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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 bank borrower in the interbank market and study how access to overnight credit is affected by changes in public and private measures of borrower creditworthiness. Although there is evidence that lenders respond to adverse changes in public information about credit quality by restricting access to the market in a fashion consistent with market discipline, there is also evidence that borrowers respond to adverse changes in private information about credit quality by increasing leverage so as to offset the future impact on earnings. While the responsiveness of investors to public information is comforting, we document evidence that suggests that banks are able to manage the real information content of these disclosures. In particular, public measures of loan portfolio performance have information about future loan charge-offs, but only in quarters when the bank is examined by supervisors. However, the loan supply curve is not any more sensitive to public disclosures about nonperforming loans in an exam quarter, suggesting that investors are unaware of this information management.

Key words: earnings, management, market, discipline, opaqueness, banks

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0. Introduction

There are extensive theoretical and empirical literatures establishing that banks as delegated monitors produce private information about borrowers which cannot directly be conveyed to investors.[1] Of course this phenomenon raises the natural question of whether or not the practice of lending to an opaque firm transforms a bank into an opaque borrower itself. A recent empirical literature tackles this question with mixed conclusions. On one hand, 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 bank stocks 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 authors conclude that banks are no more opaque than non-banks, an alternative interpretation of their results is that banks have a greater ability to manage earnings than non-banks given discretion in the timing of recognizing unrealized losses and gains.

[1] James and Smith (2000) survey a large literature documenting that the delegated monitoring of firms by banks creates private information. In models of financial intermediation, it is important that private information is non-contractible. While the formula for a soft drink might be kept from investors, this does not keep the investors from accurately valuing the soft drink manufacturer's securities.

There is a large academic literature which develops evidence consistent with the claim that banks manage earnings. Beatty, Ke, and Petroni (2002) illustrate that relative to privately-held banks, publicly-traded banks report fewer small earnings declines, are more likely to use loan loss provisions and security gain realizations to eliminate small earnings decreases, and report longer strings of consecutive earnings increases. Robb (1998) documents that bank managers are more likely to use loan loss provisions when equity market analysts have reached a consensus in their earnings predictions. Karaoglu (2004) documents evidence that banks use the gains from loan transfers to influence both reported earnings and regulatory capital, even after controlling for other economic motivations. Gunther and Moore (2003) highlight evidence that bank examination timing affects the accuracy of disclosures in regulatory reports, as adverse revisions to *Call Reports of Income and Condition* are more likely in quarters when the bank is under examination by supervisors. These facts are important because a recent study by the FDIC concludes that allegations of fraud play a major role in contributing recent failures, possibly involving 70 percent of failures since 1998. However, the fundamental question is whether or not investors can see through this window-dressing and effectively allocate and price credit to bank borrowers.

This question takes greater relevance given the growing interest by economists and policymakers in understanding the role that the market could play in regulating banks.[2] For example, 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 1999, the Shadow Committee on Financial Regulation made a proposal 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. In addition, the potential for market discipline to complement bank supervision through improved disclosure or mandatory subordinated debt requirements has been studied extensively by economists at the Federal Reserve, most notably in Staff Studies (1999, 2000) by the Board of Governors.[3]

The contribution of this paper to the literature begins with the observation that even in the presence of semi-strong efficient markets, the usefulness of prices can be undermined by the presence of non-contractible private information because

[2] 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 risk.

[3] The need to involve the market in regulation is motivated by the possibility that investors either have a greater ability (due to increasing complexity on bank activities) and/or willingness (due to regulatory capture) to monitor the behavior of commercial banks. In different discussions of market discipline, information in securities prices could be used for

it typically involves financial constraints.[4] These somewhat arbitrary restrictions on borrowing involve a de-coupling of the marginal product of capital from its marginal cost and imply that investment is more sensitive to cash flow and liquidity than it is to interest rates.[5] Given considerable evidence from the literature on the lending channel of monetary policy that financial constraints in banks amplify the effect of monetary policy on lending, it seems reasonable to question whether or not the specialness of banks as lenders necessarily creates an opaqueness of banks as borrowers, which in turn impedes the effectiveness of market discipline.[6,7]

We make important contributions to the literature on market discipline by focusing our analysis on transactions-level data from Fedwire describing the federal funds market. In contrast to the existing literature on market discipline surveyed below, we seriously address the problem of identifying the capital supply curve faced by banks instead of focusing on correlation of prices with

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different purposes: to supplement supervisory information; as triggers for supervisory action; as a means to regulate banks directly; or even as means to regulate the regulators.

[4] While the presence of private information alone does not imply that securities prices are useless, it clearly reduces the role that investors can play in monitoring bank behavior, especially when firms have the ability to manage the real information content of public disclosures.

[5] See Fazzari, Hubbard, and Peterson (1998) and Campello and Almeida (2005) for background. For example, when a firm faces a binding collateral constraint, the marginal product of capital lies above the cost of capital, and changes in spreads have no effect on investment.

[6] Key studies on the lending channel are differentiated by the underlying proxy for the severity of financial constraints: size in Kashyap and Stein (1995), capital in Kishan and Opiela (2002), affiliation with a multi-bank holding company in Ashcraft (2001), and publicly-traded equity in Holod and Peek (2004).

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 creditworthiness affect the supply of credit faced by a bank borrower. 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

[7] To be clear, the point is not that the the market is unable to affect bank behavior, it is that when private information is sufficiently important, investors are unable to focus their ire on the right banks. In other words, the market is not sensitive enough to risk before problems materialze, and then becomes too sensitive.

with moral hazard, increasing the frequency of borrowing and liquidity risk by reducing target reserve balances.

Using the presence of publicly-traded equity as a measure of information problems, we document that lenders reward public banks with a more favorable supply curve than private banks, and that the supply curve of public banks is more sensitive to changes in public disclosures about creditworthiness. We interpret this evidence as convincing evidence that there is a link between the presence of public equity and financial constraints. That being said, we document that public banks are much more aggressive in borrowing in response to adverse private information, implying paradoxically that the moral hazard problems are more severe in public banks than private banks.

Finally, we document evidence which suggests banks are able to manage the real information content of public disclosures of loan portfolio quality, but find no evidence that investors are able to respond appropriately. In particular, the ratio of public problem loans to capital only has information about future loan charge-offs during a quarter that the bank is examined by supervisors, but the federal funds supply curve fails to react any more strongly to these disclosures in exam quarters versus other quarters. We conclude that the presence of private

information significantly limits the role that investors can play in monitoring financial institutions as long as these institutions are able to manage earnings and the real information content of disclosures to investors.

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. Methods

This paper starts with the presumption that it is impossible to test for the presence of market discipline in banking without first having a convincing strategy for identifying the supply curve for loanable funds facing a borrower. This view is motivated by the likelihood that changes in borrower creditworthiness are correlated with movements in the demand for credit. 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 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 largely ignored by the literature to this point.[8]

2.1 Background on the federal funds market

Banks hold balances known as reserves in an account at a Federal Reserve district bank which connect the bank with the rest of the payments system, permitting the institution to send and receive payments to other banks through

Fedwire. For example, when a bank customer deposits a check drawn on a customer at another bank, reserves are transferred from the other bank's reserve account. On the other hand, when a bank purchases securities from a dealer, reserves are transferred from the bank's account to the dealer. While banks are forced by regulation to hold reserves as a fraction of the deposits on their balance sheet, these reserve requirements are typically not binding given the amount of currency that banks hold in their ATMs.[9]

Reserves do not pay interest directly, which makes them costly for the bank to hold, as the bank could use these balances to purchase interest-bearing money market securities. However, reserves can be put to profitable use, as banks always have the option to lend reserves to another bank in the federal funds market. A federal funds loan is an overnight unsecured loan of reserves between two banks typically in denominations of $1 million at an interest rate negotiated between the borrower and lender.[10] Since a federal funds loan is subordinated to deposits in the seniority of claims and viewed as a close substitute to money market instruments, federal lenders are highly-sensitive to the risk of borrowers.

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[8] Ioannidou et al (2006) attempt to make progress on this issue by focusing on how both price and quantity respond to measures of risk in Bolivian data, arguing that an increase in spreads and decrease in quantity is consistent with a shift in the supply curve and not the demand curve.

[9] See Peristiani and Bennet (2002) for a complete discussion. Recall that reserves are the sum of balances at the Federal Reserve and currency, each of which is a liability of a Federal Reserve Bank.

[10] While the Federal Reserve sets a target for the interest rate on these loans referred to as the federal funds rate, this is only a weighted-average across brokered loan transactions.

Moreover, as a federal funds loan is just an oral agreement between two banks, there is no way for a lender to know how much a bank has already borrowed from other lenders on a given day.

While a small number of large banks use the federal funds market as a source of funding every day, most banks only borrow in the market infrequently for liquidity purposes. The demand for federal funds for these banks is driven by the fact that negative reserve balances are costly to the bank. In particular, a negative balance at the end of the day is penalized at an annual interest rate equal to the federal funds rate plus 400 basis points. Moreover, a negative balance during the day is charged at an annual interest rate equal to 30 basis points and limited to an amount determined by bank capital. A bank facing a negative balance near the end of the day is challenged by the fact that it takes two business days in order to settle a securities trade, which means that a bank is not able to sell or lend securities in order to increase reserves by the close of Fedwire at 6:30 pm.[11] In fact, the only way to eliminate a negative balance

[11] Repo agreements can be used in order to immediately increase bank reserves, but this market only operates in the morning. To the extent that repo agreements between banks occur in $1 million denominations and are reversed the following business day, we may inappropriately label some repo transactions as federal funds loans, but this makes it more difficult to find a relationship between borrowing and liquidity (since repo transactions are not closely linked to a bank's liquidity situation) as well as between borrowing and creditworthiness (since the relationship between risk and borrowing is weaker for secured debt).

immediately toward the end of the day is to borrow reserves from another bank through a federal funds loan.[12]

Since a federal funds loan is repaid with interest the following business day, it is a means for smoothing a transitory negative outflow of reserves. However, if an outflow of reserves today is not offset on future days, the bank will need to sell securities in order to increase its reserve balance or be forced borrow reserves more frequently, which is obviously costly.

2.2 Empirical Strategy

We start with the view that a bank borrower has a single line of credit for reserves with a large bank which is used infrequently for liquidity purposes. This view is motivated by the fact that for banks which do not use the inter-bank market as a marginal source of funding, the median number of lenders during a quarter is 1 and the median number of loans is 5, implying that over a quarter the bank borrows federal funds about once every maintenance period from the same lender. Our view is that a typical credit line involves a fixed spread over the funds rate and a quantity constraint, which motivates the kinked supply curve

[12] While banks do have the option of borrowing reserves directly from the Federal Reserve at the discount window, few

illustrated in Figure 1. If a bank needs more reserves than provided by the line, it is forced to find another lender, which provides it with liquidity on less favorable terms: a higher spread and lower credit limit. This implies that the supply curve might have slope, but only when the borrower is forced to change lenders. Finally, note that an adverse change in the financial condition of the borrower that is observed by the lender can prompt a reduction in the credit limit and/or an increase in the spread.

As the purchase of federal funds is insurance against an overnight overdraft, one would expect the demand for federal funds to be decreasing in the insurance premium, i.e. the interest rate on the loan of reserves.[13] The position of the demand curve is naturally affected by daily shocks to a bank's liquidity position, shifting to the right on days of less liquidity. Together with a rule for borrowing and lending as a function of liquidity, the bank-specific distribution of liquidity shocks determines the bank's average reserve balance over the quarter.

The key insight of our approach is recognition of the fact one can use these daily shocks to the reserve balance in order to trace out the federal funds supply curve

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actually do, probably due to the stigma associated with such borrowing. See Furfine (2003) for evidence on this point.

[13] While the empirical demand curve has a negative slope, it is relatively steep. Note that the fraction of days with an overnight overdraft is negatively correlated with the level of the federal funds rate, but this relationship is weak, implying

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.[14]

Once we have identified the supply curve for a bank-quarter, we can test for market discipline by measuring how the supply curve changes between bank-quarters. In particular, consider what happens when a lender reacts to adverse public information about a borrower by decreasing the credit line. Figure 2 illustrates that this action has an adverse effect on borrowing, but only at the lowest levels of liquidity, and has no differential effect on spreads. When the lender reduces the credit limit and increases the interest rate, we still observe a

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that a bank is not willing to borrow less frequently for a given amount of liquidity to avoid an overnight overdraft as the cost of borrowing declines.

[14] As support the weaker assumption above, note that for the sub-sample of publicly-traded banks, the shocks to reserves are uncorrelated with equity returns at a daily frequency for the sub-sample of publicly-traded banks.

stronger effect on borrowing at the lowest levels of liquidity and should find no differential effect of the spread across liquidity.[15]

A challenge in identifying market discipline is that the demand for federal funds can shift between quarters. In the sub-sample of banks which do not use federal funds as a marginal source of funding, these changes in demand are driven by changes in the distribution of liquidity shocks and by changes in the bank's target reserve balance. Note that each of these shifts in demand potentially has a differential effect on borrowing across the level of liquidity. In particular, an increase in the target reserve balance is associated with a greater reduction in borrowing at low levels of liquidity than high levels of liquidity. At the same time, an outflow of reserves would have a greater effect on borrowing when liquidity is low than when liquidity is high. In order to ensure that we have identified shifts in the supply curve as opposed to shifts in the demand curve, it is necessary to verify how the average balance and distribution of liquidity shocks has changed between bank-quarters.

2. Data

[15] Note that there is a restriction here on the slope of the demand curve relative to the changes in spread versus quantity. An increase in spread affects borrowing along the demand curve at all levels of liquidity, and thus has no differential effect. At the same time, a decrease in the credit line affects borrowing, but only at lowest levels of liquidity. As long as the change in spreads does not imply a reduction in borrowing greater than the decrease in the credit line, we have a

The analysis begins with a dataset of all Fedwire transactions and balances collected from October 2001 to February 2005. We follow the procedure established by Furfine (2000) in order to identify federal funds loans from Fedwire transactions.[16] 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. As 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.

As 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 end-of-day balance would have been if it was unable to participate in the inter-bank

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differential effect of creditworthiness across the level of liquidity. Since the empirical demand curve is relatively steep, this assumption does not seem restrictive.

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. We deal with the complications that this heterogeneity creates for comparing the daily liquidity situation of banks through the construction of 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. We emphasize that the use of bank-quarter distributions implies that bank liquidity on a particular day is measured relative to its liquidity on other days of the same quarter, and not relative to the liquidity of other banks.

Panel A of Table (1) summarizes the bank-day federal funds dataset. While line 1 documents that 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 just

[16] While the data is available, we exclude all observations from September 2001 from our analysis so that results being are

under half of the borrowing banks have issued public equity in line 10 and the average bank has a considerable buffer of excess regulatory capital in line 6, where capital is defined as the ratio of total capital to risk-based assets.

Our first measure of creditworthiness is a predicted probability of failure constructed using historical experience over 1986-1995. We estimate a Probit model for failure in 1 year using bank *Call Reports* with the following regressors: log assets, federal funds and repos lent to assets, tradable assets to assets, loans to assets, securities to assets, real estate owned to assets, subordinated debt to assets, equity to assets, time deposits greater than $100,000 to assets, return on assets, and loan portfolio components. Taking these estimated coefficients and the actual balance sheets of banks in our sample, we then compute the predicted probability of default for each of our borrowers in the federal funds market 2001-2004. Line 11 of panel A of Table (1) documents that this mean PD is only 5 basis points, but it ranges from 0 to 409 basis points, largely consistent with a portfolio of investment-grade credits.

Our second measure of creditworthiness involves the ratio of problem loans to equity capital, which has been shown to be a useful summary measure of bank

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not driven by the extraordinary circumstances described by McAndrews and Potter (2002) in the market following the

financial condition.[17] In our analysis, we distinguish between non-performing loans that are public knowledge and non-performing loans that are non-public information. In particular, publicly-traded banks disclose the amount of loans past due for between 90-180 days and for loans where interest is no longer accruing in financial statements filed with the SEC immediately after the end of the quarter. On the other hand banks report to supervisors but do not disclose on their public financial statements information about loans past due between 30-89 days. This data is not released to the public until about 105 days after the quarter, which gives the bank time to exploit this information. Moreover, this information is released at a time when it is in principle useless to investors. In particular, at the same time that information about loans 30-89 days past due two quarters ago becomes public, the bank is disclosing updated information about those loans to investors through loans 90-180 days past due from the most recent quarter. Lines 7, 8 and 9 of panel A of Table (1) illustrate that the non-public component corresponds to more than 50 percent of total problem loans.

It is obviously 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

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terrorist attack on New York City on September 11, 2201.

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 (2) illustrates that our public measure of loan portfolio quality has explanatory power for next quarter's loan charge-offs after controlling for this quarter's loan charge-offs.[18] 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. Note that when both measures are included in the regression in column (2), it is actually the private measure which absorbs all of the explanatory power, a fact which we will explain later on by documenting

[17] Ashcraft (2006) documents that the ratio of problem loans to capital tracks supervisory CAMEL ratings of 3/4/5 quite well.

[18] We do not use a bank fixed-effect specification here since we are trying to predict future charge-offs with current information. The use of a fixed effect is not consistent with this exercise as it uses future information.

evidence that banks manage the real information content of public disclosures to investors.

Our third measure of creditworthiness for the sub-sample of publicly-traded institutions is the expected default frequency (EDF) implied from equity prices, as implemented by Bharath and Shumway (2005). We construct this probability following under the assumption that all bank leverage is long-term debt. It is well-known that the Merton model does not fit well for financial institutions given their extreme leverage, and this shows up in line 12 of each panel of Table 1 as the one-year probabilities of default are two orders of magnitude larger on average than those from our Probit model.

Since measures of creditworthiness only vary across bank-quarters, 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). For example, a particular bank which has 60 observations over the first quarter of 2004 (on for each business day) in the bank-day data set has 5 observations in the first quarter of 2004 in the aggregated data

set, one for each of the five quintiles of the bank's liquidity position over that quarter. In particular, the 12 days with the lowest clean balance are placed in the first quintile while the 12 days with the highest clean balance are placed in the fifth quintile. The specification of interest is a regression of each dependent variable $y_{i,q,p}$ (measuring average frequency, quantity or price of borrowing over all days in that liquidity quintile) on bank-quarter 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.[19]

3. Analysis

The analysis begins in Section 3.1 by documenting that there is a robust connection between our liquidity shocks and the demand for credit, which in turn traces out the supply curve faced by a borrower. Section 3.2 studies how

this supply curve shifts between quarters in response to within-bank between-quarter changes in two public measures of bank creditworthiness: the balance-sheet predicted probability of failure from and the ratio of problem loans to capital. Section 3.3 studies the relationship between the private measure of creditworthiness and bank behavior while Section 3.4 documents the relationship between a measure of creditworthiness that incorporates both public and private information. Section 3.5 investigates differences in how investors treat publicly-traded and private banks under the presumption that information problems are less severe in public banks. Finally, Section 3.6 documents evidence that banks are able to manage the real information content of public disclosures about loan portfolio quality across exam quarter, and investigates whether or not the market responds to these real changes in the informativeness of public disclosures.

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 $\psi_P = 0$.

[19] We emphasize that there are no Probit regressions in this paper, nor is a Probit specification appropriate as the

Results are reported in Table (3), which documents the relationship between quintiles of the clean liquidity distribution and access to the federal funds market.

The first column documents in lines 6 to 9 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 in line 6 (the most negative liquidity shock) is 15.0 percentage points more likely to borrow. Notice the expected pattern in the coefficients across the liquidity quintiles, as less liquidity is monotonically related to 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.

Line 3 of the first column documents that within-bank changes in the ratio of public problem loans to capital are associated with lower borrowing, but the coefficient of -0.1589 does not disentangle supply and demand effects. In order to put this magnitude in context, note that a one standard deviation (0.0810) deterioration in public credit quality is associated with a 1.29 percentage point

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dependent variables measure the average frequency, quantity and price of borrowing (none of which is a dummy

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 0.042 on capital in line 5 indicates that a one standard deviation (0.0825) decrease in bank capital is associated with a 0.35 percentage point decline in the probability of borrowing.

The second column of the table documents that liquidity shocks also affect the intensive margin for the sub-sample of bank-quarter-quintiles during which the bank actually borrows. In particular, line 6 documents that a bank with in liquidity the first quintile will borrow 48.64 percentage points more than a bank with liquidity in the fifth quintile. Since mean borrowing (which is measured relative to transactions deposits) is 81.1 percent, this result 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 in line 6 will pay 1.58 basis points more than a bank with liquidity in the fifth quintile. We conclude that there is strong evidence of a first stage, as

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variable) over all business days in that liquidity quntile for a bank in a particular quarter.

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 provides information about risk that would helps supervisors allocate supervisory resources in the right place or prevents supervisors from forbearing against problem banks.[20] 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.[21] The conventional interpretation of the newfound relationship between spreads and

[20] An exhaustive survey of this literature is conducted by Flannery (1999).

[21] 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.

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.[22]

While research on the information in subordinated debt spreads is extensive, there has been little work on 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, and King (2005) documents a relationship between spreads, quantities and public measures of risk consistent with market discipline, but neither of these authors makes a serious attempt to establish whether this correlation is driven by supply or demand factors.

We test for the presence of market discipline in the federal funds market by investigating how 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 Tables (4a) and (4b), which estimate equation (1) using the two measures of creditworthiness discussed above: the predicted probability of failure from

[22] 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.

balance sheets and the ratio of problem loans to capital. Each table only reports estimated coefficients on the interaction terms with the variables of interest, as the main effects were reported in Table (3).

In the first column of Table (4a), lines 1 to 4 document that an adverse change in the predicted probability of default is associated with a decrease in the supply curve, especially when looking along the extensive margin, as creditworthiness has its largest effect at the lowest level of bank liquidity. In particular, the estimated coefficient of -6.9427 in line 1 implies that a one-standard deviation change in the PD (a change of 15 basis points) is associated with a reduction in borrowing of approximately 1 percentage point at the lowest quintile relative to the highest quintile. Interestingly, the other two columns of the table document that there is little relationship between changes in creditworthiness and either the amount borrowed or spreads.

In the first column of Table (4b), lines 9 to 12 document that an adverse within-bank change in 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 of

-0.106 in line 9 implies that a one standard deviation change in the public measure of creditworthiness is associated with a 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 15.0 percentage points between these liquidity quintiles from line 6 of Table (3), this result suggests that the reduction in the probability of borrowing due to reduced credit quality is about 5.8 (=0.87/15.0) 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 line 9 indicates that a one standard deviation change in the ratio of public problem loans to capital is associated with a 4.33 percentage point reduction in the amount of borrowed. Given a difference in average borrowing of 48.7 percent, this implies 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, but the response largely appears to be 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.[23] 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.[24]

In the banking industry, economists have long worried about how federal deposit insurance creates similar moral hazard and inefficiency by ignoring information about bank risk in setting deposit insurance premiums.[25] While there is a large literature documenting evidence of moral hazard in banking,

[23] This point is made quite clearly by John, John, and Senbet (1991) in a model of banks without deposit insurance.

most economists have presumed that this behavior is created by risk-insensitive regulation and not by the existence of private information.[26] As mentioned above, such a conclusion is surprising given considerable evidence on the importance of banks at both the micro and macro level in providing credit firms where information problems are severe.

We test for the importance of private information and for existence of moral hazard by investigating how a deterioration in our private measure of borrower creditworthiness affects access to the federal funds market. Results are illustrated in lines 13 to 16 of Table (4b).

Interestingly, the first two columns of the Table 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 (3) 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 (4b) suggests

[25] Merton (1977) first documented how risk-insensitive deposit insurance premia create incentives for excessive risk-taking and leverage.

[26] 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 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.

that a borrower reacts to a private deterioration in creditworthiness by borrowing more on days of relative illiquidity. In particular, the coefficient of 0.122 in line 13 of the first column suggests that in response to a one standard deviation (0.0791) deterioration in the private measure, the borrower actually increases 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 line 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 almost 63.3 percent of the difference in mean borrowing between these two quintiles.

There are at least two possible interpretations to this result. The supply interpretation is that adverse private information about loan portfolio quality is actually observed by uninsured depositors, who run from the bank, taking reserves with them. The subsequent negative outflow of reserves prompts an increase in borrowing by the bank if not offset by a sale of securities, and thus the results are evidence of market discipline by uninsured depositors.

Alternatively, the demand interpretation to this result is that there is a link between changes in the ratio of private problem loans to capital and the amount of borrowing on days of illiquidity through changes in bank's target reserve ratio. For example, a bank might 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. 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, because with the same distribution of liquidity shocks there is obviously a greater risk of either an overnight overdraft or a more frequent need to borrow reserves in the federal funds market.[27] Moreover, this increase in the demand for federal funds has a larger effect on days when the bank is faced with less liquidity, which is exactly what we see in Table (4b).

In order to investigate which of these interpretation is correct, we test whether or not within-bank between-quarter changes in the ratio of private loans to capital

[27] 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 larger changes in borrowing on days of relative illiquidity. Moreover, it

are correlated with either the target reserve ratio (proxied for by the average end of day reserve balance), or the liquidity shocks facing the bank (measured by the actual quintiles of the clean liquidity distribution). In order to accomplish this, 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 as well as quintiles of the clean liquidity distribution 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. Moreover, there is no correlation between changes in either public or private measures of creditworthiness and the distribution of clean liquidity, which implies that there is no run on the bank by uninsured depositors. Consequently, our interpretation of the perverse correlation between borrowing and adverse private information above is that banks permit their average reserve balance to decline in the face of adverse private information about loan portfolio quality, which explains the associated relative increases in borrowing on relatively illiquid days of the quarter. Moreover, since there is no link between our public

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seems implausible that the supply curve shifts in response to private information, especially in a fashion which implies

measures of creditworthiness and these dependent variables, this reinforces our interpretation that these variables shift the supply curve.

That being said, note in line 1 of panel (B) that there is a negative coefficient on the predicted probability of failure when the dependent variable is equal to closing balance in column (1), as well as for the quintiles of the liquidity distribution in columns (2) to (5). While the latter coefficients are not statistically different from zero, they are a warning signal, suggesting that that there might be a significant outflow of liquidity from the bank in response to changes in the probability of failure. It is possible that the coefficients in Table (4a) reflect discipline by both uninsured depositors and federal funds lenders, but unfortunately there is no way disentangle these two channels. 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.

3.4 Complete information about loan portfolio quality

more lending to banks when private information about creditworthiness is unfavorable.

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. While it is not clear what is the right way to combine these two variables into a complete measure, given the linear model estimated, it is straightforward to compute from coefficients estimated in Table (4b) the value of any linear combination of these two coefficients. If one wants to predict loan charge-offs next quarter, the coefficients from column (2) of Table 2 suggest putting nearly all weight on the private measure. On the other hand, if one wants to predict failure in the next year, unreported Probit coefficients suggest weights of approximately 50 percent on each ratio. In Table (6), we follow this latter approach by taking the simple sum public and private measures 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 benefit of publicly-traded banks

Given the broader and more timely disclosure of information to investors by publicly-traded banks, and the presence of a relatively liquid equity market through which private information can be aggregated, one naturally asks the question of whether or not there are important differences in the discipline of public and private banks. In a recent paper, Holod and Peek (2004) follow this logic in using the presence of publicly-traded equity as a measure of financial constraints, and document that the response of bank lending to monetary policy is weaker for public banks than for private banks. The authors argue that the presence of public equity reduces information problems associated with lending to these institutions, which gives them greater access to markets for federal funds and uninsured deposits. As we have a strategy for identifying the supply curve, and we have documented in Table (5) that there is no connection between public equity and either target reserves or the distribution of liquidity shocks, it seems natural to use this framework to test for the presence of financial constraints.

In order to investigate this question, Table (7) interacts the liquidity shocks with a dummy variable for the presence of publicly-traded equity. The estimated coefficients in lines 5 to 8 from the first column of the table suggest that being publicly-traded is associated with an increase in the supply curve, as banks are able to borrow more at times when they need liquidity the most. The coefficient of 0.0346 in line 5 suggests that public institutions are able to borrow 3.46 percentage points more than private banks at the most severe liquidity shock, each relative to how much it would borrow at the least severe liquidity shock. Note that there is no evidence of a shift along the intensive margin, as the presence of publicly-traded equity does not affect the amount borrowed or price of federal funds. Since we are controlling for several measures of creditworthiness, this result is strong evidence that there is a connection between information problems and the supply of inter-bank credit, suggesting that private banks face financial constraints.

Given the better access that the public banks have to the market, presumably because of information problems associated with private banks, it seems natural to ask if investors trust the public disclosures of publicly-traded institutions more than they do those of private banks. These hypotheses are tested in Tables

(8a) and (8b), which report estimates of the effect of creditworthiness on the supply of credit, broken out across the presence of publicly-traded equity.

Focusing first on the public banks, the first three columns of Table (8a) document in lines 1 to 4 strong evidence of market discipline along both the extensive and intensive margins, as a deterioration in the public measure of creditworthiness not only affects the probability of borrowing, but also the amount borrowed and spreads in a fashion consistent with a decline in the supply of credit. That being said, the first three columns document in lines 5 to 8 evidence of severe moral hazard, as public institutions take advantage of the greater trust given to them by investors by aggressively borrowing in response to an adverse private signal about loan portfolio quality. The last three columns of the table document that these results are even stronger when including the equity-implied EDF, which is also interacted with the liquidity shocks and reported in lines 9 to 12. In principle, the EDF should aggregate all information available to market participants, which means that one can convincingly interpret the non-public measure of creditworthiness as private information.

In contrast to the public banks, Table (8b) documents that there is very little market discipline of or moral hazard by private banks. The coefficients on the

ratio of public problem loans to capital are much smaller in lines 1 to 4 of column 1 than the previous table, and typically not statistically different from zero. There is a similar phenomenon for the private measure of creditworthiness in lines 5 to 8 of column 1. One reasonable interpretation of this results is that without earning targets to meet for equity analysts, private banks have no reason to respond to an adverse private signal of loan portfolio quality.

Together, these results suggest that the market is believes that there are information problems associated with private banks, and restricts their access to overnight credit in a fashion consistent with financial constraints. Interestingly, publicly-traded banks not only receive better access, but the market appears to trust the financial information disclosed by public banks more than similar information disclosed by private banks. That being said, there is evidence that public banks abuse this greater trust by borrowing aggressively in response to adverse private information.

3.6 The real information content of public disclosures

Given informative public and private measures of creditworthiness, there are at least two interpretations of our 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 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 might 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 raises the possibility that banks are able to actively manage the amount of real information in public disclosures in a fashion that blunts the effectiveness of market discipline over longer periods of time.

To get a better 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 the last two columns of Table (2). In particular, we use supervisory data in order to identify quarters during the sample in which a bank exam is started by supervisors. As an asset quality review typically checks 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 actually described by the estimated coefficient in line 2 of the third, which documents that there is actually no information in public disclosures of loan portfolio quality during non-exam quarters. In contrast, in line 7, there is significant information in the public measure about future charge-offs during exam quarters. This result is further reinforced by column (4), which documents in line 8 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.

Given differences in the real information content of public disclosures about loan portfolio quality, one might ask whether or not the market or bank supervisors recognize what is going on. If investors understand changes in the real information contained in public disclosures, one would expect access to the market to be more sensitive to these disclosures during exam quarters than non-exam quarters. At the same time, if on-site monitoring of banks is effective is

reducing moral hazard, one might expect to find less aggressive borrowing in response to adverse private information during an exam quarter than a non-exam quarter.

We study these issues in Table (9), which breaks out the coefficient on the interaction of liquidity with creditworthiness across exam quarter. Results from the first column suggest that if anything, investors actually become less sensitive to public disclosures during exam quarters than they are during non-exam quarters. Interestingly, the aggressive borrowing by the bank in response to an adverse change in private information is significantly reduced during the quarter in which supervisors start a bank exam, especially along the intensive margin. These results suggest that investors do not fully understand the ability of banks to manage the real information content of public disclosures, and demonstrates the value of on-site monitoring of banks. Together, this evidence suggests that there are real limits to what the market can do to regulate banks.

4. Conclusions

We have developed compelling evidence that banks exploit private information about loan portfolio quality in order to smooth future earnings and to manage

the real information content of public disclosures. While one possible conclusion is that the market cannot play a meaningful role in the supervision of banks, we feel this interpretation of the data is overstated because it takes the supervisory regime as given. Instead, one might conclude that in order for investors to play a greater role in disciplining bank behavior, they need banks to make more timely, comprehensive, and accurate disclosures about loan portfolio quality.

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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
10. 1(public)	461,708	0.4699	0.0000	0.4991	0.0000	1.0000
11. Pr(fail in 1 year)	459,610	0.0005	0.0002	0.0016	0.0000	0.0409
12. EDF	144,704	0.1482	0.1237	0.1270	0.0000	0.6263

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
10. 1(public)	36,464	0.4720	0.0000	0.4992	0.0000	1.0000
11. Pr(fail in 1 year)	36,366	0.0005	0.0002	0.0015	0.0000	0.0409
12. EDF	12,388	0.1460	0.1207	0.1275	0.0000	0.6263

Table 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: The Real Information Content of Public Disclosures about Bank Loan Portfolio Quality

	(1)	(2)	(3)	(4)
1. charge-offs	0.7270***	0.7158***	0.7188***	0.7058***
	(0.0767)	(0.0745)	(0.0739)	(0.0712)
2. npl^{pb}/k	0.0023*	0.0012	0.0003	-0.0004
	(0.0012)	(0.0010)	(0.0006)	(0.0007)
3. npl^{pv}/k		0.0027***		0.0019**
		(0.0010)		(0.0008)
4. ln(assets)	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
5. public	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0000)
6. exam			-0.0003	-0.0004
			(0.0002)	(0.0003)
7. (npl^{pb}/k)*exam			0.0055*	0.0046*
			(0.0033)	(0.0027)
8. (npl^{pv}/k)*exam				0.0017
				(0.0023)
9. Observations	5,341	5,341	5,341	5,341
10. R-squared	0.41	0.41	0.41	0.42

Table 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 October 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. The statistical significance of estimated coefficients is denoted using ***, **, and * for the 1, 5, and 10 percent levels, respectively.

Table 3: Liquidity Shocks and Bank Borrowing			
	Pr(Borrow)	**Borrowing**	**Spread**
1. Pr(fail in 1 year)	2.0254*	261.2046**	8.2262
	(1.2019)	(104.7742)	(9.9897)
	0.0291	-1.6183*	-0.0384
2. (npl^{pv}/k)	(0.0253)	(0.8753)	(0.0425)
	-0.1589***	-0.5041**	-0.0224
3. (npl^{pb}/k)	(0.0295)	(0.3397)	(0.0208)
	0.0622***	0.7739**	-0.0077
4. log(assets)	(0.0082)	(0.2831)	(0.0082)
	0.0420***	11.8697	0.0992
5. capital	(0.0172)	(4.4523)	(0.0849)
	0.1501***	0.4864***	0.0158***
6. (liquidity = 1)	(0.0034)	(0.1180)	(0.0030)
	0.0757***	0.2909**	0.0078***
7. (liquidity = 2)	(0.0029)	(0.1159)	(0.0029)
	0.0442***	0.1830*	0.0078**
8. (liquidity = 3)	(0.0027)	(0.1088)	(0.0046)
	0.0212***	0.0834	0.0033
9. (liquidity = 4)	(0.0026)	(0.1256)	(0.0032)
10. Observations	36,366	10,644	10,644
11. R-squared	0.78	0.46	0.91

Table notes: the table reports coefficients and standard errors from OLS regressions of each dependent variable listed by column on bank characteristics listed in rows 1 to 5, dummy variables for each of the first four quintiles of a bank's daily reserve shock distribution (liquidity) in lines 6 to 9, and other unreported controls listed in the text. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 4a: Tests of Market Efficiency [probability of failure]			
	Pr(Borrow)	**Borrowing**	**Spread**
1. (liquidity = 1)*pf	-6.9427***	-8.4985	2.2135
	(1.5474)	(99.7186)	(3.8630)
2. (liquidity = 2)*pf	-5.8365***	14.8923	-0.1181
	(1.2114)	(110.3654)	(3.5235)
3. (liquidity = 3)*pf	-2.7158**	31.9653	11.8762
	(1.1753)	(103.4510)	(14.1721)
4. (liquidity = 4)*pf	-1.6771	8.0453	3.9825
	(1.0802)	(115.5319)	(3.5651)
5. Observations	36,366	10,644	10,644
6. R-squared	0.78	0.46	0.91

Table 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 4b: Tests of Market Efficiency [ratio of problem loans to capital]			
	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 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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: Creditworthiness, Average Balance, and Liquidity Distribution

A. Public and Private Measures of Creditworthiness

	Closing Balance	L_{20}	L_{40}	L_{60}	L_{80}
1. (npl^{pv}/k)	-0.2267**	0.3261	-0.5864	-1.5749	-3.2476
	(0.1132)	(1.9070)	(2.4782)	(3.0922)	(3.9713)
2. (npl^{pb}/k)	-0.0094	0.6919	0.9033	1.0399	1.2037
	(0.0357)	(0.7211)	(0.8611)	(1.0014)	(1.2032)
3. lna	0.0274	-1.2364	-0.5395	0.1396	1.3705
	(0.1097)	(2.0605)	(2.6767)	(3.2430)	(4.0607)
4. rbc	-0.0247	25.4196	29.8803	32.9539	36.7943
	(0.1392)	(23.7224)	(27.7690)	(31.4306)	(35.0830)
5. public	0.0195	0.2614	0.3737	0.5689	0.8096
	(0.0237)	(0.2745)	(0.3779)	(0.5427)	(0.7578)
Observations	7,355	7,355	7,355	7,355	7,355
R-squared	0.25	0.24	0.23	0.24	0.24

B. Predicted Probability of Failure

	Closing Balance	L_{20}	L_{40}	L_{60}	L_{80}
1. Pr(fail in 1 year)	-10.3044**	-42.0761	-84.4134	-156.3611	-269.9431
	(4.4585)	(52.1299)	(82.9348)	(118.9181)	(171.5525)
2. lna	0.0225	0.8330	1.8740	2.8129	4.2755
	(0.1120)	(0.8418)	(1.5285)	(2.0649)	(2.9371)
3. rbc	-0.1457	-3.4496	-4.3271	-7.5653	-10.4935
	(0.2774)	(3.4830)	(4.9999)	(8.2053)	(12.1495)
4. public	0.0138	0.1664	0.2478	0.3885	0.5556
	(0.0228)	(0.1772)	(0.2833)	(0.4393)	(0.6441)
Observations	7,335	7,335	7,335	7,335	7,335
R-squared	0.25	0.23	0.22	0.24	0.24

Table notes: the data refer to quarterly observations on commercial banks that ever borrow in the federal funds market over the sample period. Each column in each panel is a separate regression of the dependent variable listed in that column on each of the regressors listed in the rows with a full set of time effects. These dependent variables include: the closing balance; each of the 20th, 40th, 60th, and 80th percnetiles of the clean balance distribution over the bank-quarter. Standard errors are corrected for heteroskedasticity and clustered at the bank level. The statistical significance of estimated coefficients is denoted using **, *, and * for the 1, 5, and 10 percent levels, respectively.

Table 6: 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 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 7: Financial Constraints and Private Banks			
	Pr(Borrow)	**Borrowing**	**Spread**
1. (liquidity = 1)	0.1648***	-0.8892	0.0286**
	(0.0083)	(0.6913)	(0.0131)
2. (liquidity = 2)	0.0743***	-0.0474	-0.0049
	(0.0068)	(0.4734)	(0.0116)
3. (liquidity = 3)	0.0414***	0.1404	0.0024
	(0.0065)	(0.4642)	(0.0127)
4. (liquidity = 4)	0.0195***	-0.8349	-0.0089
	(0.0066)	(0.7739)	(0.0131)
5. (liquidity = 1)*1(public)	0.0346***	0.2987	-0.0075
	(0.0076)	(0.5195)	(0.0084)
6. (liquidity = 2)*1(public)	0.0326***	0.1649	-0.0009
	(0.0065)	(0.5086)	(0.0081)
7. (liquidity = 3)*1(public)	0.0200***	0.1704	0.0073
	(0.0060)	(0.4762)	(0.0129)
8. (liquidity = 4)*1(public)	0.0107*	0.2719	0.0003
	(0.0060)	(0.5542)	(0.0086)
9. Observations	36,463	10,679	10,679
10. R-squared	0.78	0.47	0.89

Table 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 8a: Market Discipline of Public Banks						
	Pr(Borrow)	**Borrowing**	**Spread**	**Pr(Borrow)**	**Borrowing**	**Spread**
1. (liquidity = 1)*(npl^{pb}/k)	-0.2502**	-4.0848**	0.1465	-0.3614**	-6.9403***	-0.0732
	(0.1058)	(1.7500)	(0.1159)	(0.1193)	(2.4783)	(0.1265)
2. (liquidity = 2) *(npl^{pb}/k)	-0.1019	-3.0009**	-0.0796	-0.1907*	-5.0942**	-0.2178*
	(0.0949)	(1.5021)	(0.1101)	(0.1038)	(2.2148)	(0.1179)
3. (liquidity = 3) *(npl^{pb}/k)	0.0474	-2.0727	0.2279	-0.0028	-3.6762*	0.2252
	(0.0922)	(1.5146)	(0.2305)	(0.0993)	(2.1623)	(0.2958)
4. (liquidity = 4) *(npl^{pb}/k)	0.0278	-1.9180	-0.0056	0.0380	-2.8700	-0.1108
	(0.0923)	(1.6992)	(0.1152)	(0.0978)	(2.4111)	(0.1250)
5. (liquidity = 1)*(npl^{pv}/k)	0.4725***	9.2022***	-0.0618	0.6225***	11.3299***	0.0823
	(0.1243)	(2.5856)	(0.0941)	(0.1372)	(3.3707)	(0.0956)
6. (liquidity = 2) *(npl^{pv}/k)	0.3534***	5.6159***	0.0332	0.4970***	7.4799***	0.1342
	(0.1185)	(2.0947)	(0.0917)	(0.1259)	(2.7543)	(0.0932)
7. (liquidity = 3) *(npl^{pv}/k)	0.2240**	4.3641**	-0.1215	0.3413***	5.8592**	-0.1324
	(0.1159)	(2.0462)	(0.1304)	(0.1200)	(2.6734)	(0.1693)
8. (liquidity = 4) *(npl^{pv}/k)	0.0765	3.0946	0.0314	0.1269	3.5155	0.0983
	(0.1042)	(2.3043)	(0.0944)	(0.1022)	(2.9741)	(0.1000)
9. (liquidity = 1)*edf				0.0328	0.5322	0.0564
				(0.0523)	(0.7667)	(0.0384)
10. (liquidity = 1)*edf				0.1103**	0.6780	0.0863**
				(0.0463)	(0.6539)	(0.0386)
11. (liquidity = 1)*edf				0.1176*	0.5726	0.1010*
				(0.0440)	(0.6256)	(0.0581)
12. (liquidity = 1)*edf				0.0586	0.6875	0.0495
				(0.0432)	(0.6851)	(0.0396)
13. Observations	17,211	6,958	6,958	12,388	4,985	4,985
14. R-squared	0.81	0.72	0.88	0.82	0.76	0.87

Table 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 8b: Market Discipline of Private Banks			
	Pr(Borrow)	**Borrowing**	**Spread**
1. (liquidity = 1)*(npl^{pb}/k)	-0.0635	0.0001	0.0189
	(0.0670)	(1.4230)	(0.0619)
2. (liquidity = 2) *(npl^{pb}/k)	-0.0784	0.2540	0.0616
	(0.0627)	(1.4507)	(0.0545)
3. (liquidity = 3) *(npl^{pb}/k)	-0.0399	0.3011	-0.0016
	(0.0608)	(1.4049)	(0.0617)
4. (liquidity = 4) *(npl^{pb}/k)	-0.0202	0.3658	-0.0081
	(0.0513)	(1.5039)	(0.0544)
5. (liquidity = 1)*(npl^{pv}/k)	0.0548	1.0822	-0.0163
	(0.0490)	(0.9535)	(0.0558)
6. (liquidity = 2) *(npl^{pv}/k)	0.0866*	0.6128	-0.0463
	(0.0489)	(1.0048)	(0.0450)
7. (liquidity = 3) *(npl^{pv}/k)	0.0876**	0.5459	-0.0472
	(0.0429)	(1.0110)	(0.0461)
8. (liquidity = 4) *(npl^{pv}/k)	0.0102	0.4777	0.0091
	(0.0366)	(1.0731)	(0.0433)
9. Observations	19,252	3,721	3,721
10. R-squared	0.67	0.37	0.91

Table 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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 9: Market Efficiency Across Exam Quarter			
	Pr(borrow)	**Borrow**	**Spread**
1. (liquidity = 1)*(npl^{pv}/k)	0.158**	3.921***	0.073*
	(0.061)	(1.312)	(0.042)
2. (liquidity = 2)*(npl^{pv}/k)	0.154**	2.164**	0.044
	(0.062)	(0.922)	(0.041)
3. (liquidity = 3)*(npl^{pv}/k)	0.113**	1.681*	0.043
	(0.057)	(0.873)	(0.043)
4. (liquidity = 4)*(npl^{pv}/k)	0.020	0.960	0.033
	(0.046)	(1.041)	(0.039)
5. (liquidity = 1)*(npl^{pb}/k)	-0.140*	-0.573	0.006
	(0.077)	(0.860)	(0.046)
6. (liquidity = 2)*(npl^{pb}/k)	-0.153**	-0.395	0.029
	(0.072)	(0.764)	(0.042)
7. (liquidity = 3)*(npl^{pb}/k)	-0.086	-0.268	-0.016
	(0.068)	(0.764)	(0.048)
8. (liquidity = 4)*(npl^{pb}/k)	-0.082	-0.219	-0.022
	(0.054)	(0.764)	(0.043)
9. (liquidity = 1)*(npl^{pv}/k)*exam	-0.074	-2.875***	-0.192***
	(0.079)	(1.084)	(0.070)
10. (liquidity = 2)*(npl^{pv}/k)*exam	-0.039	-1.598*	-0.127**
	(0.076)	(0.890)	(0.050)
11. (liquidity = 3)*(npl^{pv}/k)*exam	0.004	-1.654	-0.264**
	(0.065)	(1.142)	(0.129)
12. (liquidity = 4)*(npl^{pv}/k)*exam	-0.003	-1.739	-0.076
	(0.055)	(1.747)	(0.048)
13. (liquidity = 1)*(npl^{pb}/k)*exam	0.078	0.239	0.142
	(0.083)	(1.157)	(0.102)
14. (liquidity = 2)*(npl^{pb}/k)*exam	0.170**	0.659	-0.032
	(0.073)	(1.497)	(0.083)
15. (liquidity = 3)*(npl^{pb}/k)*exam	0.170**	1.248	0.376
	(0.066)	(2.007)	(0.288)
16. (liquidity = 4)*(npl^{pb}/k)*exam	0.212***	1.651	0.130
	(0.055)	(2.725)	(0.093)
17. Observations	36,100	10,570	10,570
18. R-squared	0.78	0.40	0.91

Table 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), and interactions of the bank characteristics with the liquidity dummies. The data includes bank-quarter-liquidity quintile observations for the approximately 700 commercial banks which ever borrowed in the federal funds market from October 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.

9. Figures

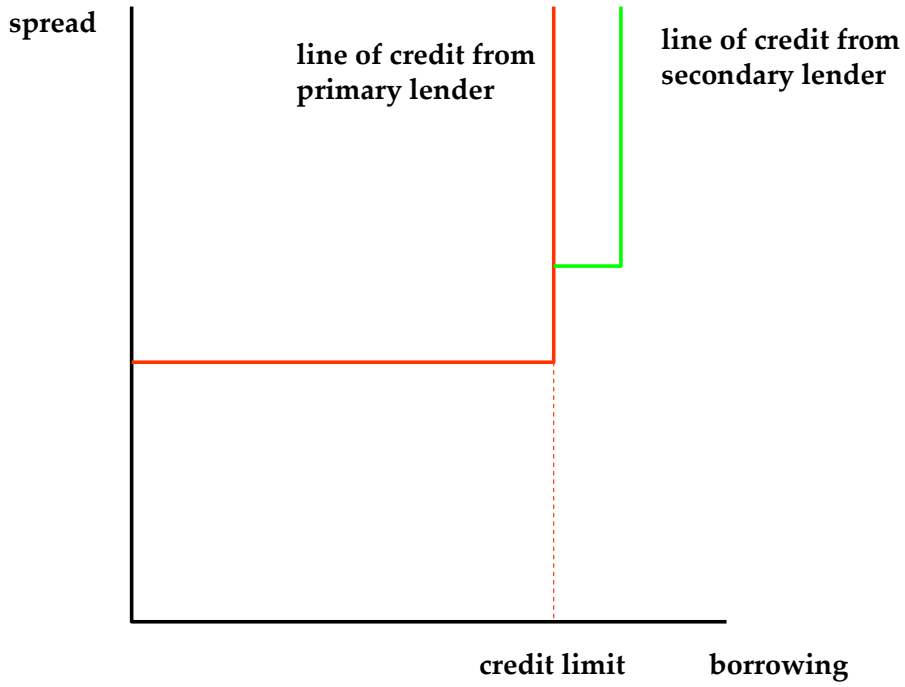

Figure 1: The supply of loanable funds facing a borrower

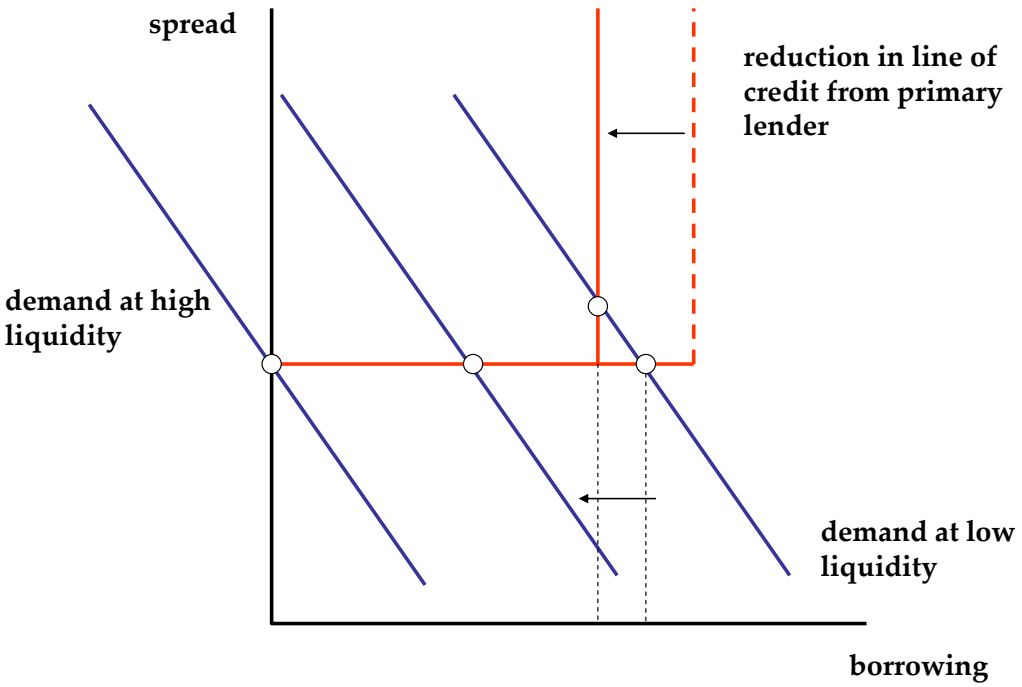

Figure 2: The differential effect of creditworthiness on borrowing across liquidity