ON THE MARKET DISCIPLINE OF INFORMATIONALLY-OPAQUE FIRMS: EVIDENCE FROM BANK BORROWERS IN THE FEDERAL FUNDS MARKET

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On the Market Discipline of Informationally-Opaque Firms: Evidence from Bank Borrowers in the Federal Funds Market [#]

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Abstract

Using plausibly exogenous variation in demand for federal funds created by daily shocks to reserve balances, we identify the supply curve facing a borrower in this market, and study how access is affected by changes in public and private measures of borrower creditworthiness. While there is evidence that lenders respond to adverse changes in public information by restricting access to the market in a fashion consistent with market discipline, there is also evidence that borrowers are able to respond to adverse changes in private information by increasing leverage and risk in a fashion consistent with moral hazard. Moreover, we document that access is largely insensitive to measures of creditworthiness that use both public and private information. Finally, we document evidence that borrowers are able to manage the real information content of public disclosures, as these only have information about future performance during quarters when a bank is examined by supervisors. We conclude that private information is sufficiently important in banks that the scope for market discipline is quite limited.

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0. Introduction

Economists and bank regulators have recently shown great interest in involving the market more in the supervision of banks, in particular through the use of mandatory subordinated debt requirements. A proposal by a group of economists at the American Enterprise Institute (1999) recommends to the Basel Committee on Bank Supervision that the current risk-based capital framework be scrapped and replaced by tougher leverage requirements, part of which would be met through the frequent issue of subordinated debt by banks. Recently, Wall and Evanoff (2000) propose adding a mandatory subordinated debt requirement to the current risk-based capital regime, where institutions regularly roll over short-term debt. The potential for market discipline created by subordinated debt has is studied extensively in a Staff Study (1999) by the Board of Governors of the Federal Reserve. Moreover, the third pillar of the June 2004 version of the Revised Basel Accord emphasizes the importance of market discipline though increased transparency and disclosure.

In its most basic form, market discipline corresponds to the semi-strong form of the efficient markets hypothesis described in Fama (1970) as applied to traded bank securities, and implies that prices should reflect all available public

information about credit risk. In different discussions of market discipline, the information in securities prices could be used to supplement supervisory information, as triggers for supervisory action, as a means to regulate banks directly, or even as means to regulate the regulators. The contribution of this paper begins with the observation that even in the presence of semi-strong efficient markets for bank securities, prices are useful only when private information about bank risk is unimportant. Given the presence of extensive theoretical and empirical literatures establishing that banks as delegated monitors produce private information about borrowers which cannot directly be conveyed to investors, it is not obvious that the market could ever contribute meaningfully to the regulation of banks.

A recent literature on the opaqueness of banks as borrowers has not cleared up this issue. Morgan (2002) presents evidence that the ratings agencies disagree more about the credit ratings of banks than non-financial firms, and that disagreement increases as the share of informationally-opaque assets increases. On the other hand, Flannery, Kwan, and Nimalendran (2004) conclude that large banks have similar microstructure properties and analyst coverage to matched non-financial firms, and that bank earnings forecasts are more accurate, less dispersed, and revised less frequently. While the existing literature has focused

on whether or not private information is more important in banks than in other firms, this paper studies the question of whether or not private information is sufficiently important in banks as to undermine the ability of the market to impose discipline on banks.

We make at least two important contributions to the literature by focusing our analysis on the federal funds market. In contrast to the existing literature on market discipline, we seriously address the problem of identifying the capital supply curve faced by banks instead of focusing on correlation of prices with risk, as the latter may confound supply and demand effects. In particular, we use plausibly exogenous daily shocks to a bank's liquidity position which affect the demand for federal funds borrowing in order to trace out the supply curve facing a bank over a quarter, and then use changes in bank financial condition between quarters in order to test the informational efficiency of the federal funds market. As market discipline is fundamentally a hypothesis about how the supply curve reacts to public information about bank risk, we feel this is an important advance in methodology.

Moreover, this paper is the first which evaluates how both public and private information about bank risk affect access to capital markets. In particular, we

collect both public and private information about bank loan portfolio quality, and investigate how access to the federal funds market is affected by adverse changes in each measure of risk. While there is evidence that the market responds to adverse changes in the public measures of loan portfolio quality by reducing supply in a fashion consistent with market discipline, there is evidence that banks exploit adverse changes in the private measure of loan portfolio quality by increasing demand in a fashion consistent with moral hazard, increasing the frequency of borrowing and liquidity risk by reducing target reserve balances. While one might hope that private information is unimportant, we document evidence that access to the market is unaffected by a complete measure of loan portfolio quality which incorporates both public and private information. We conclude that the specialness of banks as delegated monitors is associated with an opaqueness of banks as borrowers, which significantly undermines the ability of the market to play an important role in regulating banks.

The paper proceeds as follows: the data and methods employed are discussed in Sections 1 and 2, respectively; analysis appears in Section 3 and conclusions in Section 4.

1. Data

The analysis begins with a dataset of all Fedwire transactions and balances collected from September 2001 to February 2005. We follow the procedure established by Furfine (2000) in order to identify federal funds loans from Fedwire transactions. Since federal funds transactions are not explicitly flagged in the payments dataset, we identify transfers between two banks that originate as multiples of $1,000,000 and are reversed the following business day with plausible federal funds interest. Furfine (2000) cautions that in addition to federal funds loans, these transactions may also include borrowing by correspondent banks or brokers on the behalf of clients, or overnight lending arrangements between non-financial firms. Since our focus is on access to the market for borrowers, we focus our analysis on the sub-sample of 667 banks which ever borrow in the federal funds market over the period of interest. In order to avoid results being driven by the extraordinary circumstances described by McAndrews and Potter (2002) in the market following the terrorist attack on New York City on September 11, 2201, we exclude all observations from September 2001 from our analysis.

In order to develop a measure of daily liquidity shocks, we construct the variable "clean balance" which is defined as the end-of-day balance net of all federal funds lending and borrowing during the day. The clean balance is presumably where a bank's the end-of-day balance would have been if it was unable to participate in the inter-bank market during that day. Banks use the federal funds market in order to turn a high clean balance into a normal end-of-day balance through lending, and turn a low clean balance into a normal end-of-day balance through borrowing. A natural challenge in measuring a bank's daily liquidity situation is that each bank likely has its own target reserve balance and reserve management strategy. In order to overcome the effect that this heterogeneity might have in comparing the daily liquidity situation of banks, we construct quintiles of the daily liquidity distribution for each bank-quarter. The use of bank-specific liquidity distributions better focuses the analysis on within-bank changes in the liquidity situation and overcomes the problem of comparing liquidity positions between two different banks.

Panel (a) of Table 1 summarizes the bank-day federal funds dataset. While an institution borrows at an average rate of one out of every five bank-days, this is skewed by a small set of institutions which borrow frequently as there is no borrowing on the median bank-day. Note that a little more than half of the

borrowing banks have issued public equity and the average bank has a considerable buffer of excess regulatory capital.

In the analysis below, we make use of the fact that while complete information about loan portfolio quality is collected in the *Call Reports of Income and Condition*, only a subset of this information is released to the public. In particular, banks are forced to disclose loans past due for between 90-180 days and for loans where interest is no longer accruing. On the other hand, banks report to supervisors but do not publicly disclose information about loans past due between 30-89 days. We use the ratio of problem loans to capital as an overall measure of bank creditworthiness. The last three rows of panel (a) of Table 1 illustrate that the confidential component corresponds to more than 50 percent of total problem loans.

2. Methods

This paper starts with the presumption that it is impossible to test for the presence market discipline in banking without first having a convincing strategy for identifying the capital supply schedule. This view is motivated by the likelihood that changes in borrower creditworthiness are correlated with

movements in the capital demand curve. In particular, if a decline in creditworthiness is prompted by a decline in the profitability of investment opportunities, one might naturally expect to see a decline in borrowing even when investors do not react to the decline in creditworthiness. At the same time, an observation that credit spreads are correlated with measures of borrower creditworthiness does not necessarily imply that investors are actively reacting to these changes in borrower condition in a fashion consistent with market discipline. For example, a borrower may respond to a deterioration in creditworthiness by increasing leverage. When the capital supply curve is upward-sloping, this behavior translates into higher prices, which in turn generates a correlation between spreads and creditworthiness that may seem comforting, but really has nothing to do with market discipline. It follows that any serious investigation of discipline by investors must start with a clear strategy to identify the credit supply curve.

The conventional solution to this econometric problem is to identify shocks to the borrower's credit demand curve in order to trace out the credit supply curve. By focusing our analysis on the inter-bank market, we are able to overcome the challenges which have been ignored by the literature to this point. In particular, we have complete historical data on both the price and quantity of debt as well

as firm balance sheets, measures of public and non-public information about firm creditworthiness, and a source of variation in the demand for credit that is plausibly unrelated to firm creditworthiness.

On the latter point, we use changes in a bank's clean reserve balance – the end of day reserve balance net of any federal funds borrowing or lending – as a source of demand for federal funds credit. Reserves flow into and out of the bank every day due to wire transfers, check-clearing, and ACH payments. On a day when a bank has had a relatively large outflow of funds from its reserve account, it is likely to borrow reserves from another bank in the federal funds market before the close of business in order to avoid the risk of an overnight overdraft. Holding the borrowing bank's financial condition constant, these daily shocks to the reserve balance will move the demand curve, tracing out the federal funds supply curve faced by the a bank.

In order to implement this strategy in practice, it is necessary to make one of two assumptions about the relationship between these demand shocks and bank creditworthiness. The stronger assumption is that information about bank creditworthiness is constant over some short period of time, implying that it is impossible for daily demand shocks to be correlated with changes in the supply

curve because the supply curve does not move. The weaker assumption is that while information about borrower condition may not be constant over some short period of time, there is no relationship between these changes in creditworthiness with the changes in the bank's clean reserve balance. As support the weaker assumption assumption above, we document in Ashcraft and Bleakley (2005) that for the sub-sample of publcly-traded banks, the shocks to reserves are uncorrelated with equity returns at high frequencies.

In order to implement this strategy, we choose to use daily variation in a bank's clean reserve balance over a quarter in order to identify the supply curve, and then to use variation in measures of bank creditworthiness between quarters in order to identify the relationship between borrower condition and the supply curve.

A natural challenge in identifying this second link is that the demand for federal funds can shift between quarters, and that changes in bank creditworthiness are correlated with changes the demand for federal funds. In particular, when a bank becomes less creditworthy, it is likely that its profit opportunities have declined, so it difficult to determine whether or not a decline in borrowing is driven by supply or a demand. In order to solve this second problem, we focus

our analysis on the differential effect that creditworthiness has on the price and quantity of federal funds borrowing at different point of the distribution of clean reserve balance. While the simple demand explanation would imply that the bank would borrow less at every percentile of the distribution of clean balance, the supply explanation would imply that the bank would borrow less when faced with a negative liquidity shock than when faced with a positive liquidity shock.

3. Analysis

The analysis sample aggregates from the bank-day dataset to a bank-quarter-liquidity quintile dataset, and includes the approximately 700 commercial banks which ever borrowed in the federal funds market between October 2001 and February 2005. This dataset is unbalanced panel of banks (i), with observations in each quarter (q) and liquidity percentile (p). The specification of interest is a regression of each dependent variable $y_{i,q,p}$ measuring quantity or price of borrowing on bank-level variables $X_{i,q}$, dummies for the liquidity quintile $L_{i,q,p}$, interactions of the bank-level variables with the liquidity dummies, and a full set of bank η_i and time γ_q fixed effects.

$$(1) \qquad y_{i,q,p} = \alpha+\delta X_{i,q}+\Sigma_p \beta_p * L_{i,q,p}(1+\psi_p X_{i,q})+\eta_i+\gamma_q+\varepsilon_{i,q,p}$$

Throughout the paper, each model is estimated by ordinary least squares, and uses standard errors which have been corrected for heteroskedasticity.

3.1 Liquidity shocks and borrowing

Before investigating how changes in borrower creditworthiness between quarters affect the supply curve, we first demonstrate that our within-quarter demand shocks actually identify the supply curve. In order to accomplish this, we focus on estimating equation (1) without the interactions, restricting $\psi_p = 0$. Results are reported in Table 2, which documents the relationship between quintiles of the clean liquidity distribution and access to the federal funds market.

The first column documents in rows 6-8 that days with low liquidity are associated with higher a probability of borrowing. In particular, relative to a shock in the fifth quintile (the most positive liquidity shock), a bank with liquidity in the first quintile (the most negative liquidity shock) is 14.9 percent more likely to borrow. Notice the declining pattern in the coefficients across the

liquidity qunitiles, as less liquidity is monotonically related with a higher probability of borrowing in the expected fashion. As mean borrowing is 20.91 percent in the sample, this result implies that demand shocks explain a significant amount of the borrowing of the average bank in the market.

Note that row 2 of the first column documents that changes in the public measure of creditworthiness are associated with lower borrowing, but the coefficient of -0.151 does not disentangle supply and demand effects. In order to put the above magnitudes in context, not that a one standard deviation (0.0810) deterioration in public credit quality is associated with a 1.2 percentage point decline in borrowing. We emphasize that this is just a correlation between public creditworthiness and borrowing, and does not necessarily reflect a shift in the supply curve. Similarly, the coefficient of 0.062 on capital in row 4 indicates that a one standard deviation (0.0825) decrease in bank capital is associated with a 0.51 percentage point decline in the probability of borrowing.

The second column of the table documents for the sub-sample of bank-quarter-quintiles during which the bank actually borrows, that liquidity shocks also affect the intensive margin. In particular, a bank with in liquidity the first quintile will borrow 48.7 percentage points more than a bank with liquidity in

the fifth quintile. Since mean borrowing (which is relative to transactions deposits) is 81.1 percent, this results suggests that demand shocks also explain an economically significant amount of variation in borrowing along the intensive margin.

The third column of the table documents that liquidity shocks also affect the interest rate that banks pay on overnight loans, implying that the marginal cost curve is indeed upward-sloping, although the coefficients imply that it is fairly flat. In particular, a bank with liquidity in the first quintile will pay 1.5 basis points more than a bank with liquidity in the fifth quintile. While this number does seem small, it explains an economically meaningful fraction of the variance of spreads, as the difference between the 90^{th} and 10^{th} percentiles is only 30 basis points.

We conclude that there is strong evidence of a first stage, as liquidity shocks appear to affect access to the federal funds market in an economically significant fashion.

3.2 Public information about loan portfolio quality

A large academic literature has extensively tested whether or not the market for subordinated debt, equity, or large CDs could provide information about default risk that helps supervisors allocate supervisory resources in the right place or prevents supervisors from forbearing against problem banks. While early research found little relationship between the measured subordinated debt spreads over U.S. Treasuries and measures of risk from the bank balance sheet, studies using more recent data have been more successful in finding evidence that subordinated debt holders are effective monitors of bank behavior.[1] One popular interpretation of the newfound relationship between spreads and risk is that subordinated debt holders felt safe under implicit guarantees by the FDIC to assume any losses, which were ended by Congress in the early 1990s.[2]

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[1] Avery, Belton, and Goldberg (1988) found no evidence in a sample of the 100 largest Bank Holding Companies over 1983-1984 that debt spreads were sensitive to either ratings by Moody's or Standard and Poor's or a FDIC index of risk. Gorton and Santomero (1990) argued that the spread-risk relationship should actually be non-linear. As the payoffs to bonds effectively look like those to equity when leverage is high. This observation did little, however, to illuminate a relationship between debt prices and risk, casting serious doubts on the ability of subordinated debt to impose any market discipline on banks.

Flannery and Sorescu (1996) investigated the issue over a longer panel using more recent data (1983-1991) on 422 bonds issued largely by Bank Holding Companies. The authors found that spreads are sensitive to measures of leverage, accruing loans past due, and real estate holdings of the holding company, but that this relationship is strongest with more recent data. These findings were largely confirmed by DeYoung et. al. (1998). Jagtiani, Kaufman, and Lemieux (1999) find evidence that there is little difference between the pricing of debt issued by banks or bank holding companies. Morgan and Stiroh (2001) also present evidence that the spread - risk relationship on bank bonds is weaker for larger and less transparent banks.

[2] This story is difficult to reconcile, however, with widespread evidence that depositors have imposed market discipline on banks Hannan and Hanweck (1988) found that interest rates on Jumbo Certificates of Deposit issued by 300 large banks in 1985:I were sensitive to balance sheet measures of risk. Park and Peristiani (1998) found evidence in a sample of Savings and Loans over 1987-1991 that banks one would predict to fail on the basis of balance sheet characteristics paid higher interest rates to uninsured depositors and had slower growth rates of uninsured deposits. Finally, Cook and Spellman (1994) concluded that GAAP insolvent Savings and Loans paid risk premia on their insured deposits in 1987-1988.

Despite success in identifying a correlation between spreads and balance sheet measures of risk, economists have had less success in using spreads to predict future financial distress. In particular, neither subordinated debt nor large CD spreads significantly improve the Type I – Type II error trade-off that exists in the current regulatory model of supervisory rating downgrades. An important challenge facing proponents of subordinated debt is a systematic study of models of corporate bond spreads by Huang and Huang (2004) which concludes that very little of a bond spread can be attributed to credit risk, implying the ratio of signal to noise is very low. While spreads are correlated with balance sheet measures of risk, they are also correlated with other factors that have very little to do with future financial performance, which reduces their usefulness for supervisors.[3]

While research on the information in subordinated debt spreads is extensive, there has been little work on the presence of market discipline in the market for federal funds. Furfine (2001) documents that spreads on federal funds loans are sensitive to public measures of credit risk, but the author makes no serious

[3] This problem is no better when studying implied default risk from equity prices. Currey, Fissel, and Hanwick (2003) demonstrate that coefficients in a regression of supervisory rating downgrades on equity market variables are highly unstable and often flip sign over time. If you don't know whether a high stock price is a good thing or a bad thing, knowing the stock price isn't going to help you out much in forecasting future performance.

attempt to establish whether this correlation is driven by supply or demand factors.

In order to test for the presence of market discipline in the federal funds market, we test whether or not changes in publicly-observed measures of borrower creditworthiness between quarters affect the position of the supply curve which was identified for each quarter in the previous section. Results are displayed in Table 3, which estimates equation (1) and reports estimated coefficients on the interaction terms.

In the first column, rows 9 to 12 of the table document that an adverse change in the public measure of bank creditworthiness (the ratio of public problem loans to capital) reduces the probability that a bank borrows in the federal funds market when liquidity is in the first quintile relative to the fifth quintile. In particular, the coefficient implies that a one standard deviation change in the public measure of creditworthiness is associated with an 0.87 percentage point reduction in the probability of borrowing when liquidity is in the first quintile relative to the last quintile. Given that a difference in average borrowing of 14.9 percentage points between these liquidity quintiles from Table 3, this result

suggests that the reduction in the probably of borrowing due to reduced credit quality is about 5.8 (=0.87/14.9) percentage points of mean borrowing.

The second column of the table documents that there is no market discipline along the intensive margin, although this test does not has as much power as the test along the extensive margin. In particular, the coefficient of -0.535 in row 5 indicates that the same change in public creditworthiness is associated with a 4.33 percentage point point reduction in the amount of borrowed. Given a difference in average borrowing of 48.7 percent, this implies an that borrowing is reduced by 8.9 percent of the mean, but this is not statistically different than zero. The third column of the table clearly documents that changes in credit quality do not appear to have any effect on the price of credit.

In summary, we conclude that there is evidence that lenders in the federal funds market respond to changes in a public measure of bank credit quality by restricing access to the market along the extensive margin.

3.3 Private information about loan portfolio quality

It is well-known that the existence of limited liability combined with private information about risk permits an insensitivity of debt spreads to risk, which in

turn creates incentives for excessive risk-taking and leverage frequently referred to as moral hazard.[4] In financial markets, investors typically respond this problem of asymmetric information through financial constraints on the ability of firms to borrow through arbitrary demands for adequate collateral or limits on leverage. While the reaction of financial markets does not eliminate moral hazard, it is generally associated with a reduction in the amount of credit available to those with profitable investment opportunities. It follows that financial constraints are associated with inefficiencies in the allocation of credit from investors to borrowers.

In the banking industry, economists have long worried about how federal deposit insurance creates similar moral hazard by ignoring information about bank risk in setting deposit insurance premiums.[5] While there is a large literature documenting evidence of moral hazard in banking, most economists have presumed that this behavior is created by risk-insensitive regulation and not by the existence of private information.[6] Such a conclusion is surprising given considerable evidence on the importance of banks at both the micro and

[4] This point is made quite clearly by John, John, and Senbet (1991) in a model of banks.
[5] Merton (1977) first documented how risk-insensitive deposit insurance premia create incentives for excessive risk-taking and leverage.
[6] Demsetz, Saidenberg, and Strahan (1996) and Keeley (1990) document evidence suggesting that shareholders are responsive to charter value. Hovakimian and Kane (2000) document evidence suggesting that bank capital requirements and other deposit insurance reforms in the late 1980s and early 1990s did not prevent large banks from shifting risk to the

macro level in providing credit firms where information problems are severe.[7] While there is a recent literature on how the uniqueness of banks as monitors translates into the opaqueness of banks as borrowers, the presence of private information in banks has not been highlighted as an important source of moral hazard.

In order to test for the importance of private information and presence of moral hazard, we test how a deterioration in our private measures of borrower creditworthiness affects access to the federal funds market. Results are illustrated in rows 13 to 16 of Table 3.

Interestingly, the first two columns document that the interaction of the private measure of loan portfolio quality with liquidity has the opposite sign of the interaction with the public measure. While the main effect from column (1) of Table 2 documents that there is no correlation between within-bank changes in private information about loan portfolio quality and access to the federal funds market, the coefficient pattern in column (1) of Table 3 suggests that a borrower reacts to a private deterioration in creditworthiness by borrowing more on days

safety net. On the other hand, Park and Peristiani (2003) conclude that despite the difficult financial environment of 1986 to 1992, shareholders' incentive for moral hazard was limited to a small fraction of highly risk banks.

of relative illiquidity. In particular, the coefficient of 0.122 in row 13 of the first column suggests that in response to a one standard deviation (0.0791) deterioration in the private measure, the borrower actually increaeses borrowing by 0.97 percentage points when using the first versus fifth quintiles, which is 6.48 percent of the difference in average borrowing between these two quintiles. Along the extensive margin, the coefficient of 3.462 in row 13 of the second column indicates that in response to the same one standard deterioration in the private measure, the amount borrowed increases by 27.38 percent when using the first versus fifth quintiles, which almos 63.3 percent of the difference in mean borrowing between these two quintiles.

One might expect that a borrower which suffers from a deterioration in a private measure of loan portfolio quality would try to take advantage of the market by increasing leverage. In particular, this behavior would be consistent with the traditional moral hazard problem in banking created by deposit insurance priced in a risk-insensitive fashion, which creates incentives for excessive leverage and risk-taking. However, such a story would better fit an observation of higher borrowing in the federal funds market for every level of liquidity, and does not explain why a change in the private measure of creditworthiness would induce

[7] James and Smith (2000) survey a large literature suggesting that delegated monitoring of firms by banks creates

larger changes in borrowing on days of relative illiquidity. Moreover, it seems implausible that the supply curve shifts in response to private information, especially in a fashion which implies more lending to banks when private information about creditworthiness is unfavorable.

A better explanation for why there might be a link between changes in the private measure of loan quality and changes borrowing on days of illiquidity is that there is a connection between changes in the former and the bank's target reserve ratio. When a non-banking firm has enough liquid assets on the balance sheet, it does not need to secure financing for liquidity purposes. However, when financial problems eat away at liquid assets, the firm will likely need to secure financing in order to make up the difference. A bank may react to adverse private information about loan portfolio quality, which likely contains information about future income, by reducing its liquidity through its target reserve balance. One motivation for such behavior is that by being more aggressive in facing the risk of a negative end-of-day balance, the bank is able to invest non-interest bearing reserves into money market securities or loans which generate interest or trading income. Of course the trade-off involved with the lower target reserve balance, taking the distribution of liquidity shocks as given

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information. Ashcraft (2005) documents evidence that this information has macroeconomic importance, as healthy bank

is a greater risk of either an overnight overdraft or a need to borrow reserves in the federal funds market. Moreover, this increase in the demand for federal funds should have a larger effect on days when the bank is faced with less liquidity, which is exactly what we see in Table 3.

In order to investigate this issue further, we aggregate our data to the bank-quarter frequency and analyze the link between within-bank changes in our measures of creditworthiness and the average end-of-day clean reserve balance in Table (5). The first column of the table illustrates that there is indeed a negative correlation between the private measure of loan portfolio quality and the average reserve balance, but no correlation with the public measure of creditworthiness. As banks permit their average reserve balance to decline in the face of adverse private information about loan portfolio quality, this would explain the associated relative increases in borrowing on relatively illiquid days of the quarter.

In summary, we conclude that banks exploit private information about loan portfolio quality in a fashion consistent with moral hazard through the choice of their target reserve ratio.

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failures have permanent effects on real economic activity.

3.4 Complete information about loan portfolio quality

While there is some evidence presented above that banks exploit private information in order to take advantage of the lenders, one might think that this problem is somehow small or economically unimportant, and that on balance the market does a good job of providing discipline on banks overall. For example, if public and private information are highly correlated, the presence of private information does not necessarily undermine the effectiveness of market discipline. In order to test this hypothesis, we construct a complete measure of bank creditworthiness, using the sum of public and private measures of loan portfolio quality. In Table (6), we analyze the effect of this complete measure of loan quality on access to the federal funds market. The results from all three columns suggest that lenders are not effective in reacting to a complete measure of borrower creditworthiness, as the signs on all of the coefficients have the wrong sign and almost all are not statistically different from zero. In other words, private information about loan quality is sufficiently significant and uncorrelated with public information about loan quality that lenders are unable to adequately impose discipline on borrowers.

3.5 The real information content of public disclosures

Before drawing strong inferences about the implications of these results, it is important to establish that our public and private measures of creditworthiness actually contain information about the credit risk associated with a federal funds loan. Since there are no observed defaults on federal funds loans over our sample period, we limit ourselves to studying the link between our measures of loan portfolio quality and future loan performance. As information from regulatory reports is typically lagged and federal funds borrowing is typically an overnight instrument, we focus our analysis on predicting current loan charge-offs using information from previous quarters.

The first column of Table (7) illustrates that our public measure of loan portfolio quality has explanatory power for next quarter's loan charge-offs over after controlling for this quarter's loan charge-offs. More importantly, the second column demonstrates that there is important information about future charge-offs in the private measure of loan portfolio quality, controlling for the public measure. Together, these results suggest that one cannot dismiss the results linking access to the inter-bank market with our measures of creditworthiness

using the simple argument that these measures have no information about the credit risk of a federal funds loan.

Given informative public and private measures of creditworthiness, there are at least two interpretations of these results. A relatively benign view of the fact established above that a complete measure of loan portfolio quality does not affect access to the federal funds market is might be that banks are opaque and that existing public disclosures are inadequate for the market to make an accurate overall assessment of bank creditworthiness. In particular, while the market may not be able to react to an adverse private signal about bank credit quality, as long as a borrowing bank is unable to manage the real quality of information in public disclosures, the ability of the bank to take advantage of the market will be short-lived as the private measure of loan portfolio quality becomes public over time. On the other hand, a more skeptical view of these facts raises the possibility that banks are able to actively manage the amount of information in public disclosures in a fashion that blunts the effectiveness of market discipline over longer periods of time.

In order to develop a sense for which of these interpretations should be taken more seriously, we take a closer look at the real quality of information in the

public measure of loan portfolio quality in Table (7). In particular, we use supervisory data in order to identify quarters during the sample in which the bank is examined by regulators. A part of every asset quality review is a check to be sure that the bank has accurately classified the performance of each loan. One might naturally think that if disclosures asset about quality are only audited in one quarter of the year, that the real information in non-exam quarters about future performance is less than the real information in exam quarters. This view is reinforced by the coefficients in the third column suggest that there is actually no information in public disclosures of loan portfolio quality during non-exam quarters, but that there is significant information about future charge-offs during exam quarters. This result is further reinforced by column (4), which documents that there is no difference in the information content of private measures of loan portfolio quality across exam quarter. Note that this result involves both good and bad news for bank regulators. While it is comforting to know that bank supervisors are creating value to the market through costly exams, the fact that public disclosures have no information in other quarters about future loan charge-offs is disconcerting.

In summary, there is considerable evidence which suggests that banks are able to avoid market discipline by managing the real information content of public disclosures about loan portfolio quality.

4. Conclusions

Whether or not private information is an important source of moral hazard in banking has important implications for how to regulate banks. Given that private information leads to financial constraints which are associated with inefficiencies in the allocation of credit, evidence that private information is important in banking puts important limits on the usefulness of the market in regulating banks. Second, an important role of private information in banking would suggest that regulating banks on the basis of public information as is done by the existing risk-based capital regime would do little to mitigate the underlying moral hazard problems which prompt capital regulation in the first place.

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8. Tables

Table 1: Descriptive Statistics

a. Bank-day dataset

	n	mean	median	std	min	max
1. pr(borrow)	460,892	0.2083	0.0000	0.4061	0.0000	1.0000
2. mean borrowing	95,985	0.9741	0.2183	4.6970	0.0001	546.2343
3. mean interest	95,985	1.3967	1.2924	0.3539	0.0001	9.4733
4. public equity	460,892	0.5251	1.0000	0.4994	0.0000	1.0000
5. ln(assets)	460,892	-0.0276	-0.3562	1.7896	-4.7289	6.5609
6. capital	460,892	0.1404	0.1221	0.0829	0.0498	2.9068
7. (npl^{pb}/k)	460,892	0.0643	0.0458	0.0809	0.0000	1.6714
8. (npl^{pv}/k)	460,892	0.0664	0.0480	0.0791	0.0000	1.2482
9. (npl^{t}/k)	460,892	0.1306	0.1016	0.1367	0.0000	2.6634

b. Bank-quarter-liquidity quintile dataset

	n	mean	median	std	min	max
1. pr(borrow)	36,461	0.2091	0.0000	0.3829	0.0000	1.0000
2. mean borrowing	10,675	0.8109	0.1308	4.6033	0.0001	195.1360
3. mean interest	10,675	1.4291	1.3400	0.3632	0.0270	9.4733
4. public equity	36,461	0.5261	1.0000	0.4993	0.0000	1.0000
5. ln(assets)	36,461	-0.0187	-0.3494	1.7871	-4.7289	6.5609
6. capital	36,461	0.1403	0.1219	0.0825	0.0498	2.9068
7. (npl^{pb}/k)	36,461	0.0643	0.0458	0.0810	0.0000	1.6714
8. (npl^{pv}/k)	36,461	0.0661	0.0479	0.0786	0.0000	1.2482
9. (npl^{t}/k)	36,461	0.1304	0.1016	0.1364	0.0000	2.6634

Notes: the table reports the number of observations, mean, median, standard deviation, minimum, and maximum of each variable listed in each of the bank-day dataset in panel (a) and the bank-quarter-liquidity quintile dataset in panel (b).

Table 2: Liquidity Shocks and Bank Borrowing			
	Pr(Borrow)	**Borrowing**	**Spread**
	0.039	0.830	-0.017
1. (npl^{pv}/k)	(0.025)	(0.958)	(0.025)
	-0.151**	0.198	-0.009
2. (npl^{pb}/k)	(0.028)	(0.302)	(0.020)
	0.061**	0.758**	-0.010
3. log(assets)	(0.008)	(0.273)	(0.008)
	0.062**	20.559**	-0.046
4. capital	(0.013)	(5.897)	(0.059)
	0.149**	0.487**	0.015**
5. (liquidity = 1)	(0.003)	(0.120)	(0.003)
	0.074**	0.283*	0.007*
6. (liquidity = 2)	(0.003)	(0.115)	(0.003)
	0.043**	0.164	0.008
7. (liquidity = 3)	(0.003)	(0.109)	(0.005)
	0.021**	0.080	0.003
8. (liquidity = 4)	(0.003)	(0.124)	(0.003)
9. Observations	36,463	10,679	10,679
10. R-squared	0.77	0.47	0.91

Notes: the table reports coefficients and standard errors from OLS regressions of each dependent variable listed by column on bank characteristics, a dummy variable for each of the first four quintiles of a bank's daily reserve shock distribution (liquidity). The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from September 2001 to February 2005. Each specification employs time and bank fixed effects, and standard errors have been corrected for heteroskedasticity. The statistical significance of estimated coefficients is denoted using **, *, and + for the 1, 5, and 10 percent levels, respectively.

Table 3: Tests of Market Efficiency			
	Pr(Borrow)	**Borrowing**	**Spread**
1. (liquidity = 1)*lna	0.010**	0.149*	0.001
	(0.002)	(0.071)	(0.002)
2. (liquidity = 2)*lna	0.015**	0.075	0.002
	(0.001)	(0.068)	(0.002)
3. (liquidity = 3)*lna	0.013**	0.032	0.000
	(0.001)	(0.060)	(0.003)
4. (liquidity = 4)*lna	0.008**	0.045	0.002
	(0.001)	(0.072)	(0.002)
5. (liquidity = 1)*capital	-0.239**	7.338+	-0.065
	(0.045)	(4.143)	(0.069)
6. (liquidity = 2) *capital	-0.115**	0.670	0.076
	(0.037)	(2.521)	(0.051)
7. (liquidity = 3) *capital	-0.052	-1.100	0.007
	(0.036)	(2.356)	(0.052)
8. (liquidity = 4) *capital	-0.027	4.854	0.048
	(0.037)	(4.688)	(0.056)
9. (liquidity = 1)*(npl^{pb}/k)	-0.106+	-0.535	0.042
	(0.058)	(0.901)	(0.048)
10. (liquidity = 2) *(npl^{pb}/k)	-0.091+	-0.287	0.024
	(0.054)	(0.861)	(0.044)
11. (liquidity = 3) *(npl^{pb}/k)	-0.028	0.019	0.049
	(0.052)	(0.898)	(0.064)
12. (liquidity = 4) *(npl^{pb}/k)	-0.013	0.041	0.006
	(0.046)	(0.938)	(0.043)
13. (liquidity = 1)*(npl^{pv}/k)	0.122*	3.462**	0.001
	(0.048)	(1.184)	(0.040)
14. (liquidity = 2) *(npl^{pv}/k)	0.136**	1.955+	-0.009
	(0.047)	(1.046)	(0.037)
15. (liquidity = 3) *(npl^{pv}/k)	0.115**	1.491	-0.024
	(0.043)	(1.057)	(0.042)
16. (liquidity = 4) *(npl^{pv}/k)	0.024	0.982	0.005
	(0.038)	(1.198)	(0.035)
17. Observations	36,463	10,679	10,679
18. R-squared	0.78	0.47	0.91

Table 5: The Effect of Creditworthiness and Access to Public Equity on End-of-Day Reserve Balances		
	(1)	**(2)**
(npl^{pv}/k)	-0.224*	
	(0.112)	
(npl^{pb}/k)	-0.008	
	(0.035)	
log(assets)	0.024	0.023
	(0.110)	(0.110)
risk-based capital	-0.024	-0.021
	(0.138)	(0.137)
public	0.032	0.032
	(0.020)	(0.020)
(mean) effective	87.610+	85.321+
	(46.184)	(45.993)
(npl^{pt}/k)		-0.103+
		(0.055)
Observations	7,355	7,355
R-squared	0.24	0.24

Notes: the table reports coefficients and standard errors from OLS regressions of the average end-of-day reserve balance on bank characteristics. The data includes bank-quarter observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from September 2001 to February 2005. Each specification employs time and bank fixed effects, and standard errors have been corrected for heteroskedasticity. The statistical significance of estimated coefficients is denoted using **, *, and + for the 1, 5, and 10 percent levels, respectively.

Table 5: Tests of Semi-Strong Market Efficiency			
	Pr(Borrow)	**Borrowing**	**Spread**
1. (liquidity = 1)*lna	0.010**	0.141*	0.001
	(0.002)	(0.070)	(0.002)
2. (liquidity = 2)*lna	0.015**	0.070	0.002
	(0.001)	(0.067)	(0.002)
3. (liquidity = 3)*lna	0.013**	0.029	0.000
	(0.001)	(0.060)	(0.003)
4. (liquidity = 4)*lna	0.008**	0.043	0.002
	(0.001)	(0.071)	(0.002)
5. (liquidity = 1)*capital	-0.242**	7.194+	-0.063
	(0.045)	(4.139)	(0.069)
6. (liquidity = 2) *capital	-0.118**	0.582	0.077
	(0.037)	(2.512)	(0.050)
7. (liquidity = 3) *capital	-0.054	-1.154	0.009
	(0.036)	(2.351)	(0.051)
8. (liquidity = 4) *capital	-0.027	4.822	0.048
	(0.037)	(4.682)	(0.056)
9. (liquidity = 1)*(npl^{pt}/k)	0.006	1.582*	0.021
	(0.030)	(0.685)	(0.018)
10. (liquidity = 2) *(npl^{pt}/k)	0.020	0.894	0.007
	(0.028)	(0.556)	(0.017)
11. (liquidity = 3) *(npl^{pt}/k)	0.042	0.790	0.010
	(0.027)	(0.551)	(0.024)
12. (liquidity = 4) *(npl^{pt}/k)	0.005	0.543	0.005
	(0.025)	(0.601)	(0.017)
13. Observations	36,463	10,679	10,679
14. R-squared	0.78	0.47	0.91

Table 6: The Real Information Content of Public Disclosures about Bank Loan Portfolio Quality				
	(1)	**(2)**	**(3)**	**(4)**
charge-offs	0.7270**	0.7158**	0.7188**	0.7058**
	(0.0767)	(0.0745)	(0.0739)	(0.0712)
npl^{pb}/k	0.0023+	0.0012	0.0003	-0.0004
	(0.0012)	(0.0010)	(0.0006)	(0.0007)
npl^{pv}/k		0.0027**		0.0019*
		(0.0010)		(0.0008)
ln(assets)	0.0001**	0.0001**	0.0001**	0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
public	-0.0002**	-0.0002**	-0.0002**	-0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0000)
exam			-0.0003	-0.0004
			(0.0002)	(0.0003)
(npl^{pb}/k)*exam			0.0055+	0.0046+
			(0.0033)	(0.0027)
(npl^{pv}/k)*exam				0.0017
				(0.0023)
Observations	5,341	5,341	5,341	5,341
R-squared	0.41	0.41	0.41	0.42

Notes: the table displays coefficients from a regression of loan-charge-offs next quarter on loan charge-offs this quarter, public and private measures of bank creditworthiness, a dummy variable (exam) for quarters in which the bank is examined by supervisors, and a dummy variable (public) identifying a publicly-traded bank or affiliation with a publicly-traded holding company. The data includes bank-quarter observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from September 2001 to February 2005. Each model employs a full set of time fixed effects, and standard errors are corrected for heteroskedasticity and clustered at the bank level.