Where does the Information in Mark-to-Market Come from?

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Abstract

We study how accounting measurement interacts with banks' loan origination and retention decisions and evaluate the overall efficiency of mark-to-market accounting (MTM) relative to historical cost accounting (HC) in this context. On the one hand, MTM exploits the information in loan prices. As such, it improves the accuracy of loan valuation and ex-ante incentives. On the other hand, exploiting the information in loan prices alters the process by which information is impounded into price and induces strategic behavior. The overall efficiency of MTM is a trade-off of these two forces. Relative to HC, MTM could induce banks to retain excessive exposure to the risk of the loans they originate, damage price discovery in the loan market, and reduce banks' ex-ante incentive to originate good loans. These results imply an economy with an inefficient risk distribution and a lower overall loan quality.

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"The measurement of position necessarily disturbs momentum, and vice versa"

- Heisenberg (1929)

1 Introduction

Conventional wisdom holds that by exploiting the information in asset prices MTM makes asset valuation more accurate. The enhanced accuracy then improves firm behavior and results in various benefits. But where does the information in asset prices come from? In a market with frictions, asset prices are sensitive to the very firm behavior MTM intends to influence. As a result, MTM exploits and affects the information in asset prices simultaneously, and its efficiency should be evaluated in this context.

To examine the efficiency of MTM, we study the loan market with banks following the "originate-to-distribute" (OTD) model. Banks have expertise in originating loans but for various exogenous reasons find it costly to maintain the loans on their own books. Absent information asymmetry between banks and investors, banks pass through all the loans they originate to investors. The information in the loan price is perfect and independent of accounting measurement. Accounting is then simply irrelevant. However, banks receive private information about the quality of their loans because of their expertise in loan origination. In responding to the lemons problem, good banks (banks with good loans) retain a portion of their loans and sell the rest at a high price. How we measure the retained loan now has real effects on bank behavior.

We consider two polar cases of accounting measurement: MTM and HC. HC records the retained loan at its amortized cost, while MTM values it at the market price of the portion of the loan that was sold. In essence, MTM requires the early recognition of the expected economic profits or losses on the retained loan by exploiting the information in loan price.

The inefficiency of HC is obvious. HC ignores the information in loan price. In a signaling equilibrium, the price of the loan that was sold is informative about the quality

of the loan that is retained. Furthermore, there seems to be a liquid market for the retained loan because the sold portion of the same loan is actively traded. Yet, HC does not allow banks to recognize the expected economic profit on the retained interest until the loan pays off. This delayed recognition increases the cost for banks to keep the retained interest on their books and reduces banks' ex-ante incentive to originate good loans.

MTM attempts to overcome this inefficiency. By using the information in the loan price to value the retention, MTM improves the accuracy of the valuation of the retained interest. All else equal (retention held constant), this enhanced valuation accuracy under MTM reduces the cost of price discovery in the loan market and stimulates banks' ex-ante incentive to originate good loans. However, switching from HC to MTM also changes the banks' retention decisions. Even though only good banks retain a portion of the loan in equilibrium, MTM also reduces the marginal cost for bad banks to mimic. Thus, good banks have to retain an even higher portion of the loan to distinguish themselves. In an attempt to exploit the information in the loan price, MTM interferes with the signaling process that sustains the informativeness of the loan price. It is this feedback effect that compromises the overall efficiency of MTM. In particular, we demonstrate three consequences of MTM.

First, the higher retention required for signaling under MTM (relative to HC) means that banks retain excessive exposure to the risk of loans they originated. Second, signaling could break down and the informativeness of the loan price could be destroyed under MTM. As the required retention exceeds a threshold (beyond which sales accounting is not applicable) when switching to MTM, separation becomes infeasible. In any resulting non-separating equilibrium, the market prices of loans are less informative about the quality of the retained loans. Thus, the attempt to exploit the information in the market price by moving to MTM destroys the informativeness of the market price. Finally, MTM could reduce the value of originating good loans, resulting in banks' lower ex-ante incentive to originate good loans and a lower overall quality of loans in the economy. The value of originating good loans hinges on the cost of signaling that sustains the price discovery in

the loan market. On the one hand, improved valuation accuracy by MTM reduces the unit cost of holding the retained loan, reducing the signaling cost. On the other hand, the higher retention under MTM increases the signaling cost. When the latter effect dominates the former, MTM increases the cost of price discovery and reduces the value of originating good loans.

The most important contribution of our paper is to highlight the reverse causality between accounting measurement and the liquidity (information) of asset markets, liquidity broadly defined as the sensitivity of the loan price to banks' trading. It is commonly perceived that illiquidity of asset markets is the main implementation obstacle for MTM. For example, the three levels of inputs for fair value measurement in FAS 157 are based on the (il)liquidity of the asset market. Our analysis emphasizes on the reverse causality: MTM influences banks' behavior that endogenously determines the information and liquidity in the asset market. This interaction creates a *conceptual* obstacle for MTM.

In this respect, even though there has been a growing theoretical literature examining the costs and benefits of MTM, the relation between MTM and liquidity has not been examined until recently. Allen and Carletti (2008) and Plantin, Shin, and Sapra (2008) are the first to show how MTM could exacerbate illiquidity in asset markets. Firms' sales caused by an initial shock affect the market price and MTM feeds the price impact back into firms' sales, resulting in a loop that amplifies the initial shock in the market. In Plantin, Shin, and Sapra (2008), when one firm sells into an illiquid market and pushes down the price, other firms' are implicated due to MTM. This creates a complementarity among firm's decisions to sell. The resulting coordination failure amplifies the initial shock, exacerbates market illiquidity, and induces "artificial" volatility in asset prices. In Allen and Carletti (2008), under MTM the insurance sector's fire sale leads to the violation of the capital requirement of the banking sector and the resulting fire sale by the banking sector puts further downward pressure on the fire-sale price, resulting in the contagion between the two sectors. We extend their work by endogenizing the illiquidity from the primitive friction of information asymmetry. The information in the loan price and the

liquidity in the loan market are sustained by the privately costly signaling. As soon as one attempts to exploit them by marking the retained loan to the market price, the private cost to sustain price discovery increases and the liquidity could deteriorate.

Our paper also contributes to the understanding of the ex-ante efficiency of MTM relative to HC. Given the two-way relation between MTM and information in asset prices, the benefit of MTM in the form of the improvement in valuation accuracy should be balanced with the endogenous cost arising from the change in the firms' real decisions. Not only do we study the trading (retention) decisions given the bank's loan portfolio, we also examine how the ex-ante origination decisions, which determine the quality of a bank's initial loan portfolio, are influenced by accounting measurement. This ex-ante perspective is imperative because it is inherently difficult to evaluate the overall efficiency of a policy or system based on ex-post results in a second-best world. In this respect, our paper responds directly to the call for studies on the ex-ante effect of MTM (e.g. Laux and Leuz (2009a,b)). For example, in our model MTM could result in an economy with an inefficient risk distribution and a lower overall loan quality. To the extent that these two factors are relevant for a financial crisis, our analysis sheds light on the role of MTM in the build-up of problems in the system that could lead us to a crisis. Therefore, our analysis might inform the ongoing regulatory reform.

The point that the overall efficiency of MTM should take into account the endogenous nature of the information is also shared by Reis and Stocken (2007) and Gorton, He, and Huang (2008). Reis and Stocken (2007) study the production and price setting behavior of firms in a duopoly. They show that it is difficult to implement fair value measurements because they are endogenous to the strategic interactions between firms. Gorton, He, and Huang (2008) study the optimal use of information gleaned from market prices of securities in solving the agency problem between a principal-investor and an agent-trader. They show that the inclusion of market prices in the compensation contract induces traders to collude and manipulate market prices when they are able to do so.

Finally, we believe that the logic that how we measure a bank's balance sheet changes

the bank's balance sheet is a general feature of accounting measurement beyond our particular model (e.g. Kanodia (1980)). It is reminiscent of the "Lucas Critique" that policies derived from the observed empirical relation could change the underlying relation. In general, attempting to resolve accounting measurement problems via a market-based solution could lead to unintended and sometimes undesirable consequences. A firm's business model is viable only if it has some competitive advantage over the market in conducting its activities. As a result, the core assets and liabilities on a firm's balance sheet, dictated by its business model, are often subject to the same market frictions that sustain the business model. Market prices in these markets are thus endogenously linked to the firm's activities that are guided partially by accounting measurement. This feedback loop is illustrated in Figure 1.

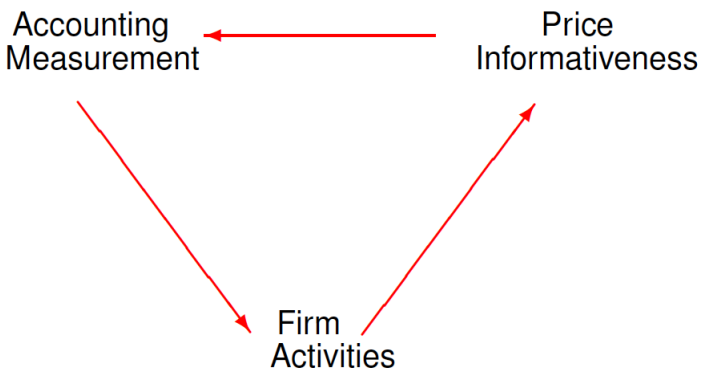

Figure 1: Feedback loop of accounting measurement

The rest of the paper is organized as follows. Section 2 describes the model, Section 3 presents the equilibria, Section 4 states our main results, Section 5 considers various extensions to the basic model, and Section 6 concludes. The Appendix includes details on the accounting for securitizations (Appendix A) and the proofs that are not in the text (Appendix B).

2 Model

Accounting measurement is inextricably connected to business transactions. Thus, we describe our model in three steps. First, we detail out the business model and the formation of the bank's balance sheet in our model economy. Second, we specify the payoffs of players in the game. In particular, we link accounting measurement to the players' payoffs. Finally, we describe the different rules of accounting measurement in detail.

2.1 The bank's business model and decisions

There are three dates, $t = 0, 1, 2$, and a continuum of ex-ante identical banks. A representative bank follows the originate-to-distribute (OTD) model. On the one hand, the bank has expertise in originating loans. On the other hand, it is costly for the bank to retain loans on its own books. Thus, without frictions, the bank would sell (distribute) its entire loan portfolio in the loan market.

A loan originated at $t = 0$ generates a random cash flow $\widetilde{\theta}+\widetilde{x}$ at $t = 2$. θ, the realization of $\widetilde{\theta}$, is privately observed by the bank at $t = 1$. θ can take two values: either good (G) or bad (B), $G > B$. The ex-ante probability distribution of $\widetilde{\theta}$ depends on the origination effort at $t = 0$ in a way that will be specified later. In contrast, the realization of $\widetilde{x}$ is not revealed to anyone, including the bank, until $t = 2$. $\widetilde{x}$ has density $f(x)$ and distribution $F(x)$ in $[\underline{x}, \overline{x}]$, with $-\infty \leq \underline{x} < \overline{x} \leq \infty$, $f(x) > 0$, and $E[\widetilde{x}] = 0$. Thus, the expected cash flow of a loan conditional on the bank's private information at $t = 1$ is $E[\widetilde{\theta} + \widetilde{x}|\theta] = \theta$. We call θ the quality (type) of a loan or interchangeably the quality (type) of the bank. This private information about loan quality is the main friction in the loan market.

The bank is financed by an exogenous capital structure mix of debt and equity. The bank's decisions are made by the owner-manager on behalf of equity holders. The owner-manager assumption abstracts away from the agency issue between the management and the equity holders of the bank. Thus, the terms "bank", "equity-holder" and "owner-manager" are interchangeable.

The owner-manager makes two decisions: the origination decision at $t = 0$ and the retention decision at $t = 1$. At $t = 0$, the owner-manager exerts an uncontractible effort m, at a private cost of $s(m)$, to originate one unit of a loan. As mentioned above, the effort m determines the distribution of $\widetilde{\theta}$. Specifically, $\Pr(\widetilde{\theta}(m) = G) = m$. That is, a bank with origination effort m receives a good loan ($\theta = G$) with probability m and a bad loan ($\theta = B$) with probability $1 - m$. By the law of large numbers, m also measures the average quality of loans in the economy.

The owner-manager makes the other decision, the retention decision, at $t = 1$ after learning its type θ. We assume that the bank incurs a cost c for every unit of the risky loan it carries on its books from $t = 1$ to $t = 2$. We discuss the various interpretations of cost c in Section 5 and will stick to the interpretation of c as a regulatory cost for the ease of reference in the rest of the paper. As a result of this cost c, the second part of the OTD model is at work and the bank has an incentive to sell the loan at $t = 1$. However, the retention decision is non-trivial because the bank faces the lemons problem in the loan market as a result of its private knowledge of the loan type θ, which in turn results from its expertise in loan origination (the first part of the OTD model). To overcome the lemons problem, the bank adopts a standard "skin in the game" solution. It retains k portion of the loan on its own books and investors respond with a per-unit price $p(k), k \in \left[0, \overline{k}\right]$, for the $1 - k$ portion of the loan it sells.[1] As a result, the bank endogenously holds a non-cash asset, i.e. the retained interest, on its balance sheet. We focus on the measurement of this endogenous asset and show that its measurement has real effects on both the bank's retention decision at $t = 1$ and the origination decision at $t = 0$.

At $t = 2$, the payoff of the loan realizes and all claimholders are paid off accordingly. There is no discounting and all parties are risk-neutral. The timing of the model is summarized in Figure 2.

[1] $\overline{k}$ is the upper limit of retention beyond which the transfer of a loan cannot be recognized as a sale in accounting. $\overline{k}$ does not play any substantial role in the model but we keep it to capture this important institutional feature.

$t = 0$	1	2
Origination decision: Bank exerts effort m to originate a loan. m improves the expected loan quality.	Retention decision: Bank learns loan quality θ; decides fraction k to retain and $1-k$ to sell; Market prices the loan at $p(k)$.	Cash flow realization: all claimholders are paid off.

Figure 2: Timeline

2.2 The bank's objective functions

At each stage of the sequential game, the owner-manager maximizes the expected present value of dividends (all payoffs to equity holders). Denote the dividends distributed at $t = 1$ and $t = 2$ by d_1 and d_2, respectively. d_2 is the liquidation dividend and thus includes the return of initial equity. At $t = 1$, the bank's decision problem is

$$\max_{k,d_1,d_2} d_1 + E_1\left[\widetilde{d}_2\right] \tag{1}$$

A series of constraints is detailed in Appendix B to link the retention decision k to dividends d_1 and d_2. Besides the accounting identities we highlight two economically significant constraints.

The first constraint is limited liability. It regulates d_1 and d_2 to be non-negative. Non-negative d_2 introduces the classic conflict of interest between equity and debt holders. When the realization of x at $t = 2$ is low and thus the loan performs poorly, equity is first and debt is second in line to absorb the loss. The distribution of dividends at $t = 1$ reduces the equity available to absorb losses at $t = 2$ and thus shifts the risk of potential future loss to the debt holders. Thus, all else equal, the bank has an incentive to distribute dividends at $t = 1$ as much as possible. Essentially, the early distribution of dividends

affords the equity holders a call option on the performance of the bank's assets. Without any restriction on the distribution of dividends at $t = 1$, debt would be more expensive or even infeasible. One of the most important institutions in practice to mitigate this fundamental conflict of interest between equity and debt holders of the bank is to link the dividend distribution to accounting measurement. We formalize this second constraint to the bank's decision problem above in the following assumption.

Assumption 1. *The amount of dividends a bank is allowed to distribute at $t = 1$ cannot exceed its retained earnings at $t = 1$ (before dividend distribution).*

We explain the consequences of Assumption 1 for our model first before providing justifications at the end of this subsection. Denote the accounting earnings at $t = 1$ and $t = 2$ under accounting regime A and retention decision k by $e_1^A(k)$ and $e_2^A(k)$, respectively.

Lemma 1. With the following assumptions of (i) limited liability, (ii) Assumption 1, (iii) the bank's survival to $t = 2$ (footnote 3) and (iv) the initial retained earnings at $t = 1$ of zero and the initial equity r, the solution to decision problem (1) is as follows

- $d_1^* = e_1^A(k)$,
- $d_2^* = \max\left\{e_2^A(k) + r, 0\right\}$,
- $k^* = \arg\max_k e_1^A(k) + E_1\left[\max\left\{\widetilde{e}_2^A(k) + r, 0\right\}\right]$.

It turns out that the initial equity r only rescales the payoff x and does not play any role in the model. We thus set $r = 0$ to simplify the math. The details of the proof of Lemma 1 are provided in Appendix B. The results are intuitive but significant. We can now formalize the bank's decision problems in the sequential game in terms of earnings. Accounting measurement could matter now.

At the final date, $t = 2$, the loan cash flow is realized. After all other claimholders have been satisfied, the remainder of the loan cash flow is paid to the equity holders of the bank subject to limited liability. The (equilibrium) distribution to the owner-manager

is $d_2^* = \max\left\{e_2^A(k), 0\right\}$ because no retained earnings are carried over from $t = 1$ in equilibrium.

At the interim date, $t = 1$, the bank sells a fraction k of its loan, revalues the retained fraction $1 - k$ based on the accounting regime in place and recognizes earnings $e_1^A(k)$ accordingly. The (equilibrium) distribution to the equity holders given k is $d_1^* = e_1^A(k)$. Therefore, the bank's retention decision problem at $t = 1$ is summarized as

$$\max_{k \in [0,\overline{k}]} U^A(k;\theta) \equiv e_1^A(k) + E\left[\max\left\{\widetilde{e}_2^A, 0\right\} | \theta\right] \tag{2}$$

The optimum of the problem is denoted by $V^A(\theta) \equiv U^A(k^*;\theta)$, where k^* is the optimal retention. $V^A(\theta)$ is the expected equilibrium payoff to a bank of type θ. Without any friction, $V^A(\theta)$ would be the same as the expected cash flow of a loan. With frictions in our model, however, it is (weakly) lower than the expected cash flow of a loan.

At the initial date, $t = 0$, the owner-manager makes no dividend distribution as the bank only just originated the loan. Thus the owner-manager maximizes his expected payoff and the origination decision problem is summarized as

$$\max_{m \in [0,1]} E_0\left[V^A\left(\widetilde{\theta}(m)\right)\right] - s(m) \tag{3}$$

where $E_0\left[V^A\left(\widetilde{\theta}(m)\right)\right] = mV^A(G) + (1-m)V^A(B)$ and $s(m)$ is the owner-manager's private cost of exerting effort. When a bank exerts effort m at cost $s(m)$ at $t = 0$, it expects that with probability m (or $1 - m$) it will receive a good (or bad) loan at $t = 1$, and the good (or bad) loan will be worth $V^A(G)$ (or $V^A(B)$). $V^A(\theta)$, the expected equilibrium payoff to a bank of type θ, is derived from the retention problem (2) at $t = 1$. Therefore, the two objective functions of the bank, (2) and (3), correspond to the two decisions at $t = 1$ and $t = 0$, respectively, and are linked to each other consistently.

Before we turn to the description of the accounting measurement and the determination of $e_1^A(k)$ and $e_2^A(k)$ in the next subsection, we briefly discuss Assumption 1. This

assumption captures real-world intuition reasonably well. A prototype bank in our model is an insured-deposit bank. The bank issues insured debt (deposits), makes risky loans, pays the FDIC insurance premium based on its risky balance sheet, and is subject to limited liability. In the event of non-performance of the loans on the bank's balance sheet, the equity of the bank is first in line to absorb losses. However, the equity holders are not obliged to contribute new capital or disgorge dividends previously received. As a result, the bank has an incentive to pay dividends as early as possible. To curtail such abuse of limited liability, the bank's dividend distribution is restricted by, among other things, a capital requirement. Since the capital requirement is mainly based on accounting numbers, the amount of dividend the bank could distribute without violating the capital requirement is linked to such accounting numbers as earnings. All else equal, the higher the earnings the more freedom the bank has to distribute dividends. To the extent that the regulator could be viewed as a representative of the debt holders of the bank, the example could also be extended to other uninsured financial institutions where the capital requirement is replaced by other forms of payout restrictions, such as debt covenants. Smith and Warner (1979) discuss the prevalence and rationale for restricting dividend payouts to retained earnings.

Alternatively, we could also interpret Assumption 1 more broadly. What is required for our model is that accounting measurement affects the payoffs of the decision maker, being the equity holders or the manager. If there is a conflict of interest between the manager and the rest of the stakeholders of the bank as a whole and the manager of the bank has to be the decision maker (of the origination and retention decisions), then we should interpret the dividend distribution as compensation to the manager and the accounting-based restriction on the dividend distribution in Assumption 1 as an accounting-based component of compensation. In this sense, our payoff structure is also similar to that in Plantin, Shin, and Sapra (2008) and Bleck and Liu (2007). In the model by Plantin, Shin, and Sapra (2008), accounting is relevant because the manager's compensation is tied to short-term earnings. Similarly, in Bleck and Liu (2007), the manager's compensation is

based on short-term option-like accounting numbers as in our model.

2.3 Accounting measurement and earnings determination

The only non-cash asset on the balance sheet of our bank is the retained interest k. The key accounting measurement issue is how we measure the value of the retained interest. We consider two polar accounting regimes: HC and MTM. Under HC, the k portion of the loan that is retained by the bank is recorded at its initial book value B_0, $G > B_0 > B$. Under MTM, the retained portion is revalued to the market price of the portion of the loan that was sold, $p(k)$.[2] In other words, MTM requires the bank to recognize the economic profit or loss, $k(p(k) - B_0)$, at $t = 1$ before the loan pays off. Recall that $p(k)$ is the per-unit price of the loan that was sold. Early recognition of the economic profit or loss on the retained portion of the loan is the main difference between HC and MTM. We include in Appendix A a detailed description of the accounting treatment for retained interests resulting from a securitization, one of the most common transactions that typically leaves banks with a retained interest, and discuss the empirical relevance of retained interests in Section 5.

Now we state the determination of earnings for the first period

$$e_1^A(k) \equiv (1-k)(p(k) - B_0) - kc + e^0 + k\left(B_1^A - B_0\right), \qquad A \in \{H\,(HC), M\,(MTM)\}$$

$$B_1^A = \begin{cases} p(k) & if\ A = M \\ B_0 & if\ A = H \end{cases}$$

At $t = 1$, the bank recognizes the profit for the portion of the loan that was sold,

[2] In practice, for example in FAS 157, MTM reflects the extent to which market prices for the same or similar assets influence the valuation of an asset. For example, under MTM retained interests could be directly marked to the market prices of the homogeneous portion that has been sold. Alternatively, if there are no homogeneous assets for the retained interest, retained interests could be valued by valuation models that use inputs implied from the market prices of the sold assets that derive from the same loan pools.

$(1-k)(p(k)-B_0)$. kc is the regulatory cost charge against earnings when the bank retains k portion of the loan. e^0 is the bank's earnings from all other sources and is assumed to satisfy $e^0 > c + B_0 - B$.[3] The crux of the analysis concerns the last term. The bank recognizes the economic profit or loss on the retention by revaluing it from its initial B_0 to its new book value B_1^A (per unit) under accounting regime A. Under MTM ($A = M$), the bank marks the (per-unit) book value of the retention to the market price, that is $B_1^A = p(k)$, and recognizes as earnings the capital appreciation of the retained interest, $k(p(k) - B_0)$. Under HC ($A = H$), the (per-unit) book value of the retained interest remains unchanged at its original cost B_0, that is $B_1^H = B_0$; the expected profit on the retained interest is not recognized at $t = 1$.

We turn to the earnings for the second period

$$e_2^A(k;\theta) \equiv k\left[(\theta + x) - B_1^A\right], \qquad \theta \in \{G, B\}, A \in \{H, M\}$$

At $t = 2$, when the loan pays off, $e_2^A(k;\theta)$ is recognized as the difference between the cash flow of the retained interest and its book value. Under HC $B_1^H = B_0$, so that the earnings at $t = 2$ equal $k[(\theta + x) - B_0]$. In contrast, under MTM $B_1^M = p(k)$, so that the earnings at $t = 2$ are given by $k[(\theta + x) - p(k)]$. For limited liability to bind at $t = 2$ with a probability that is positive but less than 1, the distribution of x has to be sufficiently risky. Specifically, we assume that $0 < F\left(B_1^A - \theta\right) < 1$ or $\underline{x} < B_1^A - \theta < \overline{x}$ for any A and θ.

Substituting the expressions for e_1^A and e_2^A into the retention problem (2), the bank's objective function at $t = 1$ can be rewritten as follows

$$U^A(k;\theta) = p(k) - B_0 + e^0 + k(-c + \theta - p(k) + A_\theta) \tag{4}$$

[3] This sufficient condition ensures that the game does not end at $t = 1$ under any accounting regime or retention decision. The results are not affected if e^0 is also added to earnings of other periods.

where

$$A_\theta \equiv \int_{\underline{x}}^{B_1^A-\theta} \left(B_1^A - \theta - x\right) dF(x) \tag{5}$$

A_θ is the option value of limited liability for the bank of type θ, $\theta \in \{G, B\}$, under accounting regime A, $A \in \{H, M\}$. It varies across bank types and accounting regimes. It is straightforward to show that it satisfies $G - B > A_\theta > 0$.

Retention is more costly for the bad type than for the good type under any accounting regime. The tradeoff driving the retention decision is clear from equation (4). The value of the retained interest k has three components. First, the bank bears a regulatory cost c, driving the bank to reduce its retention. Second, the bank receives an expected incremental payoff of $\theta - p(k)$ for the part of the fundamentals that has not been recognized as earnings at $t = 1$. This differential payoff across types makes signaling possible. Third, retention also gives the bank a free option A_θ and the value of this option varies across accounting regimes and types, partially offsetting the cost of retention for the bank.

As a benchmark, we assume that banks would follow the OTD model in the absence of information asymmetry in the loan market. Equivalently, cost c is high enough to discourage retention in the benchmark case despite the option value of retention, that is, $c > c_1 \equiv H_B + \left(\frac{1-\bar{k}}{\bar{k}}\right)(G - B)$. Note that H_B could be written out from the expression of A_θ (equation (5)).

3 Equilibrium

3.1 Retention decision at $t = 1$

At $t = 1$, the bank has learned its type and chooses a retention level to signal its type to the loan market. We focus only on separating equilibria.[4] To keep the focus on the economic discussion in the text, we refer the interested reader to Appendix B for the

[4]Since the loan price is not informative about the quality of the retained interest in a pooling equilibrium, our research question of how accounting measurement affects the informativeness of the loan price is moot among pooling equilibria.

standard technical details. For the retention game, Propositions 1 and 2 summarize the results.

Proposition 1. *Under HC, the unique separating equilibrium is the least costly separating equilibrium with* $k^{H*}(G) = \frac{G-B}{G-B+c-H_B}$ *and* $k^{H*}(B) = 0$. *The per-unit prices of the loans conditional on retention are* $p\left(k^{H*}(G)\right) = G$ *and* $p\left(k^{H*}(B)\right) = B$. *The banks' equilibrium payoffs are* $V^H(G) = G - B_0 + e^0 - k^{H*}(G)(c - H_G)$ *and* $V^H(B) = B - B_0 + e^0$.

In this equilibrium, the loan price is informative about the quality of the loan. Since the loan retained on the bank's books is homogeneous to the part sold in the market, the loan price is also informative about the quality of the retained interest. However, this informativeness of the loan price comes at a cost in that the bank with a good loan has to retain a critical fraction $k^{H*}(G)$ of the loan on its books. This signal costs the good bank $k^{H*}(G)(c - H_G)$.

Proposition 2. *Under MTM, there are two cases. Define* $c_2 \equiv M_B + \left(\frac{1-\bar{k}}{\bar{k}}\right)(G - B) > c_1$.

Case 1. If $c \geq c_2$, the unique separating equilibrium is the least costly separating equilibrium with $k^{M*}(G) = \frac{G-B}{G-B+c-M_B}$ and $k^{M*}(B) = 0$. The per-unit prices of the loans conditional on retention are $p\left(k^{M*}(G)\right) = G$ and $p\left(k^{M*}(B)\right) = B$. The banks' equilibrium payoffs are $V^M(G) = G - B_0 + e^0 - k^{M*}(G)(c - M_G)$ and $V^M(B) = B - B_0 + e^0$.

Case 2. If $c_2 > c > c_1$, there does not exist any pure-strategy separating equilibrium.

In the first case of the separating equilibrium, the bank with a good loan retains $k^{M*}(G)$ to serve as a signal of its quality. The price discovery in the loan market again comes at a cost of $k^{M*}(G)(c - M_G)$. In the second case of $c_2 > c > c_1$, the good bank still has an incentive to separate itself from the bad bank because $G > B$. However, the good bank could not perfectly do so because the level of retention is restricted by an upper bound of

$\overline{k}$. We examine the second case in Section 4.3. Until then we focus on the first case where there exists a unique separating equilibrium under both MTM and HC.

The information conveyed by the signaling game at $t = 1$ improves the efficiency of the origination game at $t = 0$ and thus the signaling game is not purely dissipative. We study this ex-ante benefit of signaling in the next subsection.

3.2 Origination decision at $t = 0$

Given the equilibrium in the retention game at $t = 1$, the solution to the origination problem at $t = 0$ in (3) is simply determined by its first-order condition

$$V^A(G) - V^A(B) = s'\left(m^{A*}\right) \tag{6}$$

Recall $s(m)$ is the private origination cost to the owner-manager. The condition has a unique interior solution if $s(m)$ satisfies the standard properties: $s(0) = 0, s'(0) = 0, s'(1) = S, s'' > 0$, where S is a large positive number. The most important feature of the first-order condition is that it is the expected payoff differential of good and bad loans at $t = 1$ that determines the bank's ex-ante incentive to exert effort. The higher the payoff differential, the higher the optimal effort m^{A*}. Note that m^{A*} is also the fraction of good loans in the economy by the law of large numbers. Price discovery in the loan market drives the origination efforts by banks and thereby determines the overall quality of loans in the economy. Accounting measurement affects the cost of price discovery and thus ex-ante incentives.

This link between the retention game at $t = 1$ and the origination decision at $t = 0$ is a key innovation that permits an ex-ante evaluation of MTM. At $t = 0$, the uncontractibility of the owner-manager's origination effort gives rise to a moral hazard problem. The solution to the moral hazard problem relies on the information supplied by the price discovery in the loan market at $t = 1$. This link grants significance to the standard signaling game at $t = 1$. In a stand-alone signaling model, signaling (separating equilibrium) in general is wasteful

from a social perspective and Pareto-dominated in particular when the fraction of the good type is low. Our model links the signaling game at the retention stage to the moral hazard problem at the origination stage and gives potential social value to the signaling game. Not only does accounting measurement directly affect the retention decision at $t = 1$, it also influences the bank's origination efforts at $t = 0$. This has implications for the comparison of different types of securitizations and current proposals to regulate them, as we will discuss in Section 5.3.

For convenience and completeness, we also state the benchmark case of symmetric information in the loan market.

Lemma 2. *When θ is public information, the accounting regime is irrelevant and banks follow the OTD model. In the unique equilibrium, the banks distribute the entire loan by setting $k^* = 0$. The per-unit prices of the loans are $p(G) = G$ and $p(B) = B$. The banks' equilibrium payoffs are $V^A(G) = G - B_0 + e^0$ and $V^A(B) = B - B_0 + e^0$. The bank exerts first-best effort satisfying the first-order condition (6).*

4 Analysis

In this Section, we analyze the economic consequences of moving from HC to MTM for banks and the loan market. Relative to HC, MTM forces banks to retain greater exposure to the risk of the loans they originated on their own books and could reduce banks' ex-ante incentive to originate good loans. We also show that MTM, in an attempt to exploit the information in the loan price, could destroy its informativeness.

4.1 MTM and banks' exposure to risk

Proposition 3. *When $c \geq c_2$, banks retain more loans on their own balance sheets under MTM than they do under HC, that is, $k^{M*} \geq k^{H*}$ (equality for type B).*

MTM induces banks to deviate further away from their OTD model. The OTD model dictates that banks distribute the risk of the loans they originated to investors who are

better able to bear it. In the absence of information asymmetry in the loan market, banks therefore dispose of all of their loans regardless of the accounting regime, as in Lemma 2. However, the information asymmetry between banks and investors is an inevitable consequence of banks' expertise in originating loans. In this second-best scenario, the efficiency of the loan market in identifying loan quality is only sustained by good banks' suboptimal exposure to the risk of the loans they originated. The accounting regime matters now by influencing the economic tradeoffs of the retention decision.

Proposition 3 shows that MTM leads to greater suboptimal risk retention than HC. The intuition is clear. The bad bank's incentive to mimic drives the equilibrium retention. In equilibrium, the bad bank with the equilibrium retention $k^{A*}(B) = 0$ receives an expected payoff of $B - B_0 + e^0$. In contrast, if the bad type mimicked the good type with $k^{A*}(G)$, it would receive an expected payoff of $U^A\left(k^{A*}(G); B\right) = G - B_0 + e^0 + k^{A*}(G)(-c + B - G + A_B)$. The binding incentive compatibility condition of the bad type equates the two expected payoffs, resulting in

$$G - B = k^{A*}(G)(G - B + c - A_B)$$

for $A \in \{H, M\}$. Since the marginal benefit for bad banks to mimic is fixed at $G - B$, the equilibrium retention is determined by the bad bank's marginal retention cost, $G - B + c - A_B$, $A \in \{H, M\}$.

Lemma 3. *The option value of limited liability for bad banks is larger under MTM than under HC, that is, $M_B > H_B$.*

While holding the marginal benefit constant, early recognition of the expected economic profit on the retained position reduces the marginal retention cost for bad banks and thereby increases their incentive to mimic. As a result, good banks are forced to retain a larger position in order to distinguish themselves from bad banks.

Proposition 3 helps explain the puzzling observation that banks have maintained excessive exposure to the risk of the loans they originated. This concentration of risk in the

banking sector has been alleged as one of the key factors that turned the subprime mortgage crisis into a full-fledged financial crisis. Banks retain skin in the game to overcome the information asymmetry problem in the loan market. MTM exacerbates the problem by forcing banks to put even more loans on their own balance sheets.

This costly retention affects the value of loans to banks. We examine the consequence of the loan value for the banks' origination decision next.

4.2 Incentive to originate good loans

Proposition 4. *There exists a threshold of* c, $\widehat{c}$ (defined in the proof below)*, above which the expected payoff of originating a good loan at* $t = 0$ *is lower under MTM than it is under HC, that is,* $V^M(G) < V^H(G)$.

Proof. Denote the value differential of a good loan under MTM and HC by $\Delta(c)$.

$$\begin{aligned}
\Delta(c) &\equiv V^M(G) - V^H(G) \\
&= k^{H*}(G)(c - H_G) - k^{M*}(G)(c - M_G) \qquad (7) \\
&= \frac{G - B}{(G - B + c - M_B)(G - B + c - H_B)} \times \\
&\quad [(G - B)(M_G - H_G) + M_B H_G - M_G H_B - c[M_B - H_B - (M_G - H_G)]]
\end{aligned}$$

As shown in Lemma 4 (on the following page), $M_B - H_B - (M_G - H_G) > 0$. Thus, $\Delta(c)$ is decreasing in c. Further, $\Delta\left(\frac{(G-B)(M_G-H_G)+M_B H_G - M_G H_B}{[M_B - H_B - (M_G - H_G)]} + \varepsilon\right) < 0$ for any positive ε. Thus, if $\Delta(c_2) < 0$, $V^M(G) < V^H(G)$; if $\Delta(c_2) > 0$, there exists a $c^* > c_2$ such that $\triangle(c^*) = 0$. For any $c > c^*$, $\triangle(c) < 0$. Whether $\Delta(c_2) > 0$ depends on the shape of $f(x)$. Thus, $V^M(G) < V^H(G)$ if $c > \widehat{c} \equiv \max\{c^*, c_2\}$. □

Proposition 4 shows that MTM could reduce the value of originating good loans. In the presence of information asymmetry in the loan market, the value of owning a good loan crucially depends on the price discovery in the loan market. However, price discovery, via signaling in the model, is costly and offsets the value of originating good loans. When the

informativeness of the loan price relies on the banks' incentive to signal and MTM changes the banks' incentive to signal, the efficiency of MTM of exploiting the information in the loan market is compromised.

Under HC, the separating equilibrium is inefficient in that banks cannot recognize the expected economic profit on the retained interest, the quality of which is fully revealed in equilibrium. MTM intends to overcome this inefficiency through early recognition based on the loan price. All else equal, MTM increases the option value of retention to compensate good banks for bearing the retention cost. However, early recognition under MTM also increases the bad banks' incentive to mimic. As shown in Proposition 3, MTM forces good banks to retain a higher portion of the loan. As a result, the net impact of MTM on the value of originating a good loan is a tradeoff between a lower unit retention cost and a higher equilibrium retention.

This tradeoff, as highlighted in equation (7), is complicated. For example, regulatory cost c both reduces the retention level ($\frac{\partial k^{A*}(G)}{\partial c} < 0$) and increases the unit retention. Proposition 4 shows that the balance is tilted to the detriment of MTM as c increases. The key to understanding the intuition behind Proposition 4 is the following Lemma.

Lemma 4. *While the option value of limited liability increases for both good and bad banks when switching to MTM, it increases more for bad banks, that is $M_B - H_B > M_G - H_G$.*

The bad bank benefits more from the early recognition under MTM because it is much closer to the threshold of limited liability if it holds the same fraction of the loan as the good bank. This differential change in the option value of limited liability for bad and good banks drives the result in Proposition 4.

The retention level is determined by the *bad* bank's marginal retention cost $c - A_B$ while the unit retention cost is determined by the *good* bank's marginal retention cost $c - A_G$. When switching from HC to MTM, the reduction in the good bank's marginal retention cost is less than the reduction of the bad bank's marginal retention cost. When c is high, the level effect dominates the unit retention effect and MTM reduces the value

of originating good loans.

Corollary 1. *For $c > \widehat{c} \geqslant c_2$, banks exert less effort ex ante to originate good loans under MTM than under HC, that is, $m^{M*} < m^{H*}$. As a result, the overall loan quality in the economy is lower under MTM than it is under HC.*

4.3 Information and liquidity under MTM

Moving to MTM increases the equilibrium retention of loans. Since retention is restricted to $\overline{k}$ at most, signaling becomes impossible when the required retention exceeds $\overline{k}$. This happens when the direct cost c is mild and thus fails to deter bad banks from mimicking.

Proposition 5. *For $c_2 > c > c_1$, there does not exist any pure-strategy separating equilibrium under MTM. In contrast, there is a unique pure-strategy separating equilibrium under HC.*

In an attempt to "correct" the inefficiency of HC by exploiting the informativeness of the loan price, MTM destroys the information in the loan price. In the presence of market frictions, the informativeness of the asset prices is fragile in that it is sustained by a costly underlying market process. The previous two subsections show that the attempt to extract information from the asset prices makes the underlying process much costlier. Further, Proposition 5 shows that in the extreme destroys the informativeness of the loan price.

This theoretical observation is of particular importance to accounting. Accounting is always an integral part of a firm's institution and serves to fulfill a firm's business model. A firm's business model is viable only if the firm has some competitive advantage over the market in conducting its activities. In other words, a firm operates in areas where market frictions are present. Since which assets and liabilities a firm holds on its balance sheet is dictated by its business model, it is unlikely that a firm's core assets and liabilities, which accounting is designed to measure, are actively traded in frictionless markets. Therefore, when we contemplate on the effect of accounting rules, such as MTM, it is important

to put the issue in the context of a firm's business model and the accompanying market imperfections.

Since accounting is designed to cope with the frictions in the market, one should be cautious not to over-rely on the market to solve problems in accounting. The debate about MTM often focuses exclusively on the exogenous liquidity in asset markets. Many commentators have observed that there are no active markets for a bank's assets and liabilities and consequently expressed concerns about applying MTM under those circumstances.

Our model goes one step further. Not only does accounting passively respond to the exogenous liquidity, we also show that accounting could actively influence the provision of information and liquidity in asset markets. In fact, even if there appears to be an active market, applying MTM may be detrimental to the functioning of this market and could have unintended consequences both for the information and the liquidity in this market. We emphasize two such effects.

First, the informativeness of the loan price is sustained by the costly signaling of the good bank and could disappear under the pressure from MTM. Marking the retained interest to the market price makes it more costly for the good bank to send a signal relative to HC. The higher cost reduces the incentive to supply information to the market and the information in the loan price vanishes in the extreme.

Second, MTM directly influences market liquidity leaving it extremely fragile. Before applying MTM, there is an active market that trades the $1 - k$ portion of the same loan. Since the retained securities are identical to those traded in the market, it therefore seems "indisputable" that an active market for the retained interest exists. Therefore, one may argue that MTM should be preferred for the valuation of the retained interest. The existence of an active market for the retained interest is nonetheless an illusion for the bank. As soon as the bank starts to mark the value of the retained interest to the market price, the loan market responds and the liquidity either deteriorates or disappears.

5 Discussion and Extensions

The basic model illustrates the point that the attempt to exploit the information in asset prices interferes with the market mechanism that sustains the informativeness of price in the first place. It is this feedback effect that could compromise the efficiency of MTM and other market-based policies. In this Section, we discuss the robustness of the model to various alternative specifications and provide justifications for some key assumptions.

5.1 Interpretations of retention cost c

Cost c plays a crucial role in the model. Conceptually, c reflects the cost excess for the bank, relative to other parties, to hold the loan. In the past three decades, the banking business model has been shifting from the traditional "originate-to-hold" model to the "originate-to-distribute" model (e.g. Bernanke (2008)).[5] This shift is driven by the relative cost of financing loans with internal versus external capital. Berger, Kashyap, and Scalise (1995) "emphasizes regulatory changes and technical and financial innovations as the central driving forces behind transformation of the industry". Deregulation has increased competition in deposit markets and increased the cost to fund loans with deposits; technical and financial innovations reduce the cost to obtain funds from the loan market. As the internal cost of capital increases and external cost of capital decreases, it becomes more likely that the bank that originates the loan is not the best party to hold the loan. We capture this driving force behind the OTD model by assuming that the bank, relative to investors in the loan market, incurs an extra cost c for retaining a unit of risky asset on its balance sheet.

One interpretation of the cost c is the regulatory cost imposed on regulated financial

[5] By the second quarter of 2008, the outstanding balance of asset-based securities (ABS), including both mortgage and non-mortgage related ABS, is estimated to be \$10.24 trillion in the United States and \$2.25 trillion in Europe, with an issuance of \$3,455 billion in the U.S. and \$652 billion in Europe in 2007, according to SIFMA data. Securities Industry and Financial Markets Association (SIFMA), http://www.sifma.org/research/pdf/2008-08_ESF_Q2.pdf. In addition, banks also distribute loans through the syndicated loan market and the secondary loan market, which had an annual volume exceeding \$1 trillion in the past few years.

institutions. It could be thought of as the assessment charged by the Federal Deposit Insurance Corporation (FDIC) in the United States, which is a function of the risk of a bank's balance sheet. Alternatively, a typical capital requirement stipulates that banks set aside a capital reserve for the risky assets on their balance sheets. c reflects the marginal cost for the bank to meet the capital requirement when they take on one more unit of a risky asset.

For unregulated financial institutions, the cost c could correspond to any cost differentials for them and investors to fund loans. For example, c could be interpreted as the cost associated with the lack of diversification when a financial institution retains all of the loans it originates on its own books (e.g. Leland and Pyle (1977)). For another example, c could reflect the relative expertise or investment opportunity of the financial institution and investors in the loan market. The financial institution has a competitive advantage in originating loans but other parties (investors) have a competitive advantage in managing the loans; similarly, the financial institution has other profitable investment projects but faces a financial constraint while investors have idle capital (e.g. Gorton and Pennacchi (1995)).

5.2 Other alternatives to improve the efficiency of MTM

Given the possible inefficiency of MTM, an interesting question is whether measures to improve its efficiency exist either in the hands of the regulator or the bank? When c is interpreted as a regulatory cost, one might naturally wonder if regulators could improve the efficiency of MTM by linking c to such observable bank characteristics as the retention level. The optimal design of c in a general setting is apparently beyond the scope of this paper. Instead, with the interpretation of c as the FDIC assessment, if we assume that regulators are subject to the same budget constraints under HC and MTM, then, a combination of MTM and any assessment rule that links c to the retention does not qualitatively change the trade-off of MTM. The intuition is as follows. Indexing c to the retention is based on the same idea as MTM, namely to exploit the information in loan price. Since regulators

have the same information problem investors face, the change in c cannot be set as a function of the bank's true type and instead has to be imposed uniformly. Since bad banks benefit more from early recognition, the differential benefit still exists after the regulators increase c for both banks and indexing c to retention k could exacerbate the problem in the same way MTM does.

Banks could take some measures to exploit the information in the retention. For example, banks could resell, hedge, or collateralize the retained interest after its quality has been established by the signaling game. These issues do not arise in our model because it only spans two periods but would if we allowed for a more elaborate model. However, conceptually these measures share the same idea of exploiting the information in the loan market. We conjecture that the essence of the arguments in the previous paragraph still applies. There is no free information when information has to be sustained by a costly private action.[6]

5.3 Pre-commitment vs. ex-post discretion in loan distribution

In our model banks choose the retention after they learn about the quality of their loans, resulting in ex-post inefficiency of dissipative signaling. An alternative is for banks to use pre-committed retention whereby banks pre-commit to a retention level before they originate loans. An apparent drawback of this pre-commitment is that nothing could prevent the banks from deviating from the commitment after they learn the information ex post. More subtly, discretionary ex-post retention dominates pre-committed retention when the moral hazard problem in loan origination is severe. The intuition highlights the novel feature of our model that information revealed through ex-post signaling is useful in resolving the moral hazard in the origination effort. Thus, the value of ex-post signaling is greater the more severe the moral hazard problem in the origination. Therefore, the severity of moral hazard in loan origination is an important predictor of the bank's choice

[6] From a theoretical perspective, there is a vast literature on how to address this commitment issue in signaling games (e.g. Admati and Perry (1987); Nöldeke and Van Damme (1990); Swinkels (1999)).

of securitization methods.

5.4 Relevance of "skin in the game"

We use "skin in the game" to motivate the rationale for holding retained interest and then study the effect of accounting measurement of retained interest. While it is still debated whether "skin in the game" actually worked as intended, there is both theoretical and empirical support for this assumption. Retaining partial interests by the bank could be a solution to both its information advantage over investors or its unobservable incentive to improve the value of loans (e.g. Leland and Pyle (1977); Gorton and Pennacchi (1995); DeMarzo and Duffie (1999); Gorton, He, and Huang (2008)). There is also empirical evidence indicating that banks do have private information and use retention as a signal (e.g. Simons (1993); Sufi (2007); Loutskina and Strahan (2008); Keys, Mukherjee, Seru, and Vig (2009)). Further, retained interest is typically a large component on a bank's balance sheet and exerts important influences on a bank's income statement. Using the data from regulatory filings (e.g. schedules HC-S in Y-9C and RC-S in Call Reports) that U.S. bank holding companies file quarterly with the Federal Reserve, Chen, Liu, and Ryan (2008) report that on average the value of interest-only strips and subordinated asset-backed securities, two components of retained interests, accounts for about 11% of the outstanding principal balance of private label securitized loans. The information about a bank's position in retention interest is also available from SEC filings (e.g. 10-Q and 10-K) if the position is material.

5.5 Middle ground: Lower of Cost or Market

Our analysis relies on the comparison of two accounting regimes in their pure forms. In the model, book values under MTM rely solely on current information extracted from market prices while book values under HC do not at all. This choice of pure accounting regimes is intentional to underscore the main theoretical point of the paper. In reality, HC is often implemented using information from market prices in some circumstances in the form of

the so-called lower-of-cost-or-market rule (LCM). LCM requires a downward revaluation of the book value of an asset from its current book value but does not allow an upward revaluation. In other words, relative to HC, LCM requires the early recognition of losses (and is thus also known as HC with impairment). Note that in our model LCM would behave in the same manner as HC because the early recognition of losses is not an issue. Rather, the inefficiency in our model under HC manifests itself as the undervaluation of retained interest and this undervaluation issue would still exist under LCM.

5.6 Proportional retention and optimal security design

We model the retention as a proportional holding to circumvent the issue of optimal security design. In general, the optimal securities that should be retained as skin in the game are those that are most sensitive to the seller's private information (Innes (1990); DeMarzo and Duffie (1999); Fender and Mitchell (2009)). Proportional retention is optimal only in certain environments. However, endogenizing the security design in our model creates additional complexity. One issue is that the optimal security design provides banks another way for differentiation. How accounting measurement interacts with the optimal security design is an interesting topic in and of itself. Another issue regarding introducing optimal security design is that it requires the endogenous specification of the regulatory cost c, which is an important component of the payoff of the retention. We leave this extension to future research.

6 Conclusion

In this paper, we propose a new mechanism by which MTM could impose inefficiency on banks. We show that, relative to HC, MTM could induce banks to retain excessive exposure to the risk of the loans they originated and reduce banks' ex-ante incentive to originate good loans. These results derive from the main theoretical insight of the paper. In the presence of market frictions, the informativeness of asset prices is fragile in that

it is sustained by an underlying market process. The attempt to extract information from asset prices makes the underlying process costlier and in the extreme destroys the informativeness of the price. It is this feedback effect that compromises the efficiency of MTM and causes damage to the real economy. Our paper underscores that information and liquidity in asset markets are not exogenous. Rather, they are determined by the incentives and ability of market participants to overcome market frictions. Accounting measurement changes these incentives. Understanding the interplay between accounting measurement and the market process that deals with the market friction is thus of importance if we are to improve the functioning of markets with frictions.

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Appendices

A Accounting Treatment for Retained Interest in Securitizations

In general, the shift from HC to MTM has accelerated during the past decade. This appendix describes the accounting for retained interests of securitizations.

Conditional on sales accounting, FAS 140 stipulates the accounting treatment on the transaction date. The subsequent revaluation depends on how the retained interest, a security, is classified. Securities can be classified as trading, available-for-sale (AFS), or held-to-maturity (HTM), with different accounting treatments (FAS 115 and FAS 157). The only restriction FAS 140 imposes on subsequent classification is that prepayment-sensitive securities be classified as either trading or AFS. For simplicity, we assume that the loan is measured at cost before the transaction.

On the transaction date, items could be classified into two overlapping categories for accounting purposes: proceeds received and retained interest. Proceeds received include cash and any other assets obtained, such as derivatives received that do not use the transferred assets as underlying assets. Liabilities incurred, including recourse commitments, are both proceeds and retained interest. Other retained interests include interests in transferred assets, such as proportional holding, interest-only strips (IO), subordinated securities, and Mortgage Servicing Rights (MSRs).

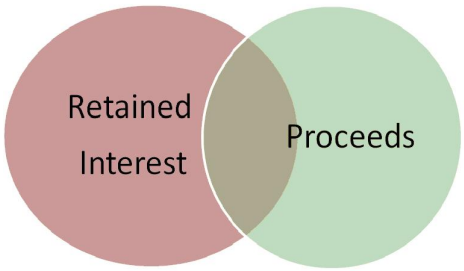

Figure 3: Classification of considerations from a securitization

For accounting purposes, retained interests that are not proceeds are recorded at prorated cost at inception (the proration is based on fair value). The rationale is that the firm has not relinquished its control over these assets and therefore these are not considered to have been sold yet. However, this rationale is overwritten when the retention is classified as an AFS or trading security and thus FAS 115 and FAS 157 apply.

The proceeds are fair valued at inception. The firm receives these assets or assumes these liabilities as considerations for the sale. FAS 156 requires the fair value option for MSRs at inception (afterwards firms can choose whether to measure MSRs at impaired cost or fair value) and therefore treats MSRs as proceeds. FAS 166 further requires that all assets obtained and liabilities incurred in a securitization be initially measured at fair value. Thus, for accounting purposes, there are no retained interests that are not proceeds after FAS 166.

Subsequently, the accounting treatment of retained interests as well as the proceeds depends on their classification. FAS 140 does not directly govern the classification; instead, FAS 115 and FAS 157 apply. The only requirement of FAS 140 is that prepayment-sensitive securities could not be classified as HTM. It can only be prepayment sensitive if the underlying loans are subject to prepayment (e.g. residential mortgages but not commercial mortgages). Therefore, not only the retained interests but also the proceeds could be revalued either at impaired cost or at fair value. Most big banks choose fair value. The incurred liabilities could be subject to FAS 5 Loss Contingency.

The transferability of the retained interests is typically not restricted in securitizations. Banks could transfer the retained interests, including selling MSRs or securitizing the IOs. This transferability does not contradict skin in the game. If the retention was previously used for signaling, banks wouldn't be able to sell it at a price commensurate with "high retention". As a result of this transferability and the FAS 140's requirement that prepayment-sensitive retained interests couldn't be classified as HTM, retained interests are rarely classified as HTM.

B Proofs

Proof of Lemma 1

The bank at $t = 0$ starts with a cash balance C, a loan B_0, a debt (deposits) D that pays an interest rate normalized to zero, an initial equity r that satisfies the minimum capital requirement, and no retained earnings. For simplicity, we assume that there are no new accruals at $t = 1$ except for the revaluation of the retained asset. That is, the bank pays the regulatory cost and dividend with cash and receives cash for the earnings from other sources (e^0) at $t = 1$. The cash flow of the loan, $\theta + x$, realizes at $t = 2$. Recall from the text that d_1 and d_2 are the dividends for periods 1 and 2, respectively. For simplicity, we also include in d_2 the liquidation of initial equity at $t = 2$. The bank's retention decision at $t = 1$ could be written as follows

$$\max_{k,d_1,d_2} d_1 + E_1\left[\widetilde{d}_2\right] \tag{8}$$

$$s.t.\ d_1 \geq 0, \quad d_2 \geq 0 \tag{9}$$

$$d_1 \leq e_1 \tag{10}$$

$$C + B_0 = D + r \tag{11}$$

$$e_1 + e_2 = \theta + x - B_0 - ck + e^0 \tag{12}$$

$$d_2 \leq \max\left\{C + e^0 - ck - d_1 + \theta + x - D, 0\right\} \tag{13}$$

We prove that this dividend-based program is equivalent to the following earnings-based program

$$\max_k e_1(k) + E_1\left[\max\{\widetilde{e}_2(k), 0\}\right]$$

We omit index A because the proof does not depend on the accounting regime. Constraint (9) captures the bank's limited liability: the dividend distribution cannot be negative. Constraint (10) applies Assumption 1 that d_1 cannot exceed the retained earnings at $t = 1$ before dividends (the initial retained earnings are assumed to be zero). As discussed

in footnote 3, we have assumed that $\max\{e_1(k), 0\} = e_1(k)$ to avoid the uninteresting case in which the game ends at $t = 1$. Thus, constraint (10) is $d_1 \leq e_1$. Constraint (11) is the accounting identity at $t = 0$: assets equal debt plus equity. Constraint (12) imposes the restriction that the sum of earnings over the life of the bank should equal the sum of the bank's net cash flow (net of debt and initial equity). Constraint (13) imposes the payout restriction on d_2 when the bank is liquidated. It states that the distribution to equity holders at $t = 2$ is the residual. At $t = 2$, the bank starts with a cash balance $C + e^0 - ck - d_1$, receives $\theta + x$ cash from the loan, and pay cash D to debt holders. The residual cash, $\max\left\{C + e^0 - ck - d_1 + \theta + x - D, 0\right\}$, is distributed back to the equity holders. We could rewrite it as follows

$$\begin{aligned} d_2 &\leq \max\left\{C + e^0 - ck - d_1 + \theta + x - D, 0\right\} \\ &= \max\left\{\theta + x - B_0 - ck + e^0 - d_1 + r, 0\right\} \\ &= \max\{e_1 + e_2 - d_1 + r, 0\} \end{aligned}$$

The second to last step follows from constraint (11) and the last step from constraint (12). In equilibrium, this constraint must bind as the bank would otherwise leave resources in the firm upon liquidation. Therefore,

$$d_2^* = \max\{e_1 + e_2 - d_1 + r, 0\} \tag{14}$$

At $t = 1$, given k, the bank faces the following problem

$$\begin{aligned} &\max_{d_1} d_1 + E_1\left[\max\{e_1 + \widetilde{e}_2 - d_1 + r, 0\}\right] \\ s.t. \quad & d_1 \leq e_1 \end{aligned}$$

The objective function is increasing in d_1. Therefore,

$$d_1^* = e_1 \tag{15}$$

Plugging d_1^* into (14),

$$\begin{aligned} d_2^* &= \max\{e_2 + r + e_1 - d_1, 0\} \\ &= \max\{e_2 + r, 0\} \end{aligned}$$

Plugging both d_1^* and d_2^* into the objective function (8), we could rewrite the bank's objective function as

$$\max_k e_1(k) + E_1\left[\max\{\widetilde{e}_2(k) + r, 0\}\right]$$

This proves Lemma 1.

Proof of Lemmas 3 and 4

Since subsequent proofs use Lemmas 3 and 4, we prove these first.

Let $y \equiv B_1^A - \theta$

$$\frac{dA_\theta}{dy} = \frac{d}{dy}\int_{\underline{x}}^{y} (y - x)\, dF(x) = F(y) > 0$$

In any separating equilibrium under HC and MTM, $p\left(k^{H*}(G)\right) = p\left(k^{M*}(G)\right) = G$ and only the good bank retains a positive portion of the loan. Thus, $B_1^A = G$ or B_0. Since $B_0 - B < G - B$, $H_B < M_B$. Since $B_0 - G < G - G$, $H_G < M_G$. This proves Lemma 3.

Further,

$$\frac{d^2 A_\theta}{dy d\theta} = -f(y) < 0$$

Since $G > B$, $(M_B - H_B) > (M_G - H_G)$. This proves Lemma 4.

Proof of Proposition 1

The equilibrium concept we use for the retention game is Perfect Bayesian Equilibrium (PBE).

Definition. (Perfect Bayesian Equilibrium) A Perfect Bayesian Equilibrium (PBE) is a strategy profile (p, k) and belief $\mu(\theta|k)$ such that

1. given investors' pricing strategy $p(k)$ and belief $\mu(\theta|k)$, the bank's retention strategy $k(\theta)$ maximizes its expected payoff $U^A(k(\theta);\theta)$;

2. given the bank's retention strategy $k(\theta)$, investors break even under the pricing strategy $p(k)$;

3. investors' belief $\mu(\theta|k)$ is consistent with their pricing strategy $p(k)$ and updated according to Bayes rule, where possible.

We first identify all the separating PBEs. In a separating PBE, $k^{A*}(G) \neq k^{A*}(B) = 0$ and the equilibrium belief is $\mu(G|k^{A*}(G)) = \mu(B|k^{A*}(B)) = 1$. Given the equilibrium belief, the complete set of separating PBE levels of retention (S_s) is determined by the incentive compatibility constraints of both types.

$$U(0;B) \geq U\left(k^{A*}(G);B\right) \Rightarrow k^{A*}(G) \geq \frac{G-B}{G-B+c-A_B} \tag{16}$$

$$U\left(k^{A*}(G);G\right) \geq U(0;G) \Rightarrow k^{A*}(G) \leq \frac{G-B}{c-A_G} \tag{17}$$

$$S_s = \left\{(k^{A*}(G), k^{A*}(B))|k^{A*}(B) = 0, k^{A*}(G) \in \left[\frac{G-B}{G-B+c-A_B}, \frac{G-B}{c-A_G}\right]\right\} \tag{18}$$

S_s is nonempty since $G - B > A_B - A_G$.

We now apply the Intuitive Criterion to refine away all PBEs that involve $k^{A*}(G) \in \left(\frac{G-B}{G-B+c-A_B}, \frac{G-B}{c-A_G}\right]$. For any such $k^{A*}(G)$, consider a deviation $\widehat{k}^A = \frac{G-B}{G-B+c-A_B}$. The Intuitive Criterion requires that $\mu(B|\widehat{k}^A) = 0$ because $\widehat{k}^A$ is an equilibrium-dominated action for type B by equation (16) (the most favorable belief of investors upon observing $\widehat{k}^A$ is G). This implies that $\mu\left(G|\widehat{k}^A\right) = 1$. Given this belief, $\widehat{k}^A$ is a profitable deviation for type G by equation (17). Thus, any $k^{A*}(G) \in \left(\frac{G-B}{G-B+c-A_B}, \frac{G-B}{c-A_G}\right]$ does not survive.

The only PBE that survives is $(k^{A*}(B) = 0, k^{A*}(G) = \frac{G-B}{G-B+c-A_B})$. Finally, since $c > c_1 \equiv H_B + \left(\frac{1-\overline{k}}{\overline{k}}\right)(G-B)$, we have $k^{H*}(G) \in \left(0, \overline{k}\right)$.

Proof of Proposition 2

Case 1: $c \geq c_2$. The proof is in Proposition 1 (setting $A = M$). Since $c \geq c_2 \equiv M_B + \left(\frac{1-\overline{k}}{\overline{k}}\right)(G-B)$, we have $k^{M*}(G) \in \left(0, \overline{k}\right]$. $c_2 \geq c_1$ follows from Lemma 3.

Case 2: $c_2 > c > c_1$. From the proof of Case 1, any separating equilibrium requires $k^{M*}(G) \geq \frac{G-B}{G-B+c-M_B}$. If $c_2 > c > c_1$, then $k^{M*}(G) > \overline{k}$, which is infeasible. Thus, there does not exist any pure-strategy separating equilibrium.

Proof of Lemma 2

With the loan quality being public information, loans are priced at their expected cash flow θ. That is, $p(k) = \theta$. A bank of type θ under accounting regime A chooses k to maximize

$$U^A(k;\theta) = \theta - B_0 + e^0 - k\left(c - L(A,\theta)\right)$$

$$L(A,\theta) \equiv \int_{\underline{x}}^{B_1^A - \theta} \left(B_1^A - \theta - x\right) dF(x), \qquad A \in \{H, M\}$$

By Lemma 3 and $G > B_0 > B$, it could be verified that $\max\{L(A,\theta) : A \in \{H,M\}, \theta \in \{G,B\}\} = H_B < c_1$.

Thus, when $c > c_1 > \max\{L(A,\theta) : A \in \{H,M\}, \theta \in \{G,B\}\}$, $c - L(A,\theta)$ is always positive. Hence, $k^* = 0$ for both banks under both accounting regimes and $V^A(\theta) \equiv U^A(0;\theta) = \theta - B_0 + e^0$. The optimal effort m^* is such that $s'(m^*) = G - B$, which is independent of the accounting regime A.

Proof of Proposition 3

For $c \geq c_2$, we have

$$k^{H*}(G) - k^{M*}(G) = \frac{G - B}{[G - B + (c - H_B)]\,[G - B + (c - M_B)]}(H_B - M_B) < 0$$

The last inequality follows from Lemma 3.

Proof of Corollary 1

It follows directly from Proposition 4 and the optimal origination effort in equation (6).

Proof of Proposition 5

It follows directly from Propositions 1 and 2.