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Real Bills Revisited: Market Value Accounting and Loan Maturity

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This paper analyzes the effects of market value accounting (MVA) on loan maturity. I show that in the presence of asymmetric information MVA introduces a bias into asset valuation against longer-term illiquid assets. This bias increases interest rates for long-maturity loans and induces a shift to short-term self-liquidating loans. With the liquidity production of banks curtailed, borrowers may face "excessive" liquidation. The desirability of MVA applied to loans is thus questionable. *Journal of Economic Literature* Classification Numbers: G21, G28, M41.

That this doctrine is a very fallacious one your committee cannot entertain a doubt

Henry Thornton (1811)[1]

1. INTRODUCTION

Market value accounting (MVA) for banks and thrifts is a popular proposal for improving the economic functioning of the financial system. By replacing the current historical valuation of assets and liabilities with a market-based valuation, advocates [see Benston *et al.* (1986)] argue that bank accounting values, particularly bank capital, will more accurately

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[1] Cited in Fetter (1965, p. 43).

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reflect the economic condition of the bank. Since bank capital forms the basis for most regulatory and deposit insurer action, such accuracy would improve the ability of regulators to deal with problem institutions. Critics (for example, Berger *et al.* (1991)] counter, however, that MVA will do little to improve the evaluation of bank condition due to a wide range of implementation difficulties, including the difficulty of estimating actual values and the cost of continual updating. Moreover, opponents note that the variability introduced by continual revaluation may induce unwanted effects on bank behavior.

This paper focuses on a different aspect of the market value debate by analyzing the effect of MVA on loan maturity. The thesis of this paper is that in the presence of asymmetric information MVA introduces a bias into asset valuation against longer-term illiquid assets such as loans. This bias arises because of the well-known difficulty of establishing market prices for assets in the presence of private information [see Lucas and McDonald (1987) or Pennachi (1988)]. Of perhaps more importance, I show that this bias causes interest rates for such long-maturity loans to increase to cover the cost of the market value requirement, and this induces a shift to more short-term, self-liquidating loans. By redirecting the allocation of credit toward short-term credit, MVA changes both the composition and the function of the bank's lending activities.

Such a loan policy is reminiscent of the real bills doctrine of the 19th century.[2] While the laws of efflux and reflux which originally led to the doctrine have faded from economic orthodoxy, I argue that applying MVA rules to loans leads to the same credit policy. With such a policy, the liquidity production function of banks is curtailed, and consequently borrowers face increased liquidity risks. I apply arguments originally developed by Diamond (1991) to show that this may lead to "excessive" liquidation from the perspective of the borrower. This brings into question the desirability of applying MVA to loans.

By focusing on the link between maturity and MVA, my work fits into the growing literature investigating the link between liquidity and the lending function [see, for example, Diamond and Dybvig (1983), Diamond (1991), Hart and Moore (1989)]. The approach in this paper builds from that in Diamond (1991) in that liquidity risk may arise when lending con-

[2] The real bills doctrine originally arose to preserve the banking system from the instability arising from excessive note and credit expansion. It is generally identified with the views of the "Banking School" in 19th century England, although early U.S. banking was also largely governed by this view. The gist of the real bills philosophy is perhaps aptly conveyed by Thomas Tooke's declaration [cited in Mints (1945, p. 93)] that: "It is of the very essence of the [banking] system that their advances, whether by loan or discount, should be for such short periods, and on securities so solid and convertible, as to insure the return of the money advanced in time to meet the utmost amount of their engagement. Advances on mortgages, for terms of years, are not proper banking securities." For more discussion on the real bills doctrine, see Smith (1992).

tracts have maturities different from those of the projects they finance. That the accounting treatment of loans may also affect the provision of liquidity is a new contribution of this work. My model suggests that MVA may introduce a trade-off for borrowers between increased cost (with longer-term debt) and increased liquidity risk (with short-term debt). Such a trade-off is similar to that found by Bolton and Scharfstein (1990) in their analysis of predatory behavior and agency problems in financial contracts.

A second contribution of this research is to provide a new perspective for the debate regarding the desirability of adopting a new accounting standard for the banking system. While a substantial body of literature examining this issue has developed [see, for example, Barth (1991), Morris and Sellon (1991), White (1991), Bernard *et al.* (1991)], the sheer complexity of the underlying problem sets limitations on even the most insightful analyses. This research shares that limitation; indeed, as I discuss, there is not even consensus on what MVA is, let alone how it should be applied. But I argue that there are important dimensions of the MVA debate relating to information and asset values that are fundamental to evaluating any proposed change. And I argue that viewing MVA from this perspective provides at least a partial answer as to when such an accounting standard may be desirable.

In particular, my model suggests that MVA may provide more accurate (and hence presumably more desirable) valuations when asset value changes are publicly observed. Such changes can arise from interest rate movements, or simply from changes in observable cash flows, suggesting that proposals to adopt "partial MVA" for traded securities only may be worthwhile. Where MVA "fails" in my model is when it is applied to longer-term assets, such as loans, in which the bank's information (and expertise) are likely to be important. This objection, also raised by Berger *et al.* (1991), takes on particular importance for banks where upward of 60% of their assets may involve such characteristics.[3]

One caveat on the policy prescriptions of this research must be stressed. To focus on the implications for loan maturity, the model addresses only the asset side of the balance sheet, and is a simplified representation of that. The MVA issue also applies to the liability side, an aspect about which my model provides no guidance. Moreover, my analysis does not consider any of the implementation issues so extensively examined by other authors. The analysis does suggest an important interaction between MVA and credit allocation, and the implications of this are discussed in the paper.

[3] That banks play an important role in the market for long-term credit can be seen from the Survey of Current Lending, November 2–6, 1992 (see *Federal Reserve Bulletin*, February 1993). During that week, banks made $4,575,958,000 in new (long-term) loans with an average maturity of 48 months and 9,564,119,000 in (short-term) loans (with maturities greater than 1 month but less than a year) with an average maturity of 152 days.

The paper is organized as follows. The next section discusses the concept of MVA and details the specific MVA application that is analyzed in this research. In Section 3, I develop a simple multiperiod lending model and investigate how MVA affects the value of loans in the presence of both symmetric and asymmetric information. Section 4 extends the analysis to include both short- and long-term contracts and the effects of liquidation on the bank's lending decision. I then investigate how asymmetric information affects the bank's lending decision and discuss the alternative equilbrium outcomes that can arise. I also examine the tradeoffs facing short-term and long-term borrowers. The final section summarizes my results and discusses their applicability to the policy debate surrounding MVA.

2. MVA FOR BANKS

At a superficial level, the concept of MVA is straightforward: assets or liabilities should be valued for accounting purposes at current market value. However, the application of MVA to banking is remarkably complex, raising issues related to scope, measurement, implementation, and even desirability. While many of these issues are beyond the scope of this paper, in this section I consider the underlying problem and define the specific applications that are considered.

Currently, banking employs historical cost valuation whereby assets and liabilities are carried on the balance sheet at historical cost. This standard is motivated by the argument that banks acquire loans and securities with the intention of holding them to maturity. Interim fluctuations in value are viewed as inconsequential in that at maturity the asset will be worth its face value (in the absence of credit losses). Historical accounting thus measures the "underlying" value of an asset, but does not capture its value at each point in time.

Historical accounting is applied to all liabilities (deposits, borrowing, etc.), to the bank's loans, and to most of the bank's securities holdings. An exception arises with respect to securities held in the bank's trading account. Bank security holdings are divided into an investment account and a trading account, where the latter contains those securities which the bank designates it does not intend to hold to maturity. Such securities must be valued for accounting purposes at the "lower of cost or market" (LOCOM). Securities held in the bank's investment account are valued at historical cost, and these constitute the bulk of the bank's securities. For example, over the period 1986–1992 only 0.8% of securities held by superregional and regional banks were in their trading accounts; for 1991, only 2.9% of money-center bank securities were held in the trading account.[4]

[4] Indeed, Salomon Brothers notes that "trading account activity (assets carried at market) is centered in generic securities and is heavily concentrated in a few banks." The figures

Proposals to require MVA for banks have been put forth by a wide variety of groups including the Financial Accounting Standards Board (1990), the American Institute of Certified Public Accountants (1990), the Office of Thrift Supervison (1990), and the Federal Financial Institutions Examination Council (1990) [see Morris and Sellon (1991) for more detailed discussion]. Moreover, both the Securities and Exchange Commission and the Federal Reserve have expressed opinions regarding the desirability of MVA, as has the U.S. Treasury. Yet, whereas proposals abound, there is little consensus as to what should be required, and this diversity has contributed to the contentiousness of MVA.

One issue complicating the MVA debate is what should be included. Whereas some proposals require that every balance sheet entry be carried at market values, other proposals are more limited. These partial schemes typically limit MVA to assets only, and some (for example, the FASB proposal) would further restrict the application of MVA to securities and traded off-balance sheet activities. Although measuring assets by one standard and liabilities by another would appear to be confounding, it is these partial schemes that are currently being considered most actively.[5]

In this paper, I focus on "partial" MVA. In particular, my analysis examines the effects of requiring the bank to value assets (both loans and securities) at market. In my framework, this market valuation must be done for each *individual* asset and not for the loan or security portfolio as a whole. This individual valuation captures a prominent feature of current MVA proposals in that it is the actual value and not the value on average that MVA advocates desire. But this requirement engenders a new difficulty: what is the market value for each of the bank's assets? The standard approach for determining this value has been to use the asset's market price. Yet, this is surely an abstraction: value is intrinsically defined over some time interval while a price can capture value only at a single point in time. Moreover, a second difficulty is that while a market price may be easy to determine for traded secuities, it need not be for assets which rarely if ever trade in a market. In the absence of well-defined market prices, the "correct" value to assign an asset is problematic both because of lack of availability and because illiquidity may introduce large bid–ask spreads into asset prices.

In this paper, I adopt the simple approach of defining the market price

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cited above, as well as a discussion of bank trading and investment accounts, can be found in Salomon Brothers (1993).

[5] Another issue in the MVA debate is whether values should be reported on the balance sheet or as footnotes. Currently, FASB 107 requires market values (or "fair" values) to be disclosed in footnotes for all bank financial instruments including loans and time and demand deposits. It is widely believed that FASB 107 is a precursor to a broader requirement of such reporting on balance sheet and income statements. This issue is considered in Barth (1991) and is not addressed here.

to be that which would arise if the asset were sold in the market, ceteris paribus. Thus, I focus on how given current markets an MVA requirement would affect valuation. Certainly, it is possible that MVA would, in turn, create new markets and with them new market prices. But how, or even if, new markets develop is surely speculative, and attempts to address this issue without first ascertaining the direct effects of MVA seem premature. As will be apparent, I view this pricing problem as paramount to determining the feasibility and desirability of any MVA standard. I argue that for at least some assets, market prices cannot hope to be unbiased estimates of current value.

A final issue relates to the frequency of MVA adjustments. In a friction-free world (or at least one without transaction costs, search costs, or asymmetric information) one could require that asset prices be continuously updated. However, such perfection is not within our grasp, and no current MVA proposals envision continuous updating. What is typically required is periodic updating, with the timing determined by the bank's financial and regulatory demands. In this paper, I adopt the convention that values must be updated at the end of the "period." Since the length of a period is unspecified, this is completely general. But the interpretation I find most useful is to view a one-period loan as short term and multiple-period loans as long term. Since bank lending has increasingly focused on short-term loans, this interpretation may also allow insight into factors affecting the allocation of credit between bank and nonbank providers.

In the next section, I develop a simple model to address these issues. Because of my specific focus on MVA, the model is necessarily parsimonious. In later sections, I extend the model to consider more general aspects of MVA.

3. THE MODEL

I consider an economy in which firms undertake projects that are funded exclusively by bank loans. For simplicity, I assume that each project requires the same investment amount, which is normalized to 1. As my focus is on intermediation over time, the model incorporates three time periods, denoted 0, 1, and 2. At time 0 loan decisions are made, and funds are disbursed. Paybacks for the loans can occur at times 1 and 2 depending on the maturity of the loan. Following the structure of Diamond and Dybvig (1983) or Diamond (1991), I incorporate illiquidity by assuming that payoffs to all projects occur at time 2. Hence, the production process underlying the loan is such that at time 1 the project may have a low or even negative return due to the incompleteness of the project.

There are two types of firms, good and bad. A firm's type is defined by the outcome of its project realized at time 2, with good firms receiving a payoff of G^* and bad firms receiving a payoff of B. There may also be a nonassignable control rent, θ, that accrues only to the project manager. Such control rents may arise because of moral hazard, difficulties in monitoring, or private information of borrowers [see Diamond (1991) for more discussion], but because they are nonassignable they cannot be transferred to the lender in the event of project bankruptcy. The effect of such control rents is examined in Section 4.

I assume there is a positive probability γ that a project is good and a corresponding probability, $1 - \gamma$, that a project is bad. At time 0, a firm does not know its type and, as all firms look the same, neither the market nor the banks can distinguish between good and bad firms. At time 1, there may be information about the time 2 payoffs (and hence about the firm's type). If such information is private, I assume that it is known to the firm itself and to its banker.[6] At time 2, all information is public as the projects pay off.

In a competitive banking market, the amount that the borrower repays must be sufficient to provide the bank a zero expected profit. I assume that banks act competitively and that they fund loans with a combination of deposits and capital. In the following analysis, I assume that the cost of capital, r_K, exceeds the cost of deposits, r_D. The higher funding cost for capital can be justified by the tax-advantaged position of deposits. As Pennachi (1988) and Orgler and Taggart (1983) have shown, the deductibility of deposit interest makes the cost of deposits lower than that of equity. A second factor that may contribute to a divergence in explicit funding rates is agency problems associated with issuing capital.[7] Besanko and Kanatas (1992) raise the intriguing argument that if the value of the bank depends on insiders' efforts, then raising additional capital dilutes their ownership share. Since this lowers the value of the firm to the insider, they respond by reducing effort, with a resultant fall in the value of the equity. This dictates that providers of capital must receive a higher return, resulting in a greater cost for capital than deposits.[8]

With deposits cheaper, it follows that the bank would prefer to fund all loans with as little capital as possible. Since this shifts all risks of bank

[6] I assume that firms learn any private information at time 1 and so do not know at time 0 if they are good or bad. If they know their type, then their choice of loan contracts could have signaling value, an issue addressed by Flannery (1986). As our focus here is on MVA, this issue is not considered.

[7] Flannery (1989) also presents a model of risk-neutral, competitive markets in which the expected return on equity exceeds that of deposits due to the option value of deposit insurance guarantees. Empirical evidence suggesting a differential cost between deposits and capital is given in O'Hara and Shaw (1990).

[8] In the Besanko and Kanatas model, this increased cost arises whether capital is composed of equity or subordinate debt. Hence, in the analysis which follows, issuing debt to meet capital requirements will still be more costly to the firm than issuing deposits.

failure to the regulators, I assume that bank capital levels are also constrained by a capital requirement whereby the ratio of capital to loan values must exceed K, a regulator-specified level. Such a capital requirement is an important and pervasive characteristic of actual banking markets. As banks are initially identical, face the same capital requirement, and are competitive, I assume that their overall cost of funds is an exogenously given $r = Kr_K + (1 - K)r_D$.

An important feature of this model is that all participants (i.e., banks, firms, and the market) are assumed to have rational expectations. While the exact implications of this become apparent shortly, this assumption permits the value of firms (projects) at any point in time to reflect more than just their current value given that period's cash flows. This assumption, in combination with the assumption of competitive lending markets, also permits the value of loans to be calculated. It is to this calculation that we now turn our attention.

Initially, suppose that all loans are for two periods, so that the borrower receives the money at the end of period 0 and repays in period 2.[9] Such long-term financing aligns the term of the loan with the length of the project and hence obviates the need for interim financing. To simplify the analysis, I assume that all interest is paid at the end of the loan, thus avoiding the numerical nuisance of calculating interim interest payments. Given a loan size of 1, this dictates that the expected repayment for a two-period loan must equal $(1 + r)^2$.

The explicit loan payment amount depends on the outcome of the project. If the firm has a bad project, then its payoff is B, which is assumed to be strictly less than $(1 + r)^2$. In this case, the firm is bankrupt and the total proceeds of the project go to the bank. If the project is successful, then the firm receives G^* and pays a prespecified amount G to the bank, where $G^* \geq G > (1 + r)^2$. The expected unconditional payoff to the bank of a project at time 2 is thus $\gamma G + (1 - \gamma)B$, where G is set so that

$$\gamma G + (1 - \gamma)B = (1 + r)^2. \tag{1}$$

It follows that since loan types are unknown at time 0, all loans must have the same market price. In a competitive market, the value of the loan is simply given by its discounted cash flow, so the time 0 book value of the loan, p_0, must be 1. If interest rates are unchanged and there is no new information, then the book value of the loan at time 1 is[10]

[9] As loans are long term, it is not possible for the bank to "call" the loan at time 1 (I consider this alternative contract in the next section).

[10] The two-period loan is depicted as a discount instrument and consequently the book value of the loan is adjusted for the accrued interest. An explicit interim interest payment could be included without affecting the results of the analysis.

$$\frac{\gamma G + (1 - \gamma)B}{(1 + r)} = p_1. \tag{2}$$

Note that this differs from the time 0 price by the accrual of the interest.

Suppose now that interest rates have changed so that the bank's cost of funds is $r' > r$. Since all market participants know the level of interest rates, the market value of the loan falls to $p_1' < p_1$. If the bank uses historical accounting, this change in value is irrelevant; the bank values the loan at p_1 regardless of market conditions. But a bank using MVA would have to recognize a loss. While this latter action introduces variability into the bank's asset value, it captures the unassailable fact that the bank faces an opportunity cost loss because its funds are invested at r instead of r'. Hence, regardless of the fact that the bank will hold the loan to maturity, the bank has suffered a loss on the loan. MVA thus serves to measure the bank's position more accurately because it can recognize the opportunity loss inherent in the bank's position.

Now consider the other factor affecting loan value, the nature of the underlying project. Although at time 0 loan types were unknown, by time 1 at least some participants may have information about the loan. Consider first the case where the project type is publicly observable. Initially, let the market interest rate be unchanged from period 0 (i.e., r). With the market observing the type, good loans are now worth

$$p_G^1 = \frac{G}{1 + r} \tag{3}$$

and bad loans are worth

$$p_B^1 = \frac{B}{1 + r}, \tag{4}$$

where $p_G^1 > p_1 > p_B^1$.

If the banks were to value the loans at the new market price, then holders of good loans would recognize a gain and holders of bad loans a loss. Consequently, MVA would introduce changes in the bank's balance sheet relative to book value accounting. These changes would clearly be appropriate: the true value of good loans is higher and the true value of bad loans is lower. Note also that with types publicly known, there is no debate about the appropriate values to attach to the loans. Since the loans are noncallable, any interim liquidation value of the project is irrelevant. The market value of the loan is simply the discounted cash flow, which can be universally calculated given the information available to the market.

Suppose now that types are not publicly observable. If the project's type is private information to the firm and its banker, what is the loan's market price? Note that the market price cannot be the book value p_1. Any bank holding a bad loan would immediately sell it to the market because $p_1 > p_B^1$. Indeed, since holders of good loans would never sell at a price below p_G^1 and holders of bad loans would sell at any price above p_B^1, market participants know that only bad loans would be sold. The market value of the loans will thus be p_B^1, and at this price, the market value accurately reflects the value of the loans being sold. This price does not, however, reflect the value of the loans overall. Indeed, the average value of the loans is still the book value p_1.

This divergence between actual and market values arises because of the well-known lemons problem [see Lucas and MacDonald (1987)], in which the presence of private information causes the market price to understate the true value of the asset. In the model, the "bad" price results because with discrete asset values and only information-based trading, the market price settles to the lowest possible level. If asset values were continuously distributed, however, then even this price is too high as the market ceases to exist. Of course, such worst-case scenarios ignore other reasons for trading which, in turn, would raise the market price above the strictly bad price. But even with such trading, if private information is important in determining the asset's value, the market price will always be below the average price.

In actual banking markets, there is some evidence that such a divergence in price does arise for some assets. While active loan markets do exist for loans to larger, better known credits, markets for smaller company credits typically do not. For example, Salomon Brothers in 1990 made an active (public) market in approximately 29 bank loans, a far cry from the 1885 listed equities on the New York Stock Exchange. There is a private market for loan sales, but estimates of its size vary. Gorton and Haubrich (1989), using call report data, estimate it to be approximately \$236 billion in the first quarter of 1988.[11] They also present evidence that the market is dominated by money-center and large correspondent banks. This may reflect, in part, the fact that in the late 1980s as much as one-half of the loans sold were used to finance mergers and acquisitions. Another substantial area for loan sales has been in LDC (less-developed country) debt, where the loans traded typically involve official credits and not specific loans to small borrowers.

These charactaristics of the loan sale market suggest that while market prices may be unbiased for some credits, it is not the case for all loans,

[11] Gorton and Haubrich (1989) provide an excellent description of the loan sale market, as well as an interesting discussion of the potential moral hazard problems involved.

and particularly not for credits to smaller borrowers. Indeed, LeGrand (1992) notes that "smaller multibank revolving credits tend to be so illiquid that trying to sell them may prove to be simply an exercise in frustration." Even in the market for large, well-known credits, however, spreads can be as large as 200–400 basis points, which is consistent with asymmetric information problems and suggests that bid prices (or the price at which a loan could be sold) are biased downward.

A related problem is that few loans by small banks ever trade, and Becketti and Morris (1987) present evidence that small bank participation in loan sales actually decreased in the 1980s.[12] This limited role of small banks is important in light of the reputation arguments given for loan sales in the presence of moral hazard. Specifically, Becketti and Morris acknowledge the potential bias in loan prices arising from moral hazard, but argue that "no bank can continue to prosper as a loan merchant if its reputation for controlling quality is suspect." Even if this is correct, the limited participation of small banks means that such reputation effects cannot apply, dictating that moral hazard costs will remain large for the types of loans typically made (and held) by small banks.

Finally, indirect evidence of the effect of moral hazard can be found in the market for asset-backed securities. Although there is a large market for such securities, virtually all issues have credit enhancement or, as is the case for credit card-backed securities, are sold with recourse against the issuer. Such financial guarantees are expensive, but presumably are attractive to issuers because market prices would otherwise be too low due to the moral hazard problem. This raises the important implication that the market prices we do observe may be only those consistent with low- or zero-risk assets; markets for other assets simply would not exist.[13]

This suggests that market prices may be biased due to two different effects. If assets are in the same ex ante risk class, then market prices can be biased downward due to the lemons problem. But if markets (and, hence, market prices) exist only for low-risk assets, then extrapolating from those market prices to infer other nontraded asset prices can result in an *upward* bias due to the differences in ex ante risk classes. In this analysis, I focus only on assets in the same risk class and, hence, this

[12] Becketti and Morris find that from 1983 to 1987 the fraction of banks that had loan sales greater than 1% of assets declined from 20 to 17%. They attribute this to loan sales increasingly being used as an alternative to commercial paper, and as small banks do not lend to such large, widely followed credits, they are not able to operate in the loan sales market. Gorton and Haubrich (1989), however, dispute this commercial paper alternative argument.

[13] Even in these active markets, however, it may not always be possible to determine the market price; Mondschein (1992) notes that in the mortgage securities markets, prices for nonconforming loans are typically not available.

upward bias is not a factor. But such a risk-class bias may be important in valuing some of the assets typically found on bank balance sheets.

These arguments suggest that market prices for at least some types of bank loans need not accurately reflect true asset values. Consequently, for those assets, MVA will also fail to reflect true values and will introduce a bias into a bank's balance sheet that does not arise when the bank uses historical accounting. In the model developed here, MVA rules would require the bank to write all loans down to p_1^B, understating the true asset value by $p_1 - p_1^B$.

One response to this bias is to estimate the value of the loans using a criterion independent of the market price. Two related approaches have been suggested. First, if "comparable" assets exist which trade in markets, then matrix pricing techniques can be applied to infer hypothetical yields from observed market yields on similar instruments. For many assets, however, "comparables" do not exist and the standard technique is then to compute discounted cash flows based on projected future payoffs. Second, FASB Ruling 107 requires companies to state in the body or notes of financial statements the *fair value* of financial instruments (including all loans), where fair values can be estimates based on projected cash flows using appropriate discount rates.

In our model, such discounted cash flows can also be determined by noting that at time 1 market participants know that γ of the loans are good and that $1 - \gamma$ are bad.[14] Using these probabilities, the best estimate of the loan's value is its discounted expected cash flow, or

$$\frac{\gamma G + (1 - \gamma)B}{(1 + r)} = p_1. \tag{5}$$

But this is the book value of the loan calculated earlier! In the presence of private information, therefore, attempts to remove the lemons bias can do no better than the value established by book value accounting.

The analysis suggests that MVA dominates book value accounting whenever information is symmetric. If there is private information, this may no longer be true and MVA may impact a bias to an asset's valuation. In the next section, I investigate this bias in more detail.

4. MVA AND BANK BEHAVIOR

If the bank is now required to use MVA, what will be the effect on the banking markets? Under MVA, the bank must adjust the value of its loans

[14] I am assuming a large universe of firms so the probabilities γ and $1 - \gamma$ correspond to the actual fractions of good and bad firms found in the economy.

to their time 1 value. Since the bank's capital-to-loan value ratio must be at least K, this adjustment may necessitate additions to (or allow deletions from) its capital account.

In the previous section, the loan contract was structured so that the expected return on the loan just equaled the bank's cost of funds. Because of the default possibility introduced by bad projects, however, the quoted loan interest rate must be higher than the interest rate the bank pays for its funds. In particular, since the bank uses the gains on the good loans to offset the losses on the bad, it follows that $G > (1 + r)^2$. There exists an interest rate, call it i, such that $G = (1 + i)^2$, so that i can be defined by

$$i = \sqrt{G} - 1. \tag{6}$$

Since $i > r$, it follow that the loan rate can be expressed as $i = r + \lambda$, where r is the bank's cost of funds and λ is a default premium on the loan.

Perhaps the simplest change to consider is the pure interest rate effect induced by changes in the bank's cost of funds. With MVA, the bank will recognize a loss at time 1 if rates rise and a gain if rates fall. Since the bank is risk neutral and the expected change in interest rates is zero, the net expected effect of the MVA rule is also zero. Therefore, when the bank is pricing its loans at time 0, the MVA requirement is of no consequence. A similar noneffect occurs if project type information is publicly available. Although banks with bad loans must write off capital, those with good projects reap a capital benefit. The net expected result for the bank is zero, and so the impact of marking the asset to market again has no effect on the bank's pricing decision.

In the two cases just considered, any downward revaluation in the loan's value is counterbalanced by an equally likely upward revaluation. This is not the case, however, when information is asymmetric. With private information, market prices are biased downward, meaning that the upside potential no longer remains. At time 1, each bank must take a writedown of $p_1 - p_B$ on every loan. While good loans will subsequently be revalued at time 2 (bad loans, of course, will not), the bank faces a one-period cost at time 1 of $(p_1 - p_B)(1 - K)(r_K - r)$, where r_K is the cost of capital and K is the exogenously given capital–asset ratio. This cost of complying with the MVA requirement is strictly positive as $r_K > r$ and $p_1 > p_B$. This dictates that the bank can no longer satisfy its zero-profit requirement by setting the loan rate at i, but instead must set a higher rate $i' > i$.[15]

In the previous section, I showed that MVA would impart a downward

[15] In particular, the bank will set a new good project-required payoff of $G' > G$. Denoting discounted compliance costs by c, the new interest rate $i' = \sqrt{G'} - 1 = r + \lambda + c$.

bias at time 1 to the value of the bank's loans. This, in turn, causes an upward bias in the loan rate at time 0 as banks rationally adjust their rates to reflect their expected future cost. This increase in interest rates is a pure "dead-weight" loss; the loans themselves are not riskier nor is the bank more likely to make bad versus good loans. What causes the revision is simply that the loans are more expensive because of the cost of their accounting treatment.

At this higher interest rate the bank can expect to break even on its two-period loans. For the borrowers, however, it may be that the higher interest rate is such that positive expected net present-value projects no longer remain so. In this case, the higher interest rate may preclude firms from undertaking projects that they otherwise would have pursued. An alternative to this outcome is to borrow via a short-term or single-period loan. In the next section, I consider the implications of MVA for loan maturity choice.

5. LOAN MATURITY AND MVA

In the previous sections, the loan contracts had the same maturity structure as the underlying projects. However, with two-period loans now more expensive, a borrower may prefer to use a sequence of short-term lending contracts. Borrowing via one-period loans necessitates that the firm "roll over" its debt and hence introduces the risk that the firm will face liquidity constraints at time 1 should the bank refuse to extend additional credit.

It is useful to delineate exactly how lending occurs if the borrower uses a sequence of short-term contracts. With a one-period loan, the borrower receives the loan at time 0 and repays the full amount plus interest at time 1. Because there are no project cash flows until time 2, the borrower cannot simply take funds from the underlying project to meet this loan payment. Instead, the borrower's ability to repay the initial loan depends on the bank's willingness to lend to the borrower again at time 1. In the analysis which follows I implicitly assume that the borrower deals with the same bank at time 0 and time 1. For the case where information is symmetric (or there is no new information) this assumption is innocuous; any other bank would make the same decisions as the initial lender. I discuss later in this section when this will not necessarily be the case and propose an alternative arrangement that permits lending by other banks.

For the bank, this sequential borrowing dictates that its lending decisions are interrelated and hence must be solved via dynamic programming. As with all dynamic programs, the solution is found by working backward from the last period, so we begin by considering the bank's time

1 problem. At time 1, the bank has three possible actions it can take. It can lend the borrower no new money, thereby forcing the borrower to default on its time 0 loan. In this case, the bank owns the project and is assumed to liquidate it at the interim value, L. Second, the bank can lend the borrower sufficient funds to retire its period 1 obligation. In this case, the borrower is able to roll over the loan, with the second-period loan allowing the borrower to continue operations. Third, the bank can lend the borrower some money at time 1, but not enough to retire the time 1 debt. In this case, the borrower cannot pay its time 1 obligation, but if the value of finishing the project exceeds its liquidation value, the project is continued. These possible outcomes at time 1, in turn, influence the contract the bank will offer at time 0. Whatever the contract offered, it must satisfy the constraint that the bank receive, at least, its cost of funds.

To determine these contracts, it is first useful to analyze the simplest scenario where there is no new information at time 1. Let D denote the size of the time 0 obligation and let G_s denote the payoff required from a successful project at time 2 (note that G_s need not be the same payoff amount as that from the two-period loan analyzed previously). Proposition 1 demonstrates the form of the equilibrium interest rates for this no-information case.

PROPOSITION 1 (The "No Information" Case). *Suppose that there is no new information at time* 1. *Then, provided that* $G_s = (1 + r)^2 - (1 - \gamma)B]/\gamma \le G^*$, *the equilibrium interest rates are given by*

$$i_1 = r$$

$$i_2 = \frac{(1 + r)^2 - (1 - \gamma)B - \gamma(1 + r)}{\gamma(1 + r)}.$$

Proof. See the Appendix.

This equilibrium exhibits a number of interesting properties. Provided the payoffs are feasible (i.e., $G_s \le G^*$), the bank knows that its expected return on the second-period loan meets its minimum profit condition. Consequently, the bank will be willing to roll over the loan at time 1. This has two important implications. First, with no rollover risk, first-period loans are actually riskless for the bank and so its prices them accordingly at its cost of funds. Second, even though the borrower holds short-term loans, he faces no liquidity risk as the bank merely relends the money for a subsequent loan. The stated interest rates that the borrower faces reflect the fact that uncertainty occurs only at the end of the loan. Because the borrower is risk neutral, he would be indifferent between paying disparate one-period rates or borrowing at a constant average two-period rate if the two alternatives had the same expected cost.

Earlier we examined how the accounting treatment of the loan affected valuation when lending was long term. Now this same question arises in the case of short-term lending. In this equilibrium, the accounting treatment is clearly irrelevant. Since all loans are fully repaid at time 1, it follows that their value is identical under both a historical and a MVA approach. With no new information at time 1, the loan's valuation is unaffected by the passage of time.

A more interesting scenario arises when new information is available at time 1. Initially, assume that this information is symmetric so that everyone knows at time 1 whether the project will be good or bad. Consider again the time 1 loan. The time 1 value of each project is simply its (now certain) time 2 payoff discounted by $1 + r$. This implies that a good borrower could always repay a loan of amount $G_s/1 + r$, while a bad borrower could with certainty repay only a loan of $B/1 + r$. Since there is no uncertainty over a borrower's type, it follows that the most a bad borrower can borrow at time 1 is this amount, as any larger loan cannot be repaid.

Given this information, the bank will not lend the full amount to some borrowers at time 1 and, depending on the expected cash flows and liquidation value, may force some projects into liquidation. Hence, unlike in the previous case, some borrowers will face limitations on their time 1 borrowing. Let G_C denote the payoff required from a successful project at time 2 if all projects are continued (i.e., liquidation is not optimal) and let G_D denote this payoff if liquidation can occur. Proposition 2 demonstrates the equilibrium interest rates that will prevail in the economy.

PROPOSITION 2 Equilibrium with Symmetric Information. *Suppose that new information on project type is available at time* 1 *and is known to all market participants. If* $L < B/(1 + r)$, *then provided* $G_C = [(1 + r)^2 - (1 - \gamma)B]/\gamma \leq G^*$, *the equilibrium interest rates are given by*

$$i_1 = \frac{(1 + r)^2 - (1 - \gamma)B - \gamma(1 + r)}{\gamma(1 + r)}$$

$$i_2 = r.$$

If $L > B/(1 + r)$, *then provided* $G_D = [(1 + r)^2 - (1 + r)(1 - \gamma)L]/\gamma \leq G^*$, *the equilibrium interest rates are given by*

$$i_1 = \frac{(1 + r) - (1 - \gamma)L - \gamma}{\gamma}$$

$$i_2 = r.$$

Proof. See the Appendix.

In this equilibrium, the bank will fund all good loans and may continue the bad loans if their liquidation value is low enough. If the bank does roll over the bad loan, however, it will lend only $B/(1 + r)$ at time 1. This reflects the fact that with the project's outcome known, a bad borrower can repay only a loan of that amount. Given the respective good and bad loan sizes, it follows that both good and bad loans in period 2 will always be paid off and hence the bank charges its cost of funds for all its second-period loans.

One result of this loan policy is that the bank recognizes its losses on bad loans at time 1. Hence, although the bank may continue to fund the loan, it does so at the new lower value. Of course, such losses are offset by the gains that the bank also recognizes on its good loans at time 1, so that the bank's expected return is zero. What is important to stress, however is that with short-term loans, any divergence in realized value at maturity from the face value represents a loan loss and not a change to the loan's balance sheet value. Whether the bank uses historical accounting or MVA, it will treat this transaction the same way.

A second result of this equilibrium is that some borrowers may not be able to borrow at all at time 1. If a project's liquidation value is high enough, the bank may discontinue lending, thereby causing the borrower to default on his first-period loan. Note that if $L > B/(1 + r)$ then the first-period interest rate charged to the borrower is lower than if $B/(1 + r) > L$ because the ability to liquidate raises the return to the lender from the bad project. But this now results in some projects being terminated early, exposing the borrower to liquidity risk. While this is optimal for the bank, it need not be optimal for the project owners. In particular, Diamond (1991) shows that if there exist nonmarketable control rents, short-term debt can result in excessive liquidation from the borrower's perspective.

The essence of Diamond's argument can be incorporated into our analysis by allowing project returns to include a non-state-contingent return to the managers. This return, or control rent, can be thought of as the benefit that the manager is able to extract from his position. Such rents may reflect reputational returns that will accrue to the management or simply benefits arising from their current position. What matters is that such rents are not assignable to lenders. Let these control rents be denoted by θ so that the total payoff to the manager of a firm with a good project is $G^* + \theta$ and to a bad project is $B + \theta$.[16]

One can think of an action being optimal for the managers if it is the action that they would choose if they were the sole owner of the project

[16] The control rent θ is assumed independent of project type. This is consistent with the notion that being the manager conveys benefits independent of outcome. The analysis can also accommodate type-contingent control rents.

(i.e., had advanced their own money for the project). From the perspective of the firm, therefore, liquidation at time 1 is optimal only if $L > B/(1 + r) + \theta$. For any liquidation level below this, the managers would be willing to put additional money into the firm if they could raise it. From the bank's perspective, however, liquidation is optimal whenever $L > B/(1 + r)$. This divergence dictates that from the borrower's perspective the bank will liquidate "too much," and borrowers will face a liquidity risk that does not arise with two-period loans.[17]

For the borrower, this liquidation property introduces an interesting trade-off into his or her initial borrowing decision. If the borrower enters a two-period loan, then this liquidity risk is no longer a concern. But, from our earlier discussion, the interest rate for such a loan may be higher than the "competitive" level because of the bias introduced by the MVA requirement. This bias arises, however, only when information is asymmetric. To determine whether such a liquidity–price trade-off actually arises, therefore, we must examine the short-term lending equilibrium with asymmetric information.

With asymmetric information, the determination of equilibrium becomes more complex. Because the bank has private information, whether the borrower is good or bad is now no longer apparent to the market. Consequently, the bank may be tempted to exploit its information at the expense of its borrowers. Moreover, in whatever equilibrium prevails, it must be the case that the bank's actions at time 1 are optimal given its information and choices at the time (the sequential rationality requirement). This means, for example, that promises by the bank to take a certain action at time 1 are credible only if that action will, in fact, be optimal for the bank when time 1 arrives.

To address these issues, we require a bit more structure. In particular, previously I assumed that the borrower dealt with the same bank in both periods. This was innocuous when information was symmetric, but now this would allow the bank to exploit its private information by threatening to "cut off" good borrowers at time 1 unless they agreed to pay a higher interest rate. To retain our focus on the competitive outcome, I consider the following framework. At time 1, the initial lender offers the borrower a loan size and an interest rate for the time 2 loan. This offer may, of course, involve no new loan or a reduced amount. The market (the other

[17] Note that liquidation occurs because the manager is unable to arrange sufficient financing at time 1 and so defaults. One solution from the borrower's perspective to this excessive liquidation problem is to arrange at time 0 for a loan commitment at time 1. Berkovitch and Greenbaum (1991) demonstrate that such contracts may avoid the underinvestment problem that can arise when borrowers have private information. While my model does not consider loan commitments or other off-balance sheet contracts, my analysis implies that a likely outcome of imposing MVA would be to increase the demand for loan commitments.

banks) can observe this loan offer, and the borrower can then approach other banks for their offers for lending. If an outside bank matches or betters the loan offer of the initial lender, then the borrower is free to move to the other bank.[18] This means, for example, that if the initial lender offers a loan of size $B/(1 + r)$, then it will accept that amount in payment for its first-period loan. As is typically assumed, if the banks offer identical contracts, then the borrower is assumed to stay with the initial lender.

This sequential approach allows for the determination of an equilibrium in which the bank's optimal strategy incorporates the fact that while other banks do not know the borrower's type, they can observe the initial lender's decision. This restricts the first bank's ability to capture additional rents from borrowers.[19] As my focus is on the effects of MVA in competitive markets, abstracting from such market power complications seems appropriate. I discuss later in this section how departing from this framework affects my results.

To determine the equilibrium in this model, I employ the sequential equilibrium concept of Kreps and Wilson (1982). In a sequential equilibrium, strategies are conjectured for the players and best responses are then determined. Equilibrium requires that these strategies and responses be consistent and optimal. What matters for my analysis is whether with asymmetric information short-term borrowers face liquidation risk. Proposition 3 demonstrates that this does, indeed, occur.

PROPOSITION 3 (Equilibrium with Asymmetric Information). *Suppose that information on borrower type is available at time 1 and is private to the bank and the borrower. Then, if* $L > B/(1 + r)$ *and provided* $G_D = [(1 + r)^2 - (1 + r)(1 - \gamma)L]/\gamma \le G^*$, *there is a sequential equilibrium in which the interest rate structure is given by*

$$i_1 = \frac{(1 + r) - (1 - \gamma)L - \gamma}{\gamma}$$

$$i_2 = r.$$

If $L < B/(1 + r)$, *then, provided* $G_C = [(1 + r)^2 - (1 - \gamma)B]/\gamma \le G^*$, *there is a sequential equilibrium in which the interest rate structure is given by*

[18] In the simple framework considered here, there are no costs to switching to a new bank. Such costs might be expected to arise if it were costly to find another bank ("search" costs) or if banks had to expend resources to investigate new borrowers. If such costs did arise, then this would allow the initial lender to extract additional rents up to the cost of switching.

[19] For examples of models in which the bank does extract such rents, see Sharpe (1990) and Rajan (1992).

$$i_1 = \frac{(1 + r)^2 - (1 - \gamma)B - \gamma(1 + r)}{\gamma(1 + r)}$$

$$i_2 = r.$$

Proof. See the Appendix.

Proposition 3 demonstrates that the outcome with asymmetric information retains the property that bad borrowers face liquidation if the return on the project is low enough. If liquidation is not optimal, then the bank continues to fund the loan but at the reduced loan size of $B/(1 + r)$. Hence, the bank again recognizes gains and losses on its loans at time 1 rather than at time 2. The good borrower receives sufficient funds to pay off his first-period obligation, and all borrowers pay an interest rate equal to the bank's cost of funds in period 2.

For the borrower, this equilibrium means that the decision to fund the project with short-term loans or long-term loans involves a trade-off. With asymmetric information and a MVA requirement, long-term loans are more expensive but short-term loans involve a liquidation risk. In Diamond (1991) such a liquidity-risk trade-off resulted in firms with medium credit ratings preferring to go long, while the highest rated firms prefer to go short (firms with the worst credit rating have no choice but to borrow short). In the setting analyzed here, borrowers do not know ex ante whether they are good or bad, so the maturity choice is influenced by the relative size of the potential lost control rents and the actual increased interest costs. But, because MVA increases the cost of long-term funding, it makes it more likely that firms will choose short-maturity contracts resulting in the bank's credit policy being that of providing short-term, self-liquidating loans. This "real bills" effect implies increased liquidation risk for borrowers because banks are providing less liquidity for the economy.

While this reduction in liquidity would seem to be a negative effect of MVA, two important caveats are in order. First, determining whether the economy is worse off with MVA than with historical accounting would require evaluating a social welfare function, an analysis I have not performed. In a more general setting, benefits to MVA that are not a feature of my model might appear, and similarly with respect to drawbacks to historical accounting. What may analysis shows is that liquidity will decrease; policymakers should thus be aware of this consequence in weighing the cost and benefits of alternative accounting standards.

A second caveat relates to the robustness and generality of the equilibrium. As is well known in models with asymmetric information, the equilibrium need not be unique. Thus while the outcome in Proposition 3 is an equilibrium of the model, there may be others as well. This is particularly true if we depart from the sequential timing structure employed in the construction of the equilibrium. If, for example, the market were not able to observe the initial lender's roll-over offer, then the equilibrium outcome could differ radically from that depicted.

What matters for my analysis is whether these alternative equilibria could vitiate the liquidation result depicted above. While it is certainly not possible to answer this for every possible market structure or assumption, it is the case that in the model analyzed here, liquidation of bad projects remains a general property. To see why, suppose we assume that the market cannot observe the initial lender's roll-over decision and, for simplicity, that liquidation is optimal for bad loans [i.e., $L > B/(1 + r)$]. The initial lender can then determine his strategy based on expectations of his competitors actions, and in equilibrium these expectations and strategies must be consistent.

For liquidation to not arise, it must be the case that the bank chooses to ignore its private information and treat bad loans as good. One equilibrium in which this occurs is the no-information equilibrium considered earlier in Proposition 1. Suppose we consider a simple form of that equilbrium in which the bank charges all borrowers a low interest rate in period 1 and a non-type-dependent rate in period 2. Now consider what happens at time 2. If other banks were offering the interest rate structure depicted in Proposition 3, then a bank offering our candidate interest rate structure would be attractive to bad borrowers (who face liquidation at other banks) but not to good borrowers (who pay only the risk-free rate). This selection bias dictates that the strategy in which all borrowers are treated the same cannot be part of an equilibrium as it results in sure losses to the bank.

Suppose instead that the bank offered the interest rate structure in Proposition 2, where any time 2 loan is charged the low rate of interest while first-period loans pay high rates. Again, consider the bank's strategy at time 1. If the bank continues the loans it knows are bad, then since $L > B/(1 + r)$, this results in lowering the bank's profit with respect to its bad loans. Thus, the optimal strategy is to liquidate those loans. There can be new borrowers (or, alternatively, bad borrowers can attempt to borrow elsewhere), but given its own strategy, the bank knows that only bad borrowers would seek funds outside. Suppose that the bank expects that any borrower who approaches it at time 2 is also bad. Then the bank's optimal strategy is to make no loans to outsiders. This suggests that in all cases the bank liquidates bad loans, and continues good loans to the future. It is easy to see that this strategy is consistent with the bank's expectations and the actions of bad borrowers. This also results in borrowers facing liquidation risk.

One aspect of this equilibrium that may seem problematic is with respect to good borrowers. If the bank's time 1 lending decision is not observable to the market, then the bank can exploit its good borrowers by threatening to cut them off at time 1 unless they pay a higher interest rate. Note, however, that if the bank does cut off the good borrower, then the bank receives only L as the good borrower defaults on the time 1 loan. If the bank rolls over the loan, the borrower can pay the high first-period rate and repay the second-period rate. This strictly dominates the bank's return from liquidation, and hence any such liquidation threat by the bank is simply not credible; at time 1 the bank will always lend the money rather than lose by liquidation. This suggests a robustness to the equilibrium depicted in Proposition 3 and hence a generality to its policy implications.

5. CONCLUSIONS

What then are we to conclude regarding MVA? If the purpose of MVA is to improve the ability of regulators and the market to accurately evaluate bank portfolios, then my analysis suggests that MVA will meet this goal when value changes are due to observable variables. For bank's debt security holdings, or for the myriad interest rate-based products (swaps, caps and floors, etc.) currently held by banks, such conditions are likely to be met. But for loans in which the bank's expertise or monitoring abilities are likely to be important, MVA introduces several distortions into the lending process.

These arise because MVA inhibits the bank's ability to provide liquidity for illiquid borrowers. In my model, MVA fails because the market price cannot accurately reflect private information. With prices biased downward, the MVA requirement penalizes banks (and consequently borrowers) who lend on long-term, illiquid projects. Yet, it is precisely for such projects that the monitoring and information-gathering expertise of the banks provide value. For short-term, easily evaluated projects, market alternatives such as commercial paper already provide funding.

While the goal of capturing more accurately the bank's financial condition is certainly laudable, its pursuit should not blind policymakers to the broader goal of having an efficiently functioning financial system. In my analysis, applying MVA to loans furthers neither accuracy nor efficiency. What it may provide is a false sense of certainty. Viewed from this perspective, it would appear that MVA applied to loan values can only be a fallacy.

APPENDIX

Proof Proposition 1. At time 0, the bank has loaned the borrower \$1 and at time 1 is owed \$$D$. Given this, the bank's time 1 problem is to specify time 2 payoffs such that

$$D(1 + r) = (1 - \gamma)B + \gamma G_S \tag{A1}$$

$$\Rightarrow G_S = \frac{D(1 + r) - (1 - \gamma)B}{\gamma}. \tag{A2}$$

Provided this is feasible ($0 \leq G_S \leq G^*$), this dictates that the borrower will be able to borrow at time 1. The zero profit condition at time 0 then gives $D = 1 + r$. Substituting into (A2) yields

$$G_S = \frac{(1 + r)^2 - (1 - \gamma)B}{\gamma} \tag{A3}$$

and the equilibrium interest rates follow from simple algebraic manipulation. ■

Proof of Proposition 2. Consider first the case where $L < B/(1 + r)$, or liquidation yields a lower return than continuing the loan. At time 0, the bank has \$1 and will receive \$$D$ at time 1. At time 1, the value of the good project is $G_C(1 + r)$ and the bad is $B(1 + r)$. At time 1, therefore, a loan of $G_C(G_C \leq G)$ on good projects and B on bad projects yields a certain return of r. Loans of any greater amount cannot satisfy the minimum profit condition. This implies that at time 0

$$(1 + r) = D = (1 - \gamma)\left[\frac{B}{(1 + r)}\right] + \gamma\left[\frac{G_C}{(1 + r)}\right] \tag{A4}$$

or

$$G_C = \frac{(1 + r)^2 - (1 - \gamma)B}{\gamma}, \tag{A5}$$

which is identical to (A3). The interest rates are then as given in the proposition.

Now consider the case where $L > B/(1 + r)$. Denote the good loan payoff by G_D. Then, the proof is identical except that the value of the bad project at time 1 is L. Equation (A4) thus becomes

$$(1 + r) = D = (1 - \gamma)L + \gamma \left[\frac{G_D}{(1 + r)}\right]. \tag{A6}$$

This dictates that

$$G_D = \frac{(1 + r)^2 - (1 - r)(1 - \gamma)L}{\gamma}$$

and the result follows. ■

Proof of Proposition 3. Consider the case where $L > B/(1 + r)$. The claim is that sequential equilibrium strategies are as follows. The bank's strategy at time 1 is to offer a good borrower a loan of $G_D/(1 + r)$, where $G_D = [(1 + r)^2 - (1 - \gamma)(1 + r)L]/\gamma$, at interest rate r and to liquidate a bad borrower. Any firm that comes from another bank is believed to be: (1) good, if they were offered a loan and are offered the same loan size as their previous bank offered at rate r, and (2) bad if they were offered liquidation and are rejected. At time 0, the banks loan one to each firm at interest rate i_1. The good firms at time 1 accept an offer of $G_D/(1 + r)$ at r and reject anything else from their banker. If they are offered anything other than $G_D/(1 + r)$ at r, they borrow the offered amount (up to $1 + i_1$) from another bank at r and use it to pay off their first-period loan. The bad firms at time 1 accept any offer from their banker. At time 0, each firm borrows one at interest rate i_1.

To check that these are equilibrium strategies, we first need to show that no deviations are profitable. First, consider the bank's offer to a good firm. The bank cannot obtain an interest rate above r as the firm would repay the loan with a new loan from another bank at rate r. The bank has no incentive to offer a loan size above $G_D/(1 + r)$ and if it offers less, the firm will repay this lower amount by a loan from another bank. The bank cannot credibly threaten to liquidate the firm as at liquidation time it would want to continue rather than liquidate. Second, the bank's offer to bad firms is clearly optimal. Similarly, bad firms have no alternative to liquidation. Finally, good firms accept the loan offered at r as they can obtain the same loan elsewhere at r and would reject any higher interest rate as they can obtain r elsewhere. Optimality of time zero strategies follows the same argument as in the proof of Proposition 2.

Finally, we need to show that the expectations meet the requirements of the sequential equilibrium concept. First, note that as in equilibrium no firms actually leave their bank, any expectations are consistent with Bayes' Rule. Second, the expectations given are correct for any firms that mistakenly go to another bank. Third, the belief and strategy pair is a consistent assessment. To see this, let the initial bank offer a loan to the good (bad) borrower with probability $1 - \varepsilon$ (ε) and liquidate with probability $\varepsilon(1-\varepsilon)$. Then, by Bayes' Rule, the other banks' probability that a firm is good given that it was offered a loan (was offered liquidation) is $[\gamma(1-\varepsilon)/(\gamma+\varepsilon(1-2\gamma))]$ $[\gamma\varepsilon/(1-\varepsilon-\gamma)]$. As $\varepsilon \rightarrow 0$, this sequence of assessments converges to the equilibrium assessment.

In the case where $L < B/(1+r)$, the bank's strategy changes to loaning bad firms $B/(1+r)$ at rate r and good firms $G_C/(1+r)$, where $G_C = [(1+r)^2 - (1-\gamma)B]/\gamma$, at rate r. Any firm coming from another bank is believed to be (1) good if it was offered a loan above $B/(1+r)$ and is thus offered the same loan at rate r and (2) bad if it was offered $B/(1+r)$ or less (or if it was offered liquidation) and is loaned the same amount at rate r. That these strategies and expectations form a sequential equilibrium follows the same argument as that above. ■

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