First draft: 4/12/2008

Is Mark-to-Market Accounting Destabilizing? Analysis and Implications for Policy

John Heaton[1],
Deborah Lucas[2]
Robert McDonald[3]

Prepared for the Carnegie Rochester Conference on Public Policy, April 17-18, 2009. We are grateful to Robert Magee for helpful discussions of financial accounting. We emphasize the usual disclaimer that all errors are our own.

[1] University of Chicago and NBER

[2] Northwestern University and NBER

[3] Northwestern University

Abstract

Fundamental economic principles provide a rationale for requiring financial institutions to use mark-to-market, or fair value, accounting for financial reporting. The recent turmoil in financial markets, however, has raised questions about whether fair value accounting is exacerbating the problems. In this paper we review the history and practice of fair value accounting, and summarize the literature on the channels through which it can adversely affect the real economy. We propose a new model to study the interaction of accounting rules with regulatory capital requirements, and show that even when market prices always reflect fundamental values, the interaction of fair value accounting rules and a simple capital requirement can create inefficiencies that are absent when capital is measured by adjusted book value. These distortions can be avoided, however, by redefining capital requirements to be procyclical rather than by abandoning fair value accounting and the other benefits that it provides.

1. Introduction

Fundamental economic principles provide a rationale for requiring financial institutions to use mark-to-market, or fair value, accounting: (1) Market prices are generally the best available measure of economic value. They are forward looking and aggregate private information. (2) Market values are easily inferred from transaction prices, which are hard to manipulate in active financial markets. (3) It is not meaningful to draw a distinction between liquidation value -- as measured by market prices -- and ongoing value, since liquidation values reflect that assets will be redeployed in their highest value use.

The abrupt and protracted meltdown of world financial markets has brought these assumptions into doubt, and raised questions about whether mark-to-market accounting is one of the factors exacerbating the ongoing problems.

The academic literature has suggested several channels through which mark-to-market accounting could have unintended negative consequences in illiquid markets. One is that it can be manipulated.[4] Sham transactions in thin markets could be used to generate high prices, allowing similar assets to be artificially marked up. A second concern is that the rule can exacerbate illiquidity. If institutions are unwilling to sell securities at prices that force them to mark down other assets, for instance because doing so could force asset sales, the requirement could reduce trade. Related to these effects, there is the possibility of multiple equilibria: When prices are high, capital and margin requirements are satisfied, whereas when prices fall, capital requirements are violated, causing asset sales and a further drop in asset prices and capital.

In this paper we focus on one mechanism by which accounting rules can have real macroeconomic consequences: through their interaction with regulatory capital requirements. We develop a general equilibrium model in which to study this interaction, and show that even when market prices always reflect fundamental values, the interaction of fair value accounting rules and a simple capital requirement can create inefficiencies that are absent when capital is

[4] We provide a short survey of this literature in section 2.4.

measured by adjusted book value, an alternative measure favored by many bankers. These problems can be avoided, however, by redefining capital requirements to be procyclical, instead of by abandoning fair value accounting and the other benefits associated with it.

To provide a context for the analysis, we begin in Section 2 with an explanation of the rationale for and a brief history of fair value accounting, and explain how accounting rules impact the measurement of regulatory capital. We also review the theoretical literature on the channels through which fair value accounting can have negative consequences in illiquid markets. In Section 3 we present a theoretical model in which the accounting definition of bank capital and the regulatory capital requirements has implications for aggregate outcomes, and characterize equilibrium prices and quantities. In Section 4 we examine the model's implications for policy, and consider more broadly what it suggests about unregulated financial institutions that are subject to margin requirements but not capital requirements. Section 5 concludes.

2. Background

In this section we provide an overview of some conceptual and practical issues related to fair value accounting, along with some historical context. It is important to recognize that financial accounting statements can be constructed in a variety of ways and are used for a variety of purposes. Consumers of accounting statements include investors, regulators, customers, competitors, and the firm itself. The choice of accounting rule may depend upon the intended use of the accounting report, although our view is that there should be a strong presumption in favor of fair value accounting.

It is also worth noting that much of the discussion about accounting methods and rules presumes that for a given firm, the accounting reports will emphasize numbers computed in one particular way. In practice, there is an emphasized set of numbers and alternatives are presented in footnotes, and thus at least for some purposes, diminished in importance. (For example, a firm could elect to report the value of a particular set of assets at historical cost with fair value in a footnote.) At least at a conceptual level, one could imagine requiring firms to report both book

values and fair values, and then letting report users make accounting elections, rather than having the firm (or the SEC) making those elections on their behalf.

2.1 Historical Cost and Fair Value Accounting: An Economic Perspective

Accountants and regulators have long grappled with the problem of whether and how changes in the market value of assets should be incorporated into accounting reports. The issue is perhaps most contentious to the extent that accounting reports are used in the regulatory process: A reported number may have direct implications for the regulatory supervision of the firm – for instance via a capital requirement or affecting required contributions to pension plans. Many managers also voice concern about effect of accounting rules on the volatility of earnings.

First, it is helpful to understand what we mean when we talk about historical cost accounting and fair value accounting.[5] Conceptually, accounting for assets at fair value and accounting for them at book are polar extremes. Fair value accounting relies on changes in the balance sheet to measure changes in the financial condition of a firm, while historic cost accounting relies on realizations of cash flow to measure changes in financial condition.[6]

Suppose one wants to measure firm resources available to equity holders. One can measure resources as a flow (the change in available resources per unit time, ideally measured by the income statement) or as a stock (the total value of resources at a point in time, ideally measured by the balance sheet). Probably the most basic accounting notion is that of net income, measured as the difference between revenue and cost, with both defined based on current cash flows. (Interest expense is here treated as a cost.) An accounting system that emphasizes net income measured in this way is implicitly based on historical cost because it measures current cash flows ignoring revaluations of assets and liabilities in reporting the performance of the firm.

[5]The SEC report emphasizes that the terms "historical cost" and "fair value" are more accurately referred to as "past entry price" and "exit price", language that is used by the Financial Accounting Standards Board.

[6] In practice the assets of financial institutions are often accounted for at adjusted book values, which is a hybrid measure based on historical purchase price adjusted for foreseeable but unrealized losses from defaults. It does not incorporate the price of market risk associated with those defaults.

At the other extreme, one could measure income as net cash flows plus the net change in the market value of assets less liabilities. This is the idea behind fair value accounting. Fair value accounting emphasizes the balance sheet, while historical cost accounting fixes the balance sheet, essentially ignoring it.

In frictionless markets, fair value accounting unquestionably provides the theoretically correct measure of the change in resources available to shareholders. Asset and liability values reflect future cash flows, and thus profits and losses generated by asset revaluations are simply recognitions at one time of future cash flows. If a firm were operating at a loss under historic cost accounting but a profit under fair value, it would be possible to borrow or issue equity to fund current operations out of expected gains from future operations.

There are at least four common objections to fair value accounting:

First, many object that asset valuations under fair value accounting are more manipulable than cash flows under historical cost accounting. While there is likely truth in this, it is possible to manipulate reported earnings as well, particularly with accrual accounting. Also, as we argue below, the history of accounting methods has been that historical cost accounting seems satisfactory until times of economic stress, at which point particular asset classes or industries have been switched to fair value accounting. This has resulted in the steady incursion of fair value over the last 30 years.

Second, some argue that earnings are more volatile under fair value accounting than under historical cost accounting. This seems like an odd objection. If the firm believes that earnings should be less volatile than reported using fair value, the narration and footnotes in accounting reports should provide an opportunity to make the case that things have not really changed. If asset values are truly changing rapidly, this seems like information that would be of interest to owners and other stakeholders of a firm.

Third, the SEC study (SEC, 2008) mentions an "oft-cited concern about fair value: that there is an inconsistency between the fair value accounting model and a typical company's business model as an ongoing entity." (p. 176). Presumably this objection refers to a firm that is "house rich but cash poor", with valuable assets but temporarily low cash flow. This objection ignores the fact, already mentioned, that firms routinely use financing to fund current operations out of future cash flow.

Fourth, valuations may be imperfect. It is true that prices of some assets can be measured more reliably than others, but it seems odd to object to a system on the grounds that it may measure prices incorrectly, when the alternative is almost certain to measure prices incorrectly.

There are benefits to fair value accounting besides its theoretical appeal. It is possible that firms will behave differently under a fair value accounting regime. An investor or firm considering the purchase or establishment of an asset position will take into account the prospect of future marking to market. In particular, a firm acquiring a risky asset will know that it has to live with the public consequences of the risk. Firms would no longer have an incentive to securitize or otherwise sell assets solely to recognize accounting gains, and there would be no value in trying to boost earnings by cherry-picking assets to sell. Under a fair value regime, hedging strategies designed to smooth earnings are better aligned with economic risk avoidance, and compensation contracts that depend on accounting earnings may provide better incentives for controlling risk.

2.2 History

The SEC's 2008 report (SEC, 2008) on fair value accounting provides an excellent discussion of history and the issues, and we draw upon it heavily. Historically, a significant financial event or crisis has often served as impetus for a reconsideration of the accounting rules governing reported assets valuations. The credit crisis of 2008 has generated calls for such a reconsideration of accounting rules, and the SEC report specifically mentions as past catalysts the Great Depression, the market decline of 1973 and 1974, and the savings and loan crisis of the 1980s.

Prior to the Great Depression (and thus prior to the establishment of the SEC), firms had flexibility about reporting asset valuations. In practice, firms revalued assets both up and down. Fabricant (1936) examined a sample of SEC filings (filed when the SEC was a brand new agency) and found that 75% of the firms in his sample had written asset values either up or down, with write-downs substantially exceeding write-ups. One of the first SEC commissioners, Robert Healey, had been general counsel of the Federal Trade Commission, and in that position had studied the asset valuation practices of public utility holding companies. He was incensed by write-ups that he viewed as manipulative (Zeff, 2007). Stemming from these concerns about accounting manipulations, the SEC essentially forbade upward revaluations of assets, and favored historical cost accounting. By 1940, upward revaluations were rare. Zeff (2007) documents the SEC's repeated efforts to prevent revaluations and to install historic cost accounting as a standard. The SEC's resistance held firm until the late 1970s, by which time the inflation of the 1970s (which affected companies generally) and the large oil price increases (which differentially affected oil and gas producers) made the shortcomings of historical cost accounting obvious.[7] In particular, special accounting exceptions were made for oil and gas firms.

The savings and loan crisis of the 1980's provided another impetus to move away from strict historical cost accounting. Banks that had made long-term mortgage loans and borrowed short-term suffered severe economic losses when interest rates increased. A fair value accounting system would in principal have made these losses obvious, but with historical cost accounting and the resulting emphasis on realization, S&L losses took years to be formally recognized.

[7] Zeff notes that the SEC's stance in favor of historical cost accounting was reflected in CPA exams, and thus "as the authoritative literature in the United States moves inexorably towards shades of fair value accounting, its qualified accountants are only now learning about a regime of accounting that had been systematically excluded from their professional education. This circumstance makes any transition from the traditional model to fair value accounting all the more difficult to achieve successfully and with good effect in the United States."

Finally, the introduction of financial derivatives in the 1970s and 1980s required changes in accounting rules. Financial futures allowed firms to take zero-investment positions that could quickly accrue large gains or losses and there were no accounting standard recognizing the novel character of these contracts. In response, SFAS 52 and 80 required fair value accounting for foreign exchange contracts and futures contracts not used in hedging.

In the mid-1980's, the FASB initiated a wide-ranging project on financial instruments, intended to address derivatives, debt-equity distinctions, and the like. The result has been a wide-ranging overhaul of accounting standard presented in a number of statements, including most recently SFAS 157 and 159. We will provide a brief overview of the evolution of fair value accounting for investments in securities. There has been a parallel set of standard for derivatives that we will not discuss.

Financial reporting standards address two distinct issues related to fair value: whether to *disclose* the fair value of assets and liabilities, and whether to incorporate changes in fair value into reported earnings. The reporting standards also specify which kinds of assets are covered by that standard. At the time the FASB began the project on financial instruments mark-to-market accounting was commonplace for assets held in trading accounts. The problem the FASB faced was whether and how to generalize the trading account treatment to assets held for other purposes.

SFAS 107 (1991) required "all entities to disclose the fair value of financial instruments, both assets and liabilities recognized and not recognized in the statement of financial position, for which it is practicable to estimate fair value" (p. 4). At the same time, the FASB provided substantial leeway: "*practicable* means that an estimate of fair value can be made without incurring excessive costs. It is a dynamic concept: what is practicable for one entity might not be for another; what is not practicable in one year might be in another." Fair value computed under this standard had no implications for earnings.

SFAS 115 (1993) created the basic accounting structure for "debt and equity securities" (but explicitly not for unsecuritized loans) that is still in use today. Specifically, SFAS 115 states

"Debt securities that the enterprise has the positive intent and ability to hold to maturity are classified as *held-to-maturity securities* and reported at amortized cost. Debt and equity securities that are bought and held principally for the purpose of selling them in the near term are classified as *trading securities* and reported at fair value, with unrealized gains and losses included in earnings. Debt and equity securities not classified as either held-to-maturity securities or trading securities are classified as *available-for-sale securities* and reported at fair value, with unrealized gains and losses excluded from earnings and reported in a separate component of shareholders' equity."

The "separate component" of shareholders equity is reported on balance sheet under "other comprehensive income" (OCI). The category was designed to reconcile stocks and flows but at the same time keep certain flows separate from earnings. The unrealized gains and losses in OCI are reported in earnings if the asset is sold. There is also another circumstance in which OCI is realized and incorporated into earnings: "For individual securities classified as either available-for-sale or held-to-maturity, an enterprise shall determine whether a decline in fair value below the amortized cost basis is other than temporary.… If the decline in fair value is judged to be *other than temporary*, the cost basis of the individual security shall be written down to fair value as a new cost basis and the amount of the write-down shall be included in earnings (that is, accounted for as a realized loss)." (emphasis added)

Thus, under SFAS 115, debt securities that sustain a permanent loss are required to be marked to market, with the loss flowing through the income statement. Notably, this imparts a conservative bias to earnings since assets that subsequently recover cannot be marked back up.

SFAS 157 (2006) defined fair value as the "price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." The statement created a hierarchy of valuations: Levels 1, 2, and 3, defined as prices observed in the market (level 1), based upon inputs observed in the market (level 2), and with unobservable inputs (level 3). This is sometimes described as "mark-to-market, mark-to-matrix, and mark-to-model." Important in the definition of fair value is the notion of an orderly

transaction. Forced liquidations and distressed sales are mentioned as examples of non-orderly transactions.

Finally, SFAS 159 (2007) expanded the range of assets that could receive fair value treatment. For example, under 159, it is possible to use fair value for available-for-sale assets, and gains and losses on these assets would then flow through the income statement. SFAS 159 also permitted firms to market their own liabilities to market, a somewhat controversial provision that would permit a firm with bond prices falling due to deteriorating credit, to realize a gain. The statement allowed the firm to elect fair value treatment on individual classes of options.

2.3 Financial Accounting and Regulatory Capital

Regulatory accounting, including the calculation of capital, is based upon standard financial accounting. Regulators define capital by adding up various accounting categories, but the basic accounting principles used to construct those categories apply. One interesting issue is the treatment of other comprehensive income, which is excluded from capital calculations.

The current accounting controversy hinges in large part on the phrase "other than temporary" in SFAS 115. CMOs and their variants are held by financial institutions in the available for sale or possibly the held to maturity category. In either case, if a decline in fair value is "other than temporary", institutions are required to mark to market with the resulting loss flowing through the income statement. Since regulators rely on accounting measures of capital adjusted for changes that flow into earnings, if banks are required to recognize losses for accounting purposes, they will be in trouble for regulatory capital purposes.

Following congressional pressure, the FASB on April 2, 2009, voted to revise SFAS 157 to account for fair value calculations when a market is inactive. The FASB said that the forthcoming rule will "Affirm that the objective of fair value when the market for an asset is not active is the price that would be received to sell the asset in an orderly transaction (that is, not a forced liquidation or distressed sale) between market participants at the measurement date under current market conditions (that is, in the inactive market)." The Board also said that it would

"require an entity to disclose a change in valuation technique (and the related inputs) resulting from the application of the FSP and to quantify its effects, if practicable." (FSP=FASB Staff Position). As a practical matter, auditors, and to a lesser extent the SEC, are the arbiters of what is reasonable in specific instances.

The upshot seems to be that if the market is deemed inactive, banks have leeway to use their own judgment to determine if an asset has suffered a decline in fair value. Opponents to the change worry that this will cause asset values, and hence regulatory capital, to be artificially elevated.

2.4 Literature Review[8]

Much of the theoretical literature focuses on the interaction between market liquidity and balance sheet constraints. The liquidity of the markets for the assets held by financial institutions can have important consequences for firms following market-to-market accounting while facing capital requirements or contractual restrictions. In an illiquid market, prices display "short-run" fluctuations that may have little to do with the fundamental or long-run values. These short-run fluctuations can then force firms to raise capital in a costly manner by, for example, issuing equity or selling assets at temporarily depressed prices. Since prices in an illiquid market are expected to mean-revert, marking assets or liabilities to short-run price movements can lead to substantial costs for institutions.

Besides influencing the costs directly faced by firms adhering to capital requirements, market illiquidity can be the source of an important general equilibrium feedback between market prices and institutional behavior. For example Brunnermeier and Pedersen (2008) consider the spiral than can occur when traders face capital and margin requirements while trading in markets where they provide liquidity. After an initial loss, traders face funding problems due to margin or capital requirements. As they attempt to reduce their positions prices are driven down further resulting in additional margin calls and hence a downward spiral in prices. This mechanism is

[8] Incomplete review of the literature. More to be added. Apologies to those not cited properly at this point!

related to the "credit cycles" models of Kiyotaki and Moore (1997) and others. Adrian and Shin (2009) provide some evidence for these cycles in the behavior of investment banks.

Plantin, Sapra and Shin (2008) consider an equilibrium setting where institutions make decisions about whether to securitize their portfolios and face either mark-to-market valuation or historical cost valuation. Relative to historical-cost valuation, market-to-market valuation induces institutions to securitize their assets more efficiently. When markets for the assets are relatively illiquid this result is overturned. The illiquidity of markets in future periods induces institutions to trade more aggressively earlier. The result is inefficient securitization and more price volatility.

At the level of an institution, the costs of adhering to capital constraints in illiquid markets will be anticipated and affect institutional behavior. For example bankers will respond to illiquidity in one market by holding buffers of liquid securities. In addition they may use the latitude they have within the accounting rules to affect their exposure to market-to-market requirements. Milbradt (2008) develops the optimal response of a firm to liquidity concerns when it is possible for an institution to shield itself from market-to-market requirements by halting trading in over-the-counter markets. The result is that assets are carried at values above market prices. Investors respond to the halt in trading by discounting the price of the institution.

Besides the feedback through liquidity, balance sheet constraints influence the identity of the marginal trader in markets and can therefore influence the amount of risk present in a market. For example Danielson, Shin and Zigrand (2009) consider a setting where traders face Value-at-Risk (VaR) constraints and fluctuating asset values. The VaR constraint influences their willingness to take risk. In response prices fluctuate more than would be predicted by fundamentals.[9]

[9] Fluctuations of this type also occur if trader wealth influences their willingness to take risk. This is consider, for example, by Xiong (2001), Pavlova and Rigobon (2008) and others.

3. The Model

In this section we propose a model that allows us to analyze how the accounting definition of bank capital can affect the social costs associated with a banking system that relies on capital requirements to discourage excessive risk-taking.[10] Unlike the literature surveyed above, we assume that price fluctuations are driven by time variation in fundamentals rather than by liquidity shocks. Even in this setting the interaction of fair value accounting rules and simple capital constraints are shown to lead to inefficient outcomes that can be avoided by either changing the accounting regime or by modifying the capital requirement.

The economy lasts for three periods, times *0, 1* and *2*. It is populated by a representative consumer, firms, banks, and the government.

3.1 Agents and Their Constraints

Consumers. At time 0, a representative consumer is endowed with one unit of productive capital of which $x^s(0)$ is invested in a portfolio of risky bank equity, $x^d(0)$ in insured bank deposits, and $x^b(0)$ in a risk-free storage technology with unlimited capacity. Utility is defined over time 2 consumption.

The equity portfolio has a stochastic payoff at time 2, which is described below. The storage technology produces one unit of time 2 output for each unit of time 0 input. We assume parameters are such that in equilibrium deposits do not satisfy the demand for risk-free assets at time 0, so that a positive quantity is invested in the risk-free storage technology. Taking claims to risk-free time 2 consumption as the numeraire, the price of risk-free securities is fixed at 1.

[10] Note that we do not provide a reason for banks to add value to the economy, nor do we include any benefit from deposit insurance. However, one can imagine that banks enhance the productive capacity of the firms through monitoring services, and that the mechanism of deposit insurance and capital requirements serves to reduce the cost of monitoring the banks. In any case, we take the assumed structure as reflecting salient aspects of the current financial system and make no claims about global efficiency.

At time 1 there are no further physical investment opportunities, but the demand for assets changes in response to new information, causing the price of equity to adjust to clear markets.

Invested quantities $x^s(t)$, $x^d(t)$, and $x^b(t)$, $t=0,1$, are chosen to maximize expected utility over time 2 consumption, C.[11] Consumption equals the total return on investments net of taxes, τ, grossed up by the deadweight cost of taxation, λ. More formally, at $t=0,1$ the consumer maximizes:

$$E_t\left(C - \frac{\gamma}{2}C^2\right) \tag{1}$$

At time 0 this is subject to the budget constraint:

$$x^s(0) + x^d(0) + x^b(0) = 1. \tag{2}$$

At time 1 the consumer re-optimizes subject to the wealth constraint:

$$P^s(1)x^s(1) + \left(x^d(1) + x^b(1)\right) = W_1 \tag{3}$$

where $C \le e_2 + x^d(0) + x^b(0) - \tau(1+\lambda)$, e_2 is the value of bank equity in time 2 consumption units, and W_t is time t wealth.

Firms. There are N firms that *are ex ante* identical. Each invests deposits and equity capital raised from banks in a constant-returns-to-scale technology to produce the homogeneous consumption good. To capture the idea that equity capital is more costly than debt capital without modeling a specific friction that causes this to be true, we assume that only a fraction, ψ, of invested equity is productive.[12] At time 0, firm i invests capital, $B_0 = \frac{\psi x^s(0) + x^d(0)}{N}$, in a technology that has a stochastic payoff at time 2, $X_{i,2}$, where

$$X_{i,2} = (r + \omega_t^i + \omega_p^i + \omega_m^i)B_0 \tag{4}$$

[11] For simplicity we assume utility is quadratic, but the qualitative results hold for more general utility specifications.

[12] Without some cost to equity or some benefit to deposits, it would be optimal in this model to require all-equity financing.

The average return on investment is the sum of four components, the unconditional mean, $r>1$, plus three shocks: ω_t^i is a normally distributed idiosyncratic shock that is privately observable to the firm and its bank at time 1; ω_p^i is a normally distributed mean 0 idiosyncratic shock that is publicly observable at time 1, and independent of the privately observed shock; and ω_m^i is a normally distributed mean 0 shock that is independent of the first two shocks but that is correlated across firms. The standard deviation of a type j shock is σ_j. The correlated shock is the source of aggregate output risk. The correlation of output across firms, ρ, is stochastic, with $\rho \in \{\rho_L, \rho_H\}$ and an equal probability of each outcome. At time 1, all agents learn the realization of ρ, which triggers a revaluation of equity. Since N is large, $\sum_{i=1}^{N} \omega_j^i = 0$ for $j = \iota, p$. At time 2 the firm is liquidated and output delivered to its bank.[13]

Banks. All firms, and hence all banks, are identical at time 0. Each bank invests its share of the aggregate supply of capital $\left(x^s(0) + x^d(0)\right)/N$ in a single firm.[14] Its on-balance-sheet assets consist entirely of this investment. Banks liabilities include government-insured deposits, $x^d(0)/N$, and publicly held equity valued at $x^e(0)/N$. Bank equity holders receive the residual value of assets at time 2 when the bank is liquidated. Banks are managed in the interest of equity holders.

At time 1, after learning the idiosyncratic realizations of firm output ω_ι^i and ω_p^i and the correlation of aggregate risk across firms ρ, banks that satisfy the capital requirement have the opportunity to invest in a risk-generating technology (e.g., off-balance-sheet derivative contracts) that generates a mean zero shock paying $\varepsilon = \{x, -x\}$ at time 2, in exchange for paying a fixed cost $\overline{f}$. [15]

[13] More realistically, banks would make risky loans to firms and the representative agent would own firm equity as well as bank equity and deposits. Incorporating this more complicated security structure into the model would not change the basic conclusions of the analysis.

[14] The "i" subscript may be suppressed when a quantity is identical across firms or banks.

[15] The cost can be interpreted as reputation loss for the bank manager who may be eventually found out to have gambled, where the likelihood of detection is increasing in the amount of risk taken. With this interpretation, the cost would affect the amount of risk taken but would not consume real resources. Whether or not the cost is taken to reduce real output, however, has no effect on the qualitative results.

Whether or not the bank chooses to take risk is not revealed to consumers or regulators until time 2.

To reduce the incentive for costly risk-taking, banks are subject to a regulatory capital requirement. It stipulates that the ratio of bank equity to bank assets, $E_{t,i}/A_{,t,i}$, must exceed a minimum level κ. At time 0 the constraint is always satisfied by the initial choices of deposits and equity. If at time 1 the re-pricing of bank equity causes the constraint to be violated, the bank is forced to reorganize and incurs a fixed cost ξ. Banks that are reorganized are assumed to be unable to invest in the risk-taking technology, for instance because they are more heavily scrutinized by regulators. We assume $\overline{f} > \xi$, so it is worthwhile to incur reorganization costs to prevent a bank from certain risk-taking.

At time 2, the bank has total assets $X_{i,2} + I_{g,i}\varepsilon_i - I_{r,i}\xi - I_{g,i}\overline{f}$, where I_r is an indicator function equal to 1 if reorganization has occurred and 0 otherwise, I_g is an indicator function equal to 1 if additional risk was taken and zero otherwise, and ε is the realization of the additional risk. The bank pays depositors:

$$\min\left[X_{i,2} + I_{g,i}\varepsilon_i - I_{r,i}\xi - I_{g,i}\overline{f}, x^d(0)/N\right] \tag{5}$$

and any residual bank value is paid out to equity holders. When assets fall short of promised payments to depositors, the insurer makes the bank's depositors whole.

The information structure and timing of cash flows is summarized in Figure 1 (to be added).

Government. The government runs the deposit insurance system, determines the taxes and transfers that balance the system, and sets capital requirements. The deposit insurance system ensures that deposits are paid off in full. Tax collections equal the sum of these expenses multiplied by a factor $\lambda \geq 1$, where λ-1 is the deadweight cost of taxation.

3.2 Equilibrium Prices and Quantities

The time 0 asset allocation is found by solving the consumer's maximization problem. Differentiating (1) with respect to the share of the endowment invested in the stock portfolio and imposing the budget constraint (2) yields the first order condition:

$$E_0\big((1-\gamma C)(R_s-1)\big)=0 \tag{6}$$

where R_s is the total return on a unit of capital invested in the stock portfolio. A relatively simple expression for R_s can be found by noting that in equilibrium the total return equals total firm output net of aggregate reorganization and risk-taking costs, minus firm payments to depositors. Since total taxes cover what banks owe to depositors but are unable to pay, taxes are effectively a transfer to equity holders. Then total payoff on equity per unit of investment can be written as:

$$R_s=\left(\sum_{i=1}^{N}(r+\omega_t^i+\omega_p^i+\omega_m^i)B_0-\xi L(\cdot)-\overline{f}F(\cdot)-x^d(0)+\tau(\cdot)\right)/x^s(0) \tag{7}$$

L(·) is the number of banks that experience a costly reorganization, and *F(·)* is the number of banks that utilize the risk-taking technology. In equilibrium these costs and taxes will depend on the way in which capital is measured, as discussed below. Notice that $B_0=\psi x^s(0)+x^d(0)$. Denote the sum of the correlated shocks by ω_m. Since the publicly and privately observed idiosyncratic shocks sum to zero, (7) can be rewritten as:

$$R_s=\Big((r+\omega_m)(\psi x^s(0)+x^d(0))-\xi L(\cdot)-\overline{f}F(\cdot)-x^d(0)+\tau(\cdot)\Big)/x^s(0). \tag{8}$$

Consumption is the sum of the return on equity, deposits, and the storage technology, minus the cost of taxes:

$$\begin{aligned} C&=(r+\omega_m)(\psi x^s(0)+x^d(0))-\xi L(\cdot)-\overline{f}F(\cdot)-x^d(0)+\tau(\cdot)+x^d(0)+x^b(0)-\tau(\cdot)(1+\lambda)\\ &=(r+\omega_m)(\psi x^s(0)+x^d(0))-\xi L(\cdot)-\overline{f}F(\cdot)+x^b(0)-\tau(\cdot)\lambda \end{aligned} \tag{9}$$

Substituting (8) and (9) into (6),

$$0=E_0\left(\begin{array}{l}(1-\gamma\Big((r+\omega_m)(\psi x^s(0)+x^d(0))-\xi L(\cdot)-\overline{f}F(\cdot)+x^b(0)-\tau(\cdot)\lambda\Big)\cdot\\ \left(\Big[(r+\omega_m)(\psi x^s(0)+x^d(0))-\xi L(\cdot)-\overline{f}F(\cdot)-x^d(0)+\tau(\cdot)\Big]/x^s(0)-1\right)\end{array}\right) \tag{10}$$

The amount of risk-free investment in the storage technology, $x^b(0)$, is determined by the total demand for risk-free assets. As is verified below, to maximize the value of deposit insurance

banks set initial deposits and equity so that the capital constraint just binds. In equilibrium this implies that:

$$\frac{x^s(0)}{x^s(0)+x^d(0)} = \kappa. \tag{11}$$

Equations (2), (10), and (11) determine the time 0 allocations to equity, deposits, and the storage technology.

The time 1 price of the stock portfolio is found from combining first order conditions from the consumer's time 1 optimization problem with market clearing conditions. Optimization implies:

$$E_1\left(R_s(1-\gamma C)\right) = \mu P^s(1) \tag{12a}$$

$$\text{and } E_1\left((1-\gamma C)\right) = \mu \tag{12b}$$

where μ is the Lagrangian multiplier on (3). Taking the ratio, of (12a) and (12b), and imposing the market clearing conditions that $x^j(0) = x^j(1) = x^j$ for j=s, d, b, determines the price of the stock portfolio at time 1:

$$P^s(1) = \tag{13}$$

$$\frac{E_1\left[\left((r+\omega_m)(\psi x^s + x^d) - \xi L - \overline{f}F - x^d + \tau\right)/x^s\right)\left(1-\gamma\left((r+\omega_m)(\psi x^s + x^d) - \xi L - \overline{f}F + x^b - \tau\lambda\right)\right)\right]}{E_1\left[\left(1-\gamma\left((r+\omega_m)(\psi x^s + x^d) - \xi L - \overline{f}F + x^b - \tau\lambda\right)\right)\right]}$$

The price of the equity portfolio is affected by the realization of the correlation between firm shocks, ρ. Whether the effect of higher correlation on equity price is positive or negative depends on parameter values. First, holding fixed costs and taxes constant, the term $E_1\left(-\gamma\omega_m^2(1-x^b(0))^2/x^s(0)\right)$ in the numerator of (13) decreases in ρ because the variance of the market shock per unit of investment is $\sigma_m^2 + N\rho\sigma_m^2$. This is the usual effect that the price of risky securities falls when consumption volatility increases.

It is possible, however, to choose parameters to obtain the unintuitive result that the equity price increases with aggregate risk because of the interaction between deposit insurance, liquidation rates and taxes. An increase in ρ increases expected payouts from the deposit insurance system since it increases the proportion of firms with output realizations that are too low to repay depositors in full. This has a positive effect on expected tax liabilities. Both the numerator and denominator of (13) increase in expected taxes, with taxes having a negative effect on consumption through the deadweight loss of taxation, and taxes having a positive effect on equity value because the subsidy value of deposit insurance accrues to equity holders. The direct effect of the liquidation rate on the numerator of (13) is indeterminate; it increases the marginal utility of consumption but decreases the value of equity. The liquidation rate also has an indirect effect on equity price through taxes, since taxes increase in the liquidation rate. Finally, we will show that when the bank's objective is to maximize the time 2 payout new information about ρ does not affect risk-taking at time 1, so $\overline{f}F$ is invariant to ρ.

3.2.3 Banks' Optimization Problem

The value of bank equity depends on the two choices of bank managers: (1) the initial capital ratio, and (2) whether the bank takes on additional risk at time 1. We assume that the bank's objective is to maximize the time 2 payout to equity holders. Assuming that reorganization costs and the value of access to the risk-generating technology are not too large, the initial capital ratio that accomplishes this is κ, since this maximizes the subsidy value of deposit insurance which is provided for free, and minimizes the equity financing cost $(1-\psi)x^s(0)$.

The time 1 decision whether or not to invest in the risk-taking technology maximizes:[16]

$$E_1\left\{\max\left[(r+\omega_t^i+\omega_p^i+\omega_m^i)(x^d(0)+\psi x^e(0))+I_{g,i}\varepsilon-I_{g,i}\overline{f}-x^d(0)/N,0\right]\right\} \qquad (14)$$

The decision is conditional on the bank observing the realization of its firm's public and private idiosyncratic shocks, and the realization of ρ. Holding all else fixed, there is a critical value ω^* of idiosyncratic output such that for $\omega_t^i+\omega_p^i<\omega^*$the bank weakly prefers to invest in the risky

[16] Maximizing the future value of equity also maximizes the present value, since adding idiosyncratic risk by investing in the risk-generating technology does not affect the discount rate.

technology, and otherwise chooses not to. The cutoff ω*decreases in κ, since a higher κ increases the probability that the firm's output will exceed the promised payment to depositors.

The time 1 price of an individual bank is then the sum of three components: *1/N* of the price of the diversified equity portfolio $P^S(1)$, the observable idiosyncratic shock ω_p^i, and the expected cost of risk taking conditional on ω_p^i. Denoting the conditional expected cost of risk-taking $\alpha(\omega_p^i)\overline{f}$, we have

$$P^{s,i}(1) = P^S(1)/N + \omega_p^i + \alpha(\omega_p^i)\overline{f} \tag{15}$$

4. Policy Analysis

The social cost associated with regulating the banking system is the sum of the deadweight cost of taxation, bank reorganization costs, equity financing costs, and the cost of risk-taking. We consider how the choice of κ and the definition of bank equity and assets affect this total cost, and derive the cost-minimizing policy with regard to the definition of κ and bank capital.

We begin by considering the optimal policy when the capital requirement is a constant value that is conditional only on public information at time 0. That is, policymakers choose a capital requirement κ* to minimize:

$$E_0\left[\lambda\tau(\kappa) + \overline{f}F(\kappa) + (1-\psi)x^S(0) + \xi L(\kappa)\right] \tag{16}$$

Holding asset prices and the initial investments in risky firms fixed, the costs of taxation and risk-taking decrease in κ.[17] Taxes decline because banks are more likely to be able to repay depositors, and risk-taking decreases because bank equity is less like a call option and because those banks most likely to take excessive risk are reorganized.[18] On the other hand, the cost of equity financing increases with the capital requirement, since a larger fraction of invested assets

[17] We assume that the general equilibrium effects of varying κ over the relevant range are small, and do not affect quantities enough to make the effects non-monotonic.

[18] Notice that we assume the regulator is risk neutral, and therefore we do not have to take into account the cyclicality of costs and the effect on the consumer's utility, which we expect would be second order.

is in the form of equity. Because returns are proportional to invested capital, when the initial capital requirement binds it is straightforward to show that the foreclosure rate is not directly sensitive to the choice of κ.

We now turn to the central question, which is whether measuring capital in market value terms minimizes the social cost given by (16), or whether there is an alternative definition of capital, also based on public information, that dominates?

Recall that the price of bank equity at time 0 depends on the expectation of ρ, whereas at time 1 it depends on its realization, which by assumption is binomial with $\rho \in \{\rho_L, \rho_H\}$. When the dominant effect of higher correlation is via risk aversion, the effect will be for prices to fall when ρ_H is realized since aggregate consumption risk increases, but as discussed above it is possible for the effect to go in the other direction because of the effects of deposit insurance. In either case, market prices are sensitive to information about the aggregate state. However, the payoff on individual bank equity depends on the total volatility associated with the firm's investments, but not the correlation between payoffs across firms. Hence the realization of ρ is irrelevant to the decision of bankers maximizing (14) on whether or not to take additional risk.

Since the purpose of imposing a capital requirement is to discourage risk-taking, but the realization of ρ does not affect the propensity of banks to take risk, measuring capital in a way that depends on the expected value of ρ rather than the realized value provides better incentives and is welfare improving. Alternatively, specifying a state dependent capital requirement to be used in conjunction with a market-value definition of capital improves welfare relative to a policy that evaluates market capital relative to a fixed ratio. This intuition is established formally in proposition 1.

Proposition 1: Let κ^* be the capital requirement that minimizes (16) when bank capital is evaluated in market value terms, and assume that the distortionary tax cost, λ, is zero.

(a) Holding κ^* fixed, there exists an alternative definition of bank capital, based on the publicly observed idiosyncratic shock ω_p^i but independent of the realization of ρ, that reduces social cost relative to measuring bank capital at market prices.

(b) There exists a state-dependent capital requirement that, when capital is measured in market value terms, reduces the social cost relative to a capital requirement fixed at κ^*. Specifically, a procyclical $\kappa^*(\rho)$ that increases with the price of the bank equity portfolio is welfare improving relative to a fixed capital ratio.

Proof of (a): With a market value capital requirement, a bank will be reorganized if:

$$\frac{P^{s,i}(1)x^s(0)}{P^{s,i}(1)x^s(0)+x^d(0)} < \kappa^*. \tag{17}$$

The price of the bank is given by (15). It is linear in the price of the bank equity portfolio $P^s(1)$, which varies with the realization of ρ.

Examining the bank's optimization problem (14) and the regulator's objective function (16), the optimal capital requirement clearly depends on the conditional volatility of output at time 1, $\sigma_m^2/N+\sigma_t^2$, and on the realization of the publicly observed idiosyncratic shock, ω_p^i, since both affect the probability that the bank will choose to take on costly risk. For instance, if ω_p^i is very negative it is better to reorganize the bank and prevent certain risk-taking since we assume $\overline{f} > \xi$. Equation (14) does not depend on ρ, and equation (16) depends on ρ only through the distortionary cost of taxation, which increases in ρ. Here we assume that λ is zero, so the optimal incentive must be independent of ρ.

Since κ^* is chosen at time 0 to balance average reorganization costs with average risk-taking costs, the realized reorganization rate (amount of risk-taking) is lower (higher) than is optimal when $P^s(1)$ is high, and conversely when $P^s(1)$ is low. Let $P^{s,i}(1,\overline{\rho})$ be an alternative measure of firm value based on the book value of the equity portfolio (which is equal to 1) plus a fixed adjustment δ, where:

$$P^{s,i}(1,\overline{\rho}) = (\frac{1}{N}+\delta) + \omega_p^i + \alpha(\omega_p^i)\overline{f} \tag{18}$$

If $P^{s,i}(1,\bar{\rho})$, which we will refer to as "adjusted book value", is used in (17) instead of a bank's market value, the reorganization rate will be independent of ρ, and by continuity there exists a δ that sets the reorganization rate to a constant value that optimizes the static tradeoff between the cost of risk-taking, reorganization, and equity finance.

Proof of (b): Let $\kappa_0 \equiv \frac{P^{s,i}(1,\bar{\rho})x^s(0)}{P^{s,i}(1,\bar{\rho})x^s(0)+x^d(0)}$, where the adjusted book value of bank stock is given by (18). From the proof of (a), it is clear that welfare is increased by setting a state-dependent, market value capital requirement such that:

$$\frac{P^{s,i}(1)x^s(0)}{P^{s,i}(1)x^s(0)+x^d(0)} < \kappa^* + \left(\frac{P^{s,i}(1)x^s(0)}{P^{s,i}(1)x^s(0)+x^d(0)} - \kappa_0 \right) \equiv \kappa(\rho). \tag{19}$$

This is welfare improving because it is identical in effect to the capital requirement described in part (a). It is procyclical because $\frac{P^{s,i}(1)x^s(0)}{P^{s,i}(1)x^s(0)+x^d(0)}$ increases in the time 1 stock price.

4.1 Discussion

The above results illustrate several important points about the interaction between fair value accounting and capital requirements that we believe are likely to be carry over to less restrictive settings.

The incentive for a bank to gamble depends on its capital, and on the risks associated with its assets and liabilities, broadly defined. Some factors that affect market prices, such as the price of aggregate risk, may have little effect on the incentive to gamble. In other words, incentives may be mostly a function of actual or "*p*-measure" risk facing the bank, whereas market prices depend on risk-adjusted or "*q*-measure" risk to consumption. For instance in the model here, because of time variation in perceived aggregate risk that leaves individual bank risk unchanged, there is a potentially significant component of market price fluctuations that is unrelated to banks' incentive for risk-taking. As a result, a constant, market-value-based, minimum capital requirement is inefficient, and can cause an inefficiently high a rate of bank reorganizations (or contractions in lending) in downturns.

Interestingly, the solution to reduce inefficiency suggested in proposition 1(a), which is to define bank capital based on book value adjusted for verifiable realizations of idiosyncratic risk, is in keeping with calls for capital measured by book value adjusted for expected losses by bankers. The equivalent solution suggested in proposition 1(b), which is to set procyclical capital requirements, is consistent with recent regulatory proposals that call for higher capital requirements in good times.[19]

The analysis is not intended to suggest that market prices are irrelevant to determining appropriate capital reserves; in fact we believe that in most instances they are likely to be the most accurate measure of value. In the context of our model, if time-varying market price volatility were introduced by assuming time variation in the common component of output shocks σ_m rather than through time variation in ρ, lower market prices would coincide with states of the world where bankers would have a greater incentive to take risk, and an optimal capital requirement would be sensitive to the common component of market prices as well as to the idiosyncratic component.

4.2 Fundamental Shocks vs. Liquidity Shocks

Most critiques of fair value accounting have emphasized the effects of illiquidity on market prices, whereas the mechanism in our model arises from fundamental economic risk. To the extent that one is skeptical that liquidity rather than deteriorating fundamentals explains the recent sharp declines in asset values, this analysis makes clear that distortions can arise even when all shocks to value are fundamental.

It seems that the idea that the interaction of illiquidity and capital requirements generates social costs could be incorporated into this framework by adding an aggregate liquidity shock that is realized at time 1, and interpreting reorganization costs as arising from inefficient bank liquidations resulting from these liquidity shocks in the presence of a static capital requirement.

[19] For instance, in a speech delivered on March 20, 2009 to community bankers, Federal Reserve Chairman Ben Bernanke said, "Capital rules, accounting policies, and other regulatory standards should not make this job even more difficult by encouraging excessively procyclical behavior by financial institutions--that is, behavior that causes financial institutions to tighten credit in downturns and ease credit in booms more than is justified by changes in the creditworthiness of borrowers."

By analogy to the analysis here, if the interaction of liquidity shocks and capital requirements leads to inefficiency, modifying the form of the capital requirement may be a better way to address the distortion than by changing accounting rules.

Some bankers have argued that if an investment is intended to be held to maturity, then if its price drops due to liquidity conditions it should not affect required capital.[20] This presumes that managers' incentive to take risk is insensitive to the liquidation value of illiquid assets. While this is consistent with our simple setup where bankers are only concerned with the value of assets at maturity, in a more general setting we expect the effect of temporary price changes on incentives to be more complicated, and hence we do not interpret our results as supporting this contention.

4.3 Fair Value Accounting and Private Contracts

An interesting question is whether the adoption of fair value accounting rules causes similar problems for financial firms that are not subject to capital requirements. In a frictionless market where the interest rate on outstanding debt adjusts continuously with the risk of the underlying assets and there is a fair deposit insurance premium that also adjusts continuously, neither debt holders nor insurers require protections such as capital requirements or restrictive covenants, and managers acting in the interest of equity holders have no incentive to take uncompensated risk.

However, when financial institutions issue debt only infrequently or when deposit insurance is incompletely risk-based, equity takes on the characteristics of a call option, and its value is enhanced at the expense of unsecured debt holders and the deposit insurer by the substitution of riskier assets for safer ones. For commercial banks, capital requirements mitigate this incentive to take risk, since they prevent the call option from moving too far out-of-the-money and into a region where the value of risk-taking is high.

[20] Some sympathy to this story, and considerable political pressure, may account for the recent change by SFAS 157 to allow more discretion in the use of market values when markets are judged to be illiquid, as described in section 2.2.

Protective covenants such as margin requirements provide similar protection to the creditors of less regulated financial institutions. Margin requirements require borrowers to post additional collateral or cash when the value of specified assets declines below a contractually set trigger.

Both capital requirements and counterparty margin calls can force firms to raise capital quickly in illiquid markets, and may result in inefficient reorganizations. An important difference is that capital requirements are imposed by regulators, whereas margin requirements arise by mutual consent in private contracts.[21] Presumably, private contracts are conditioned on the measure of asset value that minimizes expected *ex post* distortions, so a switch to fair value accounting should only have unintended consequences for contracts already in effect at the time of the switch. Although we do not have data on a large sample of such agreements, it is our impression from conversations with practitioners that margin requirements are generally conditioned on market values. A detailed analysis of the effect of fair value accounting on private contracting and its equilibrium implications is beyond the scope of this paper, but an interesting question for future research.

4. Conclusions

In this paper we have provided a brief account of the history and motivation behind fair value accounting for financial securities, and a new model that we use to examine the interaction between fair value accounting and capital requirements, and its implications for social welfare.

Our analysis makes clear that some of the problems that arise with the introduction of fair value accounting are not due to the accounting rule in itself, but rather from the interaction of fair value accounting and the definition of capital requirements. Over time capital requirements are periodically revised by bank regulators, as is the FASB's definition of capital, but the two types of regulatory action is not coordinated. In fact the recent trend toward more comprehensive fair value accounting does not seem to have been accompanied by a rethinking of capital requirements and how they should be harmonized with a fair value accounting regime. As

[21] Private margin requirements can also be renegotiated *ex post*, which in some instances may avoid inefficient liquidations. However, conflicts of interest between various claimants suggest that such negotiations need not result in socially efficient outcomes.

illustrated by proposition 1, for any change in the FASB definition of capital it should be possible to specify an offsetting change in the definition of the capital requirement that makes the accounting change neutral with respect to economic outcomes. If fair value accounting has advantages in other contexts, which we believe it does, then a sensible solution to the problems caused by the interaction of volatile capital measures and a static capital requirement is to redefine the capital requirement rather than to back away from a fair value accounting standard.

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