industries like financial services. One of the most important reasons why many firms do not use market-value-based compensation under historic-cost-accounting in reality is that the market may be not very liquid, which makes the fair value unavailable. In this case, market-price-based

compensation may cause more inefficiency. Also, the market price is likely to be very volatile and the market not efficient. Nevertheless, if the shareholder implements a very complicated compensation structure, this may reduce some inefficiency of the historic-cost-accounting regime.<sup>14</sup>

However, our argument is that many theoretical compensation structures are hardly feasible in reality, particularly given the illiquidity and inefficiency of many financial markets. In order to highlight and model the effects of historic cost accounting on a market with such features, we have abstracted away from the complicated optimal compensation design by using the compensation structure that is most common in reality. We believe our main findings are robust.

APPENDIX

*Proof of Proposition 4.* Consider the change in the share price between  $T_1$  and  $T_2$  in different financial markets. Here we suppose that the ex post returns in period 1 and 2 are  $\varepsilon_1 = -a'$  and  $\varepsilon_2 = -b$ , respectively, that is, the lowest returns are realized. We consider this situation for the purpose of exploring the asset price change in extreme cases (i.e., the worst outcome). Note that when  $\varepsilon_1$  falls outside the uninformed window (e.g.,  $-a < \varepsilon < -a'$ ), the shareholder can observe the return. Hence, the lowest ex post return that the shareholder cannot observe is  $\varepsilon_1 = -a'$ .

A transparent financial market:  $a' \leq a^*$ . In such a market, the whole project is liquidated at  $T_1$ . Hence, there is no change in the share price between  $T_1$  and  $T_2$ .

$$\Delta s = s_1 - s_2 = 0. \tag{16}$$

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<sup>14</sup> Our basic argument is that under historic cost accounting, share-price-based compensation is more efficient than accounting-value-based compensation if the stock market is sufficiently efficient. However, under marking to market, accounting-value-based compensation is an improvement over share-price-based compensation if the stock market is not liquid enough. Basically, given two accounting schemes and two compensation schemes, there are four pairwise combinations between the accounting regime and the compensation scheme: (1) historic-cost-accounting regime and accounting-value-based compensation, (2) historic-cost-accounting regime and share-price-based compensation, (3) marking to market and accounting-value-based compensation, (4) marking to market and share-price-based compensation. We argue that combinations (2) and (3) are more efficient than (1) and (4). Intuitively, (1) and (4) make the performance measure endogenous. Since the manager can influence the performance measure, which determines his pay, higher inefficiency ensues. Combination (1) is the focus of our paper. As we show, historic cost accounting provides the manager with a free option to increase the book value without requiring any effort from the manager. If the manager is remunerated based on book value, he has an incentive to use this free option. This leads to inefficiency. A similar story holds for combination (4). If marking to market and a share-price-based measure are used to determine compensation, the share price is no longer exogenous. This is so because the manager can influence the share price to some degree himself. If his remuneration is simultaneously based on the share price, the manager has an incentive to inflate the share price to increase his compensation, which also leads to inefficiency.

Here we assume that if the project is liquidated early at  $T_1$ , the firm value at  $T_2$  equals its liquidation value (e.g., all the cash generated from liquidation is retained within the firm until date  $T_2$ ). Therefore, the firm value does not change in the second period.

An opaque financial market:  $a' > a^*$ . In such a market, the manager is able to pool bad with good projects by exploiting the shareholder's ignorance of the project's true quality leading the shareholder to potentially continue both types of projects. The book value is unity. Hence, the share price is the discounted expected market value of the firm at  $T_2$  conditional on the book value at  $T_1$  being unity, that is,

$$\begin{aligned}
 s_1 &= E(MV_2 \mid BV_1 = 1) \\
 &= E[(1 + g_1)(1 + \rho g_1 + \tilde{\varepsilon}_2) \mid BV_1 = 1] \\
 &= \frac{1}{2a' + a - \bar{a}} \cdot \left[ \int_{-a'}^a (1 + g_1)(1 + \rho g_1) dg_1 + \int_{\bar{a}}^{a'} (1 + g_1)(1 + \rho g_1) dg_1 \right] \\
 &= \frac{1}{2a' + a - \bar{a}} \\
 &\quad \cdot \left\{ \left[ \frac{1}{3}\rho a^3 + \frac{1}{2}(\rho + 1)a^2 + a \right] - \left[ -\frac{1}{3}\rho a^3 + \frac{1}{2}(\rho + 1)a^2 - a' \right] \right. \\
 &\quad \left. + \left[ \frac{1}{3}\rho a'^3 + \frac{1}{2}(\rho + 1)a'^2 + a' \right] - \left[ -\frac{1}{3}\rho \bar{a}^3 + \frac{1}{2}(\rho + 1)\bar{a}^2 - \bar{a} \right] \right\}.
 \end{aligned}$$

The share price at  $T_2$  is the firm's liquidation value at that date given by  $s_2 = (1 - a')(1 - \rho a' - b)$ .

Therefore, the price change is equal to

$$\begin{aligned}
 \Delta s &= s_1 - s_2 \\
 &= \frac{1}{2a' + a - \bar{a}} \\
 &\quad \cdot \left\{ \left[ \frac{1}{3}\rho a^3 + \frac{1}{2}(\rho + 1)a^2 + a \right] - \left[ -\frac{1}{3}\rho a^3 + \frac{1}{2}(\rho + 1)a^2 - a' \right] \right. \\
 &\quad \left. + \left[ \frac{1}{3}\rho a'^3 + \frac{1}{2}(\rho + 1)a'^2 + a' \right] - \left[ -\frac{1}{3}\rho \bar{a}^3 + \frac{1}{2}(\rho + 1)\bar{a}^2 - \bar{a} \right] \right\} \\
 &\quad - (1 - a')(1 - \rho a' - b). \tag{17}
 \end{aligned}$$

Putting equation (16) and (17) together, we obtain  $\Delta s$ , which measures the extent of the asset price crash, as a function of  $a'$ , which measures the degree of market opacity:

$$\Delta s = l(a') = \begin{cases} 0 & a' \in [0, a^*] \\ \frac{1}{2a' + a - \bar{a}} \cdot \begin{cases} \left[ \frac{1}{3}\rho a'^3 + \frac{1}{2}(\rho + 1)a'^2 + a \right] \\ - \left[ -\frac{1}{3}\rho a'^3 + \frac{1}{2}(\rho + 1)a'^2 - a' \right] \\ + \left[ \frac{1}{3}\rho a^3 + \frac{1}{2}(\rho + 1)a^2 + a' \right] \\ - \left[ -\frac{1}{3}\rho \bar{a}^3 + \frac{1}{2}(\rho + 1)\bar{a}^2 - \bar{a} \right] \end{cases} & a' \in (a^*, a] \end{cases} \cdot \begin{cases} \\ \\ \\ \\ -(1 - a')(1 - \rho a' - b) \end{cases}$$

With the setup of the parameters in our model,  $\Delta s$  is an increasing function of  $a'$  when the crash occurs (i.e.,  $a' \in (a^*, a]$ ), which means that the more opaque financial market displays more severe crashes. Moreover,  $\Delta s$  is a discontinuous function of  $a'$  in the whole interval  $[0, a]$ . When  $a' < a^*$ , there is no crash at all. This discontinuity means that opaqueness not only leads to more severe but also more frequent asset price crashes. This idea becomes clearer if we consider the case of multiple projects. Suppose there are many projects in each financial market, the length of the uninformed window of these projects in the same financial market is different but centered around  $a'$  of their own financial market. Hence, we can expect that the financial market with a higher  $a'$  will have more projects falling within the interval  $(a^*, a]$ , resulting in a higher frequency of crashes.

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