

# Marking-to-Market: Panacea or Pandora's Box?\*

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## Abstract

Financial institutions have been at the forefront of the debate on the controversial shift in international standards from historical cost accounting to mark-to-market accounting. We show that the trade-offs at stake in this debate are far from one-sided. While the historical cost regime leads to some inefficiencies, marking to market may lead to other types of inefficiencies by injecting artificial risk that degrades the information value of prices, and induces sub-optimal real decisions. We construct a framework that can weigh the pros and cons. We find that the damage done by marking to market is greatest when claims are (i) long-lived, (ii) illiquid, and (iii) senior. These are precisely the attributes of the key balance sheet items of banks and insurance companies. Our results therefore shed light on why banks and insurance companies have been the most vocal opponents of the shift to marking to market.

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# 1 Introduction

Accounting is sometimes seen as a veil - as a mere detail of measurement - leaving the economic fundamentals unaffected. The validity of such a view would be overwhelming in the context of completely frictionless competitive markets. Accounting would be irrelevant in such a world, since market prices are fully observable and common knowledge among all. Or, to put it the other way round, accounting is relevant only because we live in an *imperfect* world, where transaction prices may not correspond to the hypothetical market prices that would prevail in frictionless competitive markets. Therefore, the nature and consequences of the imperfections are key to the debates in accounting.

One debate that illustrates well the various issues at stake is the recent initiative of the International Accounting Standards Board (IASB) and the U.S. Financial Accounting Standards Board (FASB) toward convergence of accounting standards to a global one based on a “fair value” or “mark-to-market” reporting system in which market prices are employed in valuations as much as possible. This is in contrast to measurement systems based on historical cost which require firms to record their assets and liabilities at their original prices with no adjustments for subsequent changes in the market values of those items.<sup>1</sup>

Proponents of marking to market argue that the market value of an asset or liability is more relevant than historical cost because it reflects the amount at which that asset or liability could be bought or sold in a current transaction between willing parties. A measurement system that reflects the transactions prices would therefore lead to better insights into the risk profile of firms currently in place so that investors could exercise better market discipline and corrective action on firm’s decisions.

However, for many important classes of assets, the prices at which transactions take place do not match up well to the ideal of the hypothetical frictionless competitive market. Loans are a good example. Loans are not standardized, and do not trade in deep and liquid markets. Instead, they are typical of many types of assets that trade primarily through the over-the-counter (OTC) market, where prices are determined via bilateral bargaining and matching. Loans are also packaged and tranced into asset backed securities such as collateralized debt

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<sup>1</sup>A (small) selection of literature debating the issue includes Volcker (2001), Herz (2003), Hansen (2004), European Central Bank (2004). See also industry studies, such as the joint international working group of banking associations (JWGBA (1999)), and the Geneva Association (2004).

obligations (CDOs). However, such transactions take place in OTC markets. Thus, finding the “fair value” of a loan or securitized asset is an exercise in finding the hypothetical price that would prevail were frictionless markets to exist for such assets. Hypothetical prices can be inferred from discount rates implied by transactions prices of related securities, but OTC markets do not conform to the ideal of deep and liquid markets of the frictionless economy. OTC markets are often illiquid, displaying time varying risk premia that depend sensitively on supply shocks. They exhibit low “resiliency” in the sense that transactions prices jump after large supply shocks, with prices recovering only slowly after the shock, consistent with slow absorption of the new supply by investors and intermediaries. We discuss some of the evidence in the main body of the paper.<sup>2</sup>

The key to the debate is whether fair value accounting injects *excessive* volatility into transactions prices - i.e. whether marking to market leads to the emergence of an additional, endogenous source of volatility that is purely a consequence of the accounting norm, rather than something that reflects the underlying fundamentals. Real decisions are then distorted due to the measurement regime.

It is possible to draw an analogy with the theory of the second best from welfare economics. When there is more than one imperfection in a competitive economy, removing just one of these imperfections need not be welfare-improving. It is possible that the removal of one of the imperfections magnifies the negative effects of the other imperfections to the detriment of overall welfare.

Our paper is an attempt to shed light on how the second-best perspective can be brought to bear on the debate on optimal accounting standards, and to provide a framework of analysis that can weigh up the arguments on both sides. Indeed, as we will argue below, issues of measurement have a far reaching influence on the behavior of financial institutions, and determine to a large extent the efficiency of the price mechanism in guiding real decisions.

In spite of the practical importance of the issue, there has been surprisingly little theoretical work on the economic trade-offs of mark-to-market versus historical cost measurement policies until recently.<sup>3</sup> The recent papers by Allen and Carletti (2007) and Gorton, He

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<sup>2</sup>By coincidence, the final version of this paper is being prepared in the midst of the subprime mortgage liquidity crisis of the summer of 2007. The events of 2007 illustrate vividly many of the issues to be discussed below.

<sup>3</sup>There are some notable exceptions. O’Hara (1993) investigates the effect of market value accounting

and Huang (2006) are among the few papers that have investigated the financial stability implications of accounting rules, and hence shares similar objectives as our paper. Like our paper, Allen and Carletti (2007) also study an environment with illiquid items such as long term loans and insurance liabilities held by financial institutions. There are, however, important differences. In our paper, illiquidity implies that the price of an asset is sensitive to the decisions of other financial institutions. We show that such illiquidity leads to strategic complementarities that destabilize prices by creating endogenous risk. In Allen and Carletti's paper, as liquidity dries up, the price of an asset becomes a function of the amount of liquidity available in the market. They show that marking-to-market may lead to contagion between a banking sector and an insurance sector. Gorton, He and Huang (2006) study the effect of compensation schemes for traders in principal-agent relationships. As in our paper, they show that marked-to-market compensation contracts introduce an externality. Traders may rationally herd, trading on irrelevant information, causing asset prices to be less informative than they would be without the marking-to-market.

We develop a parsimonious model that compares the real effects of a historical cost and mark-to-market measurement regime. The fundamental trade-off can be described as follows. The historical cost regime relies on past transaction prices, and so accounting values are insensitive to more recent price signals. This lack of sensitivity to price signals induces inefficient sales because the measurement regime does not reflect the appreciated value of the measured assets. Marking to market overcomes this price insensitivity by extracting the information conveyed by market prices, but it also *distorts* this information for illiquid assets such as loans, privately placed bonds and insurance portfolios that trade in illiquid OTC markets.

When the decision horizons are shortened due to agency problems, the anticipation of future prices affects firms' decisions which, in turn, injects artificial volatility into prices. Knowing all this, the firms become even more sensitive to short-term price movements. These effects are broadly in line with the informal arguments of practitioners, and lead to clear

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on loan maturity and finds that mark-to-market results in a preference for short-term loans over long-term loans. In contemporaneous work, Strausz (2004) posits that marking to market should mitigate information asymmetry, and derives its impact on banks' liquidity. Freixas and Tsomocos (2004) notes that the inferior intertemporal smoothing properties of marking to market should be detrimental to banks. Our analysis builds upon quite different premises, and is therefore unrelated to these contributions.

economic trade-offs between the two measurement regimes.

Our model generates the following three main implications:

1. For sufficiently short-lived assets, marking to market induces lower inefficiencies than historical cost accounting. The converse is true for sufficiently long-lived assets.
2. For sufficiently liquid assets, marking to market induces lower inefficiencies than historical cost accounting. The converse is true for sufficiently illiquid assets.
3. For sufficiently junior assets, marking to market induces lower inefficiencies than historical cost accounting. The converse is true for sufficiently senior assets.

We believe that our results shed some light on why the opposition to marking to market has been led by the banking and insurance industries. For these financial institutions a large proportion of their balance sheets consists precisely of items that are of long duration, senior, and illiquid. For banks, these items appear on the asset side of their balance sheets. Loans, typically, are senior, long-term, and very illiquid. For insurance companies, the focus is on the liabilities side of their balance sheet. Insurance liabilities are long-term, illiquid and have limited upside from the point of view of the insurance company.

Our modelling approach is to keep the details to a bare minimum, but with just enough richness to capture these effects. Our model studies financial institutions that own a loan portfolio and face the decision whether to hold it until maturity or off-load it in the securitization market. There are three ingredients that make such a decision problematic. First, the horizon of firms does not match the duration of their assets. Second, the true value of the asset cannot be contracted upon. Instead, the value of the firm can be measured only with the observed transaction prices for its assets, either the past price (historical cost regime) or the current price (mark-to-market regime). Third, the secondary market for the asset is illiquid: there is limited absorption capacity for sales.

Under the historical cost regime, short-sighted firms find it optimal to sell assets that have recently appreciated in value, since booking them at historical cost understates their worth. Despite a discount in the secondary market, the inertia in accounting values gives these short horizon firms the incentives to sell. Thus, when asset values have appreciated, the historical

cost regime leads to inefficient sales—firms have no incentives to exert their skills in the very states where those skills would be the most valuable.

A natural remedy to the inefficiency in the historical cost regime would be to shift to a mark-to-market regime where asset values are recorded at their transaction prices. This is only an imperfect solution, however. The illiquidity of the secondary market causes another type of inefficiency. A bad outcome for the asset will depress fundamental values somewhat, but the more pernicious effect comes from the negative externalities generated by other firms selling. When others sell, observed transaction prices are depressed more than is justified by the fundamentals, and exerts a negative effect on all others, but especially on those who have chosen to hold on to the asset. Anticipating this negative outcome, a short-horizon firm will be tempted to preempt the fall in price by selling the asset itself. However, such preemptive action will merely serve to amplify the price fall. In this way, the mark-to-market regime generates endogenous volatility of prices that impede the resource allocation role of prices. Using global game techniques, we can characterize such artificial volatility as a function of the underlying fundamentals. In general, marking to market tends to amplify the movements in asset prices relative to their fundamental values in bad states of the world. The mark-to-market regime leads to inefficient sales in bad times, but the historical cost regime turns out to be particularly inefficient in good times. This is why the seniority of the asset's payoff (which determines the concavity of the payoff function) and the skewness of the distribution of the future cash flows have an important impact on the choice of the optimal regime.

As the duration of assets increases, both regimes become more inefficient. However, the historical cost regime exhibits less inefficiency relative to the mark-to-market regime. This is because the negative externality exerted by other sellers becomes more severe when the duration of the asset increases, and the firms' actions are influenced more by the second-guessing of other firms' decisions.

Our model highlights the interesting interplay between liquidity and the measurement regime. As the liquidity of the asset dries up, marking-to-market becomes significantly more inefficient than the historical cost regime because strategic concerns overwhelm fundamental analysis. Strategic concerns create procyclical trades that destabilize prices in the mark-to-market regime while strategic concerns result in countercyclical trades that reduce fundamental volatility in the historical cost regime.

The rest of the paper is organized as follows. Section 2 presents a simple model in which the choice of an accounting measurement policy—mark-to-market *versus* historical cost—is not neutral. We find that both measurement regimes have important real effects in line with those conjectured by practitioners. Section 3 introduces global game techniques to reduce the number of equilibria in this simple model. Section 4 studies the impact of each measurement regime on prices and quantities in asset markets. Section 5 concludes.

## 2 The Basic Model

Our model centers on the decision of the manager of a bank who aims at maximizing the expected earnings of the bank. In practice, accounting earnings are important to bank executives because they are a basis for managerial compensation.<sup>4</sup> Compensation contracts are, however, not the only reason why bank executives care about accounting numbers in practice. In addition, accounting numbers serve to determine prudential ratios. They are therefore the main triggers of regulatory interventions, and financial institutions are punished if book values fall below regulatory prudential ratios.

In this paper, we take as given that the manager of the bank seeks to maximize accounting earnings. We do not take a stand on the particular frictions driving this fact. The assumption that accounting numbers are the only contracting inputs is particularly well suited for financial institutions. First, such firms have long-lived assets and/or liabilities. Observed free cash flows at a given date are therefore a very poor predictor of value creation (see, e.g., Plantin and Rochet (2007) for insurance examples) and accounting earnings or book values convey important additional information. Second, financial institutions own soft proprietary information about the risks that they originate. Thus, the only way they can contract about them with third parties such as arm's length financiers or prudential supervisors is by using information that can be easily verified in courts such as audited accounts.

In order to maximize the expected earnings of the bank, the manager has to decide whether to securitize a given loan portfolio before the bank's earnings are reported, or to hold the

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<sup>4</sup>A large empirical literature documents that executive compensation are tied to a firm's accounting earnings above and beyond its stock returns (see, e.g., Lambert and Larcker (1987), Jensen and Murphy (1990), and Sloan (1992)). Several theoretical papers have explained this phenomenon by showing that a firm's stock price is not an optimal aggregator of information for the firm's principal agent problem (see Paul (1992), Bushman and Indjejikian (1993)).

portfolio in the bank's balance sheet. If the bank still bears the portfolio at the reporting date, then it is measured in accordance with the prevailing accounting standard. The nature of the accounting standard will therefore impact the decision of the manager. In an imperfectly liquid market, the aggregation of managerial decisions, in turn, will impact yield spreads on asset-backed securities. If these spreads are used in arriving at the accounting value of the portfolio, there is room for further rounds of feedback between decisions and prices. The focus of the analysis is on the relationship between the measurement regime and the impact of this feedback loop.

Building on the themes laid out above, we now describe our model in more detail. There are three dates, indexed by  $t \in \{0, 1, 2\}$ . There is a continuum of financial institutions (FIs) with unit mass. For notational simplicity, FIs are *ex ante* identical. At date 0, each FI holds a loan portfolio. This portfolio has been originated in the past with a value  $v_0$  determined outside the model. At date 0, the single future cash flow generated by the portfolio, or its fundamental value henceforth, is known to all the FIs and equal to  $v$ . However, there is uncertainty about the date at which each portfolio pays off. It may pay off either at date 1, with probability  $1 - d$ , or at date 2, with probability  $d$ . Most loans generate cash flows with uncertain timing due to prepayment risk, and this is one way to interpret  $d$ . More broadly, we can interpret  $d$  as a measure of the duration of the portfolio.

The FIs are run by managers whose horizons are shorter than the durations of the loan portfolios. We assume that each manager aims to maximize the expected date-1 accounting value of the portfolio. This accounting value, in turn, depends on the prevailing accounting regime. The main friction in this economy is that the future cash flow  $v$  cannot be used in arriving at the accounting value. Instead, only two measurement regimes are available, historical cost or mark-to-market. In the case of a historical cost measurement regime, the estimate of  $v$  is given by its initial value  $v_0$ .

In the mark-to-market regime, the accounting value is in principle the market price at the reporting date. However, a crucial problem for assets such as loan portfolios is that easily observable market prices do not exist in practice. Such assets do not trade in the centralized order-processing markets that normally handles homogeneous assets. Instead, secondary fixed income markets are over-the-counter (OTC) markets in which trade is conducted through costly search and bilateral negotiations. Thus, in order to compute the "fair



value" of a loan portfolio, one needs to calibrate a valuation model with appropriate credit spreads. In practice spreads are inferred from the most liquid credit market - the credit derivative market. But even in this market, transaction prices are very sensitive to liquidity effects. In their study of a large dataset of Credit Default Swaps (CDS), Berndt et al. (2005) find dramatic variation over time in risk premia. They attribute this variation to the OTC nature of the credit derivative market that implies sluggish adjustments of the available amount of risk-bearing capital to supply shocks.<sup>5</sup>

In order to account for this illiquidity of the loan portfolio in our simple static model, we assume that the price  $p$  of the portfolio that one obtains from a valuation model calibrated with observed yield spreads is given by

$$p = \delta v - \gamma s,$$

where  $\delta$  is a positive constant less than 1,  $s$  is the proportion of financial institutions who have sold their portfolio, and  $\gamma$  is a positive constant. As is well-known, this linear demand function would result for instance from the representative potential buyer in the secondary market having exponential utility and a distribution over the valuation of the asset that is normal with mean equal to  $\delta v$ .

While linearity is only assumed for expositional simplicity, the important part of this specification is that there are two sources of heterogeneity between the FIs' fundamental valuation of the asset  $v$  and the valuation  $p$  of the potential buyers. First, the discount factor  $\delta$  captures the fact that the counterparts of the FIs are second-best owners. They have less skills in extracting the cash flows generated by the assets than the FIs, who have originated the loans and maintain an ongoing banking relationship with the original borrowers (see Diamond and Rajan (2005)). Second, the price  $p$  depends on how many of the financial institutions sell the asset. The parameter  $\gamma$  is interpreted as a measure of the liquidity of the asset. When  $\gamma = 0$ , the market for the asset is infinitely deep so that the estimated price of the asset does not depend on aggregate sales. When  $\gamma > 0$ , the price is sensitive to aggregate sales. The larger  $\gamma$  is, the more illiquid the market for the asset, and the more sensitive is the price  $p$  to the fraction  $s$  of FIs selling the asset. This price impact of loan sales captures

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<sup>5</sup>See Duffie, Garleanu, and Pedersen (2005, 2007) for elegant OTC asset pricing models. Empirical contributions include Newman and Rierson (2004), Gabaix, Krishnamurthy, and Vigneron (2006), and Longstaff, Mithal and Neis (2005).

simply the slow adjustments of risk-bearing capacity empirically observed in secondary credit markets.

At date 0, if a FI decides to securitize its portfolio, then the proceeds are stochastic, and depend on how many other FIs have also chosen to sell the asset, in the sense of securitizing the loans and offering them for sale. This captures the uncertainty and low market resiliency implied by search and bargaining frictions. In order to model this uncertainty, we will suppose that the FIs who have decided to sell are matched in random order with potential buyers between  $t = 0$  and  $t = 1$ . The place of a given FI in the queue is uniformly distributed over  $[0, s]$ , where  $s$  is the fraction of FIs having opted for a sale. Conditional on a fraction  $s$  of FIs opting for a sale, the expected proceeds from the sale are therefore

$$\delta v - \gamma \frac{s}{2}$$

We have set up the model so that selling the asset occurs for window-dressing reasons only: portfolio sales are always inefficient for a positive value of  $v$ . We believe that studying such an environment is appealing because it highlights the real impact of pure measurement frictions even in the absence of any fundamental motive for sales. Note that all our main insights would still hold under the assumption that some sales may be efficient, namely whenever  $\delta \geq 1$ . In fact, the real effects of the historical cost regime do not depend on the value of  $\delta$  while the impact of marking to market is magnified in the presence of marginally efficient sales: all the FIs always sell all their assets because selling versus holding the asset is always beneficial. Unfortunately, some sales will be inefficient from a first-best perspective. Thus, the  $\delta < 1$  environment that we study is, if anything, the one environment that actually favors the mark-to-market regime. As we will see, such an environment leaves room for a possible first-best (no sales) equilibrium when the asset is marked to market.

Each measurement regime induces significant real effects by affecting the decisions of the FIs to hold or off-load the portfolio at date 0. We carry out this analysis under the assumption that  $d + \delta > 1$ , namely when assets are sufficiently long-lived and not too specific.

Let  $\Delta_{MM}$  denote the differential expected value of carrying the portfolio *versus* selling it for a given FI manager under a mark-to-market measurement. Conditional on expecting

that a fraction  $s$  of other FIs will sell the portfolio,

$$\Delta_{MM} > 0 \iff \underbrace{(1-d)v + d(\delta v - \gamma s)}_{\text{Expected valuation if hold}} > \underbrace{\delta v - \frac{\gamma}{2}s}_{\text{Expected price if sell}}$$

Or, equivalently,

$$\Delta_{MM} > 0 \iff (1-d)(1-\delta)v > \left(d - \frac{1}{2}\right)\gamma s. \quad (1)$$

If the FI decides to securitize the portfolio, the expected proceeds are  $\delta v - \frac{\gamma}{2}s$ . Otherwise, if the portfolio pays off  $v$  at date 1, then its book value is  $v$ . If the portfolio does not pay off, then its book value is the date-1 fair value inferred from spreads observed at date 1, and is therefore equal to  $\delta v - \gamma s$ .

From (1), note that if the asset is sufficiently short-lived ( $d \leq \frac{1}{2}$ ), then inequality (1) is always satisfied if  $v > 0$ . A FI will never find it preferable to sell a loan portfolio with positive value, regardless of what other FIs do. The intuition is that when the horizon of the manager and the duration of the asset are not too different, the manager is less concerned by mismeasurement issues. The expected cost of a low fair value due to high liquidity premia (large  $s$ ) is always smaller than the expected cost of securitization. Thus, even in an illiquid market, marking to market may not distort managerial decisions if the duration of the asset is sufficiently close to the horizon of the manager. This is summarized in the following lemma.

**Lemma 1** *Suppose that the asset has a sufficiently low duration ( $d \leq \frac{1}{2}$ ). Then marking-to-market achieves the first-best in the sense that FIs never off-load their own portfolio for window-dressing reasons.*

From now on, we will restrict the analysis to the interesting case in which

$$d > \frac{1}{2}.$$

Similarly, denoting  $\Delta_{HC}$  the same differential expected value under a historical cost regime,

$$\Delta_{HC} > 0 \iff \underbrace{(1-d)v + dv_0}_{\text{Expected valuation if hold}} > \underbrace{\delta v - \frac{\gamma}{2}s}_{\text{Expected price if sell}}$$

Or, equivalently,

$$\Delta_{HC} > 0 \iff (d + \delta - 1)v < dv_0 + \frac{\gamma}{2}s. \quad (2)$$

The only difference with the mark-to-market regime is that the book value of an asset that has neither matured nor been securitized at date 1 is now  $v_0$ .

A comparison of inequalities (1) and (2) yields the central intuition of the paper. In (2), a larger  $s$  makes the inequality easier to satisfy, all else equal. Conversely, in (1), with  $d > \frac{1}{2}$ , the inequality is *less* likely to be satisfied as  $s$  increases, *ceteris paribus*. Stated differently, under the historical cost measurement regime, sales are strategic *substitutes*. If a FI believes that other FIs will sell, she finds holding on to the portfolio more valuable because expected proceeds from securitization are low. This strategic substitutability is a stabilizing phenomenon. Conversely, under the mark-to-market regime, sales are strategic *complements*: sales by other FIs make securitization more appealing, because high date-1 liquidity premia will imply a very low fair value of the portfolio. This strategic complementarity is destabilizing in essence.

From inequalities (1) and (2), it is easy to derive the possible date-0 equilibrium decisions stated in the following Proposition.

**Proposition 1** *Under the historical cost measurement regime, there is a unique equilibrium in which:*

- *FIs hold their portfolios if  $v < \frac{dv_0}{d+\delta-1}$ ;*
- *FIs sell their portfolios if  $v > \frac{dv_0 + \frac{\gamma}{2}}{d+\delta-1}$ ;*
- *Otherwise, they sell with a probability  $\pi = \frac{2}{\gamma}((d + \delta - 1)v - dv_0)$ .*

*Under the mark-to-market measurement regime:*

- *If  $v < 0$ , there is a unique equilibrium in which FIs sell their assets.*
- *If  $v > \gamma \frac{d-\frac{1}{2}}{(1-d)(1-\delta)}$ , there is a unique equilibrium in which FIs hold their assets.*
- *Otherwise, there are two pure-strategy equilibria, one in which all FIs sell their assets, one in which all FIs hold their assets.*

The equilibrium reflects the strategic substitutability of actions in the historical cost regime. When others sell, the greater is the incentive to hold. The fact that FIs sell with

some probability  $\pi$  reflect such incentives, and could alternatively be seen as an asymmetric equilibrium in which proportion  $\pi$  of the FIs sell.

Historical cost measurement has the unfortunate consequence that FIs securitize their portfolio only because their books do not reflect the embedded value of the portfolio sufficiently quickly. This accounting norm prevents a smooth transfer of wealth across dates because it does not make use of price signals. As a result, FIs do not carry out the most profitable projects whose horizons exceed their tenure. Instead, they find it preferable to realize a lower gain in the short run by selling their assets. Unfortunately, switching to a mark-to-market system is only an imperfect remedy to this myopia. By trying to extract the informational content of prices, the mark-to-market regime actually distorts this content. Marking to market may create “beauty contests” in which FIs become concerned to off-load their assets due to the concern that they expect that others will do so. In other words, marking to market adds a source of *endogenous* risk in the economy, that has nothing to do with the fundamental volatility of the portfolio’s value.

Thus, a social planner who has to opt for one of these two measurement regimes is caught between the horns of a dilemma. On the one hand, historical cost makes too little use of the information generated by market spreads, and relies too heavily on the out-dated historical cost,  $v_0$ . On the other hand, in trying to extract the informational content of prices, marking to market distorts this information by adding endogenous risk.

Further comparison between the regimes requires that the endogenous risk under the mark-to-market regime be quantified. The multiplicity of equilibria makes this difficult. In the next section, we assume that FIs do not observe  $v$  perfectly at date 0. Rather, when deciding whether to sell or hold the asset, each FI observes a noisy version of the fundamental  $v$ . Using global games techniques, we obtain unique equilibrium outcomes.

### 3 The Global Game

We will now apply techniques from the theory of global games to arrive at a unique equilibrium outcome.<sup>6</sup> The global game approach modifies the payoffs by introducing a small noise in the signals received by the agents. The interpretation is that while the agents have accurate

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<sup>6</sup>The theory of global games has been introduced by Carlsson and van Damme (1993), and Morris and Shin (1998) popularized its applications.

estimates of the fundamentals, these fundamentals are not common knowledge. The absence of common knowledge preserves the strategic uncertainty inherent in such situations, and leads to a unique equilibrium (see Morris and Shin (1998) for details).

Concretely, we will implement the global game approach as follows. We start by supposing that the payoff of the asset  $v$  is uncertain, and is distributed according to the prior  $f(\cdot)$ , which is continuous and has a connected support. We let  $F(\cdot)$  denote the c.d.f. of  $v$ .

The financial institutions do not observe the true realization of  $v$  immediately. At date 0, when facing the decision to hold or off-load the asset, each FI  $i$  observes the noisy signal  $x_i = v + \varepsilon_i$ . The noise term  $\varepsilon_i$  is distributed uniformly on the interval  $[-\eta, \eta]$ , and these noise terms are independent across FIs. We will be particularly interested in the limiting case of our framework in which  $\eta \rightarrow 0$  so that the noise becomes negligible in the limit.

In this framework, a (symmetric) equilibrium is characterized by a strategy  $s(x)$  mapping a signal  $x$  into the action set  $\{sell, hold\}$ . We will characterize the equilibrium outcomes in this limiting case in the two accounting regimes—mark-to-market and historical cost. We begin with the mark-to-market case.

### 3.1 Equilibrium in the Mark-to-Market Regime

In the mark-to-market regime, our setup is a particular case of the global game solved in Frankel, Morris, and Pauzner (2003) or Morris and Shin (2003), in which the payoff is a linear function of the fundamental  $v$ . Thus, their results can be readily applied:

**Proposition 2** *In the limit as  $\eta \rightarrow 0$ , there is a unique dominance solvable equilibrium under the mark-to-market regime. In this equilibrium,*

$$\begin{aligned} s(x) &= 0 & \text{if } x &\geq \frac{\gamma}{2} \frac{d-\frac{1}{2}}{(1-d)(1-\delta)} \\ s(x) &= 1 & \text{otherwise.} \end{aligned}$$

*In other words, in the limit, FIs sell their assets if and only if their signal is below the cutoff value  $\frac{\gamma}{2} \frac{d-\frac{1}{2}}{(1-d)(1-\delta)}$ .*

To offer some intuition for this result, we will show with a simple argument that there is a unique equilibrium in threshold strategies as  $\eta \rightarrow 0$ . A threshold strategy consists in selling the asset if and only if the signal is below some cutoff value  $\hat{x}$ . To demonstrate this result,

let us begin by showing that the strategic uncertainty—the uncertainty over the actions of other players—can be pinned down precisely in the limit as  $\eta \rightarrow 0$ .

**Lemma 2** *Suppose that all FIs follow the threshold strategy around  $\hat{x}$ . Then, conditional on receiving a signal equal to the threshold point, the density over the proportion of FIs that sell the asset is given by the uniform density in the limit as  $\eta \rightarrow 0$ .*

When  $v$  is the true state, each signal is distributed uniformly in the interval  $[v - \eta, v + \eta]$ . By the law of large numbers, when the threshold point  $\hat{x}$  lies in this interval, the proportion of firms that sell the asset is thus given by:

$$\frac{\hat{x} - (v - \eta)}{2\eta}$$

This proportion is exactly equal to some constant  $z$  when  $\frac{\hat{x} - (v - \eta)}{2\eta} = z$ . Denote the value of  $v$  that satisfies this relation by  $\hat{v}$ . Thus,

$$\hat{v} = \hat{x} + \eta(1 - 2z) \tag{3}$$

Whenever the true state  $v$  is greater than or equal to  $\hat{v}$ , then the proportion of firms that sell the asset is less than or equal to  $z$ . Thus, the probability that the proportion of firms that sell the asset is less than or equal to  $z$  is given by the probability that the true state  $v$  is greater than or equal to  $\hat{v}$ . Thus, the cumulative distribution function  $G(z)$  over the proportion of firms that sell the asset evaluated at the point  $z$  is given by the probability that the true state  $v$  is above  $\hat{v}$ .

Consider the conditional density over the true state  $v$  conditional on a signal equal to  $\hat{x}$ . Since the noise term  $\varepsilon_i$  has bounded support in  $[-\eta, \eta]$ , the *posterior* density over the true state  $v$  conditional on  $\hat{x}$ ,

$$\frac{f(v)}{\int_{\hat{x}-\eta}^{\hat{x}+\eta} f(u) du},$$

has support on the interval  $[\hat{x} - \eta, \hat{x} + \eta]$ . Since the *prior* density over  $v$  was assumed to be continuous, the *posterior* density reaches a minimum  $m(\eta)$  and a maximum  $M(\eta)$  on this interval, such that:

$$\lim_{\eta \rightarrow 0} (2\eta \times m(\eta)) = \lim_{\eta \rightarrow 0} (2\eta \times M(\eta)) = 1.$$

Conditional on being at the threshold point  $\hat{x}$ , the probability that  $v \geq \hat{v}$  is given by the area under the *posterior* density over  $v$  to the right of  $\hat{v}$ . This area will give us  $G(z)$ . From the definition of  $m$  and  $M$ , we thus have the pair of inequalities:

$$2\eta m(\eta) \left( \frac{\hat{x} + \eta - \hat{v}}{2\eta} \right) \leq G(z) \leq 2\eta M(\eta) \left( \frac{\hat{x} + \eta - \hat{v}}{2\eta} \right).$$

Thus, we conclude that in the limit:

$$\lim_{\eta \rightarrow 0} G(z) = z.$$

In other words, the cumulative distribution function over the proportion of firms that sell the asset tends to the identity function. In turn, this implies that the density function over the proportion of firms that sell tends to the uniform density. *QED*

The characterization of the threshold point in the mark-to-market regime is then obtained as the indifference point of a firm when it hypothesizes that the density over the proportion of firms that sell is given by the uniform density (so that the expected proportion of firms that sell is given by 1/2). This result readily yields the cutoff value in Proposition 2.

### 3.2 Equilibrium in the Historical-Cost Regime

In the historical cost regime, the complete information game has a unique equilibrium. Thus, it is easy to see that the introduction of an arbitrarily small noise in the fundamentals has essentially no effect on the equilibrium of the complete information game. Formally, note that the distribution of  $v$  conditional on a signal  $x_i$  tends to the degenerate density putting all weight on  $x_i$  as  $\eta \rightarrow 0$ . Thus, any equilibrium strategy of the incomplete information game,  $s_\eta(\cdot)$ , must be such that  $s_\eta(x_i)$  tends to an equilibrium strategy in the complete information game with payoff  $x_i$  as  $\eta \rightarrow 0$ . But since, unlike in the mark-to-market case, there is only one such strategy for each value  $x_i$  in the complete information game, it must be that  $s_\eta(\cdot)$  converges pointwise to this strategy:

**Proposition 3** *Suppose that the firms are operating under the historical-cost regime. Then, there is a unique equilibrium in the limit as  $\eta \rightarrow 0$ . In this equilibrium,*

$$\begin{aligned} s(x) &= 0 & \text{if } x < \frac{dv_0}{d+\delta-1}, \\ s(x) &= 1 & \text{if } x > \frac{dv_0 + \frac{\gamma}{2}}{d+\delta-1}, \\ s(x) &= \frac{2}{\gamma}((d+\delta-1)x - dv_0) & \text{otherwise.} \end{aligned}$$



*In words, the equilibria of the incomplete information game converge to the unique equilibrium of the complete information game.*

We will now investigate the implications of these equilibria on both the price and the allocation of the asset under each measurement regime.

## 4 Real Effects of Measurement Regimes

Because of managerial short-termism, the measurement frictions that we have assumed have a real impact. In the following sections, we show that the impact of measurement issues on prices and quantities is very sensitive to the nature of the accounting regime. We first study the consequences of the measurement regime on the distribution of market spreads. Next, we investigate its impact on the allocation of the portfolio. We restrict the analysis to positive values of  $v$ .

### 4.1 Measurement Regime and Price

Let  $p(v)$  denote the average price at which the loan portfolio is sold between  $t = 0$  and  $t = 1$  conditional on  $v$ . Substituting the equilibrium proportion,  $s(v)$ , of FIs off-loading the portfolio conditional on a realization  $v$  of the fundamental value in  $p(v) = \delta v - \gamma \frac{s(v)}{2}$ , it is straightforward to verify that under the historical-cost accounting regime, the average market price of the portfolio,  $p_{HC}(v)$ , is:

$$\begin{aligned} p_{HC}(v) &= \delta v & \text{if } v < v_* \equiv \frac{dv_0}{d+\delta-1}, \\ p_{HC}(v) &= (1-d)v + dv_0 & \text{if } \frac{dv_0}{d+\delta-1} \leq v \leq \frac{dv_0 + \frac{1}{2}\gamma}{d+\delta-1}, \\ p_{HC}(v) &= \delta v - \frac{1}{2}\gamma & \text{if } v > v^* \equiv \frac{dv_0 + \frac{1}{2}\gamma}{d+\delta-1}. \end{aligned} \quad (4)$$

Similarly, under the mark-to-market accounting regime, the average market price of the portfolio,  $p_{MM}(v)$ , is:

$$\begin{aligned} p_{MM}(v) &= \delta v & \text{if } v > v_c \equiv \frac{\gamma}{2} \frac{d-\frac{1}{2}}{(1-d)(1-\delta)}, \\ p_{MM}(v) &= \delta v - \frac{1}{2}\gamma & \text{if } v \leq v_c \equiv \frac{\gamma}{2} \frac{d-\frac{1}{2}}{(1-d)(1-\delta)}. \end{aligned} \quad (5)$$

Figure 1 illustrates the behavior of the price as a function of the fundamental  $v$  for given values of  $\delta$ ,  $d$ ,  $\gamma$ , and  $v_0$ .

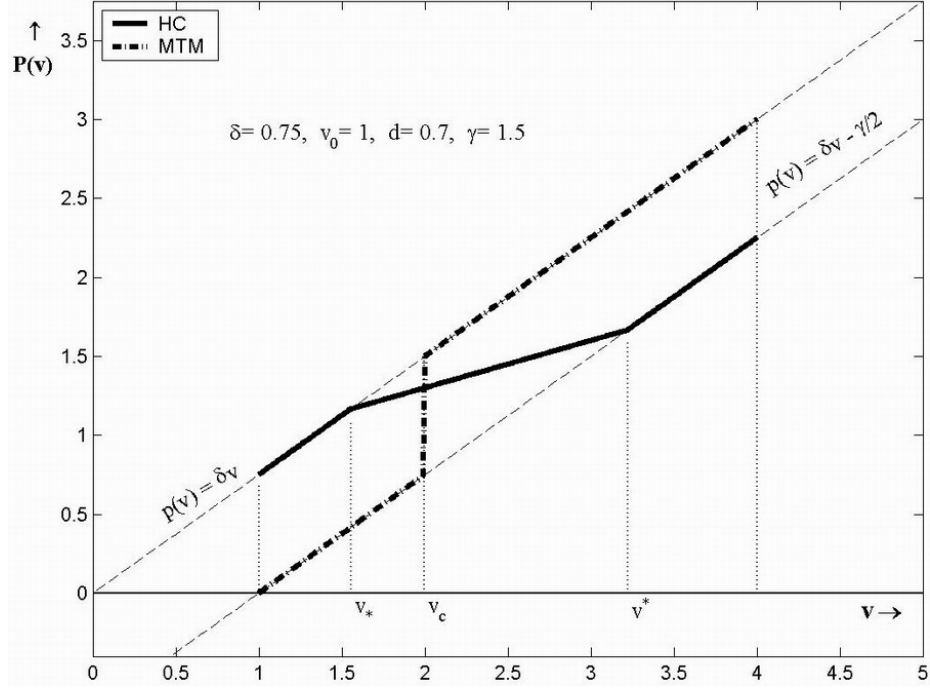


Figure 1: Price  $P(v)$  as a function of fundamental  $v$ .

That  $p_{MM}(v)$  and  $p_{HC}(v)$  cross only once implies that extreme price values are more likely under marking to market than historical cost. Under the historical cost accounting regime, the price is a continuous function of the fundamental  $v$ . Because

$$1 - d < \delta,$$

the price function  $p_{HC}(v)$  in the intermediate region  $v_* \leq v \leq v^*$  is less steep than the price function in the outer regions  $v < v_*$  and  $v > v^*$ . Strategic substitutability stabilizes the price. *It makes the price function smoother than the price  $\delta v$  that would prevail if FIs were not trading for window-dressing reasons.*

In the mark-to-market regime, the price of the asset is a discontinuous function of the fundamental at  $v = v_c \equiv \frac{\gamma}{2} \frac{d - \frac{1}{2}}{(1-d)(1-\delta)}$ . Strategic complementarity destabilizes prices. *It makes the price function steeper than the price  $\delta v$  that would prevail if FIs were not trading for window-dressing reasons.*

The resulting single-crossing property of the price functions  $p_{MM}(v)$  and  $p_{HC}(v)$  illustrated

in Figure 1 implies in particular that if the parameters are such that

$$E_v(p_{MM}(v)) = E_v(p_{HC}(v)),$$

then the distribution of  $p_{HC}$  dominates the distribution of  $p_{MM}$  in the sense of second-order stochastic dominance. In other words, for any risk-averse individual, the mark-to-market regime is superior only if the mean payoff were strictly higher. If the mean payoff under the marked-to-market regime were no higher, then the historical cost regime would be preferred by any risk-averse trader.

The differential impact of each measurement regime on the market value of the portfolio sheds some light on the arguments of each side in the current debate on accounting standards. Financial institutions have argued against marking to market on the grounds that a mark-to-market measurement regime would add undesirable artificial volatility to their reported numbers, while supporters of full fair value have argued that historical cost conceals real volatility. Our model shows that in equilibrium, the measurement regime has an impact on the stochastic discount factor that prices the portfolio. We obtain that historical cost accounting generates counter-cyclical trades that smooth the fundamental volatility of the asset, whereas in the mark-to-market regime, the feedback of measurement on pricing is pro-cyclical and increases fundamental risk. It is as if a representative investor had a counter-cyclical risk aversion under a mark-to-market regime, and a procyclical risk aversion under historical cost measurement. Thus, not only do measurement regimes misrepresent the fundamental value of assets, but they also impact the dynamics of asset prices, which, in turn, create additional measurement problems. The amplification mechanism caused by this interaction between measuring and pricing may explain why the “artificial” *versus* “fundamental” nature of market price volatility is at the heart of the debate on fair value accounting.

## 4.2 Measurement Regime and Allocative Efficiency

Each measurement regime not only affects loan prices, but also affects the quantities traded in very different ways. Loan portfolio sales for window-dressing purposes reduce the surplus that FIs could create for their long-termist claimholders by holding on to their loans. In this section, we compare losses for the FIs under each regime. Formally, the aggregate loss for a given value of  $v$ ,  $L(v)$ , is given by the total losses of FIs who securitize their portfolio instead

of holding on to it and generating  $v$ :

$$L(v) = s(v)(v - p(v)),$$

where  $s(v)$  is the (deterministic) proportion of FIs selling for a given payoff  $v$ , and  $p(v)$  is the price of the asset for each realized value of  $v$  derived in the former section. This simple form stems from the linearity of the demand curve.

Let  $L_{HC}(v)$  and  $L_{MM}(v)$  denote the respective loss functions for a realization  $v$  of the expected payoff under the historical-cost and mark-to-market regimes respectively. Using the expressions for  $p(v)$  and  $s(v)$  derived above, it is straightforward to show that:

$$L_{HC}(v) = \begin{cases} 0 & \text{if } v < v_* \\ \frac{2d}{\gamma}(v - v_0)[d(v - v_0) - (1 - \delta)v] & \text{if } v_* \leq v \leq v^* \\ (1 - \delta)v + \frac{\gamma}{2} & \text{if } v > v^* \end{cases}, \text{ and} \quad (6)$$

$$L_{MM}(v) = \begin{cases} 0 & \text{if } v > v_c \\ (1 - \delta)v + \frac{\gamma}{2} & \text{if } v \leq v_c \end{cases}. \quad (7)$$

Figure 2 shows the behavior of the loss function  $L(v)$  in each measurement regime as  $v$  changes.

Figure 2 illustrates the dramatic change in the shape of the loss function as we move across measurement regimes. Specifically, in the historical-cost regime, there is no welfare loss for very low values of  $v$ , i.e., in the lower tail region  $v < v_*$ . There is a welfare loss in the intermediate and upper tail regions. On the other hand, in the mark-to-market regime, the opposite is true. There is a welfare loss in the lower tail region  $v \leq v_c$  while there is no welfare loss in the upper tail region  $v > v_c$ . Thus, the asymmetry of the distribution of  $v$  is a key determinant of the impact of the accounting regime. To see this, assume that two assets  $X$  and  $Y$  have similar expected values but asymmetric distributions of fundamental values. Namely, below average realizations of fundamentals are more likely for asset  $X$  than for asset  $Y$  and above average realizations of fundamentals are more likely for asset  $Y$  than for asset  $X$ . Figure 2 then implies that historical cost accounting would lead to more inefficiencies than marking to market for asset  $Y$  relative to asset  $X$  because asset  $Y$  has a larger upside than asset  $X$ . Conversely, marking to market would be more detrimental than historical cost for asset  $X$  relative to asset  $Y$  because asset  $X$  has a larger downside than asset  $Y$ .

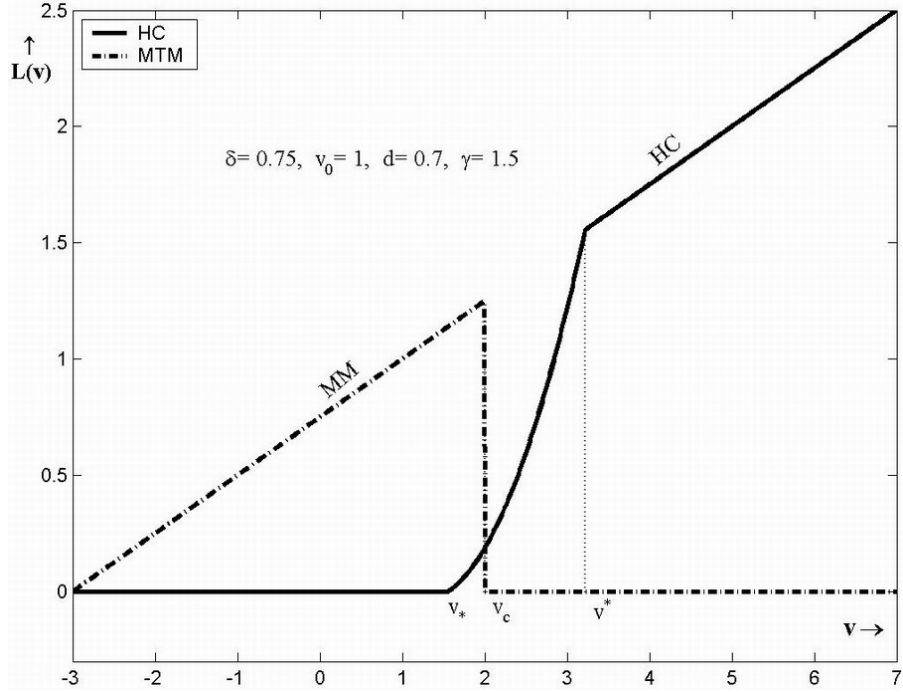


Figure 2: Surplus Loss  $L(v)$  as a function of fundamental  $v$ .

#### 4.2.1 Nature of Claim and Surplus

An inspection of Figure 2 delivers immediately the following Lemma:

**Lemma 3** *Marking to market is preferable for assets whose payoff's distribution has a sufficiently fat right tail and a sufficiently thin left tail. Conversely, the historical cost regime is preferable for assets whose payoff's distribution has a sufficiently fat left tail and a sufficiently thin right tail.*

The risk profile of financial institutions' assets—typically senior loans, and insurance liabilities involve a large potential downside and a more limited potential upside. Lemma 3 suggests that banks' assets and insurers' liabilities are typically the class of claims for which historical cost is likely to dominate mark-to-market in our environment. This result may therefore explain why banks and insurance companies have been the most vocal opponents of marking-to-market.

Lemma 3 also sheds some light on the political economy of the FASB and IASB reform. Among participants in the debate about the applicability of mark-to-market accounting to

financial institutions, prudential supervisors are typically the most vocal opponents to a full fair value regime, and insist on the possible consequences of such a reform for financial stability and pro-cyclicality of bank lending (see, e.g., Basel Committee 2000, or European Central Bank, 2004). In light of Lemma 3, supervisors' standpoint may stem from the fact that they are the representatives of the most senior claimholders of financial institutions (their customers). Meanwhile, to the extent that the accounting standard-setters are champions of equity investors, the IASB represents mostly investors in securities that have residual claims over depositors (in the case of banks) and policyholders (for insurance companies).

We will now investigate how the *ex ante* respective losses in the historical cost and mark-to-market measurement regimes,  $E(L_{HC}(v))$  and  $E(L_{MM}(v))$  respectively, vary with  $d$ , the asset's duration and  $\gamma$ , the asset's liquidity. Recall we assumed that  $v$  has a continuous density  $f(\cdot)$  and cumulative density  $F(\cdot)$ .

#### 4.2.2 Duration and Surplus

We now turn to the comparative statics of welfare with regard to the duration of the asset. We summarize our result in terms of the following proposition.

**Proposition 4** *The expected losses  $E(\tilde{L}_{MM})$  and  $E(\tilde{L}_{HC})$  in the mark-to-market and historical-cost regimes both increase in  $d$ , the asset duration. Furthermore, all else equal, there exists an interval  $(\underline{d}, \bar{d})$  where  $\frac{1}{2} < \underline{d} \leq \bar{d} < 1$  such that:*

$$\begin{aligned} E(\tilde{L}_{MM}) &< E(\tilde{L}_{HC}) \text{ for all } d < \underline{d}, \text{ and} \\ E(\tilde{L}_{MM}) &> E(\tilde{L}_{HC}) \text{ for all } d > \bar{d}. \end{aligned}$$

**Proof.** See Appendix. ■

In words, under both measurement regimes, measurement frictions have more detrimental consequences for longer-lived assets than shorter-lived assets:  $v_*$ ,  $v^*$  decrease with respect to  $d$ , and  $v_c$  increases with respect to  $d$ . But for relatively short-lived assets, the mark-to-market regime is preferable to the historical cost regime, whereas the historical cost regime is preferable for assets that have a sufficiently large duration. In other words, the surplus loss is more sensitive to duration under marking to market. The intuition behind these results is the following. FIs sell when they expect the liquidity premium to be smaller than the

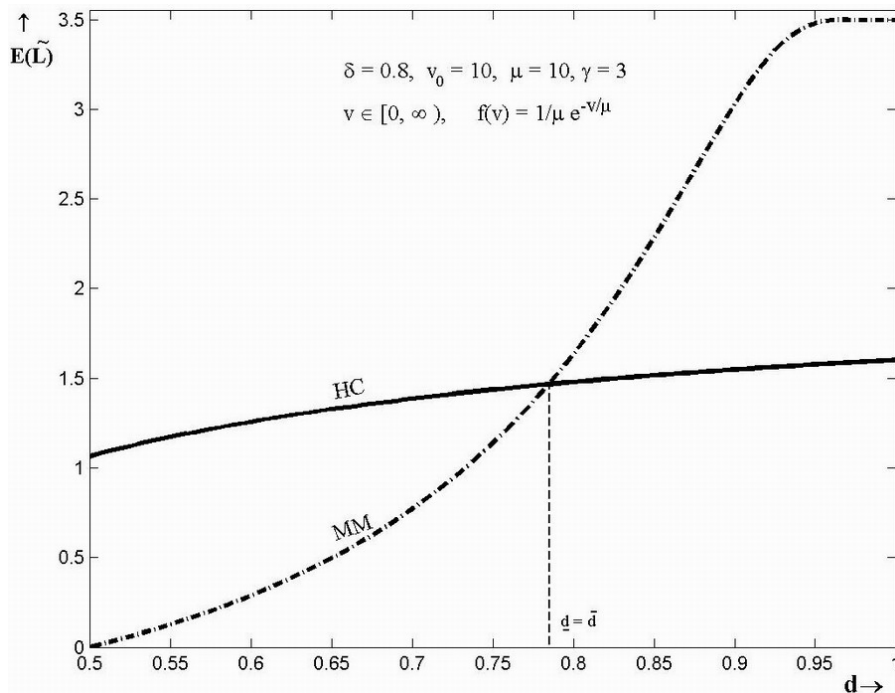


Figure 3: Impact of Duration  $d$  on Expected Surplus Loss,  $E(\tilde{L})$ .

mismeasurement of the cash flows that their assets generate. As the cash flows generated by the asset shift towards the future, other things being equal, misvaluation is more likely, and such misvaluation makes sales more appealing under both regimes. Trading behavior is very sensitive to duration in the mark-to-market regime because the threshold above which holding the asset is dominant goes up from 0 to  $\infty$  as  $d$  goes from 0.5 to 1. Thus, other things being equal, the threshold at which a FI is indifferent if 50% of the others sell,  $v_c$ , also ranges from 0 to  $\infty$  as  $d$  goes from 0.5 to 1. Trades are less sensitive to duration under historical cost accounting because of the inertia inherent to this regime. Even for arbitrarily small values of  $d$ , a FI is still willing to realize the value of the asset for large values of  $v$  by selling it. When  $d = 1$ , there is still an area to the left of  $v_* > v_0$  in which FIs never sell, because the measurement regime provides them with a “hedge”.

Figure 3 illustrates the implications of Proposition (4) for a specific environment where  $\underline{d} = \bar{d}$ .

Interestingly, this prediction supports the current U.S. generally accepted accounting principles (GAAP) reporting requirements for assets. Short-lived assets such as short-term in-

vestments and inventories are marked to market on the balance sheets while long-lived assets such as property, plant and equipment and long-term investments are not marked to market but measured at historical cost.

### 4.2.3 Liquidity and Surplus

Finally, we turn to the comparative statics of welfare with respect to the liquidity parameter  $\gamma$ . We have the following result.

**Proposition 5** *There exists an interval  $(\underline{\gamma}, \bar{\gamma})$  where  $0 < \underline{\gamma} \leq \bar{\gamma}$  such that:*

$$\begin{aligned} E(\tilde{L}_{MM}) &< E(\tilde{L}_{HC}) \text{ for all } \gamma < \underline{\gamma}, \text{ and} \\ E(\tilde{L}_{MM}) &> E(\tilde{L}_{HC}) \text{ for all } \gamma > \bar{\gamma}. \end{aligned}$$

**Proof.** See Appendix. ■

The interplay of market liquidity, captured by  $\gamma$ , with the measurement regimes is more subtle than that of duration. First, under both measurement regimes, a decrease in liquidity, namely an increase in the price impact of sales  $\gamma$ , has a negative direct impact. For a fixed number of sales  $s$ , the average sale price is lower as  $\gamma$  increases, other things being equal. Another effect of an increase in  $\gamma$ , however, is that strategic concerns become relatively more important than fundamental concerns. As the liquidity of the market dries up, the price

$$p = \delta v - \gamma s$$

becomes more dependent on the strategies of other FIs. Since different measurement regimes imply dramatic differences in the strategic nature of FIs' interactions, these strategic effects vary substantially across regimes. Because of strategic complementarity, under a mark-to-market regime, the strategic effect goes in the same direction as the direct effect. Namely, that the other FIs sell makes selling more appealing as  $\gamma$  increases. Thus, coordination is more difficult: the threshold above which FIs hold the asset increases with respect to  $\gamma$ . Conversely, strategic substitutability introduces congestion effects under historical cost. All else equal, a higher  $\gamma$  has a disciplining effect on FIs. They respond to the higher price impact of sales by selling less often, which goes against the direct effect since it reduces inefficient sales.



More formally, the expected loss in the mark-to-market regime is given by:

$$E(\tilde{L}_{MM}) = \int_{-\infty}^{v_c} [(1 - \delta)v + \frac{\gamma}{2}]f(v)dv.$$

Differentiating with respect to  $\gamma$ , yields:

$$\frac{\partial E(\tilde{L}_{MM})}{\partial \gamma} = \underbrace{\frac{1}{2}F(v_c)}_{\text{direct effect}} + \underbrace{\frac{\partial v_c}{\partial \gamma} [(1 - \delta)v_c + \frac{\gamma}{2}]f(v_c)}_{\text{indirect effect}} > 0.$$

Since  $v_c$  increases with respect to  $\gamma$ , the *ex ante* welfare loss in the mark-to-market regime increases unambiguously as the liquidity of the asset decreases.

The *ex ante* welfare loss in the historical cost regime is given by:

$$E(\tilde{L}_{HC}) = \int_{v_*}^{v^*} \frac{2d}{\gamma} [d(v - v_0) - (1 - \delta)v](v - v_0)]f(v)dv + \int_{v^*}^{\infty} [(1 - \delta)v + \frac{\gamma}{2}]f(v)dv.$$

Differentiating with respect to  $\gamma$  yields:

$$\frac{\partial E(\tilde{L}_{HC})}{\partial \gamma} = \underbrace{\frac{1}{2}[1 - F(v^*)]}_{\text{direct effect}} - \underbrace{\frac{2d}{\gamma^2} \int_{v_*}^{v^*} ((d + \delta - 1)v - dv_0)(v - v_0)]f(v)dv}_{\text{indirect effect}}$$

The direct effect is positive, the indirect effect is negative. The net effect of liquidity in the historical cost regime is therefore ambiguous. Can the negative effect overwhelm the positive effect so that welfare in the historical cost regime improves as liquidity dries up? Figure 4 shows this is indeed feasible for a specific environment. In this case, a decrease in liquidity is overall Pareto-improving in the historical cost regime because the disciplining effect on FIs overcomes the negative direct effect.

These results are again consistent with the fact that the most vocal opponents of mark-to-market accounting, such as banks and insurance companies, hold vast quantities of relatively illiquid assets and liabilities.

## 5 Concluding Remarks

The choice of a measurement regime for financial institutions is one of the most important and contentious policy issues in the financial services industry. We have developed an economic analysis of this issue. We have modelled an environment in which the only contractible

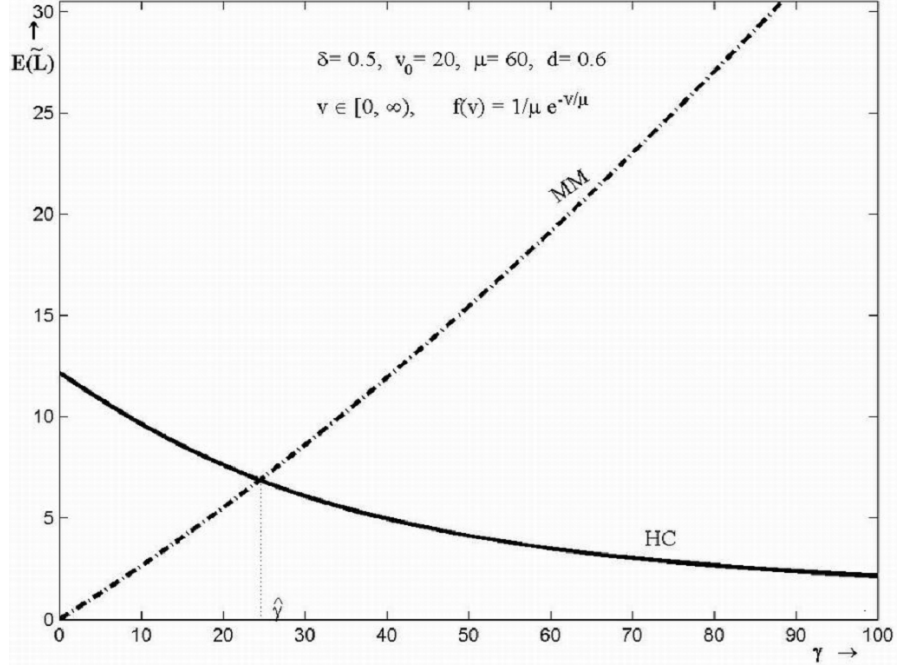


Figure 4: Impact of Liquidity  $\gamma$  on Expected Surplus Loss,  $E(\tilde{L})$ .

valuations of assets are their observed prices in an illiquid market. In such an environment, measurement policies affect firms’ actions, and these actions, in turn, affect prices. Thus, prices drive measurements, but measurement itself has an impact on pricing. We have compared a measurement regime based on past prices (historical cost) with a regime based upon current prices (mark-to-market). The historical cost regime is inefficient because it ignores price signals. However, in trying to extract the informational content of current prices, the mark-to-market regime distorts this content by adding an extra, non-fundamental component to price fluctuations. As a result, the choice between these measurement regimes boils down to a dilemma between ignoring price signals, or relying on their degraded versions. We show that the historical cost regime may dominate the mark-to-market regime when assets have a long duration, trade in a very illiquid market, or feature an important downside risk. These results help explain why the application of the regulatory mark-to-market reforms to financial institutions is so contentious. A large proportion of the balance sheets of financial institutions consists precisely of items that are of long duration, illiquid and senior.

We have analyzed a “pure” historical cost regime in this paper. In practice, the accounting

measurement for a long-lived asset is based on a historical cost with impairment measurement regime. Namely, if the fair value of a long-lived asset is below its recorded cost, it is written down to its fair value. Under a historical cost with impairment regime, our model would predict that the inefficiencies of such a regime would depend on the *nature* of the impairment of the asset. To understand this, note that the nature of the impairment will determine how the fair value of the long-lived impaired asset is computed. In particular, suppose impairment of a loan is due to some increased market risk so that the fair value of the long-lived loan is derived using stochastic discount rates obtained from recent transactions of comparable loans. In such a scenario, our model would predict that such a measurement regime would be plagued with the same inefficiencies in the left tail of fundamentals as the inefficiencies in the left tail of fundamentals in a mark-to-market regime. Given that the inefficiencies in the right hand tail of fundamentals would still persist, our model would then imply that a historical cost with impairment regime would be unambiguously worse than a mark-to-market regime. On the other hand, suppose impairment of the loan is due to the deterioration of the credit risk of a specific borrower so that the fair value of such a loan would be derived using a discount rate specific to the borrower rather than relying on discount rates of other similar transactions. In such a scenario, our model would imply that the “beauty contest” effect associated with the lower tail of fundamentals in the mark-to-market regime may be weaker or may not even arise at all. Given that the inefficiencies in the right hand tail of fundamentals would still persist, our model would predict that the inefficiencies in a historical cost with impairment would then be qualitatively similar to the inefficiencies in a historical cost regime without impairment.

Our analysis has emphasized the respective weaknesses of pure historical cost and mark-to-market regimes. It does also offer more normative implications for the design of an optimal standard. To see this, note that in our setup, marking to market at the average price observed between dates 0 and 1 (namely,  $\delta v - \frac{\gamma}{2}s$ ) instead of the actual price that the marginal seller gets at date 1 (namely,  $\delta v - \gamma s$ ) removes the risk of self-fulfilling "runs", and implements the first-best outcome. This suggests that, in practice, an optimal measurement regime for illiquid assets should discount future cash flows with discount factors that are an average of past observed discount factors over a period which is longer than the time it takes to normally arrange a sale for a non financially constrained firm. In doing so, managers would

be confident that fire sales by other firms would have a limited impact on the end-of-period valuation of their assets. This procedure should considerably remove the risk of self-fulfilling liquidity shocks that we have emphasized, while also mitigating the absence of price signals in a historical cost regime.

Our analysis suggests that the full implementation of a mark-to-market regime may need considerable investigation and care. We reiterate the importance of the second-best perspective in accounting debates. When there are multiple imperfections in the world, removing a (strict) subset of them need not always improve welfare.

Accounting is irrelevant in a frictionless world. Or, to put it the other way round, accounting is relevant only because we live in an *imperfect* world. Therefore, laying out the precise nature and consequences of the imperfections ought to be the first step in any debate in accounting.

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## Appendix

**Proof of Proposition 4.** We first show that the *ex ante* loss increase with the duration of the asset in both regimes. The *ex ante* surplus loss in the historical cost regime is given by the following expression:

$$E(\tilde{L}_{HC}) = \frac{2d}{\gamma} \int_{v_*}^{v^*} [d(v - v_0) - (1 - \delta)v](v - v_0)f(v)dv + \int_{v^*}^{\infty} [(1 - \delta)v + \frac{\gamma}{2}]f(v)dv$$

Differentiating the above expression with respect to  $d$ , we get:

$$\frac{\partial E(\tilde{L}_{HC})}{\partial d} = \int_{v_*}^{v^*} \frac{2(v - v_0)}{\gamma} [(2d + \delta - 1)v - 2dv_0]f(v)dv > 0$$

The *ex ante* surplus loss in the mark-to-market regime is given by:

$$E(\tilde{L}_{MM}) = \int_{-\infty}^{v_c} [(1 - \delta)v + \frac{\gamma}{2}]f(v)dv$$

Differentiating the above expression with respect to  $d$  yields:

$$\frac{\partial E(\tilde{L}_{MM})}{\partial d} = \frac{\partial v_c}{\partial d} [(1 - \delta)v_c + \frac{\gamma}{2}]f(v_c) > 0.$$

We have thus established that the *ex ante* surplus loss is increasing in the asset duration  $d$  for both regimes.

To show the second part of the Proposition, note that  $v_c$  increases from 0 to  $+\infty$  as  $d$  goes from 0.5 to 1, while  $v_*$  and  $v^*$  both stay in a compact set of  $\mathbb{R}_+$ . Thus, under mark-to-market, FIs end up selling all the time as  $d \rightarrow 1$ , never as  $d \rightarrow 0.5$ . In the former case, the expected loss is necessarily larger than under historical cost, while it must be smaller in the latter situation. ■

**Proof of Proposition 5.** Again,  $v_c$  grows from 0 to  $\infty$  as  $\gamma$  increases, while  $v_*$  and  $v^*$  remain in a compact set. ■