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Bank Capital and Loan Monitoring

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ABSTRACT: This paper empirically examines the association between bank capital and banks' monitoring effort. We use four proxies to measure the unobservable monitoring effort. Two of the proxies are based on loan quality (*ex post* outcomes of monitoring effort). The other two proxies are based on salary expense (*ex ante* proxies intended to capture the quality and quantity of labor input into monitoring effort). Using a bank and time fixed effects estimation, we find a positive association between bank capital and each of our measures of monitoring effort. We find that this association is more pronounced for smaller banks and banks that engage in higher levels of relationship lending. Numerous additional tests and robustness checks, including matched sample analysis and instrumental variable approach to address endogeneity, confirm our main findings. Overall, our evidence is consistent with the prediction in Mehran and Thakor (2011) that banks that keep higher capital monitor more.

JEL Classifications: G21; G32; M41.

Keywords: bank capital; bank monitoring; loan quality.

I. INTRODUCTION

Bank capital structure in general, or how much equity a bank has in its capital structure, is one of the most important targets of bank regulation. The primary reason for the importance of bank capital is that the amount of capital held by the bank affects its survival, as well its risk management incentives, such as its investment in screening and monitoring activities (see Thakor [2014] for an excellent review).[1] However, these activities are unobservable to outsiders and costly for the bank. So what stops a bank from underinvesting in monitoring effort?[2] Theory argues that banks' capital structure creates appropriate incentives for banks to engage in monitoring of its borrowers. However, theory provides two alternative views on the role of equity in banks' capital structure in incentivizing banks' monitoring effort.

One group of theories suggests that higher equity capital strengthens a bank's monitoring incentives (Holmstrom and Tirole 1997; Allen, Carletti, and Marquez 2011; Mehran and Thakor 2011). Although monitoring is costly, higher equity capital increases the survival probability of a bank, which, in turn, increases the likelihood that the bank can reap the benefits of its prior-period investment in costly monitoring in subsequent periods. Thus, higher equity capital is predicted to

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[1] We use the term "bank capital" to refer to the book value of equity on the bank's balance sheet. The regulatory view of capital is similar, but broader, and includes adjustments relating to goodwill, intangible assets, and accumulated other comprehensive income (among other things), and regulatory definitions of capital all assign a central role to equity. We conduct robustness tests using Tier 1 regulatory capital in Section VII.

[2] We do not distinguish between initial screening during the loan underwriting process and the ongoing monitoring after the loan is originated, and use the term monitoring to include both. The theories that we use to motivate our research question or our empirical design do not warrant such distinction.

strengthen banks' monitoring incentives. An alternate perspective argues that a higher level of equity capital could potentially have a negative effect on monitoring, as a higher equity cushion may shield a lazy or incompetent manager from the discipline imposed by demand deposits (Calomiris and Kahn 1991; Diamond and Rajan 2000; Kashyap, Rajan, and Stein 2008). Despite these theoretical insights, empirical evidence, especially large-sample evidence, on this issue is scant because monitoring effort is unobservable and bank capital structure choices are endogenous. Our objective in this paper is to fill this void in the literature.[3] In particular, our objective is to empirically test whether higher bank capital strengthens banks' monitoring effort.

An empirical issue we need to address is that contemporaneous bank capital is positively affected by loan quality outcomes. While we lag bank capital to address the concern regarding the mechanical relationship between capital and loan outcomes, we also need to consider the right lead-lag structure between capital structure and monitoring. Theoretical models do not give any specific guidance regarding the length of the lead-lag structure between capital structure and monitoring. In reality, we do not expect quarterly adjustments in loan quality or monitoring as a result of quarterly fluctuations in bank capital. Therefore, we use average bank capital over the prior four quarters as an approximation of the theoretical construct.

In our first set of tests, we examine the association between bank capital and two measures of loan quality that are proxies for the *ex post* outcomes of banks' monitoring effort. If bank capital strengthens monitoring incentives, then we should find a positive association between bank capital and loan outcomes. Although theories do not distinguish between public and private banks, these distinctions are important from a policy perspective. Hence, we conduct an analysis conditioning on whether the bank is publicly listed. Moreover, since monitoring is more important for relationship loans and since the value of relationship loans is likely to increase with managerial effort (Boot and Thakor 2000; Allen et al. 2011; Mehran and Thakor 2011), we examine whether the association between bank capital and monitoring effort is stronger in a subsample that is likely to comprise a larger fraction of relationship loans. Additionally, we condition on bank size as size distinctions matter not only from a policy perspective, but also prior evidence suggests that smaller banks engage in higher levels of relationship lending (Berger, Miller, Petersen, Rajan, and Stein 2005).

To capture loan quality, we use two measures of default risk inherent in the loan portfolio of the bank, namely, non-performing loans (*NPL*) and net loan charge-offs (*NCO*) (Wahlen 1994). We find a positive and significant association between bank capital and each of the two measures of loan quality (we multiply *NPL* and *NCO* by -1 to obtain *LQ1* and *LQ2*, respectively, so that higher values of each measure can be interpreted as higher loan quality). We document a positive relation between bank capital and loan quality over our sample period (1995Q1–2014Q4). The positive association also obtains for the public and private banks. The association between bank capital and loan quality is statistically stronger for banks with a higher proportion of relationship loans, and for smaller banks. The economic magnitude of the relation is large, as well. Our main tests reveal that a one-standard-deviation increase in bank capital is associated with a decrease of 17 percent, on average, in *NPL* and a 25 percent decrease in *NCO*, respectively. Our analysis controls for other determinants of loan quality, such as loan growth, bank size, portfolio composition, liquidity risk, and maturity gap. We include bank fixed effects and quarter dummies to account for average differences in loan quality across banks and average differences in loan quality across quarters, respectively, that are not captured by other exogenous variables, and to reduce correlation across error terms. To control for heteroscedasticity and possible correlation among observations of the same bank in different years, we report robust standard errors, clustered by the bank.

While loan quality is an *ex post* outcome of investment in monitoring effort, theory argues that bank capital strengthens monitoring incentives (hence a greater investment in monitoring). Thus, we also examine whether bank capital is associated with *ex ante* investment in monitoring effort. Specifically, we use two *ex ante* proxies for banks' investment in monitoring. These proxies are based on the ratio of salary expense to total non-interest expense. The intuition is that this measure captures the quality and quantity of labor input into monitoring. The first proxy (*MRSE1*) is the ratio of salary expense to total non-interest expense adjusted for whether the bank is public or private, size, and portfolio composition. The second proxy (*MRSE2*) is a comprehensive measure of monitoring effort based on Coleman, Esho, and Sharpe (2006). Coleman et al.'s (2006) measure of monitoring effort is the fixed effects regression coefficient in a regression of salary expense to total non-interest expense on various factors that are intended to capture the impact of non-monitoring activities of the bank on its salary expense, such as portfolio composition, fee income, transaction deposits, size, performance, and the number of employees (details provided in Section III).[4] Consistent with predictions in Holmstrom and Tirole (1997) and Mehran and Thakor (2011; hereafter, MT), we

[3] Figure 1 illustrates how we operationalize our primary research question.

[4] We validate our salary-based measures using other measures that reflect a bank's investment in monitoring, such as the use of standardized loan risk ratings, use of an independent loan review, and the presence of chief risk officer.

find that bank capital is positively associated with both of our *ex ante* proxies of monitoring effort. This association is stronger for smaller banks and for banks that engage in a higher level of relationship lending.[5]

An important empirical challenge for our study is that the level of equity in a bank's capital structure is endogenous, and that there may be omitted variables jointly determining bank capital on the one hand and loan quality and monitoring-related salary expense on the other. This identification challenge is overcome through numerous econometric approaches and a battery of additional tests. First, we use bank fixed effects to mitigate endogeneity concerns arising out of time-invariant omitted variables. Second, we alleviate endogeneity concerns arising from functional form imposed by linear regression by using a matched sample analysis. We divide our sample based on the level of capital—high versus low capital (above and below median). We then construct a sample of matched pairs where each high-capital bank is matched with a low-capital bank on five key observable characteristics, such as loan growth, bank size, portfolio composition, liquidity risk, and maturity gap. Our results continue to show that loan quality measures and monitoring-related salary expense measures are higher for the banks with high capital relative to banks with lower capital. Third, following Berger and Bouwman (2009, 2013), we instrument equity capital using the proportion of seniors in the market in which a bank operates and find that our inference is unaltered. Fourth, while we control for risk in our regressions, we understand that these controls may not be sufficient. Therefore, we conduct additional tests in a subsample of high-risk banks based on the proportion of risk-weighted assets to total assets. Our results remain robust. Fifth, we examine the association between bank capital and loan fair values for a subsample of banks for which loan fair values are available. This test further mitigates the concern regarding the simultaneous determination of loan quality measures and bank capital, as there is little reason to expect the fair value of loans and bank capital to be jointly determined. Finally, results are also robust to using the Tier 1 regulatory capital ratio as an alternative definition of capital.[6]

We make two important contributions to the literature. First, we provide direct and large-sample evidence on the association between bank capital and monitoring effort. Although prior studies have documented the benefits of higher capital (for example, Calomiris and Mason 2003; Calomiris and Wilson 2004), the empirical evidence on the impact of bank capital on monitoring incentives is limited and largely indirect. Using a sample of 244 bank mergers from 1989 to 2007 that were accounted for using the Purchase Method, MT show that the purchase price received by the target bank and the goodwill recognized in the acquisition are positively related to the target bank's equity capital, suggesting that bank capital is positively related to bank value in the cross-section. They interpret this evidence as supporting their theory that bank capital strengthens monitoring incentives.[7] However, small sample size and the specialized setting limit the generalizability of their results. Jayaraman and Thakor (2013) exploit international data on heterogeneous creditor rights to show that an improvement in creditor rights results in banks shifting their capital structures away from equity and toward deposits. Since stronger creditor rights reduce the need for banks to monitor their borrowers, they interpret their results to suggest that it is bank capital, rather than bank debt, that seems to provide stronger monitoring incentives for banks. Purnanandam (2011) provides somewhat direct evidence. He finds that banks with greater participation in the originate-to-distribute model originated loans of poor quality and that this effect is stronger for banks with lower capital, suggesting that lower capital reduces pre-lending screening incentives. However, his analysis is conducted over a short period of seven quarters, from 2006Q3 to 2008Q1, and the analysis is restricted to mortgage loans and hence may not generalize to other loans where monitoring is more important, such as relationship loans. In contrast, our study spans a much longer period (1995 to 2014) and examines the total loan portfolio instead of just mortgage loans. The theoretical models (Diamond and Rajan 2000, 2001; MT) highlight the importance of monitoring to the relationship loan portfolio in general and not specifically mortgage loans. Thus, an examination of the total loan portfolio and a longer time period allow for a broader interpretation of the results.

Second, our findings are relevant to the current regulatory debate surrounding the capital structure of banks. The financial crisis of 2007–2009 highlighted the adverse consequences of banks' fragile capital structure. This has prompted some to call for a dramatic increase in the use of equity by banks (Admati and Hellwig 2013; Admati, DeMarzo, Hellwig, and Pfleiderer 2013). However, others have cautioned against requiring banks to hold more equity, as it might insulate bank managers from market discipline and thereby exacerbate agency problems at the banks (Kashyap et al. 2008; Calomiris 2013). Our study contributes

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[5] While we use average capital, there may still be concern that our results capture the mechanical relationship between the boom and bust periods in the economy. Banks build up capital, have few non-performing loans, provisions, and charge-offs, and pay higher salaries and bonuses during good times. Banks experience losses, have more non-performing loans, provisions, and charge-offs, and cut back on salaries and bonuses during bad times. But for this mechanical relationship to obtain, bank capital, loan quality measures, and monitoring-related salary expense measures have to be contemporaneous. Furthermore, our results are robust to exclusion of the financial crisis quarters and including a time trend.

[6] All our results are robust to using one-quarter-lagged bank capital as our main independent variable.

[7] Prior to 2001, there were two acceptable methods to account for mergers: the Purchase Method and the Pooling of Interests Method. The Purchase Method required the acquirer to revalue the target's assets and liabilities to their fair market values, but the Pooling of Interests Method permitted the acquirer to record the target's assets and liabilities at their book values. Prior to the prohibition on the use of the Pooling of Interests Method by the Financial Accounting Standards Board (FASB) in 2001, an overwhelming majority of bank mergers were accounted for using the Pooling of Interests Method.

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to this debate by identifying an important benefit of bank equity capital: its positive impact on monitoring incentives and a corresponding positive association with loan quality. Furthermore, our evidence that capital strengthens monitoring incentives at small banks, but not at large banks, suggests that the trade-off between benefits and costs of higher capital differ by size. This evidence complements evidence in other work that suggests that bank performance, liquidity creation, and moral hazard induced by too-big-to-fail guarantees differ by size (Berger and Bouwman 2009, 2013; Koch, Richardson, and Van Horn 2016). At a minimum, our empirical evidence identifies an important benefit of higher bank capital—stronger monitoring incentives.

II. MOTIVATION, PRIOR LITERATURE, AND HYPOTHESIS DEVELOPMENT

What is Monitoring? Why is it Important?

Lending is a key business activity for a bank. Loans comprise a major portion of most banks' assets and are their primary source of revenue. Loans are also the most important source of credit risk and potential loss exposure for banks. During its underwriting process, a bank conducts a full credit assessment of the borrower (screening), including the borrower's ability to pay back or refinance the loan at the time of maturity. Depending on the size and nature of the loan, a bank may establish covenants as benchmark metrics that are intended to ensure that the borrower remains financially healthy and the bank's investment is protected. Banks may require documentation from the borrower not only at the onset of the loan, but also at frequent intervals during the life of the loan. In more complex loans, the bank may impose certain restrictions on the borrower's activities that govern what it can and cannot do with its business operations.

In addition to protecting its investment, banks also face regulatory pressure to have effective monitoring in place. Evaluation of a bank's lending policies, credit administration, and the quality of the loan portfolio is a critical aspect of the regulatory examination process. Regulators frequently request data on the monitoring function and conduct examinations to ensure that a bank's monitoring function aids in quantifying its risk, accurately calculating its capital, and setting aside an appropriate amount of reserves. The bank's condition and the quality of its management are weighted heavily in the examiner's findings concerning its lending practices. The emphasis on review and appraisal of the loan portfolio and its administration by bank management during examinations is indicative of the large portion of time and attention that bank examiners devote to loan portfolio examination. For example, the *Commercial Bank Examination Manual* (Federal Reserve System 2018) used by Federal Reserve examiners clearly highlights that bank examination involves (1) evaluating the depth and scope of the formalized policies and procedures the bank uses to manage and control its loan portfolio, and (2) forming an overview of the performance of the entire lending operation by consolidating the results of the examination programs from various lending departments. The Capital adequacy, Asset quality, Management, Earnings, Liquidity, and Sensitivity (CAMELS) ratings, which are used by all the banking regulators (Federal Reserve, Federal Deposit Insurance Corporation [FDIC], and Office of the Comptroller of the Currency [OCC]), include specifically an evaluation of the adequacy of loan and investment policies, procedures, and practices. Thus, a bank is expected to have effective monitoring in place that includes people, processes, and policies to ensure that it protects its investments.

Theories Relating to Bank Capital Structure and Monitoring

Prior work has developed several theoretical insights into the relationship between bank capital structure and its risk management incentives, and particularly its investment in screening and monitoring. The first group of theories emphasizes the importance of the fragility of bank capital structure (financing by demand deposits) and high leverage (low equity capital) to prevent shirking by bank managers. Under this view, higher equity capital serves to diminish the discipline imposed by depositors. The second group of theories views equity capital as beneficial as it is argued to strengthen the banks' monitoring incentives. We discuss these alternate views in detail below.

Role of Deposits in Inducing Monitoring Effort

The rationale for a fragile capital structure for a bank that is financed with demand deposits and little equity capital has been articulated in several papers (Calomiris and Kahn 1991; Diamond and Rajan 2000, 2001; Kashyap et al. 2008). A key argument in these papers is that the sequential service constraint feature of demand deposits serves as a credible threat of bank run, and hence disciplines the bank manager. In this framework, higher equity capital may shield the bank manager from the discipline imposed by depositors. For example, Calomiris and Kahn (1991) argue that higher bank leverage increases the risk exposure of depositors, giving them greater incentives to become informed. If they acquire adverse information, then they can respond by withdrawing their funds. Their action is likely to be emulated by other depositors, precipitating a run on the bank. Thus, the threat of a bank run then keeps the bank manager diligent and prevents shirking and excessive risk-taking. In contrast to demand deposits, claims such as equity lack this sequential servicing constraint, and hence cannot provide the same discipline as deposits.

Diamond and Rajan (2001) propose that a fragile capital structure helps address the hold-up problem. In particular, they argue that the value of a bank's loan portfolio will be affected by bank managers' investments in loan collection effort, and that bank managers may hold-up depositors by threatening to withhold their collection effort until given a higher share in the surplus. However, if the bank is financed primarily by demand deposits, then the deposit holders may threaten to prematurely withdraw their funds, which would eliminate the surplus for the bank manager. Thus, a fragile capital structure resolves the hold-up problem and allows the bank to raise financing via deposits, which, in turn, allows it to fund illiquid loans and thereby create liquidity. In Diamond and Rajan (2000), equity serves to absorb shocks resulting from volatility in asset values, but high levels of capital, by providing an equity cushion to absorb losses, might potentially shield the bank manager from market discipline (a run by the depositors) and thereby allow the manager to potentially underinvest in monitoring. Overall, the studies mentioned above identify the costs of the high level of bank equity capital.

Role of Equity in Inducing Monitoring Effort

An alternate perspective is that a higher level of bank capital strengthens monitoring incentives. There are three broad arguments that highlight the benefits of a higher level of bank capital. First, very low levels of equity can induce moral hazard by encouraging the manager to engage in excessive risk taking or asset substitution (Jensen and Meckling 1976). This risk-taking behavior is exacerbated when a financial institution is heading toward insolvency. Moral hazard combined with relaxed regulatory oversight can lead to an incentive to "gamble for resurrection" by taking on excessive risk; e.g., during the savings and loan (S&L) crisis of the 1980s (Benston and Kaufman 1986; Black and Pontell 1995; Brumbaugh 1988) and during the Texas real estate crisis (Gan 2004). To put it simply, a financial institution heading toward insolvency has an incentive to increase risk-taking akin to gambling. If the gamble pays off, then the financial institution survives. If the gamble does not work, then the financial institution goes under, and the taxpayers bear the losses. This risk-shifting behavior may manifest through a riskier loan portfolio as a result of inadequate screening and/or monitoring, either of which contributes to poor loan quality.[8] A higher level of bank capital can mitigate the moral hazard problem by reducing risk-taking incentives (Furlong and Keeley 1989). For example, Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016) find that during the European financial crisis, weakly capitalized banks borrowed not only more from the European Central Bank, but also used riskier collateral than strongly capitalized banks and actively invested in risky assets, leading to an aggregate reallocation of risky assets to weak banks.

Second, a higher level of capital increases banks' risk-absorbing capacity and this, in turn, increases the banks' risk-bearing capacity (Bhattacharya and Thakor 1993). Third, bank capital strengthens a bank's incentives to monitor its borrowers as bank failure is more costly for shareholders of well-capitalized banks (Holmstrom and Tirole 1997). In particular, MT, in a dynamic variant of Holmstrom and Tirole (1997), argue that since higher capital increases the survival probability of the bank, it increases the marginal benefit to monitoring, as greater survival probability increases the likelihood that a bank will be able to realize the gains from its prior investment in monitoring. This increases the value of a bank's relationship loan portfolio, which, in turn, further strengthens the bank's incentives to monitor. Thus, MT predict a positive association between bank capital and the value of its loan portfolio. Overall, the papers mentioned above provide an alternate perspective that higher bank capital (lower leverage) has beneficial effects on loan value, and they also identify the channel or the mechanism by which bank capital affects loan value—via stronger monitoring incentives.

However, it is important to recognize that the alternate views presented above are not mutually exclusive and can coexist. Specifically, in the first set of papers, the primary disciplinary mechanism against a manager who shirks her responsibility is the threat of a bank run by depositors. In these studies, the role of equity is to absorb losses resulting from volatility in asset values (Diamond and Rajan 2000). In contrast, in the second set of papers, there is no disciplinary role assigned to depositors. However, an empirical challenge to testing the disciplinary role of demand deposits in recent years is the dampening effect of deposit insurance and implicit government guarantees on the disciplining role of deposits. A recent paper by Calomiris and Jaremski (2019) shows that deposit insurance increased risk by removing the market discipline in the deposit market that had been constraining uninsured banks in the absence of deposit insurance.

Thus, we focus on providing an empirical test of the prediction of the theories that posit a positive association between bank capital and monitoring incentives. The MT model yields a specific implication regarding the relation between bank

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[8] For example, the excessive risk-taking in the buildup prior to the financial crisis of 2007–2009 revealed screening, as well as monitoring, failures. Decline in screening standards of mortgage lenders expanded the borrower base and fueled a high volume of risky loans. The potential to securitize these loans removed incentives to monitor. Ultimately, the result was poorer-quality loan portfolios that resulted in unprecedented losses (Purnanandam 2011).

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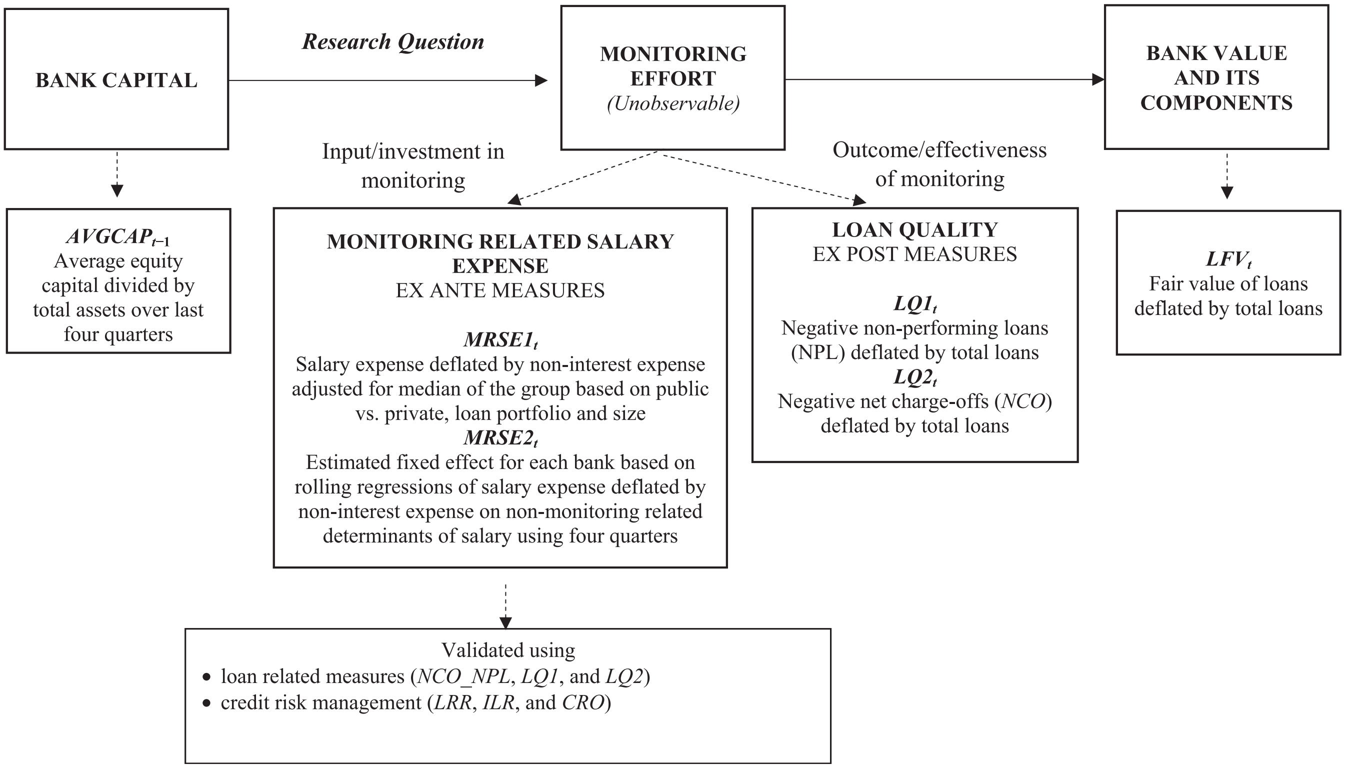
FIGURE 1
Research Design—Operationalization Using Proxies



capital, monitoring, bank value, and its components, as illustrated in Figure 1. We focus on the bank capital and monitoring, and we now state the implication in hypothesis form.

H1: Bank capital is positively associated with monitoring effort.

However, monitoring effort is unobservable. Thus, while MT provide valuable insights that guide our main hypothesis, unobservability of monitoring effort points to a need for empirical mediation. We address this key issue about how to measure monitoring effort by focusing on the outcome (effectiveness) of monitoring effort and the input (investment) into the monitoring effort. Therefore, our testable hypotheses are as follows:

H1a: Bank capital is positively associated with the outcome of monitoring effort.

H1b: Bank capital is positively associated with *ex ante* investment in the monitoring effort.

III. DATA AND VARIABLE MEASUREMENT

Our sample comprises commercial bank holding companies in the United States that operated during the 1994 to 2014 period. We use the quarterly call report data (Y-9C) from the Federal Reserve Bank of Chicago website from 1994Q1 to 2014Q4. All domestic FDIC-insured commercial bank holding companies are required to file call reports with the regulators every quarter. These reports contain detailed information on a bank's income statement, balance sheet items, and off-balance sheet activities. The content of this report changes over time to reflect the changing nature of the banking business. To ensure that we maintain consistency in the measurement of our variables over time, we check the Y-9C report format available on the Federal Reserve Bank's website for each quarter. We exclude banks for the following criteria: (1) total assets below \$500 million (equivalent of real dollars in 2006Q1) at the beginning of the quarter, (2) zero or negative equity capital at the beginning or at the end of the quarter, and (3) missing data to compute control variables in our tests. Our final sample consists of 56,580 bank quarters with 1,922 unique banks.[9] We use the CRSP-FRB link file from the Federal Reserve Bank of New York's website to identify the public banks in our sample. We obtain loan fair values from the SNL Banker database. The quarterly fair values are available from 2009Q2 onward. We collect data on loan risk ratings (*LRR*), independent loan reviews (*ILR*), and chief risk officer (*CRO*) from more than 11,000 10-Ks obtained from the data provider MylogIQ. We elaborate on these measures in Section V. Our final sample comprises 876 (1,196) unique public (private) banks with 26,153 (30,427) bank quarter observations.

Variable Definitions for Outcome Measures of Monitoring Effort as Dependent Variables

Our main independent variable is bank equity capital deflated by total assets averaged over the prior four quarters (*AVGCAP*). Our dependent variable, loan quality, is measured in two different ways: (1) non-performing loan (*NPL*), and (2) net charge-offs on loans (*NCO*). Both are deflated by total loans at the beginning of the quarter. Typically, loans become non-performing at 90 days past due or if the loan is a nonaccrual loan. A manager has little control over classification of a loan as non-performing as it involves a relatively mechanical classification when payment on the loan is overdue (Liu and Ryan 1995, 2006; Liu, Ryan, and Wahlen 1997). Thus, our first measure of loan quality, non-performing loans, is relatively non-discretionary. Bank managers charge off loans when they are deemed uncollectible. While bank managers exercise some discretion over the timing and magnitude of the NCOs, especially for commercial loans, charge-offs are often driven by exogenous factors (Bhat, Lee, and Ryan 2018). Moreover, consumer loans are automatically charged off when they become delinquent for a certain number of days.[10] Thus, our second measure of loan quality, net charge-offs, is also a relatively non-discretionary measure.

We control for a host of bank characteristics that can potentially affect loan quality. We control for the growth in loans, measured as a change in loans over the prior quarter deflated by total assets to capture effects related to loan seasoning (*LG*). We include a log of total assets to control for size (*SIZE*). We include the ratio of commercial and industrial loans to total assets (*COMM*) to control for portfolio composition and credit risk. We control for liquidity risk by including the ratio of liquid assets to total assets (*LIQUID*). We include a measure of absolute value of the one-year maturity gap to control for interest rate risk faced by the banks (*ABSGAP*). All our control variables are measured at the beginning of the quarter. See Appendix A for details on data items.

Variable Definitions for the Input Measures of Monitoring Effort as Dependent Variables

We use two proxies for monitoring-related salary expense as our proxies for *ex ante* investment in monitoring effort. Salary expense is intended to capture the quality and quantity of labor input into the monitoring process. Although banks may have information technology-based automated processes to monitor loans, loan monitoring still requires significant labor-intensive gathering of information and evaluation (Coleman et al. 2006). Banks surveyed by Treacy and Carey (2000) generally believe that loan risk rating systems involving human judgment provide more accurate estimates of risk relative to statistical models, especially for large exposures. Thus, monitoring effort is directly related to the quality and quantity of bank staff, and hence the use of salary expenses as a proxy for *ex ante* investment in monitoring. We use the median-adjusted ratio of salary expense to total non-interest expense (*SALEXP*) as our first proxy (*MRSE1*) of monitoring effort. Besides whether the bank is a public or private bank, one would expect the salary expense ratio to be driven by the size of the bank and its portfolio composition. For example, larger banks have a different business model than smaller banks (larger banks have higher trading revenue and a lower proportion of loans to total assets relative to smaller banks) and may also benefit from economies of scale. Also, due to heterogeneity, commercial loans require greater investment in monitoring. Thus, we divide our subsamples of public and private banks into small, medium, large, and very large banks based on total assets, and then we further divide each of the four groups into four subgroups based on the proportion of commercial loans to total assets (*COMM*). We form these 32 subgroups each quarter. For each bank quarter, we compute the *MRSE1* as the difference between *SALEXP* for a bank and the median for that subgroup of banks.

[9] We start with 36,519 quarterly observations (1,119 unique banks) relating to public banks, and 86,110 quarterly observations (3,034 unique banks) relating to private banks. After deleting observations with total assets below $500 million (equivalent of real dollars in 2006Q1), we have 28,709 relating to public banks (928 unique banks) and 34,755 quarterly observations (1,349 unique banks) relating to private banks. Deleting observations with negative equity capital, missing data to compute control variables, and requiring data to compute lags of variables gives us our final sample.

[10] Closed-end consumer loans must be charged off no later than 120 days past due, whereas open-end consumer loans and residential mortgages must be charged off no later than 180 days past due, as per the Federal Financial Institutions Examination Council, Uniform Retail Credit Classification and Account Measurement Policy (June 12, 2000; see: https://www.federalregister.gov/documents/2000/06/12/00-14704/uniform-retail-credit-classification-and-account-management-policy).

Several other non-monitoring factors may also affect the salary expense ratio, in addition to bank size and portfolio composition. Thus, we employ the technique used in Coleman et al. (2006) to compute our second measure of monitoring effort (*MRSE2*) by filtering out the effects of non-monitoring factors that may affect this ratio. The proxy for monitoring effort in quarter *t* is based on the estimation of a fixed effects regression with *SALEXP* as the dependent variable and the non-monitoring factors as independent variables on panel data for quarters *t*–3 to *t*. The analysis yields individual bank-specific constants (fixed effects coefficients) that become our proxy for monitoring effort at the end of quarter *t*. To control for the effect of asset composition on the salary expense ratio, we include portfolio composition: real estate (*RE*), *COMM,* and consumer (*CONS*). Fee-generating activities are typically labor-intensive and require highly skilled staff. Therefore, we include a ratio of fee to interest income (*FEE*). The salary expense ratio is expected to be affected by profitability, as well as liability composition. Hence, we control for return on assets (*ROA*) and the ratio of transitory deposits to lagged total assets (*TRANDEP*), respectively. To control for scale effects, we include a log of total assets (*SIZE*) and a log of the number of employees (*LOGEMP*). The estimation procedure is discussed in detail in Appendix B.

Validating Proxies for Monitoring Effort

To provide further support for our salary-based measures of monitoring effort, we use several additional measures that we expect to be correlated to monitoring. We explain each of these additional measures below:

(1) *NCO_NPL*—We use the ratio of net charge-offs to prior-period non-performing loans as a proxy for maintenance monitoring. A bank that invests heavily in monitoring is likely to respond more proactively to loan defaults with the hope of salvaging the loan. Such action is then expected to lower its losses. MT refer to this as "maintenance monitoring." Thus, we expect *NCO_NPL* to be lower for banks that have greater investment in monitoring based on our *MRSE1* and *MRSE2* measures.

(2) *Risk Management Measures*—Monitoring is an integral part of the overall risk management of a bank. We collect data on three measures that reflect loan monitoring activities of a bank—loan risk rating (*LRR*), independent loan review (*ILR*), and the presence of a Chief Risk Officer (*CRO*)—from the bank's 10-K filing.[11] The first and second measure directly relate to the monitoring process, and the third measure is reflective of the bank's overall risk management function.

Loan risk ratings are the primary summary indicators of risk for banks' credit exposures and are an integral part of its credit risk management. Evaluation of whether a bank has an adequate *LRR* system is an integral part of its regulatory examination. Select institutions, subject to meeting certain conditions and explicit supervisory approval, will be allowed to use the Internal Ratings-Based (IRB) approach under the Basel II framework. The IRB approach relies on their internal ratings of credit risk as primary inputs to the capital adequacy calculations. *LRR* provide the means to distill and summarize information that allows comparison of risk posed by the borrower, which would otherwise be extremely difficult given the large number and heterogeneity in borrowers of the bank (Treacy and Carey 2000). *LRR* is a dummy variable equal to 1 if the bank has a standardized loan rating system that it describes in its 10-K, and 0 otherwise. We expect banks with higher values of *MRSE1* and *MRSE2* to have *LRR* systems in their credit architecture.

Independent loan reviews are often conducted by independent loan review units within banks or by outside consultants. A bank may lack resources to have strong in-house monitoring, or it may want to verify the integrity of its loan risk ratings by an independent party, in which case, it is likely to hire outside consultants or bring in non-lending staff to conduct an independent review of the loan portfolio. This is especially true in the case of smaller banks. Hence, we collect data on whether a bank uses an independent loan review (*ILR*). *ILR* is a dummy variable equal to 1 if a bank discusses having an independent loan review in their 10-K, and 0 otherwise. We expect that banks with higher values of *MRSE1* and *MRSE2* to have a lower incidence of *ILR* given that high *MRSE1* and *MRSE2* suggest strong monitoring effort within the bank and may not necessitate the use of *ILR*.

Also, we collect data on whether a bank has a Chief Risk Officer. Prior literature documents that the presence of a Chief Risk Officer is associated with superior performance during the crisis (Aebi, Sabato, and Schmid 2012; Ellul and Yerramilli

[11] The 10-Ks are available mostly for public banks and for a small number of private banks. Given the effort involved in collecting data, we collect these data on an annual basis. We assign the value from the 10-K to all four quarters in that year. We obtained over 11,000 10-Ks of 1,135 banking companies filed during the period 1995–2015. We were able to match about 775 firms to our sample. We used the Adobe Acrobat XI Pro multiple-document search function to search for key words, using additional criteria for stemming and proximity of words to identify our variables of interest—loan risk rating, independent loan review, and chief risk officer. For example, to identify banks that use a risk rating system, we searched for the following sets of words "loan, risk, rating," "loan, risk, grading," "internal, risk, rating," etc., specifying that the words be within 20 words of each other. We downloaded the search results and manually read each result to assign a value of 1 if the bank had a loan risk rating system, and 0 otherwise.

2013). While the *CRO* is mainly tasked with the overall risk management function within a bank, loan monitoring is an important element in the risk management architecture in a bank. Thus, risk management and monitoring have to be in concert. Hence, we expect banks with high *MRSE1* and *MRSE2* to have a higher incidence of *CRO*.

Descriptive Statistics

Panel A of Table 1 provides descriptive statistics for the key variables used in the study for all banks, as well as public and private banks separately. We winsorize the data at 1 percent from both the tails to minimize the effect of outliers. The average bank in our sample has an asset base of \$16 billion (median \$1 billion). The mean (median) equity capital to total assets ratio (*AVGCAP*) is 9.2 percent (8.8 percent), and the deposits to total assets ratio (*DEP*) is 77 percent (80 percent). Loans, on average, are 65 percent of the total assets, with commercial loans being 11 percent of total assets. We also provide the distribution of other key variables in the panel. Unreported test statistics indicate that public banks in our sample are significantly larger and are statistically different on almost all characteristics, consistent with the notion that differences in ownership structure and access to capital markets cause public and private banks to be different. Given that Berger and Bouwman (2009, 2013) show that the impact of capital structure on liquidity and survival probability is related to bank size, we divide our sample into four groups—small, medium, large, and very large—with total assets cutoffs of more than or equal to \$500 million, but less than \$1 billion; equal to or more than \$1 billion and less than \$3 billion; equal to or more than \$3 billion and less than \$10 billion; and equal to or more than \$10 billion, respectively. The size classifications are based on real 2006Q1 dollars using the implicit GDP price deflator. The descriptive statistics are provided separately based on size in Panel B of Table 1. The mean equity capital to total assets ratio (*AVGCAP*) does not vary much between the four size groups. However, given the alternate sources of financing available to larger banks, the mean deposits to total assets ratio is 81 percent (78 percent) for small (medium) banks, and 74 percent (64 percent) for large (very large) banks. Loans, on average, are 67 percent of the total assets for small banks, but decrease monotonically, and are 61 percent for the very large banks. The ratio of commercial loans to total assets increases monotonically, with the ratio being 11 percent for the small banks and 14 percent for the very large banks.

IV. BANK CAPITAL AND LOAN QUALITY

The results of our main analysis are presented in Panel A of Table 2. Since lower values of *NPL* and *NCO* indicate higher loan quality, to facilitate the interpretation of the coefficient, we multiply *NPL* and *NCO* by -1 to obtain our dependent variables *LQ1* and *LQ2*, respectively. All regressions include bank fixed effects and quarter dummies to control for average differences over time across banks and average differences in loan quality across quarters that are not captured by other exogenous variables. All regressions are estimated with robust standard errors, clustered by the bank, to control for heteroscedasticity, as well as possible correlation among observations of the same bank in different years.

The first two columns of Table 2, Panel A present the results for all banks in our sample. Our main variable of interest, *AVGCAP*, is positively and significantly (at the 1 percent level) associated with both measures of loan quality. In terms of economic significance, a one-standard-deviation increase in *AVGCAP* (0.028) is associated with a decrease of 0.003 ($0.028 * 0.106$) in *NPL* and a decrease of 0.0003 ($0.028 * 0.009$) in *NCO*, respectively. Looking at the average values of these measures, it translates to a decrease of 17 percent in *NPL* and a decrease of 25 percent in *NCO*, respectively.

Turning to control variables in Table 2, Panel A, the coefficient on *LG* is positive and significant (at the 1 percent level) in both the regression specifications, consistent with the idea that quality issues become more apparent as the loans season. The coefficient on *SIZE* is negative and significant (at the 1 percent level) for *LQ2*, suggesting that larger banks have higher net charge-offs.[12] The coefficients on portfolio composition measure (*COMM*) and liquidity risk (*LIQUID*) are insignificant. *ABSGAP* is positively and significantly associated with *LQ1* and *LQ2*. The above results suggest that there is a strong positive association between bank capital and loan quality, our proxy for the *ex post* outcome of monitoring effort, consistent with H1a.

Public versus Private Banks

Next, we explore whether the association between bank capital and loan quality is different for public versus private banks to alleviate the concern that our main results are driven by the nature of the ownership of bank capital. Public banks differ from private banks on a couple of important dimensions. First, private banks are more likely to be closely held by a smaller number of shareholders, with owner-managers and directors more likely to be majority equity holders (Brickley, Linck, and Smith

[12] Purnanandam (2011) also finds a positive and significant association between size and charge offs for mortgage loans.

TABLE 1
Descriptive Statistics

Panel A: Summary Statistics

	All				Public				Private			
	n	Mean	Median	Std. Dev.	n	Mean	Median	Std. Dev.	n	Mean	Median	Std. Dev.
Capital Structure												
AVGCAP	56,580	0.092	0.088	0.028	26,153	0.093	0.089	0.026	30,427	0.091	0.087	0.030
REGCAP	56,580	0.093	0.106	0.068	26,153	0.087	0.104	0.066	30,427	0.099	0.109	0.070
DEP	56,580	0.769	0.797	0.123	26,153	0.749	0.775	0.120	30,427	0.785	0.815	0.123
UNINSDEP	56,580	0.122	0.108	0.072	26,153	0.115	0.101	0.069	30,427	0.128	0.114	0.074
COREDEP	56,580	0.188	0.183	0.101	26,153	0.184	0.181	0.099	30,427	0.191	0.186	0.102
LOANS	56,580	0.653	0.671	0.131	26,153	0.653	0.670	0.128	30,427	0.652	0.671	0.134
RWA	56,580	0.648	0.706	0.236	26,153	0.662	0.714	0.227	30,427	0.636	0.699	0.244
Monitoring Proxies												
NPL	56,580	0.017	0.010	0.026	26,153	0.016	0.009	0.021	30,427	0.019	0.010	0.030
NCO	56,580	0.001	0.001	0.003	26,153	0.001	0.001	0.002	30,427	0.001	0.000	0.003
SALEXP	56,579	0.524	0.535	0.083	26,153	0.519	0.528	0.078	30,426	0.529	0.543	0.087
MRSE1	56,579	(0.008)	0.000	0.075	26,153	(0.007)	0.000	0.073	30,426	(0.008)	0.000	0.077
MRSE2	56,518	0.001	0.003	0.090	26,151	0.000	0.000	0.092	30,367	0.001	0.004	0.088
Control Variables												
LG	56,580	0.000	0.001	0.022	26,153	0.000	0.002	0.021	30,427	0.000	0.001	0.023
TA (in billions)	56,580	16.306	1.173	111.526	26,153	26.595	1.899	155.452	30,427	7.462	0.918	46.790
COMM	56,580	0.119	0.105	0.079	26,153	0.114	0.101	0.075	30,427	0.124	0.110	0.081
LIQUID	56,580	0.243	0.227	0.114	26,153	0.236	0.222	0.106	30,427	0.249	0.232	0.121
ABSGAP	56,580	0.165	0.135	0.130	26,153	0.159	0.132	0.125	30,427	0.170	0.140	0.135
Other Variables												
LFV	10,148	0.999	0.998	0.085	8,283	0.998	0.998	0.086	1,865	1.001	0.999	0.082
NCO_NPL	56,252	0.108	0.061	0.189	25,990	0.110	0.072	0.170	30,262	0.105	0.052	0.203
LRR	20,772	0.606	1.000	0.489	19,516	0.620	1.000	0.485	1,256	0.391	0.000	0.488
ILR	20,772	0.594	1.000	0.491	19,516	0.604	1.000	0.489	1,256	0.444	0.000	0.497
CRO	20,772	0.124	0.000	0.329	19,516	0.127	0.000	0.333	1,256	0.074	0.000	0.262
SENIORS	49,100	0.274	0.144	0.379	24,416	0.309	0.149	0.457	24,528	0.239	0.143	0.275

(continued on next page)

TABLE 1 (continued)

Panel B: Summary Statistics: Small, Medium, Large, and Very Large Banks

	Small $500M ≤ *TA* < $1B				Medium $1B ≤ *TA* < $3B				Large $3B ≤ *TA* < $10B				Very Large $10B ≤ *TA*			
	n	**Mean**	**Median**	**Std. Dev.**	**n**	**Mean**	**Median**	**Std. Dev.**	**n**	**Mean**	**Median**	**Std. Dev.**	**n**	**Mean**	**Median**	**Std. Dev.**
Capital Structure																
AVGCAP	24,566	0.091	0.088	0.030	17,913	0.093	0.088	0.042	7,347	0.099	0.091	0.056	6,754	0.094	0.088	0.039
REGCAP	24,566	0.103	0.113	0.065	17,913	0.094	0.107	0.069	7,347	0.083	0.099	0.072	6,754	0.067	0.082	0.063
DEP	24,566	0.805	0.820	0.080	17,913	0.782	0.803	0.102	7,347	0.740	0.765	0.126	6,754	0.635	0.676	0.185
UNINSDEP	24,566	0.133	0.120	0.070	17,913	0.129	0.114	0.074	7,347	0.111	0.095	0.073	6,754	0.077	0.063	0.058
COREDEP	24,566	0.211	0.207	0.097	17,913	0.190	0.186	0.097	7,347	0.169	0.161	0.099	6,754	0.116	0.102	0.088
LOANS	24,566	0.666	0.678	0.122	17,913	0.659	0.674	0.125	7,347	0.630	0.658	0.141	6,754	0.611	0.650	0.155
RWA	24,566	0.677	0.708	0.187	17,913	0.662	0.712	0.224	7,347	0.575	0.682	0.289	6,754	0.588	0.710	0.321
Monitoring Proxies																
NPL	24,566	0.017	0.010	0.024	17,913	0.017	0.009	0.031	7,347	0.017	0.009	0.025	6,754	0.017	0.010	0.019
NCO	24,566	0.001	0.000	0.003	17,913	0.001	0.001	0.003	7,347	0.001	0.001	0.003	6,754	0.002	0.001	0.003
SALEXP	24,566	0.539	0.545	0.073	17,913	0.527	0.537	0.081	7,347	0.505	0.520	0.092	6,754	0.488	0.508	0.095
MRSE1	24,566	(0.005)	0.000	0.069	17,913	(0.008)	0.000	0.075	7,347	(0.010)	0.000	0.083	6,754	(0.013)	0.000	0.086
MRSE2	24,560	0.001	0.003	0.066	17,911	0.001	0.002	0.079	7,326	(0.001)	(0.002)	0.120	6,721	0.002	0.006	0.141
Control Variables																
LG	24,566	0.001	0.001	0.023	17,913	0.000	0.001	0.023	7,347	0.001	0.002	0.022	6,754	(0.000)	0.001	0.021
TA (in billions)	24,566	0.726	0.700	0.165	17,913	1.689	1.533	0.786	7,347	5.446	5.049	2.037	6,754	123.556	31.525	301.863
COMM	24,566	0.114	0.099	0.075	17,913	0.117	0.101	0.079	7,347	0.124	0.111	0.084	6,754	0.138	0.137	0.083
LIQUID	24,566	0.246	0.234	0.113	17,913	0.243	0.228	0.114	7,347	0.248	0.228	0.120	6,754	0.227	0.206	0.114
ABSGAP	24,566	0.150	0.121	0.123	17,913	0.155	0.125	0.127	7,347	0.178	0.150	0.134	6,754	0.232	0.225	0.140
Other Variables																
LFV	3,404	1.004	1.000	0.075	3,597	0.998	1.000	0.082	1,692	1.011	1.001	0.093	1,455	0.975	0.984	0.101
NCO_NPL	24,403	0.099	0.047	0.202	17,803	0.103	0.059	0.180	7,316	0.109	0.072	0.174	6,730	0.148	0.109	0.173
LRR	5,801	0.515	1.000	0.500	7,623	0.586	1.000	0.493	3,984	0.689	1.000	0.463	3,364	0.710	1.000	0.454
ILR	5,801	0.577	1.000	0.494	7,623	0.609	1.000	0.488	3,984	0.654	1.000	0.476	3,364	0.520	1.000	0.500
CRO	5,801	0.037	0.000	0.190	7,623	0.071	0.000	0.256	3,984	0.159	0.000	0.366	3,364	0.350	0.000	0.477
SENIORS	22,878	0.208	0.144	0.190	15,922	0.260	0.141	0.313	5,649	0.399	0.152	0.525	4,651	0.496	0.194	0.760

Panel A of this table reports the mean, median, and standard deviation for the primary variables used in this study for all banks, public banks, and private banks. Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. The banks are identified as public banks based on the CRSP-FRB link file available from the New York Federal Reserve website. Panel B reports the descriptive statistics for small ($500 million ≤ *TA* < $1 billion), medium ($1 billion ≤ *TA* < $3 billion), large banks ($3 billion ≤ *TA* < $10 billion), and very large banks ($10 billion ≤ *TA*). The banks are classified into the size categories based on real 2006Q1 dollars using the implicit GDP price deflator.

The variables are defined in Appendix A.

TABLE 2

Capital and Outcome-Based Measures of Monitoring

Panel A: Association between Bank Capital and Loan Quality

	All		**Public Versus Private**		**High versus Low Relationship Loans**	
Variables	***$LQ1_t$*** **(1)**	***$LQ2_t$*** **(2)**	***$LQ1_t$*** **(3)**	***$LQ2_t$*** **(4)**	***$LQ1_t$*** **(5)**	***$LQ2_t$*** **(6)**
$AVGCAP_{t-1}$	0.106***	0.009***	0.102***	0.007***	0.063***	0.007***
	(6.016)	(5.015)	(4.434)	(3.018)	(3.907)	(3.915)
$AVGCAP_{t-1} * D_{t-1}$			0.014	0.004	0.174***	0.006*
			(0.441)	(1.336)	(5.003)	(1.899)
Controls						
LG_{t-1}	0.031***	0.004***	0.032***	0.003***	0.022***	0.003***
	(7.457)	(6.895)	(5.746)	(4.440)	(5.784)	(5.515)
$SIZE_{t-1}$	0.001	−0.000**	0.002*	−0.000	0.001	−0.000**
	(0.838)	(−2.466)	(1.890)	(−1.496)	(0.960)	(−2.381)
$COMM_{t-1}$	0.006	−0.000	0.012	0.000	0.003	0.000
	(0.707)	(−0.151)	(1.352)	(0.008)	(0.380)	(0.054)
$LIQUID_{t-1}$	−0.002	0.000	−0.004	−0.000	0.000	0.000
	(−0.487)	(0.778)	(−0.683)	(−0.159)	(0.059)	(1.214)
$ABSGAP_{t-1}$	0.004*	0.001***	0.006*	0.000	0.001	0.000
	(1.931)	(2.661)	(1.789)	(1.516)	(0.701)	(1.500)
$LG_{t-1} * D_{t-1}$			−0.001	0.001	0.038***	0.003**
			(−0.114)	(0.883)	(2.867)	(1.986)
$SIZE_{t-1} * D_{t-1}$			−0.002**	−0.000*	−0.004***	−0.000***
			(−2.525)	(−1.668)	(−3.085)	(−2.847)
$COMM_{t-1} * D_{t-1}$			−0.015	−0.000	0.007	−0.001
			(−1.233)	(−0.271)	(0.638)	(−0.798)
$LIQUID_{t-1} * D_{t-1}$			0.004	0.001	−0.021***	−0.002**
			(0.605)	(1.489)	(−3.097)	(−2.345)
$ABSGAP_{t-1} * D_{t-1}$			−0.003	0.000	0.009*	0.001
			(−0.764)	(0.529)	(1.807)	(1.510)
D_{t-1}			0.032***	0.001	0.038**	0.004**
			(2.745)	(1.268)	(2.004)	(2.223)
Constant	−0.033**	0.002	−0.052***	0.001	−0.028**	0.002*
	(−2.311)	(1.497)	(−3.352)	(0.765)	(−1.964)	(1.770)
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
n	56,580	56,580	56,580	56,580	56,580	56,580
Adj. R^2	0.355	0.217	0.357	0.217	0.377	0.224

(continued on next page)

2003; Nichols, Wahlen, and Wieland 2009) compared to the diffused ownership structure of public banks. Second, private banks are typically smaller in size compared to public banks, and prior work finds that the effect of bank capital on survival probability differs across firm size (Berger and Bouwman 2009, 2013). Moreover, even among the very large banks, the public banks seem to have a "too big to fail" guarantee, whereas private banks may not, and this implicit guarantee could potentially influence banks' monitoring incentives.

The results for public and private banks are presented in Columns (3)–(4) of Panel A of Table 2. The regression model includes a dummy variable, D, which takes the value 1 if a bank is publicly listed, and 0 otherwise, interacted with $AVGCAP$ and other control variables. The positive and significant coefficient on $AVGCAP$ in both the regressions suggests that bank capital is positively and significantly associated with both measures of loan quality for private banks. The insignificant coefficient on $AVGCAP * D$ shows that the association between bank capital and loan quality measures is not statistically

TABLE 2 (continued)

Panel B: Association between Bank Capital and Loan Quality by Bank Size

	Small $500M $\leq$ *TA* < $1B		Medium $1B $\leq$ *TA* < $3B		Large $3B $\leq$ *TA* < $10B		Very Large $10B $\leq$ *TA*	
Variables	$LQ1_t$ (1)	$LQ2_t$ (2)	$LQ1_t$ (3)	$LQ2_t$ (4)	$LQ1_t$ (5)	$LQ2_t$ (6)	$LQ1_t$ (7)	$LQ2_t$ (8)
$AVGCAP_{t-1}$	0.234***	0.018***	0.132***	0.012***	0.115*	0.013**	−0.015	−0.005
	(7.495)	(5.483)	(4.880)	(3.512)	(1.918)	(2.541)	(−0.568)	(−1.547)
Controls								
LG_{t-1}	0.035***	0.004***	0.031***	0.003***	0.023	0.003**	0.003	0.003**
	(6.942)	(4.696)	(5.113)	(3.185)	(1.487)	(2.166)	(0.298)	(2.320)
$SIZE_{t-1}$	0.012***	0.000	−0.002	−0.001***	0.002	−0.000	0.001	0.000
	(4.140)	(0.583)	(−0.776)	(−3.029)	(0.550)	(−1.018)	(0.568)	(1.553)
$COMM_{t-1}$	−0.003	−0.001	0.025*	−0.000	−0.004	0.000	0.013	0.001
	(−0.206)	(−0.989)	(1.784)	(−0.124)	(−0.158)	(0.145)	(0.911)	(0.307)
$LIQUID_{t-1}$	−0.007	0.000	0.001	0.001	−0.010	0.000	0.005	0.001*
	(−1.380)	(0.218)	(0.183)	(0.928)	(−0.854)	(0.343)	(0.410)	(1.671)
$ABSGAP_{t-1}$	0.004	0.001**	0.008**	0.001**	0.010	0.001	0.003	0.000
	(1.191)	(2.398)	(2.294)	(2.115)	(1.261)	(1.199)	(0.471)	(0.615)
Constant	−0.176***	−0.004	0.003	0.008**	−0.053	0.003	−0.034	−0.005*
	(−4.779)	(−1.103)	(0.083)	(2.533)	(−0.883)	(0.647)	(−0.911)	(−1.795)
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	24,566	24,566	17,913	17,913	7,347	7,347	6,754	6,754
Adj. R^2	0.346	0.171	0.347	0.215	0.396	0.279	0.508	0.394

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.
Panel A of this table reports the results of the fixed effects regression of loan quality measures (*LQ1* [−*NPL*] and *LQ2* [−*NCO*]) on average bank capital, controlling for loan growth, bank size, loan composition, liquidity risk, and absolute value of one-year maturity gap for all the banks in the sample period 1995Q1–2014Q4 in Columns (1)–(2), for public versus private banks in Columns (3)–(4), and for banks with high versus low relationship lending in Columns (5)–(6), respectively. *D* is a dummy variable that takes the value 1 in Columns (3)–(4) (Columns (5)–(6)) if the bank is a public bank (is in the top quartile of the sample based on relationship loans), and 0 otherwise. Panel B of this table reports the results of the fixed effects regression for small, medium, large, and very large banks in Columns (1)–(2), Columns (3)–(4), Columns (5)–(6), and Columns (7)–(8), respectively. Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. The banks are identified as public banks based on the CRSP-FRB link file available from the New York Federal Reserve website. The banks are classified as small ($500 million $\leq$ *TA* < $1 billion), medium ($1 billion $\leq$ *TA* < $3 billion), large ($3 billion $\leq$ *TA* < $10 billion), and very large banks (*TA* $\leq$ $10 billion) based on real 2006Q1 dollars using the implicit GDP price deflator. t-statistics are in parentheses. All standard errors are robust, clustered by the bank.
Variables are defined in Appendix A.

different between public and private banks. This suggests that the positive association between capital and monitoring does not appear to be affected by the ownership structure of banks.

Relationship Lending and Association between Bank Capital and Loan Quality

To further validate the association between bank capital and loan quality (effectiveness of monitoring effort), we identify a situation where the role of monitoring is expected to be more important and test whether, in such an instance, the relation between capital and loan quality is stronger. Prior literature suggests that banks that invest more in monitoring their relationship with borrowers earn higher rents (Boot and Thakor 2000; Allen et al. 2011; Mehran and Thakor 2011). Greater monitoring in a relationship loan often involves providing more advisory services of value to the borrower (e.g., cash management, business planning, investing, etc.) and higher involvement in the business, in addition to more intensely monitoring the borrower's financial ratios and compliance with loan covenants. The lending bank, thus, develops a deeper relationship and can charge more in fees and earn higher rents. To identify banks that engage in a higher level of relationship lending, we use core deposits as a proxy. Banks finance informationally opaque relationship loans with core deposits, as core deposits are sluggish because banks also provide transaction and advisory services to these depositors (Song and Thakor 2007). Empirical evidence is consistent with the prediction that banks finance relationship loans with core deposits (Berlin and Mester 1999). Based on this insight, we use banks' funding mix as a proxy for the extent of banks' relationship lending, and expect the relationship between bank capital and loan quality (outcome of monitoring) to be stronger for banks with a higher proportion of core deposits (a proxy for relationship lending).

In Columns (5) and (6) of Table 2, Panel A, the dummy variable, *D,* takes the value 1 if the bank's ratio of core deposits to total assets is in the top quartile for the quarter, and 0 otherwise. We interact *AVGCAP* with *D* and other control variables. Consistent with our intuition, we find that the positive association between bank capital and loan quality is stronger for banks with higher core deposits, as evidenced by the positive and significant coefficient on the interaction between *AVGCAP* and *D* for *LQ1* (at the 1 percent level) and for *LQ2* (at the 10 percent level).

Association between Bank Capital and Loan Quality by Bank Size

Next, we investigate whether the positive association between bank capital and loan quality differs by bank size. We expect monitoring to be more critical for smaller banks than for larger banks as smaller banks engage in more relationship lending (Berger et al. 2005). Moreover, smaller banks deal with more entrepreneurial-type businesses where monitoring is more important. Smaller banks also can closely monitor their borrowers, and their organization structures enable them to effectively use their informational advantage that arises from the long history of lending and access to confidential information due to geographical proximity (Nakamura 1994). For example, banks use borrower-specific skills while monitoring, as referred to in Diamond and Rajan (2000, 2001), which is more in line with relationship lending at smaller banks. Moreover, smaller banks are less likely to be bailed out, and hence higher capital is likely more important in increasing their survival probability. Thus, we would expect capital to have a stronger effect in strengthening monitoring incentives for smaller banks, and hence the positive association between bank capital and loan quality is expected to be stronger for smaller banks relative to larger banks.

We divide our sample into four groups—small, medium, large, and very large—based on total assets using 2006Q1 dollars. Results are presented in Panel B of Table 2. Columns (1)–(2), (3)–(4), (5)–(6), and (7)–(8) present the results for small, medium, large, and very large banks, respectively. The coefficient on *AVGCAP* is positive and significant at the 1 percent level for both the measures of loan quality for small and medium banks. The coefficient on the *AVGCAP* is positive and significant (at the 10 percent level or better) for both the measures for large banks, and insignificant for the very large banks. Unreported regressions using interaction variables for the very large banks show that the association between *AVGCAP* and loan quality is statistically stronger at the 1 percent level for *LQ1* and *LQ2* for small, medium, and large banks relative to the very large banks. Overall, the results suggest that the impact of bank capital on loan quality is stronger for smaller banks relative to larger banks.[13] One plausible interpretation of this evidence could be that the trade-offs of benefits and costs of higher capital differ by size. Also, large banks have fewer relationship loans and a geographically dispersed and diversified loan portfolio, which may contribute to their underinvestment in monitoring effort.[14]

V. BANK CAPITAL AND MONITORING-RELATED SALARY EXPENSE

While our results show a positive association between bank capital and loan quality, an outcome of the monitoring effort, theory predicts an association between bank capital and monitoring effort. Thus, we now turn to establishing the relationship between *ex ante* investment in monitoring and capital. It seems reasonable to argue that banks that have stronger monitoring incentives would have a greater investment in monitoring effort, which results in better loan quality, *ceteris paribus*. Thus, we examine the association between bank capital and two proxies intended to capture the quality and quantity of labor input into monitoring effort. As explained earlier, *MRSE1* is the median-adjusted ratio of salary expense to total non-interest expense (*SALEXP*), and *MRSE2* is based on fixed effect regressions that control for the effect of non-monitoring factors on salary expense. The results of the fixed effects regression of *MRSE1* and *MRSE2* on bank capital and control variables for all banks are presented in the first two columns of Panel A of Table 3. The results show that the coefficient on *AVGCAP* is positive and significant for *MRSE1* and *MRSE2* at the 5 percent level, suggesting that, on average, bank capital is positively associated with monitoring-related salary expense for our sample banks, consistent with H1b. Results relating to public versus private banks, reported in Columns (3)–(4) of Panel A, show that the positive association between bank capital and monitoring-related salary expense measures is not sensitive to whether the bank is publicly listed or private.

[13] Our results are also robust to excluding the top money center banks (large commercial banks in major cities) and banks above $10 billion in assets.

[14] We further explore the association between bank capital and loan quality conditional on the level of relationship loans for each of the four size groups. We find that the positive association between bank capital and loan quality is stronger for banks with higher core deposits, as evidenced by the positive and significant coefficient on the interaction between *AVGCAP* and *D* (dummy that captures high level of core deposits) for *LQ1* (at the 1 percent level) for small and medium-sized banks.

TABLE 3

Capital- and Input-Based Measures of Monitoring

Panel A: Association between Bank Capital- and Monitoring-Related Salary Expense Measures

	All		Public versus Private		High versus Low Relationship Loans	
	$MRSE1_t$	$MRSE2_t$	$MRSE1_t$	$MRSE2_t$	$MRSE1_t$	$MRSE2_t$
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$AVGCAP_{t-1}$	0.148**	0.148**	0.145*	0.150*	0.065	0.089
	(2.380)	(2.299)	(1.706)	(1.654)	(1.010)	(1.314)
$AVGCAP_{t-1} * D_{t-1}$			0.014	−0.006	0.331***	0.250***
			(0.147)	(−0.049)	(3.809)	(2.735)
Controls						
LG_{t-1}	0.056***	0.040**	0.052***	0.037*	0.031**	0.038**
	(4.575)	(2.344)	(3.327)	(1.668)	(2.416)	(2.027)
$SIZE_{t-1}$	0.001	0.005	0.003	0.007	0.001	0.005
	(0.257)	(1.142)	(0.579)	(1.472)	(0.335)	(1.166)
$COMM_{t-1}$	0.000	0.086***	0.004	0.078**	0.001	0.086***
	(0.014)	(2.880)	(0.116)	(2.013)	(0.022)	(2.934)
$LIQUID_{t-1}$	−0.012	−0.032**	−0.014	−0.025	−0.006	−0.025**
	(−1.116)	(−2.560)	(−1.008)	(−1.565)	(−0.561)	(−2.028)
$ABSGAP_{t-1}$	0.017**	0.018**	0.025**	0.023**	0.017**	0.020**
	(2.389)	(2.295)	(2.471)	(1.991)	(2.138)	(2.199)
$LG_{t-1} * D_{t-1}$			0.013	0.012	0.105***	−0.003
			(0.488)	(0.340)	(3.115)	(−0.063)
$SIZE_{t-1} * D_{t-1}$			−0.003	−0.003	−0.006**	−0.002
			(−0.756)	(−0.704)	(−2.175)	(−0.596)
$COMM_{t-1} * D_{t-1}$			−0.008	0.020	−0.012	−0.008
			(−0.181)	(0.391)	(−0.380)	(−0.250)
$LIQUID_{t-1} * D_{t-1}$			0.005	−0.016	−0.050**	−0.045**
			(0.270)	(−0.790)	(−2.542)	(−2.190)
$ABSGAP_{t-1} * D_{t-1}$			−0.017	−0.010	−0.008	−0.012
			(−1.216)	(−0.612)	(−0.578)	(−0.795)
D_{t-1}			0.057	0.058	0.060	0.015
			(0.985)	(0.894)	(1.430)	(0.294)
Constant	−0.018	−0.077	−0.048	−0.109*	−0.013	−0.073
	(−0.332)	(−1.399)	(−0.715)	(−1.752)	(−0.238)	(−1.331)
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
n	56,579	56,518	56,579	56,518	56,579	56,518
Adj. R^2	0.009	0.003	0.010	0.004	0.016	0.005

(continued on next page)

Relationship Lending, Bank Capital, and Monitoring-Related Salary Expense

We perform an analysis analogous to the analysis presented in Columns (5) and (6) of Table 2, Panel A to test the association between bank capital and monitoring-related salary expense measures conditional on the level of relationship loans. We interact *AVGCAP* with *D,* a dummy variable that takes the value 1 if the bank's ratio of core deposits to total assets is in the top quartile for the quarter, and 0 otherwise. The results reported in Columns (5) and (6) of Panel A of Table 3 show that the positive association between bank capital and monitoring effort is stronger for banks with higher core deposits, as evidenced by the positive and significant coefficients on the interaction between *AVGCAP* and *D* for *MRSE1* and *MRSE2* at the 1 percent level.

Association between Bank Capital and Monitoring-Related Salary Expense by Bank Size

We report results based on the four size groups in Panel B of Table 3. Columns (1)–(2), (3)–(4), (5)–(6), and (7)–(8) present the results for small, medium, large, and very large banks, respectively. We find that the association between bank

TABLE 3 (continued)

Panel B: Association between Bank Capital and Monitoring Related Salary Expense Measures by Bank Size

	Small $\$500M \leq TA < \$1B$		Medium $\$1B \leq TA < \$3B$		Large $\$3B \leq TA < \$10B$		Very Large $\$10B \leq TA$	
Variables	$MRSE1_t$ (1)	$MRSE2_t$ (2)	$MRSE1_t$ (3)	$MRSE2_t$ (4)	$MRSE1_t$ (5)	$MRSE2_t$ (6)	$MRSE1_t$ (7)	$MRSE2_t$ (8)
$AVGCAP_{t-1}$	0.455***	0.287***	0.238*	0.249*	−0.072	−0.196	−0.352***	−0.209
	(4.938)	(3.136)	(1.933)	(1.821)	(−0.508)	(−1.190)	(−2.733)	(−1.088)
Controls								
LG_{t-1}	0.083***	0.047***	0.050**	0.029	−0.004	0.007	0.074**	0.080
	(4.889)	(2.916)	(2.401)	(1.240)	(−0.108)	(0.080)	(1.971)	(0.962)
$SIZE_{t-1}$	0.024***	0.032***	−0.002	0.015*	0.002	−0.010	−0.004	0.026
	(3.207)	(4.131)	(−0.239)	(1.910)	(0.239)	(−0.648)	(−0.398)	(1.535)
$COMM_{t-1}$	−0.056*	−0.001	0.043	0.064	−0.023	0.052	0.085	0.311***
	(−1.761)	(−0.023)	(0.824)	(1.036)	(−0.332)	(0.620)	(0.976)	(2.778)
$LIQUID_{t-1}$	−0.017	−0.011	−0.012	−0.017	−0.016	0.026	0.028	−0.133**
	(−1.081)	(−0.719)	(−0.686)	(−0.878)	(−0.660)	(0.588)	(0.728)	(−2.316)
$ABSGAP_{t-1}$	0.014	0.014	0.031***	0.006	0.026	0.055**	−0.021	0.009
	(1.540)	(1.540)	(2.914)	(0.475)	(1.418)	(2.283)	(−0.850)	(0.207)
Constant	−0.335***	−0.439***	0.016	−0.226**	0.001	0.132	0.093	−0.429
	(−3.436)	(−4.382)	(0.159)	(−2.090)	(0.005)	(0.602)	(0.518)	(−1.550)
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	24,566	24,560	17,912	17,911	7,347	7,326	6,754	6,721
Adj. R^2	0.021	0.010	0.018	0.004	0.041	-0.003	0.017	0.012

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.
Panel A of this table reports the results of the fixed effects regression of monitoring-related salary expense measures (*MRSE1* and *MRSE2*) on average bank capital, controlling for loan growth, bank size, loan composition, liquidity risk, and absolute value of one-year maturity gap for all the banks in the sample period 1995Q1–2014Q4 in Columns (1)–(2), for public versus private banks in Columns (3)–(4), and for banks with high versus low relationship lending in Columns (5)–(6), respectively. *D* is a dummy variable that takes the value 1 in Columns (3)–(4) (Columns (5)–(6)) if the bank is a public bank (is in the top quartile of the sample based on relationship loans), and 0 otherwise. Panel B of this table reports the results of the fixed effects regression for small, medium, large, and very large banks in Columns (1)–(2), Columns (3)–(4), Columns (5)–(6), and Columns (7)–(8), respectively. Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. The banks are identified as public banks based on the CRSP-FRB link file available from the New York Federal Reserve website. The banks are classified as small (\$500 million $\leq TA <$ \$1 billion), medium (\$1 billion $\leq TA <$ \$3 billion), large (\$3 billion $\leq TA <$ \$10 billion), and very large banks ($TA \leq$ \$10 billion) based on real 2006Q1 dollars using the implicit GDP price deflator. t-statistics are in parentheses. All standard errors are robust, clustered by the bank.
Variables are defined in Appendix A.

capital and monitoring effort is positive and statistically significant for both *MRSE1* and *MRSE2* at the 1 percent level for small banks, and at the 10 percent level for medium banks. However, the association is insignificant for large banks for both *MRSE1* and *MRSE2* and the very large banks for *MRSE2*, and negative and significant for the very large banks for *MRSE1*, suggesting that the role of monitoring discussed in the theoretical models is more relevant for smaller banks than larger banks.[15] Perhaps this could be due to large banks having fewer relationship loans and a geographically dispersed and diversified loan portfolio, which may cause them to underinvest in monitoring effort and/or a different business model for large banks, which are less reliant on loans in general and relationship loans in particular (Berger et al. 2005).[16]

Overall, although the results in Table 3 confirm our hypothesis that the association between bank capital and monitoring effort is positive, and is stronger for banks that engage in more relationship lending, and for smaller banks, where the role of monitoring is more important.

[15] Exploratory analysis reveals that the coefficient on *AVGCAP* becomes insignificant for *MRSE1* when we exclude banks above \$50 billion from the *VLARGE* banks.

[16] Untabulated results of the association between bank capital and monitoring effort conditional on the level of relationship loans for the four size groups reveal that the positive association between bank capital and monitoring effort is stronger for banks with higher core deposits for small and medium banks. These results are consistent with our expectation that smaller banks engage in a higher level of relationship lending (Berger et al 2005).

Validation of Monitoring-Related Salary Expense Measures

We recognize that despite our best attempts to control for the effect of non-monitoring-related factors on salary expense, the resulting *MRSE1* and *MRSE2* capture monitoring effort with some noise. Hence, in this subsection, we offer some additional evidence. First, we check for correlations between our four proxies of monitoring—the two loan quality measures and the two monitoring-related salary-based measures. Pearson correlations are presented in the lower left triangle, and Spearman correlations are presented in the upper right triangle of Panel A of Table 4. The results show that all four measures are positively and significantly correlated at the 1 percent level with each other.[17]

Next, we use loan quality measures (*LQ1* and *LQ2*) and several additional measures, such as *NCO_NPL, LRR, ILR,* and *CRO* (described earlier in Section III), that we expect to be correlated with monitoring to validate *MRSE1* and *MRSE2* as proxies for monitoring. We do this exercise for the full sample and a subsample based on portfolio composition. Based on our readings of the 10-K filings, we expect banks to employ loan risk rating more commonly to the commercial and industrial loan portfolio. While banks may use statistical models in their rating process for consumer portfolios, banks generally seem to rely more on judgmental loan risk rating systems, especially for large commercial portfolios (Treacy and Carey 2000). Similarly, the presence of a CRO may also be positively correlated with a lending portfolio that comprises a higher proportion of commercial and industrial loans, given that commercial and industrial loans are inherently riskier. Similarly, *NCO_NPL* may be sensitive to the collateral, which differs by loan type. Untabulated results show statistically significant differences in *LRR* and *CRO* (but not for *NCO_NPL* and *ILR*) between banks that have a low commercial and industrial loan portfolio relative to banks that have a high commercial and industrial loan portfolio. Specifically, 58.4 percent (9.1 percent) of our bank observations in the low *COMM* subsample have an *LRR* system (*CRO*) relative to 63.0 percent (15.91 percent) of the bank observations in the high *COMM* subsample. Thus, we also validate *MRSE1* and *MRSE2* measures controlling for the portfolio composition by dividing the sample into two groups based on median values of *MRSE1* (*MRSE2*) for the full sample and a subsample with above-median *COMM*.

The results relating to *MRSE1* (*MRSE2*) are presented in the top (bottom) half of Panel B of Table 4. First, we discuss the results based on *MRSE1*. Columns (1) and (2) (Columns (4) and (5)) show the mean for each of these measures for the low (below-median) and high (above-median) groups for the full sample (subsample with high *COMM*). As one would expect, *LQ1* and *LQ2* are higher (*NPL* is 1.3 percent, and *NCO* is 0.1 percent) for banks with high *MRSE1* than for banks with low *MRSE1* (*NPL* is 2.0 percent, and *NCO* is 0.2 percent). For banks with high *MRSE1,* the net charge-offs as a percentage of lagged non-performing loans (9.6 percent) and the incidence of using independent loan reviews (58.3 percent) are lower relative to banks with low *MRSE1* (11.9 percent and 60.5 percent, respectively). The incidence of having a loan risk rating system is higher for banks with high *MRSE1* (60.5 percent) relative to banks with low *MRSE1* (58.3 percent). These differences are statistically significant, as reported in Column (3) of Panel B. However, the difference in *CRO* between the two groups is not significant. The summary statistics in Columns (4) and (5) and the difference in means in Column (6) show a similar pattern for a subsample of banks with a high proportion of commercial and industrial loans in their loan portfolio.

The results for the subsample partitioned on high (above-median) versus low (below-median) *MRSE2* are documented in the bottom half of the table. They show a similar pattern in differences between the groups at statistically significant levels in the expected direction for *LQ1, LQ2, NCO_NPL, LRR,* and *CRO*. In particular, 13.4 percent of banks with high *MRSE2* have a *CRO* relative to 11.4 percent of banks with low *MRSE2*. The results show a similar pattern for the subsample of banks with high *COMM*. In particular, 64.9 percent of banks with high *MRSE2* have *LRR* relative to 60.9 percent of banks with low *MRSE2*.

These results give us further confidence that our *MRSE1* and *MRSE2* measures capture monitoring efforts of banks.

VI. ADDRESSING ENDOGENEITY

An important empirical challenge for our paper is that bank capital is a choice variable, and hence the relation between capital, loan quality, and salary expense could be endogenous. We have made the following choices in our research design so far to mitigate endogeneity concerns. First, we have included controls for loan growth, bank size, portfolio composition, liquidity risk, and maturity gap in our regressions. Second, we use a bank fixed effect estimation model to mitigate endogeneity concerns arising from time-invariant omitted variables. Third, we conduct our analysis conditioned on situations where we would expect monitoring to play a significant role, such as smaller banks and banks with a higher level of relationship lending. While the conditional analysis may not address endogeneity directly, it does provide additional evidence in line with theory and our intuition. Despite our attempts, we understand that these tests may not fully address endogeneity. Therefore, we conduct additional tests to mitigate endogeneity concerns using (1) matched sample analysis, and (2) an instrumental variable approach.

[17] All our four measures, *LQ1, LQ2, MRSE1,* and *MRSE2,* are also positively and significantly correlated at the 1 percent level to the loan fair value measures that we use in subsequent analysis in Section VII.

TABLE 4

Validation of Input-Based Measures of Monitoring

Panel A: Correlations between the Outcome-Based and Input-Based Measures of Monitoring

	LQ1	*LQ2*	*MRSE1*	*MRSE2*
LQ1		0.587***	0.313***	0.169***
		[56,580]	[56,579]	[56,518]
LQ2	0.531***		0.197***	0.098***
	[56,580]		[56,579]	[56,518]
MRSE1	0.254***	0.249***		0.524***
	[56,579]	[56,579]		[56,518]
MRSE2	0.130***	0.094***	0.530***	
	[56,518]	[56,518]	[56,518]	

Panel B: Differences between Average Values for High- versus Low-Monitoring Subsamples

	All			Subsample of Banks with Commercial Loans Above Median		
Variables	**Low MRSE Mean (1)**	**High MRSE Mean (2)**	**Difference (3) = (2) − (1)**	**Low MRSE Mean (4)**	**High MRSE Mean (5)**	**Difference (6) = (5) − (4)**
MRSE1						
LOAN QUALITY						
n	28,748	27,831		14,380	13,888	
LQ1	(0.020)	(0.013)	0.007***	(0.018)	(0.013)	0.005***
LQ2	(0.002)	(0.001)	0.001***	(0.002)	(0.001)	0.001***
MAINTENANCE MONITORING						
n	28,656	27,595		14,352	13,815	
NCO_NPL	0.119	0.096	(0.022)***	0.117	0.099	(0.018)***
CREDIT RISK MANAGEMENT						
n	10,351	10,421		5,002	4,969	
LRR	0.596	0.616	0.019**	0.616	0.644	0.028**
ILR	0.605	0.583	(0.022)**	0.611	0.575	(0.036)***
CRO	0.126	0.122	(0.004)	0.162	0.156	(0.005)
LOAN QUALITY						
n	28,276	28,242		13,260	15,004	
LQ1	(0.019)	(0.014)	0.005***	(0.017)	(0.014)	0.003***
LQ2	(0.002)	(0.001)	0.000***	(0.002)	(0.001)	0.000***
MAINTENANCE MONITORING						
n	28,170	28,022		13,222	14,941	
NCO_NPL	0.112	0.102	(0.010)***	0.113	0.104	(0.009)***
CREDIT RISK MANAGEMENT						
n	10,521	10,251		4,776	5,195	
LRR	0.598	0.615	0.017*	0.609	0.649	0.040***
ILR	0.591	0.597	0.006	0.589	0.597	0.009
CRO	0.114	0.134	0.020***	0.139	0.177	0.038***

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Panel A includes the coefficients of correlations between the four proxies of monitoring—*LQ1, LQ2, MRSE1,* and *MRSE2*. Number of observations is included in parentheses. Panel B includes other measures that we expect to be reflective of monitoring, such as percentage of net charge-offs given the level of non-performing loans (*NCO_NPL*), use of loan risk rating system by the bank (*LRR*), use of independent loan review (*ILR*), existence of Chief Risk Officer (*CRO*), along with loan quality measures (*LQ1*) and (*LQ2*) for two subgroups based on the level of monitoring-related salary expense measure for all banks in our sample and for banks that fall in the top half based on commercial loans in the loan portfolio.

Matched Sample Analysis

Our goal is to create a matched sample of high- and low-capital banks that are similar on key observable characteristics other than bank capital. We divide sample banks into two groups (above- and below-median) based on bank capital (*AVGCAP*) every quarter. Our goal is to match every high-capital bank with a low-capital bank based on loan growth, bank size, portfolio composition, liquidity risk, and maturity gap within the same quarter. The summary statistics of the sample banks prior to matching, reported in Columns (1)–(3) of Panel A of Table 5, reveal significant differences across almost all dimensions. We use propensity score matching to match without replacement to find unique matching banks. We can match 22,916 high-capital bank observations with 22,916 low-capital bank observations. The summary statistics reported in Columns (4)–(6) of Panel A of Table 5 show that these two groups are well matched on all dimensions except size. Low-capital banks are slightly bigger than the high-capital banks at the 10 percent level. We conduct our tests on the matched sample and report the bank fixed effect estimation results in Columns (1)–(4) in Panel B of Table 5. The coefficient on *AVGCAP* is positive and significant at the 1 percent level for *LQ1, LQ2, MRSE1,* and *MRSE2*. Thus, even after conditioning our sample to banks that are comparable along several characteristics, we find that banks with high capital monitor more, consistent with the predictions of MT.

We acknowledge that our matching analysis does not rely on a clear source of exogenous variation for identification. However, matching avoids the functional form restrictions imposed by regression and can mitigate asymptotic biases arising from endogeneity. Our matching analysis, thus, provides a useful robustness test for our main analysis. Next, we move to a more direct approach to address endogeneity.

Instrumental Variable Approach

We need an instrument that is correlated with the bank capital (valid instrument), but that is not related directly to loan quality or the monitoring-related salary expense measures (exclusion restriction). Berger and Bouwman (2009, 2013) use *SENIORS,* the fraction of seniors (people aged 65 and over) in the markets in which a bank operates as an instrument for bank capital.[18] The rationale is that seniors tend to hold larger equity portfolios than the average family (Bucks, Kennickell, and Moore 2006), and since investors have a strong preference for investing closer to home (Coval and Moskowitz 1999), Berger and Bouwman (2009, 2013) argue that small and medium banks operating in markets with more seniors have easier access to equity financing, and hence will operate with higher equity capital ratios. *SENIORS* are unlikely to be an attractive instrument for large and very large banks as these banks are not restricted geographically when it comes to raising equity. Also, there is no compelling argument or theory that predicts an association between the percentage of seniors in the bank's market and loan quality measures or monitoring-related salary expense measures, suggesting that the exclusion restriction is also satisfied.

Thus, following Berger and Bouwman (2009, 2013), we use the county and the metropolitan statistical area (MSA) level population data in the 2000 and 2010 U.S. Censuses to calculate the fraction of seniors, and apply these fractions to bank quarters in our sample from 1995Q1 to 2004Q4 and 2005Q1 to 2014Q4, respectively. If a bank operates in multiple markets, then we use its share of deposits in each market as a percentage of its total deposits as weights to calculate the bank's deposit-weighted-average fraction of seniors. We use the data from the FDIC Summary of Deposits to compute the deposit market share of the bank. Our *SENIORS* instrument varies considerably in the cross-section, but not so over time as we have data from just two U.S. Censuses (2000 and 2010). Hence, while we include quarter dummies in our analyses, we do not include bank fixed effects.

Our prior tests show that the association between bank capital and loan quality (Panel B of Table 2) and bank capital and monitoring effort (Panel B of Table 3) is weaker/not significant for the large and very large banks. Hence, we focus our instrumental variable analyses on small and medium banks. Table 6 reports the results of our first-stage and second-stage regressions. We report the results of the first stage separately for each of the eight regressions, as the sample sizes differ slightly in each of these regressions.[19] The first (next) four columns report analysis for small (medium) banks. We instrument *AVGCAP* with the moving average of deposit-weighted *SENIORS* over the prior four quarters (*AVGSEN*). We find that the coefficient on *AVGSEN* is positive and statistically significant at the 1 percent level for all eight regressions, suggesting that *AVGSEN* has a positive and significant effect on bank capital for small and medium banks. The F-statistic for the first stage is significant at the 1 percent level for all eight regressions, suggesting that we do not have a weak instrument. For completeness, we show all

[18] Becker (2007) uses the fraction of seniors as an instrument for deposits of small banks based on Survey of Consumer Finances data that show that seniors also hold more deposits than the average family. However, Berger and Bouwman (2009) argue that the impact of age on deposits is dwarfed by the impact of age on equity holdings. Using data from the 2001 Survey of Consumer Finances, Berger and Bouwman (2009) report that the median value of transaction accounts plus CDs for families headed by seniors was \$13,400 (65–74 years old) and \$15,900 (75 years old and up) versus \$6000 for all families. In contrast, the median value of stock held by families headed by seniors was \$58,800 (65–74 years old) and \$41,000 (75 years old and up) versus \$17,900 for all families (Berger and Bouwman 2009).

[19] We include all the control variables from the second stage in the first stage.

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TABLE 5

Matched Sample Analysis

Panel A: Summary Statistics on Subsample Classified Based on Above- versus Below-Median Capital for All Banks and Matched Pairs

	All (n = 56,580)			Matched (n = 45,832)		
Variables	**Above-Median *AVGCAP* (1)**	**Below-Median *AVGCAP* (2)**	**Difference (3) = (2) − (1)**	**Above-Median *AVGCAP* (4)**	**Below-Median *AVGCAP* (5)**	**Difference (6) = (5) − (4)**
n	28,269	28,311		22,916	22,916	
$AVGCAP_{t-1}$	0.111	0.072	(0.039)***	0.111	0.072	(0.038)***
LG_{t-1}	0.001	0.000	(0.001)**	0.000	0.000	0.000
$SIZE_{t-1}$	14.474	14.409	(0.064)***	14.376	14.405	0.029*
$COMM_{t-1}$	0.118	0.121	0.003***	0.118	0.118	(0.000)
$LIQUID_{t-1}$	0.243	0.243	0.000	0.245	0.243	(0.001)
$ABSGAP_{t-1}$	0.164	0.166	0.002*	0.164	0.163	(0.001)

Panel B: Matched Sample Analysis Based on Above- and Below-Median Capital

Variables	**$LQ1_t$ (1)**	**$LQ2_t$ (2)**	**$MRSE1_t$ (3)**	**$MRSE2_t$ (4)**
$AVGCAP_{t-1}$	0.114***	0.010***	0.183***	0.186***
	(6.300)	(5.223)	(2.723)	(2.780)
LG_{t-1}	0.034***	0.004***	0.057***	0.032*
	(7.788)	(6.403)	(4.031)	(1.744)
$SIZE_{t-1}$	0.001	−0.000**	0.000	0.003
	(0.615)	(−2.441)	(0.093)	(0.794)
$COMM_{t-1}$	0.006	−0.000	0.001	0.076**
	(0.777)	(−0.158)	(0.024)	(2.478)
$LIQUID_{t-1}$	−0.001	0.000	−0.017	−0.030**
	(−0.246)	(0.494)	(−1.459)	(−2.428)
$ABSGAP_{t-1}$	0.005**	0.001**	0.018**	0.018**
	(2.145)	(2.538)	(2.402)	(2.189)
Constant	−0.031**	0.002	−0.012	−0.063
	(−2.106)	(1.480)	(−0.231)	(−1.099)
Quarter Dummies	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
n	45,832	45,832	45,832	45,832
Adj. R^2	0.360	0.217	0.012	0.006

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.
This table includes the results of the matched sample analysis. We divide the bank quarter observations into two groups based on the median level of bank capital each quarter. We then proceed to create a matched pair sample for the entire time period (1995Q1–2014Q4). Panel A includes the descriptive statistics on key variables used in matching for all the banks and for the matched sample. Panel B includes the results of the fixed effects regression of loan quality measures (*LQ1* and *LQ2*) and monitoring-related salary expense measures (*MRSE1* and *MRSE2*) on average bank capital, controlling for loan growth, bank size, loan composition, liquidity risk, and the absolute value of one-year maturity gap for the matched sample. Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. t-statistics are in parentheses. All standard errors are robust, clustered by the bank.
Variables are defined in Appendix A.

results, but the Wu-Hausman F-statistic for endogeneity is not significant for *LQ1* for small banks, and for *LQ1* and *MRSE1* for medium banks. Hence, we cannot reject the null that bank capital is exogenous, suggesting that our original analyses exploring the relation between *LQ1* and bank capital (*LQ1, MRSE1,* and bank capital) are more appropriate for the small (medium) banks. The Wu-Hausman F-statistic for endogeneity is significant at the 5 percent level or better for the rest of the five regressions

TABLE 6

Addressing Endogeneity using Instrumental Variable Regressions

	Small $500M ≤ TA < $1B				Medium $1B ≤ TA < $3B			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
For Both Stages								
n	22,821	22,821	22,821	22,819	15,874	15,874	15,873	15,873
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Key Variables in the First Stage								
Dependent Variable	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$	$AVGCAP_{t-1}$
$AVGSEN_{t-1}$	0.004***	0.004***	0.004***	0.004***	0.013***	0.013***	0.013***	0.013***
	(4.466)	(4.466)	(4.466)	(4.522)	(17.89)	(17.89)	(17.89)	(17.89)
F-statistic	19.947***	19.947***	19.947***	20.453***	320.174***	320.174***	320.225***	320.225***
R^2	0.043	0.043	0.043	0.043	0.057	0.057	0.057	0.057
Key Variables in the Second Stage								
Dependent Variable	$LQ1_t$	$LQ2_t$	$MRSE1_t$	$MRSE2_t$	$LQ1_t$	$LQ2_t$	$MRSE1_t$	$MRSE2_t$
$AVGCAP_{t-1}$ (instrumented)	−0.161	0.056**	1.742**	1.331**	0.005	0.013**	0.317**	0.406**
	(−0.948)	(2.386)	(2.557)	(2.110)	(0.117)	(2.545)	(2.067)	(2.492)
Wu-Hausman F-statistic	1.955	6.627**	6.438**	4.893**	0.583	6.674***	1.142	4.096**

, * Levels of significance are denoted $p < 0.05$ and $p < 0.01$, respectively.

This table reports the results of the instrumental variable analysis. Bank capital is instrumented using *SENIORS*, the fraction of seniors calculated using county- and MSA-level population data from the 2000 and 2010 Census weighted by the deposit market share of the bank at county and MSA level. First-stage regression results show the coefficients on the instrument, *AVGSEN* (average deposit-weighted *SENIORS* over prior four quarters), and the second-stage regression results show the coefficient on instrumented *AVGCAP* in the regression of loan quality (*LQ1* and *LQ2*) and monitoring-related salary expense (*MRSE1* and *MRSE2*) on instrumented bank capital in Columns (1)–(4) and Columns (5)–(8) for small and medium banks, respectively. The banks are classified as small (TA $500 million ≤ TA < $1 billion) and medium (TA $1 billion ≤ TA < $3 billion) based on real 2006Q1 dollars using the implicit GDP price deflator.

using *LQ2, MRSE1,* and *MRSE2* as the dependent variables for small banks and *LQ2* and *MRSE2* as the dependent variables for medium banks, suggesting that we can reject the null that bank capital is exogenous. Hence, we focus our attention on these regressions. The effect of instrumented bank capital on monitoring effort is positive and significant for all five regressions (at the 5 percent level or better). Thus, the results of the instrumental variable analyses for small and medium banks validate our primary findings that bank capital and monitoring effort are positively related.

The evidence from our matching sample analysis and instrumental variable approach mitigate concerns relating to endogeneity and further validate our main findings of a positive association between bank capital and monitoring effort.

VII. ADDITIONAL ANALYSIS AND ROBUSTNESS CHECKS

We conduct a battery of additional tests to check whether our main result that bank capital is positively associated with monitoring effort is robust. The tests are discussed below.

Risk as an Alternative Explanation

It is possible that the positive association between bank capital and loan quality may be obtained due to underlying risk preferences of bank management. For example, bank managers may choose low capital (high leverage) and, at the same time, engage in risky loans. Alternatively, bank managers may be risk-averse and may choose high capital (low leverage) and engage in less risky loans. We control for credit risk, liquidity risk, and interest rate risk in our regressions, and our fixed effects estimation should control for time-invariant omitted variables.[20] To alleviate any residual concerns, we run additional tests conditioning on a measure of overall risk. Prior empirical evidence suggests that the risk-weighted ratio is the most effective predictor of failure over long time horizons (Estrella, Park, and Peristiani 2000). Hence, we use the proportion of risk-weighted assets to total assets as a measure of overall risk.[21] We classify banks in each quarter with risk-weighted assets (*RWA*) above-median (below-median) as banks with high (low) risk and repeat our main analysis. Results for the subsample with above-median *RWA* are reported in Columns (1)–(4) of Table 7. For completeness, we present the results for monitoring-related salary expense measures, as well. The coefficient on *AVGCAP* is positive and significant at the 1 percent level in all four columns, suggesting that the positive association between bank capital and monitoring effort holds in a subsample of banks exposed to high risk.

Alternative Measures of Bank Capital

Regulatory Capital

Our analysis uses the book value of equity as a proxy for bank capital. However, the regulators view bank capital in broader terms. Regulatory capital includes several adjustments to book value of equity relating to goodwill, intangible assets, and accumulated other comprehensive income (among other things) in the numerator (Tier 1 capital), and the inclusion of off-balance sheet items in the denominator (risk-weighted total assets). We have replicated our analysis using the average Tier 1 capital ratio (*AVGREGCAP*) of the bank over the prior four quarters to see whether the association between bank capital and monitoring effort is sensitive to this definition. Results are reported in Columns (5)–(8) of Table 7.[22] We find that the coefficient on *AVGREGCAP* is positive and significant at the 1 percent level for *LQ1, LQ2,* and *MRSE1,* and at the 5 percent level for *MRSE2,* suggesting that results are robust to the use of the Tier 1 ratio instead of the book value of equity.

Equity with Add-Back for Allowance for Loan Losses

We lag our bank capital as there is potentially a mechanical relationship between our loan quality measures and current bank capital. The lower the loan losses, the higher are our loan quality measures, and the higher is the bank capital (as loan losses reduce equity capital through provision for loan losses). Therefore, we add back allowance (cumulative effect of the provision for loan losses) to the current equity capital to mitigate this mechanical correlation. We rerun our loan quality regressions for the full sample and the matched sample using the average adjusted bank capital. The (untabulated) results show that our inference remains robust to this adjusted measure of bank capital.

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[20] Furthermore, our matched sample analysis should address this concern, as we match each high- and low-capital bank observation (above- and below-median capital) based on observable characteristics, including credit risk, liquidity risk, and interest rate risk.

[21] Riskier loans are bound to carry higher loan rates to compensate the banks for the higher risk. Hence, we use loan yields, measured as interest income divided by total loans, as our alternative measure of risk to partition the sample into high-risk versus low-risk banks. Results are robust to this alternate specification.

[22] The sample size is smaller as the Tier 1 ratio (or the data to compute the Tier 1 ratio) is available from 1996Q1.

TABLE 7

Additional Tests

	Banks with *RWA* Above Median				Alternative Definition of Capital = *REGULATORY CAPITAL*				Alternative Dependent Variable = *LOAN FAIR VALUES*	
Variables	$LQ1_t$ (1)	$LQ2_t$ (2)	$MRSE1_t$ (3)	$MRSE2_t$ (4)	$LQ1_t$ (5)	$LQ2_t$ (6)	$MRSE1_t$ (7)	$MRSE2_t$ (8)	LFV_t (9)	LFV_HTM_t (10)
$AVGCAP_{t-1}$	0.165***	0.013***	0.353***	0.372***					0.578***	0.615***
	(6.555)	(4.682)	(4.715)	(4.822)					(5.030)	(5.610)
$AVGREGCAP_{t-1}$					0.040***	0.005***	0.170***	0.092**		
					(2.915)	(4.300)	(4.694)	(2.194)		
LG_{t-1}	0.035***	0.004***	0.073***	0.021	0.029***	0.003***	0.050***	0.027	0.097**	0.087**
	(6.084)	(4.143)	(4.032)	(0.956)	(6.100)	(5.638)	(3.846)	(1.510)	(2.357)	(2.232)
$SIZE_{t-1}$	0.000	−0.000**	0.007	0.009	0.001	−0.000*	0.004	0.009*	−0.054***	−0.049***
	(0.201)	(−2.436)	(1.488)	(1.615)	(1.005)	(−1.680)	(0.970)	(1.893)	(−5.430)	(−5.298)
$COMM_{t-1}$	0.005	−0.001	−0.042	0.053	0.006	−0.000	−0.019	0.077**	−0.010	0.034
	(0.513)	(−1.380)	(−1.324)	(1.238)	(0.608)	(−0.256)	(−0.722)	(2.325)	(−0.127)	(0.432)
$LIQUID_{t-1}$	0.005	−0.001	0.013	−0.053**	−0.009*	−0.000	−0.029**	−0.043***	0.045	0.066***
	(1.002)	(−0.876)	(0.638)	(−2.212)	(−1.757)	(−1.314)	(−2.470)	(−3.162)	(1.601)	(2.703)
$ABSGAP_{t-1}$	0.005*	0.001*	0.025**	0.022**	0.006**	0.001***	0.019**	0.020**	0.003	−0.004
	(1.685)	(1.901)	(2.532)	(2.052)	(2.496)	(2.774)	(2.514)	(2.383)	(0.241)	(−0.302)
Constant	−0.031*	0.003	−0.129*	−0.146*	−0.032*	0.001	−0.070	−0.133**	1.713***	1.619***
	(−1.724)	(1.474)	(−1.821)	(−1.953)	(−1.749)	(0.813)	(−1.190)	(−2.100)	(11.615)	(11.849)
Quarter Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
n	26,950	26,950	26,950	26,945	48,730	48,730	48,729	48,723	8,740	8,740
Adj. R^2	0.403	0.253	0.027	0.013	0.358	0.222	0.011	0.004	0.092	0.107

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

This table includes the results of the additional tests and robustness checks discussed in Section VII. Columns (1)–(4) include the results of the fixed effects regression of loan quality measures (*LQ1* and *LQ2*) and monitoring-related salary expense measures (*MRSE1* and *MRSE2*) on average bank capital, controlling for loan growth, bank size, loan composition, liquidity risk, and absolute value of one-year maturity gap for the top half of the sample based on risk, measured as a percentage of risk-weighted assets for each quarter during the sample period 1995Q1–2014Q4. Risk-weighted assets (*RWA*) is measured as the percentage of risk-weighted assets deflated by total assets. Columns (5)–(8) include the results of the fixed effects regression of loan quality measures (*LQ1* and *LQ2*) and monitoring related salary expense measures (*MRSE1* and *MRSE2*) on *AVGREGCAP* (average tier one regulatory capital ratio), controlling for loan growth, bank size, loan composition, liquidity risk, and absolute value of one-year maturity gap for all banks during the sample period 1995Q1–2014Q4. Columns (9)–(10) report the results of the fixed effects regression of fair value of loans on average bank capital, controlling for loan growth, bank size, loan composition, liquidity risk, and the absolute value of one-year maturity gap for all the banks in the subsample period 2009Q2–2014Q4 for which quarterly fair values are available. *LFV* (*LFV_HTM*) is the fair value of all loans (fair value of held-to-maturity loans). Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. t-statistics are in parentheses. All standard errors are robust, clustered by the bank.

Variables are defined in Appendix A.

Alternative Dependent Variable—Fair Value of Loans

In our primary tests, we use loan quality as a proxy for the outcome of monitoring effort. However, theory predicts that an increase in monitoring would result in higher loan values, and hence MT also predict a positive association between capital and loan value. Thus, we directly test the association between bank capital and loan value for the subsample of banks for which the fair value of the loan portfolio is available.[23] Results are presented in Columns (9)–(10) of Table 7. The two columns present an alternate definition of the dependent variable that captures loan fair value. The dependent variable in the first (second) column is *LFV* (*LFV_HTM*), which is loan fair value for both held-to-maturity and available-for-sale loan portfolio (held-to-maturity loan portfolio only) deflated by loans at the beginning of the quarter. Both columns report results of the fixed effects regression, controlling for loan growth, bank size, portfolio composition, liquidity risk, and maturity gap. We include quarter dummies to control for time effects. The coefficient on bank capital is positive and significant at the 1 percent level in both regressions. These results validate the results of our prior analyses and support the prediction in MT that bank capital is positively associated with loan value. Moreover, the use of fair values also mitigates the endogeneity concern as there is little reason to expect that the fair values of loans and bank capital are jointly determined.[24] While loan fair values may reflect intentional or unintentional bias, this does not affect our analysis as it is unlikely that the bias is correlated with bank capital.

Alternative Deflators for Monitoring-Related Salary Expense Measures

In our primary tests, our monitoring-related salary expense measures (*MRSE1* and *MRSE2*) are computed as the ratio of salary expense to total non-interest expense. To ensure that our results are not sensitive to the choice of deflator (non-interest expense), we use an alternate deflator, total assets. We rerun our main regressions using the new *MRSE1* and *MRSE2* for the full sample and the matched sample. Untabulated results show that the coefficient on *AVGCAP* is positive and significant in all four regressions, suggesting that our results are not sensitive to the deflator used to compute salary expense ratio.

Financial Crisis

The financial crisis of 2007–2008 saw unprecedented losses in the banking industry. Therefore, we want to examine whether the relation between bank capital and monitoring effort was affected during the financial crisis period. It is likely that our proxies for monitoring effort would be affected by the tumultuous conditions during the crisis, especially our salary-based measures, when employment in the financial sector declined.

We divide our main sample into two periods—crisis period (2007Q2 to 2009Q1) and non-crisis period (1995Q1 to 2007Q1 and 2009Q2 to 2014Q4) and repeat the matching analysis for each of the subperiods. Untabulated summary statistics show that the two groups are well matched on all dimensions during the crisis period, as well as the non-crisis period. The regression analysis shows that the coefficient on the *AVGCAP* is positive and significant at least at the 5 percent level for all four measures (*LQ1, LQ2, MRSE1,* and *MRSE2*) in the non-crisis period, and positive and significant at least at the 10 percent level for *LQ1* and *LQ2,* but not for *MRSE1* and *MRSE2* in the crisis period. These results suggest that either the positive association between bank capital and monitoring effort is weaker during the crisis period or our monitoring-related salary expense proxies are sensitive to the tumultuous conditions during the crisis period.[25]

Overall, our additional analysis and robustness tests further validate our main finding that bank capital is positively associated with monitoring effort.

VIII. CONCLUSIONS

We provide large-sample empirical evidence on the association between bank capital and monitoring effort. Given the contrasting theoretical views on the impact of equity capital on monitoring incentives, as well as the current regulatory debate

[23] Loan fair values are available as a footnote disclosure for banks, which are required to file a 10-K/10-Q on an annual basis since 1992 and on a quarterly basis since 2009Q2. The SNL Banker database has the annual disclosures in machine-readable form since 2005 and the quarterly disclosures since 2009Q2. Since we use quarterly data in our main tests, we use quarterly disclosures of fair value to perform empirical analysis.

[24] While there is little reason to expect the fair values of loans and bank capital to be jointly determined, a mechanical relation between loan fair values and current bank capital may be plausible on account of loan fair values reflecting increase or decrease in credit quality. Therefore, we run a robustness check using the average of current bank capital including add-back for allowance for loan losses. Results remain unaltered.

[25] While loan losses (which are the basis for *LQ1* and *LQ2*) were affected by illiquidity, contagion, and systemic risk factors in the markets, matching on risk factors addresses this concern to a certain extent. We do not match on employment criteria; therefore, we expect our salary expense-based measures to be more sensitive to the crisis period. Employment in the financial services sector and the economy as a whole faltered, and job losses spiked as the crisis deepened, affecting salaries expenses (which are the basis for *MRSE1* and *MRSE2*). Hence, given the additional non-monitoring-related noise, we expect the association between bank capital and our monitoring-related salary expense measures of monitoring effort to be weaker during the crisis period.

surrounding the issues of costs and benefits of bank equity capital, empirical evidence on this topic is particularly valuable. However, despite the seeming importance of this research question, empirical evidence is scant, perhaps due to the unobservability of monitoring effort and potential endogeneity concerns.

We address the unobservability of monitoring effort by using measures that capture the *ex post* effectiveness of monitoring and *ex ante* investment in monitoring. We use two loan quality measures that are outcomes of monitoring effort (*ex post* measures) and two salary expense-based measures that capture the quality and quantity of labor input into monitoring (*ex ante* measures). We find that bank capital is positively associated with each of our four measures of monitoring effort. This association obtains whether the bank is publicly listed or private. Additional tests show that the association between bank capital and monitoring effort is stronger for banks where monitoring is expected to play a more important role, i.e., smaller banks and banks with a higher proportion of relationship loans.

We address endogeneity concerns by using a fixed effects estimation, a matched sample analysis, as well as an instrumental variable approach. Each of our tests aimed at addressing endogeneity validate our main findings. We perform several additional robustness checks and find that our inferences remain unchanged. Overall, our evidence is consistent with predictions in MT that banks with higher capital monitor more.

While we are careful not to draw any inference regarding the optimal capital structure of banks, our evidence highlights an important benefit of bank capital: its favorable impact on monitoring and, as a result, on loan quality, which is a significant determinant of bank value. Furthermore, our evidence that capital strengthens monitoring effort at small banks, but not at large banks, seems to suggest that the trade-off between the benefits and costs of higher capital differs by size, and that size should be an important consideration in capital requirements.

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APPENDIX A

Definitions of Variables and Other Acronyms

Variable	Description	Source
ABSGAP	The absolute value of one-year maturity gap deflated by total assets.	Y-9C—bhck3197, bhck3296, bhck3298, bhck3409, bhck2170
AVGCAP	Average of equity capital deflated by total assets for four quarters.	Y-9C—bhck3210, bhck2170
AVGSEN	Average of *SENIORS*.	
COMM	Agricultural and commercial loans deflated by total assets.	Y-9C—bhck1763, bhck1764, bhck1590, bhck2170
CONS	Consumer loans deflated by total assets.	Y-9C—bhck2008, bhck2011, bhckb538, bhckb539, bhck2170
REL	Dummy variable takes the value 1 if core deposits are in the top quartile, and 0 otherwise.	
COREDEP	Core deposits deflated by total assets. Core deposits are deposits less than \$100,000.	Y-9C—bhcb6648, bhod6648, bhck2170
CRISIS	Dummy variable takes the value 1 if the bank quarter observation falls during the financial crisis period (2007Q2 to 2009Q1), and 0 otherwise.	
CRO	Dummy variable takes the value 1 if the bank has a Chief Risk Officer, and 0 otherwise.	10-K downloaded from the data provider MylogIQ
DEP	Deposits deflated by total assets.	Y-9C—bhdm6631, bhdm6636, bhfn6631, bhfn6636, bhck2170
FEE	The ratio of fee income to total income (interest income and non-interest income).	Y-9C—bhck4079, bhck4107
ILR	Dummy variable takes the value 1 if the bank has an independent loan review, and 0 otherwise.	10-K downloaded from the data provider MylogIQ
LARGE	Banks with total assets equal to or above \$1 billion and less than \$3 billion. The size classifications are based on total assets expressed in real 2006Q1 dollars using the implicit GDP price deflator.	
LFV	Loan fair values divided by lagged total assets.	SNL Banker Data and Y-9C
LFV_HTM	Loan fair values divided by lagged total assets for held-to-maturity loan portfolio.	SNL Banker Data and Y-9C
LG	Change in loans deflated by total assets.	Y-9C—bhck2122, bhck2170

(continued on next page)

APPENDIX A (continued)

Variable	Description	Source
LIQUID	Bank's liquid assets deflated by total assets.	Y-9C—bhck0081, bhck0395, bhck0397, bhck1773, bhck1350, bhck0276, bhck0277, bhdmB987, bhdmB989, bhck2170
LOANS	Loans divided by total assets.	Y-9C—bhck2122, bhck2170
LOANYIELD	Interest income divided by loans.	Y-9C—bhck4435, bhck4436, bhckF821, bhck4059, bhck4010, bhck4393, bhck4503, bhck4504, bhck2122
LOGEMP	Log of the total number of employees.	Y-9C—bhck4150
LQ1	*NPL* multiplied by -1	
LQ2	*NCO* multiplied by -1	
LRR	Dummy variable takes the value 1 if the bank has a loan risk rating system, and 0 otherwise.	10-K downloaded from the data provider MylogIQ
MEDIUM	Banks with total assets above or equal to $1 billion and less than $3 billion. The size classifications are based on total assets expressed in real 2006Q1 dollars using the implicit GDP price deflator.	
MRSE1	Monitoring-related salary expense measure, computed as the difference between *SALEXP* for a bank and the median *SALEXP* for the banks that belong to the same quartile based on *COMM* for small, medium, large, and very large banks for the two subsamples of public and private banks each quarter.	
MRSE2	Monitoring-related salary expense measure, computed as per Coleman et al. (2006).	
NCO	Net charge-offs deflated by lagged total loans.	Y-9C—bhck4635, bhck4605, bhck2122
NCO_NPL	Net charge-offs (*NCO*) divided by lagged non-performing loans (*NPL*).	
NPL	Non-performing loans deflated by lagged total loans.	Y-9C—bhck5525, bhck5526, bhck2122
PUBLIC	Dummy variable takes the value 1 if the bank is a public bank, and 0 otherwise.	CRSP-FRB link file from: https://www.newyorkfed.org/research/banking_research/datasets.html
RE	Real estate loans deflated by total assets.	Y-9C—bhck1410, bhck2170
REGCAP	Tier 1 capital ratio.	Y-9C—bhck7206, bhck8274, bhcka223
ROA	Net income deflated by total assets.	Y-9C—bhck4300, bhck2170
RWA	Risk-weighted assets deflated by total assets.	Y-9C- bhcka223, bhck2170
SALEXP	The ratio of salary expense to total non-interest expense.	Y-9C—bhck4135, bhck4093
SENIORS	The fraction of seniors in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights.	2000 and 2010 Census of the population from U.S. Census Bureau FDIC Summary of Deposits
SIZE	Log of total assets.	Y-9C—bhck2170
SMALL	Banks with total assets above or equal to $500 million and less than $1 billion. The size classifications are based on total assets expressed in real 2006Q1 dollars using the implicit GDP price deflator.	
TA	Total assets.	Y-9C—bhck2170
TRANDEP	Transaction deposits deflated by total deposits.	Y-9C—bhcb2210, bhcb3187, bhcb2389, bhod3189, bhod3187, bhod2389, bhdm6631, bhdm6636, bhfn6631, bhfn6636
VLARGE	Banks with total assets equal to or above $10 billion. The size classifications are based on total assets expressed in real 2006Q1 dollars using the implicit GDP price deflator.	

APPENDIX B

Estimation of Monitoring-Related Salary Expense (*MRSE2*)

Our *MRSE2* measure is motivated by analysis in Coleman et al. (2006). To estimate *MRSE2,* we attempt to control for the effect of non-monitoring factors on salary expense. Specifically, for each bank, we estimate a fixed effects regression of *SALEXP* on control variables to filter out the effect of non-monitoring factors on salary expense. The bank-specific fixed effects coefficient is our proxy for monitoring effort for each bank. The fixed effects regressions were run separately for eight groups, the four size groups further divided by whether the banks were public or private. The banks are classified as small ($500 million $\leq TA <$ $1 billion), medium ($1 billion $\leq TA <$ $3 billion), large banks ($3 billion $\leq TA <$ $10 billion), and very large banks ($10 billion $\geq TA$) based on real 2006Q1 dollars using the implicit GDP price deflator. The actual estimation was done using rolling regressions every quarter for each bank involving fixed effects regression over four quarters (quarters t–3 to t) to obtain 2,064 bank-specific coefficients across 61,496 bank quarters. These bank-specific coefficients, which form our proxy for monitoring effort (*MRSE2*) for the quarter t, represent the component of the salary expense ratio (*SALEXP*) that is not explained by the impact of non-monitoring factors on the salary expense ratio.

The variables used and the estimates for the entire time period are reported in Table 8. Given that the actual estimation involved running over 600 regressions, the reported regressions are for information purposes only. Panel A in Table 8 includes the summary statistics for all banks, and Panel B includes regression estimates for public banks (Column (1)) and private banks (Column (2)). The signs of the coefficients in Panel B are generally consistent with the analysis in Coleman et al. (2006). Consumer loans are typically homogenous and are monitored as pools. It is more likely that banks use automated models to monitor consumer loans than larger and heterogeneous commercial loans. Consistent with this conjecture, commercial loans are associated with a significantly higher salary expense, while consumer loans have a negative association with the salary expense. The negative coefficient of the *FEE* suggests that banks with a greater proportion of fee income have a lower ratio of salary to non-interest expense. The coefficient on *ROA* is positive and significant, suggesting that more profitable banks have higher salary expense. The coefficient on *LOGEMP* is positive and significant, suggesting that banks with more employees have higher salary expense.

TABLE 8

Estimation of Monitoring-Related Salary Expense Measure

Panel A: Summary Statistics

	n	Mean	Median	Std. Dev.
SALEXP	63,161	0.523	0.534	0.083
RE	63,161	0.456	0.464	0.161
COMM	63,161	0.119	0.105	0.079
CONS	63,161	0.047	0.022	0.064
FEE	63,161	0.177	0.150	0.130
TRANDEP	63,161	0.583	0.581	1.364
SIZE	63,161	14.396	13.913	0.156
ROA	63,161	0.002	0.002	0.003
LOGEMP	63,161	6.197	5.765	1.334

(continued on next page)

TABLE 8 (continued)

Panel B: Regression Analysis for the Entire Time Period

Variables	Public Banks $SALEXP_t$ (1)	Private Banks $SALEXP_t$ (2)
RE_t	0.003	0.037*
	(0.166)	(1.930)
$COMM_t$	0.092***	0.053*
	(3.037)	(1.659)
$CONS_t$	−0.104***	−0.184***
	(−2.596)	(−4.177)
FEE_t	−0.074***	−0.105***
	(−3.674)	(−5.962)
$TRANDEP_t$	0.010	0.039**
	(0.593)	(1.984)
$SIZE_t$	−0.030***	−0.019
	(−4.265)	(−1.571)
ROA_t	9.231***	7.137***
	(31.199)	(22.409)
LOGEMP	0.020***	0.033**
	(2.720)	(2.391)
Constant	0.772***	0.539***
	(10.494)	(4.755)
Quarter Dummies	Yes	Yes
Bank FE	Yes	Yes
n	28,649	34,512
Adj. R^2	0.320	0.240

*, **, *** Levels of significance are denoted $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.
Panel A of this table includes variables used in the estimation of monitoring-related salary expense measure (*MRSE2*). Panel B reports the results of the regression for the public and private banks. Bank variables are obtained from the Y-9C call reports available from the Chicago Federal Reserve website. t-statistics are in parentheses. All standard errors are robust, clustered by the bank.
Variables are defined in Appendix A.