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Joseph P. Hughes, Julapa Jagtiani, and Loretta J. Mester

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We investigate the relative performance of publicly traded community banks (those with assets less than $10 billion) versus larger banks (those with assets between $10 billion and $50 billion). A body of research has shown that community banks have potential advantages in relationship lending compared with large banks, although newer research suggests that these advantages may be shrinking. In addition, the burdens placed on community banks by the regulatory reforms mandated by the Dodd–Frank Wall Street Reform and Consumer Protection Act and the need to increase investment in technology, both of which have fixed-cost components, may have disproportionately raised community banks' costs. We find that, on average, large banks financially outperform community banks as a group and are more efficient at credit-risk assessment and monitoring. But within the community bank segment, larger community banks outperform smaller community banks. Our findings, taken as a whole, suggest that there are incentives for small banks to grow larger to exploit scale economies and to achieve other scale-related benefits in terms of credit-risk monitoring. In addition, we find that small business lending is an important factor in the better performance of large community banks compared with small community banks. Thus, concern that small business lending would be adversely affected if small community banks find it beneficial to increase their scale is not supported by our results.

Keywords: community banking, scale, financial performance, small business lending.

JEL Codes: G21, L25.

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Joseph P. Hughes (corresponding author) is at Rutgers University (jphughes@rci.rutgers.edu). Julapa Jagtiani is at the Federal Reserve Bank of Philadelphia (julapa.jagtiani@phil.frb.org). Loretta J. Mester is at the Federal Reserve Bank of Cleveland and the Wharton School, University of Pennsylvania (Loretta.Mester@clev.frb.org). Hughes thanks the Whitcomb Center for Research in Financial Services at the Rutgers Business School for its support of data services used in this research. The authors thank Raman Maingi for his research assistance.

Is Bigger Necessarily Better in Community Banking?

1. Introduction

A body of research has shown that community banks have potential advantages in relationship lending compared with large banks, although newer research suggests that these advantages may be shrinking. In addition, the burdens placed on community banks by the regulatory reforms mandated by the Dodd-Frank Wall Street Reform and Consumer Protection Act and the need to increase investment in technology, both of which have fixed-cost components, may have disproportionately raised community banks' costs, with the potential to impact their ability to meet local demand or expand beyond their local communities. This paper investigates the relative performance of publicly traded community banks and larger banks. We find that, on average, large banks financially outperform community banks as a group and are more efficient at credit-risk assessment and monitoring. But within the community bank segment, larger community banks outperform smaller community banks. Our findings, taken as a whole, suggest that there are incentives for small banks to grow larger to exploit scale economies and to achieve other scale-related benefits in terms of credit-risk monitoring. In addition, we find that small business lending (SBL) is an important factor in the better performance of large community banks relative to small community banks. Thus, the concern that small community banks would curtail their SBL if these banks decide to increase their scale is not supported by our results.

We use 2013 data on 245 publicly traded, top-tier holding companies, which we divide into three groups based on asset size: *small community banks* are those with assets less than $1 billion, *large community banks* are those with assets between $1 billion and $10 billion, and *large banks* are those with assets between $10 billion and $50 billion.[2] We measure performance based on market

[2] We exclude from our study banking firms with consolidated assets more than $50 billion to focus on firms that are not considered systemically important financial institutions by the definition given in the Dodd-Frank Act.

value rather than the more commonly used accounting metrics. Accounting metrics are necessarily limited to past and current performance, while market value gauges the market's expectation of future as well as current performance in which future expected cash flows are discounted by the relevant risk-adjusted return. We recognize that to obtain the market's assessment of community bank performance, we must limit our sample to publicly traded banks. In our sample of publicly traded banks, there are 54 small community banks, 156 large community banks, and 35 large banks.

Our performance measures include *Tobin's q ratio*, which is the ratio of the market value of assets (MVA) to their replacement cost, where MVA is measured as the sum of the market value of equity and the book value of liabilities, and replacement cost is measured by the book value of assets. We also look at a *noise-adjusted Tobin's q ratio*, which eliminates the effect of statistical noise (e.g., it doesn't penalize a bank for bad luck). Another performance measure, derived using stochastic frontier techniques, measures a bank's market-value inefficiency. We estimate the highest potential market value of banks' assets using stochastic frontier estimation and measure a bank's *market-value inefficiency* as the shortfall between the bank's potential market value and its actual market value (adjusted for noise) as a share of its potential. The market-value inefficiency measure gauges the magnitude of agency problems within the bank, as it provides an estimate of systematic lost market value.

In estimating the highest potential market value, our specification incorporates the banks' decisions about the markets in which to locate their operations (i.e., we measure the highest potential market value across all banking markets). Thus, our market-value inefficiency measure penalizes banks that locate in less valuable markets, just as capital markets do. As an alternative measure of performance, we also apply frontier analysis to estimate the value of banks' investment opportunities – the highest potential value of banks' assets in the markets in which they operate (as opposed to the highest value over all banking markets). We define the ratio of this potential value to the book-value investment in assets as the *investment opportunity ratio*. It represents the value achieved by best-practice banking in these markets and is independent of the managerial actions of any individual bank.

Our findings indicate that, on average, large community banks exhibit better financial performance (in terms of a higher Tobin's *q* ratio and noise-adjusted Tobin's *q* ratio) and lower market-value inefficiency than small community banks, and that large banks achieve even better financial performance than large community banks. At the same time, we find that the value of available investment opportunities decreases with bank size. These results suggest that, on average, as banks grow larger in size, they are able to exploit their relatively less valuable investment opportunities in a way that allows them to perform better financially.[3]

Our paper also provides results that focus on SBL, an area in which small banks have traditionally had a comparative advantage. In our study, we use the data on small commercial and industrial (C&I) loans with origination amounts less than $1 million provided in the bank Call Reports.[4] The financial crisis and its aftermath shed a light on small business owners' ability to access funding. Historically, community banks have served as an important source of credit for small businesses, but the SBL market and the economic landscape have significantly changed in recent years. Jagtiani and Lemieux (2016) discuss how advanced technology has allowed large banks and nonbank alternative lenders to become more important providers of SBL since the latter part of the 2000s. The fixed cost required to invest in technology may have affected the efficiency and performance at small community banks in recent years.

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[3] Comparing only the top third of banks (based on the Tobin's *q* ratio performance measure) in each size group, we find similar results except that in this case, the difference in the average Tobin's *q* ratio for the best performers in the large bank and large community bank samples is not statistically significant.

[4] Different studies in the literature use different sources of data and therefore use different definitions of SBL. Call Reports define SBL as C&I loans with origination amounts less than $1 million, regardless of whether the borrowers are actually small. The Community Reinvestment Act defines SBL as loans made to small businesses with less than $1 million in annual gross revenue. The Federal Reserve Survey of Small Business Finance defines SBL as loans made to small businesses with fewer than 500 employees (regardless of loan size). Because of these different definitions, results may not be comparable across studies.

Our results indicate that there is no statistically significant difference in the average share of SBL activities (measured as the ratio of small business loans to assets) at our sampled small versus large community banks. Interestingly, we find that financial performance is positively related to the ratio of small business loans to assets at large community banks, but it is negatively related to this ratio at small community banks. This suggests that large community banks could potentially improve their financial performance by increasing their ratio of small business loans to assets and that small community banks might achieve better financial performance by reducing this ratio. This suggests that the optimal ratio of small business loans to assets is higher at large community banks than at small community banks.

We next explore the important factors that help determine different optimal small business loan ratios across bank size groups. We apply stochastic frontier analysis to estimate the best-practice minimum level of nonperforming loans for any given amount of total loans – controlling for the composition of the loan portfolio, its ex ante credit risk, and macroeconomic conditions and market concentration in banks' local lending markets. We define a bank's *loan performance inefficiency* as the percentage increase of a bank's actual nonperforming loan volume (adjusted for noise) over its best-practice minimum nonperforming loan volume. Banks with higher loan performance inefficiency are less proficient at credit-risk evaluation and loan monitoring, controlling for the ex ante risk taken.

We find that loan performance inefficiency of the large banks is lower than that of (small and large) community banks and that the loan performance inefficiency of large community banks is lower than that of small community banks. This suggests that, on average, larger banks are more proficient at credit-risk monitoring and credit-risk management than smaller banks.

Our findings, taken as a whole, suggest that there are incentives for small banks to grow larger to exploit scale economies and to achieve other scale-related benefits in terms of credit-risk monitoring. In addition, we find a significant positive relationship between performance and the ratio of small business loans to assets at large community banks, indicating that access to credit for small businesses need not be adversely affected if small community banks find it optimal to grow larger. Further exploration of the change in the size distribution of banks toward larger banks, which is documented by McCord and Prescott (2014), for the evolution of SBL and access to credit for small business borrowers remains for future research.

The rest of this paper is organized as follows. Section 2 provides a brief literature review. Section 3 discusses how we measure financial performance and the value of investment opportunities. Section 4 describes our data set. Section 5 discusses the empirical results on the relationship between bank size (scale) and the various measures of performance. Section 6 provides empirical results on SBL. Section 7 discusses results on the relationship between loan portfolio risk and bank market value, and Section 8 concludes.

2. Review of the Literature on Small Business Lending by Community Banks versus Larger Banks

Previous studies, including those by Berger, Miller, Petersen, Rajan, and Stein (2005); Chakraborty and Hu (2006); Beccalli and Frantz (2013); and Kowalik (2014), have documented support for the traditional view that small community banks have advantages in monitoring their customers through personal relationships. Unlike large banks that tend to serve larger firms about which there is more publicly available information, according to the traditional view, small community banks have a special role in supporting small businesses in their local communities because they are better able to form strong relationships with small, opaque firms.

However, this traditional view has been challenged in more recent studies. Berger and Udell (2006) find that large banks are, in fact, not disadvantaged in providing credit to informationally opaque (and small) firms. They explain that the conflicting evidence obtained by some studies that use international data (and find that small banks have an advantage in SBL) may be driven by the fact that lending technologies available in the U.S. may not be used in other countries. Studies based on U.S. data, including Berger, Frame, and Miller (2005) and Berger, Cowan, and Frame (2011), find that technologies such as small business credit scoring have somewhat replaced the traditional banking relationships and have allowed large banks to increase their SBL at a lower cost than small community banks. Also see the discussion in Mester (1999).

Similarly, DeYoung, Frame, Glennon, and Nigro (2011) and Peterson and Rajan (2002) noted that the distance between small business borrowers and lenders has been increasing as a result of changes in lending technology, such as the adoption of credit scoring technologies by the lending banks. The motivation for this expansion is not clear; it appears that loans made to borrowers located closer to the lending bank perform better.[5] DeYoung, Frame, Glennon, McMillen, and Nigro (2008) find that, in addition to the significant movement toward automated lending technology in recent years, small businesses have increasingly relied on larger banks as their sources of funding. Prager and Wolken (2008) confirm this, using the 2003 Survey of Small Business Finance data; they find that 70 percent of small businesses cite a big bank as their primary financial institution, but only 25 percent cite a community bank, and 5 percent cite a nonbank institution.

More recent studies, using data after the financial crisis, such as Berger, Goulding, and Rice (2014) and Berger, Cerqueiro, and Penas (2014), provide supporting evidence of the increasing roles of large banks in lending to small business and start-up firms. In addition, Jagtiani, Kotliar, and Maingi (2015) investigate bank mergers announced during the period 2000-2012 and find no adverse impact on overall SBL even after the community bank merger targets became part of the large acquiring banks. In fact, they find that post-merger, the merged banking firm's SBL tended to exceed the pre-merger SBL of the target and acquirer; i.e., SBL increased after community bank targets became larger via the merger.

[5] DeYoung, Glennon, and Nigro (2008) found that borrowers at least 25 miles away from their bank lenders were 10.8 percent more likely to default on their loans, and borrowers located at least 50 miles away were 22.1 percent more likely to default on their loans.

In addition to small businesses obtaining more of their funding from large banks, previous studies have also shown that small businesses have increased their use of nontraditional credit, such as loans from nonbank institutions and business credit cards, funded by large banks and nonbank institutions. Mester, Nakamura, and Renault (2007) report that finance companies were responsible for an increasing share of loans to businesses over time, reaching one-third by 2006. Using a longer sample period that includes more recent data after the financial crisis, Jagtiani and Lemieux (2016) confirm that nonbank institutions have been playing increasing roles in the SBL market through online lending platforms.[6]

3. Measuring Financial Performance and the Value of Investment Opportunities

3.1. Tobin's q Ratio

Hughes and Mester (2010, 2013a, 2015) provide a comprehensive discussion of the structural and nonstructural methodologies to assess bank performance. The structural approach is based on a model of bank behavior that incorporates an optimization assumption, such as profit maximization, cost minimization, or utility maximization. The nonstructural approach relates bank performance to a number of characteristics of the bank or market. Performance is measured either using accounting data, such as return on assets, or by market-value data, such as Tobin's q ratio or cumulative abnormal return from an event-study model. One advantage of the market-value measures of performance is that they can incorporate future expected performance. A firm's market value represents the market's expectation of the discounted value of the firm's current and future cash flow. Moreover, the discount rate reflects the market's assessment of the relevant risk attached to the cash flow. As such, market value constitutes a more comprehensive measure of performance than measures of current performance based on accounting data.

[6] They also suggest ways to enhance potential cooperation, such as partnerships between large banks and community banks or between banks and nonbank lenders.

Performance based on market value is frequently measured by a proxy for Tobin's *q* ratio. Tobin's *q* ratio is defined as the ratio of the MVA to their replacement cost. We use a common proxy for the MVA of bank *i* (MVA_i), which is the sum of the market value of equity and the book value of liabilities. For replacement cost, we use bank *i*'s book value of assets net of goodwill (BVA_i). Thus,

$$\text{Tobin's } q \text{ ratio} = MVA_i/BVA_i. \quad (1)$$

See Hughes and Mester (2010, 2015) for a review of the finance literature that uses Tobin's *q* ratio to measure performance.

3.2. Market-Value Inefficiency: The Magnitude of Agency Costs

Hughes, Lang, Moon, and Pagano (1997) proposed a measure of performance based on stochastic frontier techniques. This measure, called *market-value inefficiency*, measures the shortfall of a bank's achieved value of assets from its potential market value as a proportion of its potential value and provides a benchmark from which the magnitude of agency costs can be gauged. The highest potential value of a bank's investment in its assets is estimated by fitting an upper envelope of the banks' MVA to their replacement cost, which is proxied by their book value of assets net of goodwill (BVA). We fit the quadratic frontier relationship,

$$MVA_i = \alpha + \beta(BVA_i) + \gamma(BVA_i)^2 + \varepsilon_i, \quad (2)$$

with maximum likelihood techniques, where $\varepsilon_i = \nu_i - \mu_i$ is a composite error term used to distinguish statistical noise and $\nu_i \sim \text{iid } N(0,\sigma_\nu^2)$, from the systematic shortfall; i.e., the shortfall from bank *i*'s highest potential (frontier) market value. We assume that μ_i is distributed exponentially, $\mu_i\ (> 0) \sim \theta \exp(-\theta u)$. The quadratic specification allows the frontier to be nonlinear. Figure 1 illustrates this frontier and the shortfall.

The frontier value, $FMVA_i$, is defined by the deterministic kernel of the stochastic frontier,

$$FMVA_i = \alpha + \beta(BVA_i) + \gamma(BVA_i)^2. \quad (3)$$

This best-practice market value of a firm's investment in assets captures its potential value if it operated at least as efficiently as its industry peers, where peers are firms of similar size (book-value investment in assets). Thus, best practice captures not only technological performance but also market positioning.

The difference between a bank's best-practice market value ($FMVA_i$) and its observed market value adjusted for noise ($MVA_i - \nu_i$) defines the bank's market-value shortfall, μ_i, which is measured in dollars of lost market value. That is,

$$\mu_i = FMVA_i - (MVA_i - \nu_i). \quad (4)$$

Subsequently, it will be convenient to use

$$\text{the noise-adjusted Tobin's } q \text{ ratio} = (MVA_i - \nu_i)/BVA_i \quad (5)$$

The shortfall, μ_i, cannot be directly measured, so it is estimated as the expectation of μ_i conditional on ε_i:

$$\text{shortfall}_i = E(\mu_i|\varepsilon_i) = FMVA_i - (MVA_i - E(\nu_i|\varepsilon_i)). \quad (6)$$

Bauer (1990) and Jondrow, Lovell, Materov, and Schmidt (1982) describe this technique in detail.

We define the market-value inefficiency ratio as the shortfall normalized by the assets' highest potential value. Hence, a bank's shortfall ratio gives its market-value shortfall as a proportion of the highest potential value of its assets:

$$\textit{market-value inefficiency ratio}_i = \text{shortfall}_i/FMVA_i = E(\mu_i|\varepsilon_i)/FMVA_i. \quad (7)$$

Although Tobin's *q* ratio is a standard measure in the literature, the market-value inefficiency ratio offers some advantages as a measure of financial performance. First, it removes the influence of luck on performance measures and measures a firm's systematic failure to achieve its highest potential (frontier) value.[7] Thus, the stochastic frontier technique provides a conceptually sound measure of managerial and financial performance. Another advantage of the market-value inefficiency ratio is that the frontier technique identifies lost market value as well as achieved market value; hence, it gauges more directly than Tobin's *q* ratio the extent of agency

[7] This systematic lost market value captures differences among firms in market advantages as well as differences in managerial consumption of agency goods. Because managers decide the local markets in which their firms should operate, we consider market advantages as components of managerial effectiveness.

problems in an industry and permits a direct econometric investigation of the factors that contribute to firms' failure to achieve their highest potential market value. Several studies have used the market-value inefficiency ratio or the noise-adjusted Tobin's *q* ratio derived from it to measure performance.[8]

3.3. Value of Investment Opportunities

The stochastic frontier defined in equation (2) gives the highest potential value of assets observed over all markets in which banks in the sample operate. If instead we want to know the highest potential value of the bank given the markets in which it operates, we can define the *value of investment opportunities*.

To obtain this potential value, we amend equation (2) by adding variables that characterize the economic opportunities of the markets in which a bank operates. Accordingly, we fit a stochastic frontier to banks' market values, where each bank's peers are defined by the book-value of assets net of goodwill (BVA_i), the weighted average GDP growth rate ($Growth_i$) across the markets in which the bank operates, and the weighted average Herfindahl index ($Herf_i$) across these markets, where the weights are bank deposit shares.[9] We interact the bank's GDP growth and market concentration with the bank's investment in assets. Thus, banks' market values are fitted as an upper envelope using maximum likelihood:

$$MVA_i = \alpha + \beta_A (BVA_i) + \gamma_{AA} (BVA_i)^2 + \gamma_{AG} (BVA_i)(Growth_i) + \gamma_{AH} (BVA_i)(Herf_i) + \varepsilon_i \qquad (8)$$

where $\varepsilon_i = \nu_i - \mu_i$ is an error term composed of statistical noise, $\nu_i \sim \text{iid } N(0,\sigma_\nu^2)$, and the systematic shortfall, μ_i. We assume that μ_i is distributed exponentially, $\mu_i\ (> 0) \sim \theta \exp(-\theta u)$.

[8] See, for example, Habib and Ljungqvist (2005); Baele, De Jonghe, and Vander Vennet (2007); De Jonghe and Vander Vennet (2005); Hughes and Moon (2003); Hughes, Lang, Mester, and Moon (1999); Hughes, Mester, and Moon (2001); Hughes, Lang, Mester, Moon, and Pagano (2003); and Hughes and Mester (2013a, 2013b).

[9] We consider only deposits at banking institutions; deposits at thrifts and credit unions are not included in the analysis. Market share measure is calculated at the state level.

The best-practice value of a firm's investment opportunities in the markets in which it operates is given by this narrowly defined frontier value, $NPVA_i$, obtained from the deterministic kernel of the stochastic frontier:

$$NPVA_i = \alpha + \beta_A (BVA_i) + \gamma_{AA} (BVA_i)^2 + \gamma_{AG} (BVA_i)(Growth_i) + \gamma_{AH} (BVA_i)(Herf_i). \quad (9)$$

This best-practice value of a bank, narrowly defined by the markets in which it operates, represents its charter value, which is the value of its charter in a competitive auction. Franchise value, the achieved market value, differs from charter value when agency problems erode market value.

To compare the value of investment opportunities of banks differing in asset size, we normalize the frontier value obtained in equation (9) by the book-value investment in assets adjusted to remove good will, the investment opportunity ratio:

$$\text{Investment opportunity ratio}_i = NPVA_i/BVA_i. \quad (10)$$

4. The Data

As discussed earlier, we use 2013 data on 245 publicly traded, top-tier bank holding companies to measure performance and investment strategies. Our study focuses on the banking firms that are not considered systemically important financial institutions by the definition given in the Dodd-Frank Act, so here we exclude banks with consolidated assets exceeding $50 billion. The sample consists of banks with assets ranging from $341 million to $47 billion. We define two groups of publicly traded community banks: Small community banks are banks with assets less than $1 billion, and large community banks are banks with assets between $1 billion and $10 billion. There are 210 community banks in the sample, 54 small community banks, and 156 large community banks. We contrast these two groups with the sample's 35 large banks, those banks with assets between $10 billion and $50 billion.

Because we focus on market-based measures of performance, we are constrained to look at publicly traded community banks. We compared the 210 publicly traded small and large community banks in our sample with community banks that were privately held in 2013. We find no statistically significant differences in the ratio of total business loans to assets or the ratio of small business loans to assets in these two community bank groups.[10]

We draw on several sources for our data: market-value information from Compustat; accounting data from the end-of-year Y9-C reports filed with regulators; and data on the number of branches, number of states, and deposit dispersion from the *Summary of Deposits* obtained from the Federal Deposit Insurance Corporation (FDIC).

Because the Y9-C data do not report SBL at the level of the consolidated highest holding company, we collect data on outstanding small business loans from the end-of-year 2013 bank-level Call Reports and sum them to the highest holding company level by using the Federal Reserve Structure Database. We also collect information on variables characterizing the bank's growth strategy from the Structure Database, which reports the number and amount of acquisitions associated with each entity under the consolidated bank holding company. The growth strategy variables, such as the number of institutions acquired, are measured for four years, from 2011 through 2014. We measure performance at the end of 2013, but we consider acquisitions through 2014 because most of these acquisitions completed in 2014 would have been initiated in 2013 and incorporated into the share price for the 2013 market value calculation.

We gauge performance by three measures based on market value: the Tobin's q ratio (equation 1), the noise-adjusted Tobin's q ratio (equation 5), and the market-value inefficiency ratio (equation 7).

5. How Is Scale Related to Performance?

To answer this question, we examine the three important efficiency measures: the Tobin's q ratio, the noise-adjusted Tobin's q ratio, and the market-value inefficiency ratio. Overall, our

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[10] In general, the publicly traded community banks tend to be larger in size than the privately held ones. In addition, publicly traded community banks tend to hold a higher proportion of real estate loans and a lower proportion of liquid assets.

comparisons of these efficiency measures across size groups suggest that larger banks tend to exhibit better financial performance.

Table 1 presents univariate summary statistics on financial performance for the three groups of banks: panel A for small community banks, panel B for large community banks, and panel C for large banks. Table 2 presents difference-in-means tests across the three size groups. As shown in Tables 1 and 2, the two measures of Tobin's *q* ratio are positively related to asset size, while market-value inefficiency is negatively related to asset size, and the differences across the three size groups are all statistically significant. These univariate statistics suggest that, on average, large community banks exhibit better financial performance than small community banks and that large banks exhibit better overall performance than community banks.

Table 3 focuses on the best-performing banks, i.e., banks in the third of each size group with the highest Tobin's *q* ratio.[11] Among community banks, the best performing large community banks perform statistically better on average than the best performing small community banks based on both of the Tobin's *q* ratio and the market-value inefficiency ratio. In terms of investment opportunities, however, our data show that top performing large community banks obtain, on average, less valuable investment opportunities than the top performing small community banks – implying that the managers of the top performing large community banks are better at exploiting their (less valuable) investment opportunities than managers at small community banks.

When comparing large community banks versus large banks, we find that, on average, large banks outperform large community banks, even though they have lower valued investment opportunities (see Table 2). Thus, the managers of the large banks appear to be more efficient at exploiting their lower valued investment opportunities, which is reflected in their lower market-

[11] We report the results partitioned by the Tobin's *q* ratio because it is a common measure of performance in the literature. We obtain qualitatively similar results when we partition by the market-value inefficiency ratio or by the noise-adjusted Tobin's *q* ratio.

value inefficiency ratio.[12] When we compare the top performers in these size categories (see Table 3), the difference in the average Tobin's *q* ratio is not statistically different, but the top performing large banks have lower valued investment opportunities compared to the large community banks and are more efficient at exploiting these opportunities.

The differences across bank size groups in the various characteristics of investment opportunities, such as the number of branches, the number of states in which the branches are located, the geographic diversification of deposits, and the number of institutions acquired and sold as well as the amount of assets acquired and sold, are discussed in Appendix A.

5.1 What Accounts for the Scale-Related Performance Effects?

Various cost and revenue factors may be important in explaining performance differences across the bank size categories. On the revenue side, the ratio of total revenue to consolidated assets is not significantly different across size groups (see Table 2). However, when focusing on top performers only (see Table 3), the revenue ratio is slightly significantly higher for each of the two groups of community banks when they are each compared with the largest size group.

On the expense side, we find that the mean ratio of operating costs (noninterest expense) to total revenue for small community banks is not significantly different from the ratio for large community banks but is significantly higher than that of large banks (see Table 4). This is consistent with findings in the literature of scale economies in banking.[13]

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[12] The relationship of Tobin's *q* ratio to the investment opportunity ratio and the market value inefficiency ratio is discussed at length by Hughes and Mester (2013a), pp. 29–30.

[13] Inferring efficiency differences from simple comparisons of the cost ratio for different groups of banks may be misleading because the cost ratio does not control for differences among banks in their investment strategies. Riskier strategies may be relatively more costly. Hughes and Mester (2013b, 2015) and Hughes, Mester, and Moon (2001) contend that larger banks, which on average take more risk than smaller banks, incur higher costs because of their extra risk taking. These extra costs can obscure the technological scale economies due to better diversification and spreading operating costs over larger output if account is not taken of scale-related endogenous risk taking. Their investigations show that the scale economies predicted by textbooks often elude the standard approach to estimating scale economies for this reason. Hughes, Mester, and Moon (2001) find that the estimated scale economies index of the standard approach increases with better diversification but decreases with a variety of measures of risk taking.

Textbooks frequently cite "spreading the overhead" as an important source of scale economies. "Noninterest expense," the cost of labor, supplies, utilities, and fixed assets, constitutes overhead or, equivalently, operating costs. Kovner, Vickery, and Zhou (2014) estimate the response of operating costs to a proportional increase in assets. They demonstrate that finding evidence of operating cost economies depends on controlling for the investment strategy. Larger banks tend to take more risk, which is costly and which masks evidence of operating cost economies when not taken into account.[14] This point was made by Hughes and Mester (2013b, 2015) and Hughes, Mester, and Moon (2001). In addition, Kovner, Vickery, and Zhou (2014) find a pattern that implies that operating scale economies increase with bank size and that the largest financial institutions obtain the largest operating cost economies.

Delving deeper into the expense side, Table 4 reports some components of noninterest expenses. The ratio of corporate overhead to revenue shows a statistically significant decrease with bank size, which is consistent with the scale economies. As a proportion of total revenue, reporting and compliance expenses also fall with bank size, with statistically significant mean differences for small versus large community banks and small community banks versus large banks. Finally, *telecommunications* expenses also show signs of potential scale economies; however, community banks do not experience them. Both small and large community banks have the same average ratio of telecommunication expenses to total revenue, 0.008; however, the mean value of 0.006 for large banks is significantly smaller than the mean for larger community banks.[15]

Overall, most of these components of operating expenses are consistent with scale economies; however, one must be cautious inferring scale economies based on these cost ratios

[14] Without controlling for investment strategy, they find that a 10 percent increase in assets implies a 9.93 percent increase in operating costs, essentially constant returns. When the authors control for asset allocation, the cost elasticity drops to 9.79 percent, and when they control for asset allocation, revenue sources, funding structure, and organizational complexity, the ratio drops further to 8.99 percent, essentially operating cost economies.

[15] Telecommunications expenses total 1.3 percent of operating costs for smaller community banks, 1.3 percent for larger community banks, and 1.1 percent for large banks.

because these ratios do not control for potential differences across banks in their investment strategies. Riskier strategies may be relatively more costly. We further examine investment strategies, risk taking, and other balance sheet factors in the next section.

5.2 How Do Balance Sheets Differ by Bank Size?

Table 5 compares funding sources for the three groups of banks. Large banks are less dependent on deposits as their funding source than community banks. Among community banks, there is no statistically significant difference in terms of reliance on deposits regardless of whether they are large or small community banks. In terms of equity capital, large banks, on average, have higher capital to total assets than do community banks. And among community banks, large community banks hold more capital to assets than small community banks.[16] The higher capital-to-asset ratio does not always mean better capitalization, however, because the ratio does not account for the banks' portfolio risk and off-balance sheet activities.

Table 6 provides the asset components, asset quality, and off-balance sheet activities across bank size groups. Small community banks hold a significantly higher proportion of real estate assets in their portfolios compared with large community banks and large banks. The difference is particularly pronounced for commercial real estate (CRE) loans, which are generally more risky than other real estate loans, thus exposing small community banks to greater portfolio risk than larger banks. In terms of consumer loans, there is no significant difference across bank size groups. Unlike consumer loans, larger banks tend to be more active in business loans; i.e., large banks hold a higher mean proportion of business loans than community banks, and large community banks hold a higher proportion of business loans than small community banks.

By definition, *total business loans* include *small business loans*, which are defined as business loans with an initial principal balance of less than $1 million. In terms of SBL, there is not a

[16] It should be noted, however, that large banks are more active in off-balance sheet activities; thus, the capital ratio to risk-weighted assets (including off-balance sheet) may be smaller than that of community banks when accounting for the overall portfolio risks.

statistically significant difference in the mean ratio of small business loans to assets at small and large community banks (0.046 versus 0.039). However, both groups of community banks exhibit a significantly higher ratio of small business loans to assets than large banks (0.031). This is consistent with statistics reported by Jagtiani and Lemieux (2016), although they also report that the gap in the ratio of small business loans to assets between large banks and community banks has become narrower over the years.

In terms of liquidity, there is no statistically significant difference in the mean ratios of liquid assets to total assets across the three size categories. Community banks seem to be as liquid as large banks. Liquidity is also affected by other activities not recorded as assets on the balance sheet. Large banks engage in more off-balance-sheet activities than community banks. We use the ratio of *noninterest income* to total revenue as a proxy for off-balance sheet activities. Unlike large banks, community banks (large and small) are not as active in off-balance sheet activities. In terms of loan quality, we use the nonperforming loan ratio as a proxy, and we find that there is no statistically significant difference in the ratio of nonperforming loans to assets across the three size categories.[17]

To summarize, the key differences on the asset side across bank size groups pertain to CRE lending and SBL. Smaller banks are more active in both types of lending, which tend to be more risky than other types of loans. Large banks are more active in off-balance sheet activities.

How banks price their loans also differs by bank size. As indicated in Table 6, small community banks charge higher contractual interest rates on their loans, on average, than do large community banks and large banks. This higher loan rate at small community banks may reflect

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[17] Asset quality is measured by the sum of three components: 1) the amount of loans that are nonperforming, 2) the amount of loans that have been charged off, and 3) the amount of foreclosed real estate owned by the bank. Because banks differ in the aggressiveness with which they charge off nonperforming loans, our measure of nonperforming loans includes the amount of gross charge-offs in order to eliminate any bias caused by different charge-off strategies among banks.

their higher loan risk (from CRE lending and SBL), although their nonperforming loan ratio is not statistically different than the average at larger community banks and large banks.

Table 7 indicates that there are no statistically significant differences in asset allocations between the best and worst financial performers among small community banks. This relationship also holds for the best and worst performers among large community banks and the large banks. Nevertheless, the rate of loan nonperformance of the third with the lowest Tobin's q ratio is double that of the third with the highest Tobin's q ratio – a difference that holds for small and large community banks. For the largest banks, the difference is triple.

The lack of statistically significant differences in asset allocation between the best and worst performers suggests that the contrast in loan performance is not driven by asset class or category but rather it may reflect the difference in risk choice (e.g., electing to lend to riskier borrowers who default more often) or risk management (effectiveness of the banks' credit analysis and monitoring). We explore this question further in the next section.

5.3 Portfolio Risk Choice versus Risk Management Strategies

We use stochastic frontier techniques in a novel way to distinguish between nonperformance due to less effective credit evaluation and loan monitoring and nonperformance due to the bank's choice of the overall risk of its loan portfolio.

We estimate a bank's best-practice (i.e., minimum) nonperforming loan volume for any given volume of total loans, controlling for the asset composition of its portfolio, the average contractual lending rate, and the macroeconomic growth rate and market concentration across the bank's markets. A bank's average contractual lending rate incorporates a risk premium and thus controls for the bank's perception of ex ante credit risk. *Loan performance inefficiency* is gauged by the excess of a bank's observed nonperforming loan volume, adjusted for statistical noise, from its best-practice frontier and answers the question: *Given the bank's volume of total loans, loan portfolio composition, ex ante credit risk, and market conditions, by what percentage could the bank lower its* *volume of nonperforming loans were it were fully efficient at credit-risk evaluation and loan monitoring?* The best-practice minimum nonperformance frontier, which we estimate in logarithmic form and then convert to levels, is illustrated in Figure 2. The details of the estimation are provided in Appendix B, and the key results are presented in Table 8.

As indicated in Table 8, the poor performers in each size group (the third of banks in the size group with the lowest Tobin's *q* ratio) are consistently more efficient (less inefficient) at credit evaluation and loan monitoring than the top performers (the third of the banks with the highest Tobin's *q* ratio) for all size groups. For example, in the small community bank sample, poor performers exhibit statistically significantly lower loan performance inefficiency of 22.2 percent compared with 25.9 percent for the top performers. Similarly, at large community banks, loan performance inefficiency for poor versus top performers is 22.3 percent versus 24.1 percent, and at large banks, the comparable ratios are 17.9 percent for poor performers versus 22.2 percent for top performers.[18]

We also compare the frontier values of nonperformance for the better and worse performers in each size category. This allows us to determine whether these banks are choosing to lend to borrowers with higher ex ante credit risk or in markets that would result in a higher rate of nonperformance, even if the bank were fully efficient at credit-risk evaluation and loan monitoring.

As indicated in Table 8, for banks in each size category, the worst financial performers (the bottom third ranked by Tobin's *q* ratio) have both higher experienced nonperforming loan ratios (nonperforming loans/total loans) and higher best-practice nonperforming loan ratios (stochastic

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[18] As indicated in Table 8, we also find that large banks are more efficient in terms of loan nonperformance than smaller banks. These results are confirmed by a regression of loan performance inefficiency on the *ln*(total loans) and the ratio of the frontier value of nonperforming loan volume to total loans. The regression results, which are available from the authors, indicate that larger banks have lower loan performance inefficiency given inherent degree of credit risk in their portfolios (as measured by the best-practice nonperforming loan ratio). If instead of using the continuous measure of loan volume, *ln*(total loans), we use a set of indicator variables designating a bank as either a small community bank, large community bank, or large bank, we again obtain similar results, that the loan performance inefficiency of large banks is lower than the inefficiency of small community banks, and we find that this is a statistically significant difference.

frontier nonperforming loans/total loans) compared with the best financial performers (the top third ranked by Tobin's *q* ratio). This suggests that, on average, the poorer financial performers in each size category are choosing to lend to borrowers (and/or in markets) with higher default rates.

6. Does Scale Affect the Financial Incentives to Lend to Small Businesses?

Our results suggest that smaller banks are more active in CRE lending and SBL, but they do not perform as well as large banks in all efficiency measures. Smaller banks also have higher nonperforming loans and charge higher interest rates – higher risk premiums to compensate for their riskier borrowers. We explore whether such a scale-related improvement in financial performance provides an incentive for small community banks to become larger and whether this might provide them with an incentive to reduce their SBL as they grow in scale to achieve greater financial performance.

We investigate this issue in regressions of the three financial performance measures – Tobin's *q* ratio, noise-adjusted Tobin's *q* ratio, and market-value inefficiency – on the composition of lending activities, controlling for *ln*(total assets), the investment opportunity ratio, asset quality, and the composition of funding (the deposit ratio and the capital ratio).[19,20] Results are presented in Tables 9, 10, and 11 for small community banks, large community banks, and the largest banks, respectively.

$$P_i = \boldsymbol{a}_0 + \boldsymbol{a}_1 \text{ Total loans/Assets} + \boldsymbol{a}_2 \text{ Total business loans/Assets} + \boldsymbol{a}_3 \text{ Small business loans/Assets} + \mathbf{X\beta} + \varepsilon_i. \quad (11)$$

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[19] Because the performance measures are based on market values, we control for investment opportunities in these regressions. In Table 9, there is weak evidence (not significant at conventional levels) that the investment opportunity ratio is positively related to financial performance for small community banks. In Table 10, our results show strong evidence that investment opportunity is negatively related to performance for large community banks. Hughes and Mester (2013a) find that, controlling for asset size, more valuable investment opportunities that are associated with poorer financial performance are evidence of agency problems, a point that is beyond the scope of this investigation.

[20] Except, perhaps, for the small community banks, it is likely that an increase in asset size would be accompanied by a change in the composition of assets and liabilities as well as portfolio risk. Thus, one needs to be cautious in interpreting the coefficient on *ln* assets, which holds asset and liability composition and risk constant.

where P_i = Performance, as measured by Tobin's *q* ratio, noise-adjusted Tobin's *q* ratio, or market-value inefficiency, and the control factors in the **X** matrix include Residential real estate loans/Assets, Commerical real estate loans/Assets, Consumer loans/Assets, Liquid assets/Assets, Investment opportunity ratio, *ln*(Book value of assets in $1000s), Noninterest income/Total revenue, Nonperforming loans/Assets, Deposits/(Deposits + Other borrowed funds), and (Equity + Subordinated debt + Loan loss reserves)/Assets.

By controlling for the ratio of total loans to assets, a variation in any category of loans in the regression, except small business loans, implies an equivalent change in the categories of loans omitted from the regression. These omitted categories include leases, agricultural loans, loans to nondepository institutions, and other loans.

Small business loans constitute part of total business loans. Total business loan is the sum of small business loans(i.e., business loans with origination less than $1 million) and large business loans (i.e., business loans with origination greater than $1 million). Thus, a 1 percent increase in the ratio of small business loans to assets, holding constant the ratio of total business loans to assets, implies a 1 percent decrease in the ratio of large business loans to assets. Based on equation (11), the change in financial performance associated with such a change would be $\boldsymbol{a}_3 \times 0.01$. Of course, the ratio of total loans to assets is also held constant, so the variation affects only the composition of total business loans.

On the other hand, a change in the ratio of total business loans to assets holding constant the ratio of small business loans to assets implies an equivalent change in the ratio of large business loans to assets. Holding the ratio of total loans to assets constant, based on equation (11),

$$\Delta Pi = \boldsymbol{a}_2 \times \Delta \text{ Total business loans/Assets.} \quad (12)$$

For example, the change in performance associated with a 1 percent increase in the ratio of total business loans to assets = $\boldsymbol{a}_2 \times 0.01$. Because we are holding constant the ratio of small business loans to assets in this calculation, this 1 percent increase in the ratio of total business loans to assets is a 1 percent increase in the ratio of large business loans to assets. And because we are holding the ratio of total loans to assets constant, this 1 percent increase in the ratio of business loans to assets implies an equivalent change in the omitted categories of loans.

If, instead, a 1 percent increase in total business loans to assets is accompanied by a 1 percent increase in the ratio of small business loans to assets, the ratio of large business loans to assets would remain constant, and the change in performance associated with such a change would be $(\boldsymbol{a}_2 + \boldsymbol{a}_3) \times 0.01$. Holding the ratio of total loans to assets constant, such an increase implies an equivalent change in other categories of loans omitted from the regression.

A 1 percent increase in the ratio of total business lending to assets accompanied by a 1 percent increase in the ratio of total loans to assets represents an increase in overall lending effected by large business lending; the resulting change in performance is given by $(\boldsymbol{a}_1 + \boldsymbol{a}_2) \times 0.01$. If the ratio of small business loans to assets is simultaneously increased by 1 percent, the change in performance is given by $(\boldsymbol{a}_1 + \boldsymbol{a}_2 + \boldsymbol{a}_3) \times 0.01$. In the latter case, the ratio of large business loans to assets would remain constant.

Based on the regression coefficients reported in Table 9, there is some evidence (weakly significant) that small community banks have a financial incentive to *decrease* small business loans. To see this, note that a 1 percent decrease in the ratio of small business loans to assets, holding constant total business loans to assets (which implies a 1 percent increase in large business loans to assets), is associated with a statistically significant increase in Tobin's q ratio of $(-0.01) \times \boldsymbol{a}_3 = (-0.01) \times (-0.27418) = +0.0027418 = 0.27$ percent.

The results show that a 1 percent increase in the ratio of total business loans to assets combined with a 1 percent decrease in the ratio of small business loans to assets (which implies a 2 percent increase in large business loans to assets) is associated with an increase in Tobin's q ratio of $[(+0.01) \times \boldsymbol{a}_2] + [(-0.01) \times \boldsymbol{a}_3] = [(+0.01)(0.23341)] + [(-0.01)(-0.27418)] = 0.00508$, or 0.508 percent, which is significantly different from zero (with a p value of 0.052).

If the 1 percent increase in the ratio of total business loans to assets is combined with a 1 percent increase in the ratio of total loans to assets, holding the small business loan ratio constant, the associated increase in Tobin's q ratio is 0.444 percent. If, in addition, the ratio of small business loans to assets decreases by 1 percent, the increase in Tobin's q ratio is 0.718 percent. Similar results are obtained when performance is measured by the noise-adjusted Tobin's q ratio and the market-value inefficiency ratio.

Overall, we find that small community banks have a financial incentive to reduce their SBL activities and to increase their lending to larger businesses.

Unlike small community banks, we find that large community banks have a financial incentive to increase SBL. As shown in Table 10, for large community banks, a 1 percent increase in the small business loan ratio is associated with a statistically significant +0.0032021 or 0.32021 percent increase in Tobin's q ratio. And a 1 percent decrease in the total business loan ratio is associated with a statistically significant +0.0025210 or 0.25210 percent increase in Tobin's q. A simultaneous decrease of 1 percent in the total business loan ratio and a 1 percent increase in the small business loan ratio would result in a statistically significant increase of 0.572 percent in Tobin's q ratio (with p value of 0.004). This portfolio adjustment would also imply a decrease of −0.268 percent in the market-value inefficiency ratio. If this simultaneous portfolio adjustment is combined with a 1 percent decrease in the ratio of total loans to assets, the associated increase in Tobin's q ratio is 0.663 percent.

Finally, based on the results for large banks in Table 11, we find that large banks (with assets of more than $10 billion) may have an incentive to *reduce* the proportion of their assets devoted to business lending in general and SBL in particular. Although neither the coefficient, −0.02716, on the total business loan ratio nor the coefficient, −0.18834, on the small business loan ratio is statistically significant, a 1 percent decrease in both ratios combined with a 1 percent decrease in the ratio of total loans to assets is associated with a statistically significant increase of

0.00338 or 0.338 percent in Tobin's q ratio and a statistically significant decrease of −0.239 percent in the market-value inefficiency ratio.

7. Is Lending to Borrowers Who Default More Often a Value-Enhancing Strategy?

Column 2 in Tables 9, 10, and 11 reports the value of the coefficient on the ratio of nonperforming loans to assets for the regressions in which Tobin's q ratio is the dependent variable. In each of the three cases, the estimate is statistically different from 0 at a better than 1 percent level. Tables 9, 10, and 11, respectively, report that an increase in the nonperformance ratio of 1 percent (+0.01) is associated with a Tobin's q ratio that is lower by 0.0068264 for small community banks, 0.0070018 for large community banks, and 0.017512 for large banks. In other words, the higher nonperformance is associated with worse financial performance across bank size, with the size of the negative effect rising with bank size. Thus, some part of the difference in the Tobin's q ratio between the worst and best financial performers is associated with the higher nonperforming loan ratio in the worst performers. As shown in Table 7, although the worst financial performers, on average, charge their borrowers a higher contractual loan rate (perhaps reflecting the choice to lend to riskier borrowers), lending to borrowers who default more often, even at a higher average contractual interest rate, does not appear to be a value-enhancing strategy.

8. Conclusions

This paper uses 2013 market data to investigate performance and operational efficiencies at publicly traded banks with assets of less than $50 billion. We find that better financial performance is associated with larger asset size. Large community banks with assets between $1 billion and $10 billion exhibit better financial performance, on average, than small community banks with assets of less than $1 billion and that large banks with assets between $10 billion and $50 billion achieve, on average, better financial performance than large community banks. We also find that on average, in each size category, the best performing banks (in terms of highest Tobin's q ratio and lowest market-value inefficiency ratio) are associated with less valuable investment opportunities. This suggests that the better performance is associated with better management of the less valuable investment opportunities that are available.

If such a scale-related improvement in financial performance provides an incentive for smaller banks to grow in size, an important question is whether this might also provide community banks with an incentive to reduce the proportion of their assets allocated to small business loans as they grow in size to achieve scale economies. We find no evidence in support of this hypothesis. There is a significant positive relationship between financial performance and the ratio of small business loans to assets at large community banks, suggesting they would have financial incentives to increase their small business loan share as they become larger. This finding is consistent with the results of Jagtiani, Kotlier, and Maingi (2015).[21]

In estimating the contribution of total business lending and SBL to financial performance, we find that small publicly traded community banks have financial incentives to shift their lending from small businesses to larger businesses, while large community banks have a financial incentive to increase lending to small businesses. The case is different for large banks, where we find that performance is positively related to a proportional decrease in total business lending and SBL. This suggests that large banks have financial incentives to reduce their asset shares in overall business loans and in loans to small businesses.

Overall, our evidence shows that, on average, large community banks outperform small community banks. This may reflect that the costs of regulatory compliance and technology both have a fixed cost component, which results in there being a size below which the costs outweigh any lending advantages a small community bank might have. The positive relationship between the better financial performance of large community banks and their SBL activities suggests that SBL is an important component of large community banks' portfolio. Therefore, the concern that as small

[21] Jagtiani, Kotlier, and Maingi (2015) find that there were no adverse impacts on the overall lending to small businesses when small community banks grew larger as they became part of a larger acquiring bank. In fact, the combined banking firms increased their lending to small businesses more when the acquirers are large banks.

community banks become larger, they might become less effective at lending to small businesses and reduce the proportion of assets devoted to SBL, thereby adversely affecting small businesses' access to credit, is not supported by the results in this paper.

References

Baele, L., O. De Jonghe, and R. Vander Vennet (2007). "Does the Stock Market Value Bank Diversification?" *Journal of Banking and Finance* 31, 1999–2023.

Bauer, Paul W. (1990). "Recent Developments in the Econometric Estimation of Frontiers," *Journal of Econometrics* 46, 39–56.

Beccalli, Elena, and Pascal Frantz (2013). "The Determinants of Mergers and Acquisitions in Banking," *Journal of Financial Services Research* 43 (3), 265–291.

Berger, Allen, Geraldo Cerqueiro, and María Fabiana Penas (2014). "Market Size Structure and Small Business Lending: Are Crisis Times Different from Normal Times?" *Review of Finance*, 1–31.

Berger, Allen, Adrian Cowan, and Scott Frame (2011). "The Surprising Use of Credit Scoring in Small Business Lending by Community Banks and the Attendant Effects on Credit Availability, Risk, and Profitability," *Journal of Financial Services Research* 39, 1–17.

Berger, Allen, Scott Frame, and Nathan Miller (2005). "Credit Scoring and the Availability, Price, and Risk of Small Business Credit," *Journal of Money, Credit, and Banking* 37, 191–222.

Berger, Allen, William Goulding, and Tara Rice (2014). "Do Small Businesses Still Prefer Community Banks?" *Journal of Banking and Finance* 44, 264–278.

Berger, Allen, Nathan Miller, Mitchell Petersen, Raghuram Rajan, and Jeremy Stein (2005). "Does Function Follow Organizational Form? Evidence from the Lending Practice of Large and Small Banks," *Journal of Financial Economics* 76 (2), 237–269.

Berger, Allen, and Gregory Udell (2006). "A More Complete Conceptual Framework for SME Finance," *Journal of Banking and Finance* 30, 2945–2966.

Chakraborty, Atreya, and Charles Hu (2006). "Lending Relationships in Line-of-Credit and Nonline-of-Credit Loans: Evidence from Collateral Use in Small Business," *Journal of Financial Intermediation* 15, 86–107.

De Jonghe, O., and R. Vander Vennet (2005). "Competition Versus Agency Costs: An Analysis of Charter Values in European Banking," Working Paper, Ghent University.

DeYoung, Robert, Scott Frame, Dennis Glennon, Daniel McMillen, and Peter Nigro (2008). "Commercial Lending Distance and Historically Underserved Areas," *Journal of Economics and Business* 60, 149–164.

DeYoung, Robert, Scott Frame, Dennis Glennon, and Peter Nigro (2011). "The Information Revolution and Small Business Lending: The Missing Evidence," *Journal of Financial Services Research* 39 (1), 19–33.

DeYoung, Robert, Dennis Glennon, and Peter Nigro (2008). "Borrower-Lender Distance, Credit Scoring, and Loan Performance: Evidence from Informational-Opaque Small Business Borrowers," *Journal of Financial Intermediation* 17 (1), 113–143.

Habib, M.A., and A. Ljungqvist (2005). "Firm Value and Managerial Incentives: A Stochastic Frontier Approach," *Journal of Business* 78, 2053–2093.

Hughes, Joseph P., William Lang, Loretta J. Mester, L.J., and Choon-Geol Moon (1999). "The Dollars and Sense of Bank Consolidation," *Journal of Banking and Finance* 23, 291–324.

Hughes, Joseph P., William Lang, Loretta J. Mester, Choon-Geol Moon, and Michael Pagano (2003). "Do Bankers Sacrifice Value to Build Empires? Managerial Incentives, Industry Consolidation, and Financial Performance," *Journal of Banking and Finance* 27, 417–447.

Hughes, Joseph P., William Lang, Choon-Geol Moon, and Michael Pagano (1997). "Measuring the Efficiency of Capital Allocation in Commercial Banking," Working Paper 98-2, Federal Reserve Bank of Philadelphia (revised as Working Paper 2004-1, Rutgers University Economics Department).

Hughes, Joseph P., and Loretta J. Mester (2010). "Efficiency in Banking: Theory, Practice, and Evidence," in *The Oxford Handbook of Banking,* edited by A.N. Berger, P. Molyneux, and J. Wilson, Oxford University Press, Oxford, 463–485.

Hughes, Joseph P., and Loretta J. Mester (2013a). "A Primer on Market Discipline and Governance of Financial Institutions for Those in a State of Shocked Disbelief," in *Efficiency and Productivity Growth in the Financial Services Industry,* edited by Fotios Pasiouras, John Wiley and Sons, Chichester, West Sussex, United Kingdom, 19–47.

Hughes, Joseph P., and Loretta J. Mester (2013b). "Who Said Large Banks Don't Experience Scale Economies? Evidence from a Risk-Return-Driven Cost Function," *Journal of Financial Intermediation* 22:4, 559–585.

Hughes, Joseph P., and Loretta J. Mester (2015). "Measuring the Performance of Banks: Theory, Practice, Evidence, and Some Policy Implications," in *The Oxford Handbook of Banking,* second edition, edited by Allen N. Berger, Philip Molyneux, and John Wilson, Oxford University Press, Oxford, 247–270.

Hughes, Joseph P., Loretta J. Mester, and Choon-Geol Moon (2001). "Are Scale Economies in Banking Elusive or Illusive? Incorporating Capital Structure and Risk into Models of Bank Production," *Journal of Banking and Finance* 25 (12), 2169–2208.

Hughes, Joseph P., and Choon-Geol Moon (2003). "Estimating Managers' Utility Maximizing Demand for Agency Goods," Rutgers University, Working Paper 2003-24.

Jagtiani, Julapa, Ian Kotliar, and Raman Quinn Maingi (2015). "The Evolution of U.S. Community Banks and Its Impact on Small Business Lending," Federal Reserve Bank of Philadelphia, Research Working Paper RWP14-16R.

Jagtiani, Julapa, and Cathy Lemieux (2016). "Small Business Lending: Challenges and Opportunities for Community Banks — Before, During, and After the Financial Crisis," Federal Reserve Bank of Philadelphia, Working Paper #RWP 16-08, March.

Jondrow, J., C.A.K. Lovell, I.S. Materov, and P. Schmidt (1982). "On the Estimation of Technical Efficiency in the Stochastic Frontier Production Function Model," *Journal of Econometrics* 19, 233–238.

Kovner, Anna, James Vickery, and L. Zhou (2014). "Do Big Banks Have Lower Operating Costs?" Federal Reserve Bank of New York *Economic Policy Review* (December) 1–27.

Kowalik, Michal (2014). "Can Small Banks Survive Competition from Large Banks?" Federal Reserve Bank of Boston, Working Paper.

McCord, Roisin, and Edward S. Prescott (2014). "The Financial Crisis, the Collapse of Bank Entry, and Changes in the Size Distribution of Banks," Federal Reserve Bank of Richmond *Economic Quarterly* 100 (First Quarter), 23–50.

Mester, Loretta, J. (1999). "Banking Industry Consolidation: What's a Small Business to Do?" Federal Reserve Bank of Philadelphia *Business Review* (January/February), 3–16.

Mester, Loretta J., Leonard Nakamura, and Micheline Renault (2007). "Transaction Accounts and Loan Monitoring," *Review of Financial Studies* 20, 529–556.

Morgan, Donald P., and Adam B. Ashcraft (2003). "Using Loan Rates to Measure and Regulate Bank Risk: Findings and an Immodest Proposal," *Journal of Financial Services Research* 24:2/3, 181–200.

Petersen, Mitchell A., and Raghuram G. Rajan (1995). "The Effect of Credit Market Competition on Lending Relationships," *Quarterly Journal of Economics* 110:2, 407–443.

Peterson, Mitchell A., and Raghuram G. Rajan (2002). "Does Distance Still Matter? The Information Revolution in Small Business Lending," *Journal of Finance* 57, 2533–2570.

Prager, Robin, and John Wolken (2008). "The Evolving Relationship between Community Banks and Small Businesses: Evidence from the Surveys of Small Business Finances," Finance and Economics Discussion Series Working Paper 2008-60.

Figure 1

Market-Value Frontier

This figure illustrates the potential-value frontier that is obtained by stochastic frontier estimation of the quadratic relationship between the market value of assets and the book value of assets net of goodwill. The error term, $\varepsilon_i = \nu_i - \mu_i$, is a composite term used to distinguish statistical noise, $\nu_i \sim$ iid $N(0,\sigma_v^2)$, from the systematic shortfall from bank *i*'s highest potential (frontier) market value. We assume μ_i is distributed exponentially, μ_i (> 0) ~ $\theta \exp(-\theta u)$. The quadratic specification allows the frontier to be nonlinear. The potential-value frontier is the deterministic kernel of the estimated quadratic relationship.

In this example, bank *i* has invested 100 in assets and achieves a market value adjusted for statistical noise, $MVA_i - \nu_i$, of 108. Its highest potential value, $FMVA_i$, is 120. Adjusted for noise, the bank fails to achieve 12 (=120−108) of its potential value. Its market-value inefficiency ratio is 0.10 (=12/120), and its noise-adjusted Tobin's *q* ratio is 1.08 (=108/100).

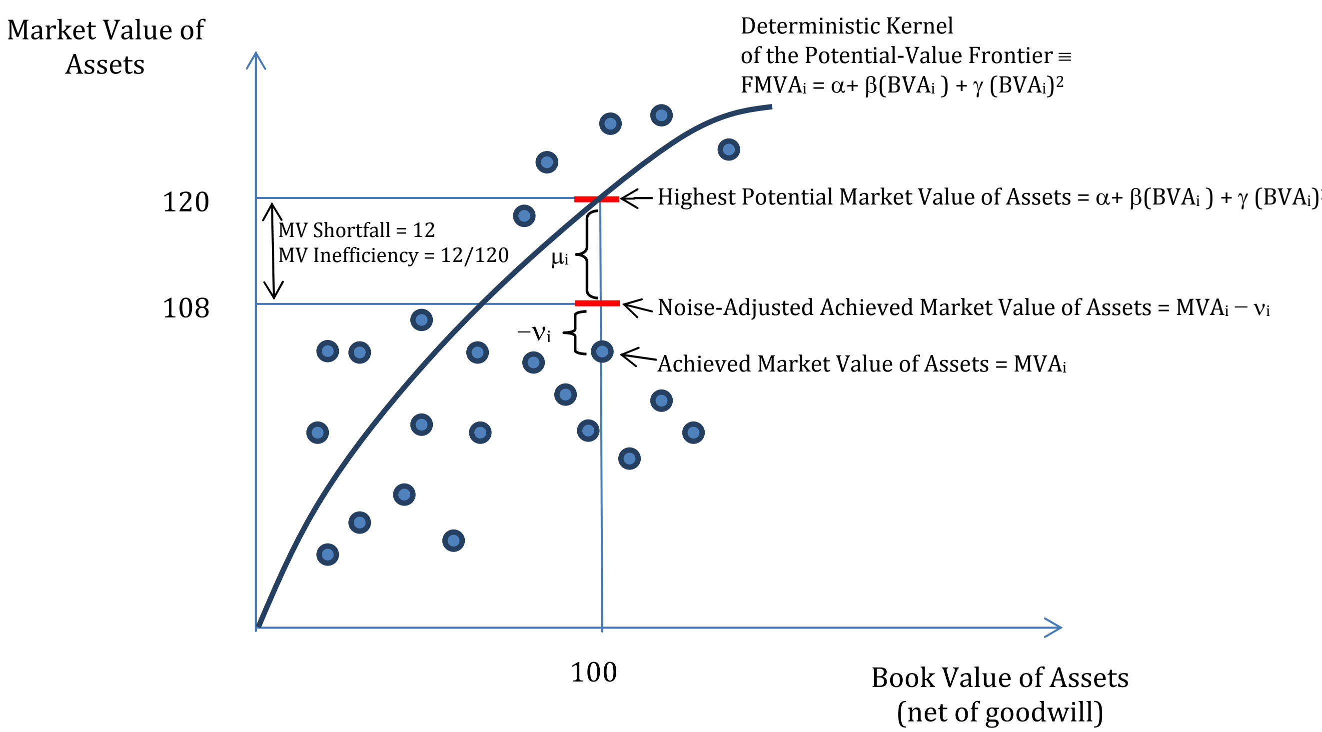

Figure 2

Best-Practice Loan Nonperformance Frontier

This figure illustrates the best-practice minimum *ln*(nonperforming loan volume) that is obtained by stochastic frontier estimation of the quadratic relationship between the *ln*(nonperforming loan volume) and *ln*(total loans), controlling for the loan portfolio composition, the average contractual lending rate, and the GDP growth rate and market concentration in the bank's market. The error term, $\varepsilon_i = \nu_i + \mu_i$, is a composite term used to distinguish statistical noise, $\nu_i \sim$ iid $N(0,\sigma_\nu^2)$, from the term, μ_i, which is a positive, half-normal error term, μ_i (≥ 0) $\sim$ iid $N(0,\sigma_\mu^2)$, that gauges systematic excess nonperformance relative to bank *i*'s best-practice minimum nonperformance. The best-practice minimum *ln*(nonperforming loan volume) is the deterministic kernel of the estimated quadratic function.

In this example, bank *i* has *ln*(total loans) of 2 and experiences *ln*(nonperforming loans) adjusted for statistical noise, $ln(NP_i)+\nu_i$, of 0.7, which is an excess of 0.2 over the best-practice minimum of 0.5. Thus, its *loan performance inefficiency* = $e^{0.2} - 1 = 1.221 - 1 = 0.221$, which implies that this bank's nonperforming loans exceed the best-practice minimum by 22.1 percent.

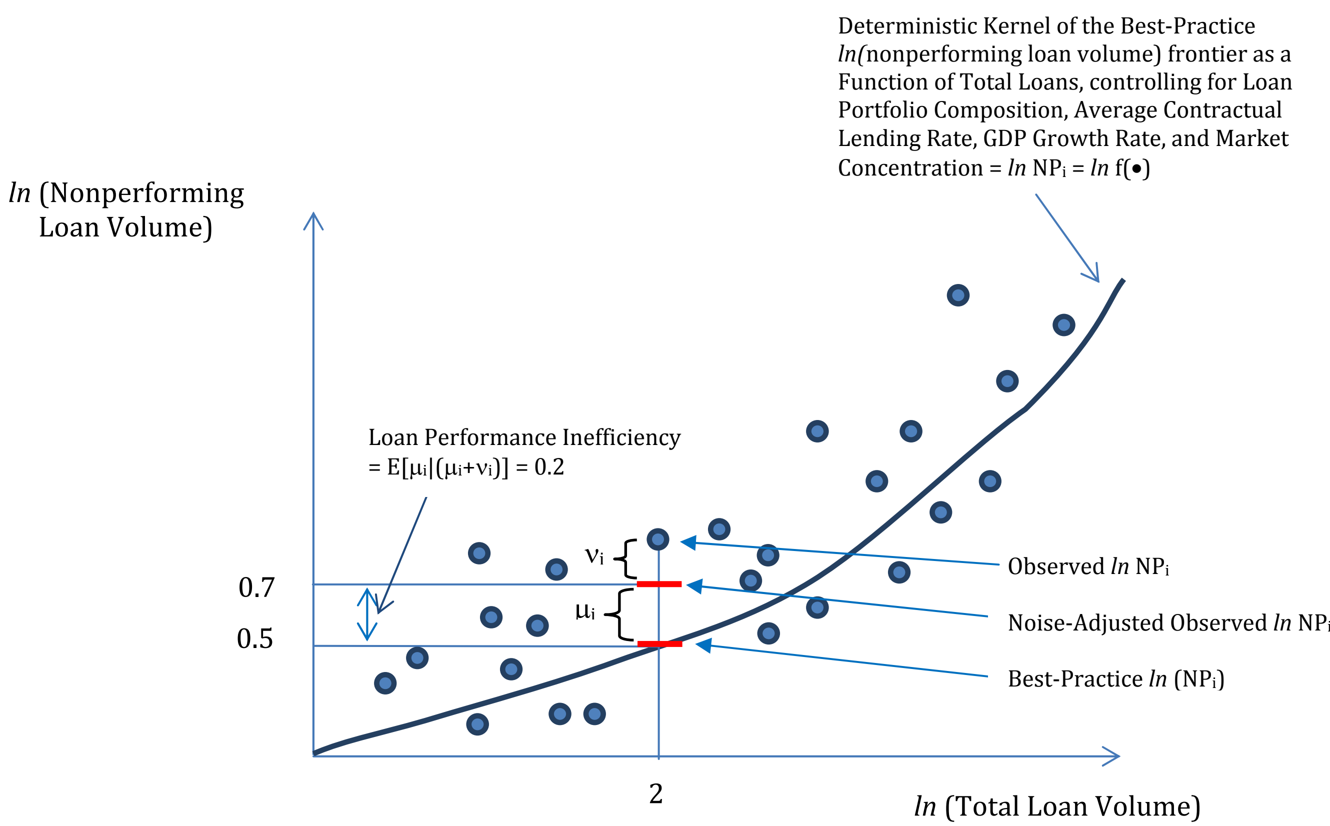

Table 1
Financial Performance

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets of less than $10 billion.

Panel A: Small Community Banks: Consolidated Assets Less Than $1 Billion

	n	**Mean**	**Median**	**Std. Dev.**	**Minimum**	**Maximum**
Book Value Assets (1,000s)	54	702,914	693,177	161,986	340,955	997,275
Noninterest Expense/ Revenue	54	0.653	0.655	0.095	0.423	0.957
Total Revenue/ Assets	54	0.049	0.047	0.008	0.035	0.076
Tobin's *q* Ratio	54	1.003	1.000	0.033	0.951	1.106
Noise-Adjusted *q* Ratio	54	0.988	0.987	0.026	0.939	1.052
Market-Value Inefficiency Ratio	54	0.555	0.554	0.060	0.444	0.700

Panel B: Large Community Banks: Consolidated Assets Between $1 Billion and $10 Billion

	n	**Mean**	**Median**	**Std. Dev.**	**Minimum**	**Maximum**
Book Value Assets (1,000s)	156	3,310,973	2,489,204	2,279,038	1,016,701	9,641,427
Noninterest Expense/ Revenue	156	0.632	0.625	0.119	0.272	1.071
Total Revenue/ Assets	156	0.048	0.046	0.016	0.028	0.223
Tobin's *q* Ratio	156	1.058	1.048	0.061	0.926	1.313
Noise-Adjusted *q* Ratio	156	1.062	1.059	0.044	0.943	1.199
Market-Value Inefficiency Ratio	156	0.264	0.254	0.117	0.045	0.474

Panel C: Large Banks: Consolidated Assets Between $10 Billion and $50 Billion

	n	**Mean**	**Median**	**Std. Dev.**	**Minimum**	**Maximum**
Book Value Assets (1,000s)	35	21,270,101	18,651,693	9,280,070	10,989,286	47,138,960
Noninterest Expense/ Revenue	35	0.596	0.594	0.119	0.319	0.881
Total Revenue/ Assets	35	0.048	0.045	0.009	0.034	0.078
Tobin's *q* Ratio	35	1.067	1.066	0.040	0.971	1.181
Noise-Adjusted *q* Ratio	35	1.073	1.074	0.036	0.975	1.149
Market-Value Inefficiency Ratio	35	0.083	0.084	0.029	0.020	0.151

Table 2
Financial Performance
Sample Partitioned by Size Group Based on Consolidated Assets

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than $p = 0.10$.

	Small Community Banks (Banks <$1 Bill) vs. Large Community Banks (Banks $1Bill–$10 Bill)			**Small Community Banks (Banks <$1 Bill) vs. Large Banks (Banks $10 Bill–50 Bill)**			**Large Community Banks (Banks $1Bill –$10 Bill) vs. Large Banks (Banks $10 Bill–$50 Billion)**		
	<$1 B	**$1 B–$10 B**		**<$1 B**	**$10 B–$50 B**		**$1 B–$10 B**	**$10 B–$50 B**	
	***n* = 54**	***n* = 156**		***n* = 54**	***n* = 35**		***n* = 156**	***n* = 35**	
	Mean	**Mean**	***p***	**Mean**	**Mean**	***p***	**Mean**	**Mean**	***p***
Book Value Assets (1,000s)	**702,914**	**3,310,973**	0.00	**702,914**	**21,270,101**	0.00	**3,310,973**	**21,270,101**	0.00
Noninterest Expense/ Total Revenue	0.653	0.632	0.19	**0.653**	**0.596**	0.01	0.632	0.596	0.11
Total Revenue/ Assets	0.049	0.048	0.59	0.049	0.048	0.36	0.048	0.048	0.75
Tobin's *q* Ratio	**1.003**	**1.058**	0.00	**1.003**	**1.067**	0.00	**1.058**	**1.067**	0.00
Noise-Adjusted Tobin's *q* Ratio	**0.988**	**1.062**	0.00	**0.988**	**1.073**	0.00	**1.062**	**1.073**	0.00
Market-Value Inefficiency Ratio	**0.555**	**0.264**	0.00	**0.555**	**0.083**	0.00	**0.264**	**0.083**	0.00

Table 3
Comparisons of Best Financial Performance by Size
Highest Third by Tobin's *q* for Each of the Size Groups

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The mean of each variable is obtained from the third of the size group with the highest Tobin's *q* – the best performers of the group. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than $p = 0.10$.

	Small Community Banks (Banks <$1 Bill) vs. Large Community Banks (Banks $1 Bill–$10 Bill)			Small Community Banks (Banks <$1 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)			Large Community Banks (Banks $1Bill–$10 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)		
	<$1 B	**$1 B–$10 B**		**<$1 B**	**$10 B–$50 B**		**$1 B–$10 B**	**$10 B–$50 B**	
	***n* = 18**	***n* = 52**		***n* = 18**	***n* = 12**		***n* = 52**	***n* = 12**	
	Mean	**Mean**	***p***	**Mean**	**Mean**	***p***	**Mean**	**Mean**	***p***
Book Value Assets (1,000s)	**749,965**	**4,889,973**	0.00	**749,965**	**19,127,849**	0.00	**4,889,973**	**19,127,849**	0.00
Noninterest Expense/Total Revenue	0.627	0.584	0.14	**0.627**	**0.553**	0.10	0.584	0.553	0.40
Total Revenue/ Assets	0.050	0.050	0.87	**0.050**	**0.043**	0.03	**0.050**	**0.043**	0.06
Tobin's *q* Ratio	**1.038**	**1.120**	0.00	**1.038**	**1.109**	0.00	1.120	1.109	0.32
Noise-Adjusted Tobin's *q* Ratio	**1.014**	**1.108**	0.00	**1.014**	**1.110**	0.00	1.108	1.110	0.77
Market-Value Inefficiency Ratio	**0.530**	**0.169**	0.00	**0.530**	**0.056**	0.00	**0.169**	**0.056**	0.00
Investment Opportunity Ratio	**1.726**	**1.286**	0.00	**1.726**	**1.186**	0.00	**1.286**	**1.186**	0.00

Table 4

Operating Expenses

Sample Partitioned by Size Group Based on Consolidated Assets

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than *p* = 0.10.

Corporate overhead consists of the sum of expenses related to accounting, auditing, advertising and marketing, and printing, as well as supplies and postage.[22] *Reporting and compliance* comprises expenses related to legal work, accounting and auditing, and consulting.[23]

	Small Community Banks (Banks <$1 B) vs. Large Community Banks (Banks $1 B–$10 B)			**Small Community Banks (Banks <$1 B) vs. Large Banks (Banks $10 B –$50 B)**			**Large Community Banks (Banks $1 B–$10 B) vs. Large Banks (Banks $10 B–$50 B)**		
	<$1 B	**$1 B–$10 B**		**<$1 B**	**$10 B–$50 B**		**$1 B $10 B**	**$10 B–$50 B**	
	***n* = 54**	***n* = 156**		***n* = 54**	***n* = 35**		***n* = 156**	***n* = 35**	
	Mean	**Mean**	***p***	**Mean**	**Mean**	***p***	**Mean**	**Mean**	***p***
Book Value Assets (1,000s)	**702,914**	**3,310,973**	0.00	**702,914**	**21,270,101**	0.00	**3,310,973**	**21,270,101**	0.00
Noninterest Expense/ Revenue	0.653	0.632	0.19	**0.653**	**0.596**	0.01	0.632	0.596	0.11
Corporate Overhead/ Revenue	**0.030**	**0.026**	0.02	**0.030**	**0.021**	0.00	**0.026**	**0.021**	0.01
Reporting-Compliance/ Revenue	**0.027**	**0.021**	0.03	**0.027**	**0.019**	0.01	0.021	0.019	0.40
Telecom-munications/ Revenue	0.008	0.008	0.94	0.008	0.006	0.12	**0.008**	**0.006**	0.04

[22] This category was used by Kovner Vickery, and Zhou (2014). Although not reported in the tables, corporate overhead represents, on average, 4.7 percent of operating costs for smaller community banks, 4.2 percent for larger community banks, and 3.4 percent for large banks.

[23] On average, reporting and compliance costs account for 4.1 percent of operating costs for smaller community banks, 3.3 percent for larger community banks, and 3.2 percent for large banks.

Table 5

Funding Sources

Sample Partitioned by Size Group Based on Consolidated Assets

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than *p* = 0.10.

	Small Community Banks (Banks <$1 Bill) vs. Large Community Banks (Banks $1 Bill–$10 Bill)			**Small Community Banks (Banks <$1 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)**			**Large Community Banks (Banks $1 Bill–$10 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)**		
	<$1 B	**$1 B–$10 B**		**<$1 B**	**$10 B–$50 B**		**$1 B–$10 B**	**$10 B–$50 B**	
	***n* = 54**	***n* = 156**		***n* = 54**	***n* = 35**		***n* = 156**	***n* = 35**	
	Mean	**Mean**	***p***	**Mean**	**Mean**	***p***	**Mean**	**Mean**	***p***
Book Value Assets (1,000s)	**702,914**	**3,310,973**	0.00	**702,914**	**21,270,101**	0.00	**3,310,973**	**21,270,101**	0.00
Deposits/ (Deposits + Other Borrowed Funds)	0.928	0.918	0.31	**0.928**	**0.875**	0.02	**0.918**	**0.875**	0.04
Book-Value Equity/ Total Assets	**0.098**	**0.106**	0.03	**0.098**	**0.113**	0.00	0.106	0.113	0.15
(Equity + Sub Debt + Loan Loss Reserves)/ Total Assets	**0.110**	**0.117**	0.04	**0.110**	**0.128**	0.00	**0.117**	**0.128**	0.02

Table 6

Asset Allocation and Quality and Off-Balance-Sheet Activity
Sample Partitioned by Size Group Based on Consolidated Assets

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing.

Total business loans include *small business loans*, which are defined as business loans with an initial principal balance of less than $1 million. *Liquid assets* are defined as sum of cash, balances at other financial institutions, federal funds sold, securities, and securities sold under agreement to repurchase.

	Small Community Banks (Banks <$1 Bill) vs. Large Community Banks (Banks $1 Bill–$10 Bill)			**Small Community Banks (Banks <$1 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)**			**Large Community Banks (Banks $1 Bill–$10 Bill) vs. Large Banks (Banks $10 Bill–$50 Bill)**		
	<$1 B	**$1 B–$10 B**		**<$1 B**	**$10 B–$50 B**		**$1 B–$10 B**	**$10 B–$50 B**	
	***n* = 54**	***n* = 156**		***n* = 54**	***n* = 35**		***n* = 156**	***n* = 35**	
	Mean	**Mean**	***p***	**Mean**	**Mean**	***p***	**Mean**	**Mean**	***p***
Book Value Assets (1,000s)	**702,914**	**3,310,973**	0.00	**702,914**	**21,270,101**	0.00	**3,310,973**	**21,270,101**	0.00
Real Estate (RE)Loans/ Assets	**0.553**	**0.502**	0.00	**0.553**	**0.387**	0.00	**0.502**	**0.387**	0.00
Residential RE Loans/Assets	0.230	0.219	0.48	**0.230**	**0.189**	0.05	0.219	0.189	0.11
Commercial RE Loans/Assets	**0.323**	**0.283**	0.00	**0.323**	**0.197**	0.00	**0.283**	**0.197**	0.00
Consumer Loans/Assets	0.023	0.032	0.25	0.023	0.037	0.11	0.032	0.037	0.47
Total Business Loans/Assets	**0.081**	**0.100**	0.03	**0.081**	**0.159**	0.00	**0.100**	**0.159**	0.00
Small Business Loans/ Assets	0.046	0.039	0.21	**0.046**	**0.031**	0.03	**0.039**	**0.031**	0.09
Liquid Assets/ Assets	0.267	0.270	0.83	0.267	0.280	0.64	0.270	0.280	0.70
Noninterest Income/ Total Revenue	0.188	0.204	0.41	**0.188**	**0.261**	0.01	**0.204**	**0.261**	0.05
Nonperforming Loans/Assets	0.029	0.024	0.13	0.029	0.023	0.17	0.024	0.023	0.76
Average Contractual Interest Rate on Loans	**0.052**	**0.049**	0.04	**0.052**	**0.046**	0.00	0.049	0.046	0.11

Table 7

Asset Allocation and Quality and Off-Balance-Sheet Activity Sample Partitioned by Size Group Based on Highest and Lowest Thirds by Tobin's *q*

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than *p* = 0.10.

	Small Community Banks Banks <$1 B High and Low Thirds by Tobin's *q* ratio			Large Community Banks Banks $1 B–$10 B High and Low Thirds by Tobin's *q* ratio			Large Banks Banks $10 B–$50 B High and Low Thirds by Tobin's *q* ratio		
	Low *q*	High *q*		Low *q*	High *q*		Low *q*	High *q*	
	n = 18	*n* = 18		*n* = 52	*n* = 52		*n* = 12	*n* = 12	
	Mean	Mean	*p*	Mean	Mean	*p*	Mean	Mean	*p*
Book Value Assets (1,000s)	676,904	749,965	0.17	**2,101,587**	**4,889,973**	0.00	24,836,997	19,127,849	0.19
Real Estate (RE) Loans/Assets	0.570	0.538	0.41	0.521	0.495	0.31	0.406	0.388	0.77
Residential RE Loans/Assets	0.216	0.233	0.57	0.233	0.212	0.31	0.213	0.185	0.57
Commercial RE Loans/Assets	0.353	0.305	0.11	0.288	0.283	0.81	0.192	0.201	0.81
Consumer Loans/Assets	0.031	0.023	0.68	0.024	0.032	0.29	0.050	0.025	0.11
Total Business Loans/Assets	0.072	0.084	0.45	0.093	0.103	0.46	0.149	0.141	0.82
Small Business Loans/ Assets	0.040	0.042	0.78	0.036	0.042	0.23	0.040	0.029	0.38
Liquid Assets/Assets	0.251	0.285	0.36	0.276	0.264	0.58	0.238	0.322	0.19
Noninterest Income/ Total Revenue	0.169	0.204	0.35	**0.179**	**0.232**	0.02	0.284	0.226	0.42
Nonperforming Loans/Assets	**0.043**	**0.021**	0.00	**0.033**	**0.017**	0.00	**0.037**	**0.012**	0.03
Average Contractual Interest Rate on Loans	0.056	0.050	0.11	**0.050**	**0.046**	0.01	0.049	0.044	0.17

Table 8

Loans, Loan Rates, and Loan Performance Efficiency
Sample Partitioned by Size Group Based on Highest and Lowest Thirds by Tobin's *q*

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. A stochastic frontier is estimated to obtain a bank's best-practice, i.e., minimum *ln*(nonperforming loan volume) for any given *ln*(total loan volume), controlling for the asset composition of its portfolio, the average contractual lending rate, and the macroeconomic growth rate and market concentration across the bank's markets. *Loan performance inefficiency* is gauged by the excess of a bank's observed nonperforming loan volume, adjusted for statistical noise, from its best-practice frontier and answers the question: Given the bank's volume of total loans, loan portfolio composition, *ex ante* credit risk, and market conditions, by what percentage could the bank lower its volume of nonperforming loans were it fully efficient at credit-risk evaluation and loan monitoring? The *ratio of the stochastic frontier (best-practice) value of nonperforming loans to total loans* represents the inherent *ex post* credit risk of the portfolio. The *p* value represents the statistical significance of the comparison of means in the pairing. Pairs of means in **bold** are statistically different at better than $p = 0.10$.

	Small Community Banks Banks <$1 Bill High and Low Thirds by Tobin's *q* ratio			**Large Community Banks Banks $1 Bill–$10 Bill High and Low Thirds by Tobin's *q* ratio**			**Large Banks Banks $10 Bill–$50 Bill High and Low Thirds by Tobin's *q* ratio**		
	Low *q*	**High *q***		**Low *q***	**High *q***		**Low *q***	**High *q***	
	***n* = 18**	***n* = 18**	***p***	***n* = 52**	***n* = 52**	***p***	**n = 12**	***n* = 12**	***p***
Book Value Assets (1,000s)	676,904	749,965	0.17	**2,101,587**	**4,889,973**	0.00	24,836,997	19,127,849	0.19
Tobin's *q* Ratio	**0.971**	**1.038**	0.00	**1.003**	**1.120**	0.00	**1.028**	**1.109**	0.00
Herfindahl Index of Competition	0.117	0.094	0.30	0.102	0.102	0.95	0.109	0.104	0.79
10-Year Average GDP Growth Rate	3.375	3.556	0.32	**3.573**	**4.045**	0.01	3.849	4.419	0.23
Average Contractual Interest Rate on Loans	0.056	0.050	0.11	**0.050**	**0.046**	0.01	0.049	0.044	0.17
Loan Performance Inefficiency	**0.222**	**0.259**	0.04	**0.223**	**0.241**	0.10	**0.179**	**0.222**	0.00
Stochastic Frontier Nonperforming Loans/Total Loans	**0.054**	**0.027**	0.01	**0.042**	**0.022**	0.00	**0.046**	**0.016**	0.02
Nonperforming Loans/Total Loans	**0.065**	**0.033**	0.01	**0.050**	**0.026**	0.00	**0.054**	**0.020**	0.02
Nonperforming Loans/Assets	**0.043**	**0.021**	0.00	**0.033**	**0.017**	0.00	**0.037**	**0.012**	0.03

Table 9

Small Community Banks: Less Than $1 Billion in Consolidated Assets

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. Regressions are estimated with OLS, and standard errors are heteroscedasticity consistent. Parameter estimates in **bold** are significantly different from zero at better than 10%.

	Dependent Variable					
	Tobin's *q* Ratio		Noise-Adjusted Tobin's *q* Ratio		Market-Value Inefficiency	
Variable	**Parameter Estimate**	**Pr > |t|**	**Parameter Estimate**	**Pr > |t|**	**Parameter Estimate**	**Pr > |t|**
Intercept	−1.74032	0.2175	−1.02372	0.2386	**4.60037**	<.0001
Investment Opportunity Ratio	**0.23704**	0.0978	0.09367	0.2760	**−0.06565**	0.0789
ln (Book Value Assets (1,000s))	**0.14511**	0.0666	**0.12026**	0.0172	**−0.28360**	<0.0001
Total Loans/Assets	0.21026	0.4568	0.13264	0.4701	−0.07842	0.3003
Residential RE Loans/Assets	0.08898	0.7727	0.05224	0.7895	−0.02463	0.7649
Commercial RE Loans/Assets	0.03711	0.9004	0.02201	0.9075	−0.01155	0.8806
Consumer Loans/Assets	0.05764	0.8516	0.03668	0.8521	−0.03016	0.7117
Total Business Loans/Assets	0.23341	0.5342	0.13869	0.5597	−0.07735	0.4438
Small Business Loans/Assets	**−0.27418**	0.0229	**−0.16875**	0.0235	**0.10243**	0.0227
Liquid Assets/Assets	0.28173	0.2204	0.17161	0.2233	−0.09748	0.1371
Noninterest Income/Total Revenue	**0.11578**	0.0070	**0.07288**	0.0096	**−0.03845**	0.0120
Nonperforming Loans/Assets	**−0.68264**	0.0048	**−0.46807**	0.0028	**0.19023**	0.0054
Deposits/(Deposits+ Other Borrowed Funds)	**0.11171**	0.0316	**0.06909**	0.0397	**−0.02923**	0.0648
(Equity + Sub Debt + Loan Loss Reserves)/ Assets	0.16216	0.3728	0.09877	0.3923	−0.01390	0.9806
n = 54	Adj. R Sq = 0.271	F=2.51	Adj. R Sq = 0.518	F=5.39	Adj. R Sq = 0.981	F=210.56
+1% in Business Loans and −1% in Small Business Loans	**0.508**	0.052	0.307	0.240	−0.180	0.146
+1% in Total Loans and +1% in Business Loans	**0.444**	0.059	**0.271**	0.058	**−0.156**	0.022
+1% in Total Loans, +1% in Business Loans and −1% in Small Business Loans	**0.718**	0.026	**0.440**	0.026	**−0.258**	0.013

Table 10

Large Community Banks: Consolidated Assets Between $1 Billion and $10 Billion

The data set includes 245 top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. Regressions are estimated with OLS, and standard errors are heteroscedasticity consistent. Parameter estimates in **bold** are significantly different from zero at better than 10%.

	Dependent Variable					
	Tobin's *q* Ratio		**Noise-Adjusted Tobin's *q* Ratio**		**Market-Value Inefficiency**	
Variable	**Parameter Estimate**	**Pr > |t|**	**Parameter Estimate**	**Pr > |t|**	**Paramete r Estimate**	**Pr > |t|**
Intercept	**1.33072**	0.0002	**1.11716**	<.0001	**1.76909**	<0.0001
Investment Opportunity Ratio	**−0.22608**	0.0220	**−0.16871**	0.0047	**0.28211**	<0.0001
log (Book Value Assets (1,000s))	0.01025	0.4802	**0.01618**	0.0822	**−0.13114**	<0.0001
Total Loans/Assets	−0.09115	0.3350	−0.04034	0.4477	0.00631	0.8610
Residential RE Loans/Assets	−0.12066	0.3196	−0.09263	0.2298	0.08633	0.1285
Commercial RE Loans/Assets	−0.02609	0.8020	−0.03637	0.5963	0.04452	0.3706
Consumer Loans/Assets	−0.05952	0.6332	−0.04736	0.5489	0.04335	0.4479
Total Business Loans/Assets	**−0.25210**	0.0627	**−0.18588**	0.0338	**0.15269**	0.0362
Small Business Loans/Assets	**0.32021**	0.0400	**0.23502**	0.0166	−0.11576	0.2120
Liquid Assets/Assets	−0.14120	0.2650	−0.10248	0.1793	0.08926	0.1394
Noninterest Income/Total Revenue	0.01639	0.3833	0.00357	0.7771	0.00477	0.7347
Nonperforming Loans/Assets	**−0.70018**	0.0029	**−0.60507**	0.0016	**0.53869**	0.0018
Deposits/(Deposits + Other Borrowed Funds)	0.01855	0.7501	0.03595	0.3844	−0.04228	0.2023
(Equity + Sub Debt + Loan Loss Reserves)/ Assets	0.19672	0.3059	0.08060	0.5354	0.04463	0.6202
n = 156	Adj. R Sq = 0.396	F=8.82	Adj. R Sq = 0.559	F=16.12	Adj. R Sq = 0.958	F=270.41
−1% in Business Loans and +1% in Small Business Loans	**0.572**	0.004	**0.421**	0.002	**−0.268**	0.039
−1% in Total Loans and −1% in Business Loans	**0.343**	0.008	**0.226**	0.005	**−0.159**	0.029
−1% in Total Loans, −1% in Business Loans, and +1% in Small Business Loans	**0.663**	0.001	**0.461**	0.000	**!0.275**	0.035

Table 11

Large Banks: Consolidated Assets Between $10 Billion and $50 Billion

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. Regressions are estimated with OLS, and standard errors are heteroscedasticity consistent. Parameter estimates in **bold** are significantly different from zero at better than 10%.

	Dependent Variable					
	Tobin's *q* Ratio		**Noise-Adjusted Tobin's *q* Ratio**		**Market-Value Inefficiency**	
Variable	**Parameter Estimate**	**Pr > |t|**	**Paramete r Estimate**	**Pr > |t|**	**Paramete r Estimate**	**Pr > |t|**
Intercept	**2.11641**	<.0001	**2.10431**	<.0001	−0.23872	0.3330
Investment Opportunity Ratio	−0.14011	0.3796	−0.11029	0.4118	0.09439	0.4179
ln (Book Value Assets (1,000s))	**−0.04870**	0.0050	**−0.05000**	0.0013	0.00988	0.4176
Total Loans/Assets	**−0.12249**	0.0021	**−0.11084**	0.0016	**0.08370**	0.0071
Residential RE Loans/Assets	−0.06433	0.5025	−0.02774	0.7330	0.01752	0.7997
Commercial RE Loans/Assets	**−0.19243**	0.0723	−0.13761	0.1228	0.11507	0.1234
Consumer Loans/Assets	0.04454	0.8091	0.10738	0.4902	−0.11066	0.4024
Total Business Loans/Assets	−0.02716	0.8031	0.01576	0.8716	−0.01854	0.8220
Small Business Loans/Assets	−0.18834	0.2618	−0.21232	0.1979	0.17425	0.2299
Liquid Assets/Assets	−0.10054	0.2088	−0.07904	0.2494	0.05412	0.3443
Noninterest Income/ Total Revenue	**−0.13306**	0.0152	**−0.10602**	0.0259	**0.08958**	0.0308
Nonperforming Loans/Assets	**−1.07512**	<.0001	**−1.03135**	<.0001	**0.90489**	<0.0001
Deposits/(Deposits + Other Borrowed Funds)	**0.14470**	0.0178	**0.11176**	0.0186	**−0.09534**	0.0200
(Equity + Sub Debt + Loan Loss Reserves)/Assets	0.21896	0.4352	0.10223	0.6470	−0.04803	0.7940
n = 35	Adj. R Sq = 0.700	F=7.09	Adj. R Sq = 0.718	F=7.66	Adj. R Sq = 0.676	F=6.45
−1% in Business Loans and −1% in Small Business Loans	0.216	0.184	0.197	0.224	−0.156	0.261
−1% in Total Loans, −1% in Business Loans, and −1% in Small Business Loans	**0.338**	0.039	**0.307**	0.055	**−0.239**	0.085
−1% in Total Loans and −1% in Commercial Real Estate Loans	**0.315**	0.005	**0.248**	0.005	**−0.199**	0.008

Appendix A
Value of Investment Opportunities, Branching Structure, Asset Acquisitions, and Sales

Tables A1 and A2 show summary statistics on the value of investment opportunities, branching structure, and asset acquisitions and sales by bank-size group. We observe statistically significant differences across all three categories of banks (small community banks, large community banks, and large banks) for most of the activities, except for assets acquired and assets sold ratios between large banks and either category of community banks. As expected, large banks are significantly more active in these activities than are community banks.

Table A3 focuses on community banks only. The left panel compares the third of the sample with the lowest Tobin's *q* ratio (worst performers) with the third with the highest Tobin's *q* ratio (best performers). The right panel compares the third of the sample with the highest market-value inefficiency ratio (i.e., the most inefficient, or equivalently, the least efficient) with the third with the lowest market-value inefficiency ratio (i.e., the least inefficient, or equivalently, the most efficient). We find that community banks in the third with the highest Tobin's *q* ratio or most efficient are, on average, larger, operate with more branches, and have more geographically diversified deposits.[24] Over the period from 2011 to 2014, the most valuable third of the publicly traded community banks also acquired more institutions and sold more institutions.

Although the most valuable third exhibits, on average, a lower investment opportunity ratio, they are able to achieve a higher average Tobin's *q* ratio, which suggests their management is better at exploiting investment opportunities. In other words, they achieve a higher proportion of their potential market value, or equivalently, have lower market value inefficiency; that is, the proportion of their potential value that they fail to achieve, after statistically eliminating the effects of luck or other noise, is lower. This is similar to our findings reported in Table 3 for large banks (with $10 billion to $50 billion in assets), which indicate that, on average, large banks have the lowest valued

[24] The deposit dispersion index is a Herfindahl index constructed as the weighted sum of the bank holding company's squared share of deposits in each of its states, where the weights are the proportion of total bank deposits found in each state.

investment opportunities, achieve the highest Tobin's q ratio, and are the most market-value efficient.

Table A1

Value of Investment Opportunities, Branching Structure, Asset Acquisitions, and Sales

The data set includes 245 publicly traded top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion.

Panel A: Consolidated Assets Less Than $1 Billion

	n	Mean	Median	Std. Dev.	Minimum	Maximum
Book Value Assets (1,000s)	54	702,914	693,177	161,986	340,955	997,275
Investment Opportunity Ratio	54	1.759	1.721	0.148	1.573	2.285
Number of Branches	54	13.333	13.000	6.225	1.000	29.000
Number of States	54	1.296	1.000	0.537	1.000	3.000
Deposit Dispersion Index	54	1.100	1.000	0.211	1.000	1.779
Number of Institutions Acquired 2011–2014	54	0.185	0.000	0.517	0.000	3.000
Number of Institutions Sold 2011–2014	54	0.148	0.000	0.359	0.000	1.000
Assets Acquired 2011–2014/ Total Assets in 2013	54	0.005	0.000	0.038	0.000	0.278
Assets Sold 2011–2014/ Total Assets in 2013	54	0.005	0.000	0.038	0.000	0.278

Panel B: Consolidated Assets Between $1 Billion and $10 Billion

	n	Mean	Median	Std. Dev.	Minimum	Maximum
Book Value Assets (1,000s)	156	3,310,973	2,489,204	2,279,038	1,016,701	9,641,427
Investment Opportunity Ratio	156	1.358	1.340	0.107	1.125	1.586
Number of Branches	156	46.269	31.500	37.916	1.000	178.000
Number of States	156	2.051	2.000	1.418	1.000	8.000
Deposit Dispersion Index	156	1.373	1.011	0.651	1.000	5.742
Number of Institutions Acquired, 2011–2014	156	1.250	0.000	2.435	0.000	19.000
Number of Institutions Sold, 2011–2014	156	0.853	0.000	1.602	0.000	9.000
Assets Acquired, 2011–2014/ Total Assets in 2013	156	0.066	0.000	0.247	0.000	2.006
Assets Sold, 2011–2014/ Total Assets in 2013	156	0.034	0.000	0.149	0.000	1.050

Table A1, continued

Panel C: Consolidated Assets Between $10 Billion and $50 Billion

	n	Mean	Median	Std. Dev.	Minimum	Maximum
Book Value Assets (1,000s)	35	21,270,101	18,651,693	9,280,070	10,989,286	47,138,960
Investment Opportunity Ratio	35	1.199	1.214	0.043	1.109	1.257
Number of Branches	35	183.600	193.000	118.436	1.000	425.000
Number of States	35	4.600	4.000	3.210	1.000	18.000
Deposit Dispersion Index	35	1.898	1.684	0.863	1.000	4.019
Number of Institutions Acquired, 2011–2014	35	2.629	1.000	3.789	0.000	16.000
Number of Institutions Sold, 2011–2014	35	1.543	1.000	1.597	0.000	5.000
Assets Acquired, 2011–2014/ Total Assets in 2013	35	0.074	0.000	0.255	0.000	1.132
Assets Sold, 2011–2014/ Total Assets in 2013	35	0.019	0.000	0.072	0.000	0.394

Table A2

Value of Investment Opportunities, Branching Structure, Asset Acquisitions, and Sales
Sample Partitioned by Size Group Based on Consolidated Assets

The data represent 245 top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion. The *p* value represents the statistical significance of the comparison of means in the pairing.

	Banks <$1 Bill vs. Banks $1 Bill–$10 Bill			Banks <$1 Bill vs. Banks $10 Bill–$50 Bill			Banks $1 Bill–$10 Bill vs. Banks $10 Bill–$50 Bill		
	<$1 B	$1 B–$10 B		<$1 B	$10 B–$50 B		$1 B–$10 B	$10 B–$50 B	
	n = 54	*n* = 156		*n* = 54	*n* = 35		*n* = 156	*n* = 35	
	Mean	Mean	*p*	Mean	Mean	*p*	Mean	Mean	*p*
Book Value Assets (1,000s)	702,914	3,310,973	0.00	702,914	21,270,101	0.00	3,310,973	21,270,101	0.00
Investment Opportunity Ratio	1.759	1.358	0.00	1.759	1.199	0.00	1.358	1.199	0.00
Number of Branches	13.333	46.269	0.00	13.333	183.600	0.00	46.269	183.600	0.00
Number of States	1.296	2.051	0.00	1.296	4.600	0.00	2.051	4.600	0.00
Deposit Dispersion Index	1.100	1.373	0.00	1.100	1.898	0.00	1.373	1.898	0.00
Number of Institutions Acquired, 2011–2014	0.185	1.250	0.00	0.185	2.629	0.00	1.250	2.629	0.05
Number of Institutions Sold, 2011–2014	0.148	0.853	0.00	0.148	1.543	0.00	0.853	1.543	0.02
Assets Acquired, 2011–2014/ Total Assets in 2013	0.005	0.066	0.00	0.005	0.074	0.12	0.066	0.074	0.85
Assets Sold, 2011–2014/ Total Assets in 2013	0.005	0.034	0.03	0.005	0.019	0.30	0.034	0.019	0.56

Table A3

Value of Investment Opportunities, Branching Structure, Asset Acquisitions, and Sales

Sample Partitioned by Smallest and Largest Thirds of Community Banks by Tobin's *q* Ratio or Inefficiency Ratio

The data represent 245 top-tier bank holding companies at the end of 2013. *Community banks* are defined as companies with consolidated assets less than $10 billion.

	Smallest and Largest Thirds of Banks <$10 Bill by Tobin's *q* Ratio				Most and Least Inefficient Thirds of Banks <$10 Bill by the Market-Value Inefficiency Ratio			
		Smallest Tobin's *q* Ratio	Largest Tobin's *q* Ratio			Most Inefficient (≡ Least Efficient)	Least Inefficient (≡ Most Efficient)	
	N	Mean	Mean	*p*	*n*	Mean	Mean	*p*
Book Value Assets (1,000s)	70	1,189,809	4,350,715	0.00	70	790,789	5,305,883	0.00
Investment Opportunity Ratio	70	1.633	1.328	0.00	70	1.708	1.265	0.00
Number of Branches	70	19.600	56.600	0.00	70	15.057	69.743	0.00
Number of States	70	1.629	2.200	0.01	70	1.414	2.543	0.00
Deposit Dispersion Index	70	1.203	1.393	0.02	70	1.156	1.572	0.00
Number of Institutions Acquired, 2011–2014	70	0.257	1.429	0.00	70	0.200	2.043	0.00
Number of Institutions, Sold, 2011–2014	70	0.186	1.071	0.00	70	0.171	1.400	0.00
Assets Acquired, 2011–2014/ Total Assets in 2013	70	0.004	0.075	0.04	70	0.004	0.080	0.01
Assets Sold, 2011–2014/ Total Assets in 2013	70	0.008	0.015	0.44	70	0.008	0.044	0.06

Appendix B
The Effectiveness of Banks' Credit Analysis and Monitoring

B.1. Background

For each bank-size group, Table 7 compares the asset allocation of the top-third performing banks with that of the bottom-third performing banks. As shown, in each size category, the worst-performing third has a statistically significant mean higher proportion of nonperforming loans – nearly twice as large – as that of the best performing third. One possibility is that the worst-performing banks are making different types of loans that default more often. However, as shown in Table 7, the allocation of assets into the categories shown are not statistically different across the best and worst performing banks in any size category.

Because the composition of the asset portfolio does not differ statistically by the type of constituent assets, it may nevertheless differ by the riskiness of these types of assets. One possibility is that banks with higher levels of nonperforming loans may be electing to lend to riskier borrowers who have a higher expected level of default. Alternatively, the higher level of nonperformance may reflect less effective credit analysis and loan monitoring. Either way, the higher proportion of nonperforming loans is associated with worse performance.

We use stochastic frontier techniques in a novel way to distinguish between nonperformance due to the degree of effectiveness of credit evaluation and monitoring and nonperformance due to the degree of risk-taking inherent in the loan portfolio. The details follow.

B.2. The Best-Practice Loan Performance and the Efficiency of Credit Evaluation and Monitoring

A bank's ratio of nonperforming loans to total loans is a common ex post measure of the riskiness of the bank's loans. On the other hand, the *average contractual interest* charged on a bank's loans gauges ex ante riskiness because it contains a risk premium that reflects the loan portfolio's average ex ante credit risk, collateral, and maturity structure. Morgan and Ashcraft (2003, p. 181) make this point: "There is strong evidence that the interest rates charged by banks on the flow of newly extended Commercial & Industrial (C&I) loans predict future loan performance and CAMEL rating downgrades by bank supervisors." Moreover, the adverse selection that results from charging a higher contractual interest rate on a particular type of loan results in higher credit risk and a higher expected rate of nonperformance.

Thus, higher expected nonperformance is linked to charging a higher contractual interest rate. For any particular average contractual interest rate, the realized volume of nonperforming loans given total loan volume depends in part on the efficiency of credit evaluation and loan monitoring. For example, if a bank does a poor job of credit evaluation, then for any given contractual interest rate, it will have underestimated the riskiness of its loans and will experience a higher rate of nonperformance for its average contractual interest rate than a bank that accurately evaluates credit risk and lends to better credit risks at the same contractual interest rate. Or, if two banks did accurate jobs of evaluating credit risk when extending new loans but one bank does a worse job of monitoring its loans, it will experience worse performance than the other bank. Thus, *for any given volume of loans and average contractual interest rate charged on them, the volume of nonperforming loans varies in part with the efficiency of credit evaluation and monitoring.*

Macroeconomic conditions and market concentration in a bank's lending markets also influence the rate of nonperformance. Petersen and Rajan (1995) provide evidence that the relationship between the contractual interest rate and nonperformance depends on banks' market power in their lending markets. Banks that operate without significant competition from other lenders are able to price initial loans to new businesses at lower-than-competitive rates to reduce the probability of default. As the businesses succeed and become more experienced, the bank can make up revenue lost to the previous lower rate. That is to say, the rate falls but not as much as it would in a more competitive market.

B.3. Specifying and Estimating the Best-Practice Loan Nonperformance Frontier

We use stochastic frontier techniques and maximum likelihood estimation to estimate a *best-practice loan performance frontier* that determines the minimum *ln*(NP) = *ln*(nonperforming loan volume), conditional on the *ln*(total loan volume), average contractual interest rate, macroeconomic conditions and market concentration in the bank's markets, and portfolio composition. That is,

$$ln\ NP_i = \boldsymbol{a}_1\ ln(Total\ loans) + [\mathbf{X} \bullet\ ln(Total\ loans)]\beta + \varepsilon_i. \quad \text{(B1)}$$

where NP_i = volume of nonperforming loans at bank *i*,

and **X** is a vector of other control variables:

x_1 = Contractual lending rate$_i$,

x_2 = Herfindahl index of market concentration across bank$_i$'s markets,

x_3 = GDP growth rate across bank$_i$'s markets,

x_4 = Small business loan volume$_i$/Total loan volume$_i$,

x_5 = Total business loan volume$_i$/Total Loan volume$_i$,

x_6 = Consumer loan volume$_i$/Total Loan Volume$_i$,

x_7 = Residential real estate loan volume$_i$/Total Loan Volume$_i$,

x_8 = Commerical real estate loan volume$_i$/Total Loan Volume$_i$,

and $\varepsilon_i = \nu_i + \mu_i$ is a composite error term.

The Herfindahl index of market concentration is a weighted average of concentration in each state in which the bank operates, and the GDP growth rate is a 10-year weighted average state GDP growth rate in the states in which the bank operates. The weights are the ratio of the deposits in the state as a proportion of total deposits across all states. The composite error term, $\varepsilon_i = \nu_i + \mu_i$, is the sum of a two-sided, normally distributed error term, $\nu_i \sim$ iid $N(0,\sigma_\nu^2)$, that captures statistical noise, and a term, μ_i, which is a positive, half-normally distributed error term, $\mu_i\ (\geq 0\ ) \sim$ iid $N(0,\sigma_\mu^2)$, that gauges systematic excess nonperformance.

Figure 2 illustrates the frontier. The frontier value, $ln\ FNP_i$, is defined by the deterministic kernel of the stochastic frontier,

$$ln\ FNP_i = \boldsymbol{a}_0 + \boldsymbol{a}_1\ ln(Total\ loans) + \mathbf{X}\boldsymbol{\beta}, \quad \text{(B2)}$$

and represents the expected best-practice *ln*(NP), i.e., *ex post* credit risk, conditional on the control variables, were the bank totally efficient at credit evaluation and monitoring.

The systematic excess nonperformance, i.e., the natural log difference between the volume of nonperforming loans, adjusted for noise, and the frontier value, is given by:

$$\mu_i = lnNP_i - \nu_i - ln\mathrm{F}NP_i\,, \qquad \text{(B3)}$$

and gauges the effectiveness of the bank's credit evaluation and monitoring.

The excess, μ_i, cannot be directly measured, so it is estimated as the expectation of μ_i conditional on ε_i:

$$\text{excess}_i = \mathrm{E}(\mu_i|\varepsilon_i) = \mathrm{E}[\mu_i|(\nu_i + \mu_i)] = lnNP_i - \mathrm{E}(\nu_i|\varepsilon_i) - ln\mathrm{F}NP_i. \qquad \text{(B3a)}$$

The percentage increase in a bank's level of nonperforming loans over its best-practice value, conditioned on the control variables is given by expressing (B3) as the ratio of the level of noise-adjusted nonperformance, $NP_i e^{-\upsilon_i}$, to the level of best practice nonperformance on the deterministic frontier, FNP_i:

$$e^{\mu_i} = {NP_i e^{-\upsilon_i}}/{FNP_i}. \qquad \text{(B3b)}$$

To obtain a measure of inefficiency that ranges between 0 and 1, we define ***loan performance inefficiency*** as:

$$loan\ performance\ inefficiency_i = e^{\mu_i} - 1 = {NP_i e^{-\upsilon_i}}/{FNP_i} - 1.$$

The estimated parameters of the frontier specified in equation (B1) are as follows (with robust standard errors in parentheses and parameters significantly different from zero at the 10 percent or better level in **bold**):

Parameter	Variable	Coefficient Estimate	Robust Standard Error
α_1	ln(total loan volume$_i$)	**0.622505**	0.070644
β_1	Contractual lending rate$_i$ × ln(total loan volume$_i$)	**2.133363**	0.497137
β_2	Herfindahl index of market concentration$_i$ × ln(total loan volume$_i$)	−0.051880	0.056596
β_3	GDP growth rate$_i$ × ln(total loan volume$_i$)	−0.002876	0.003967
β_4	Small business loan volume$_i$ × ln(total loan volume$_i$)	**−0.194893**	0.069058
β_5	(Total business loan volume$_i$/Total loan volume$_i$) × ln(total loan volume$_i$)	0.090825	0.077879

Parameter	Variable	Coefficient Estimate	Robust Standard Error
β_6	(Consumer loan volume$_i$/Total loan volume$_i$) × *ln*(total loan volume$_i$)	**0.139580**	0.074712
β_7	(Residential real estate volume$_i$/Total loan volume$_i$) × *ln*(total loan volume$_i$)	0.028707	0.066663
β_8	(Commercial real estate volume$_i$/Total loan volume$_i$) × *ln*(total loan volume$_i$)	0.027892	0.062257

We find that for any given volume of loans, a higher contractual interest rate and a higher proportion of loans in consumer loans are each associated with higher best-practice nonperformance, while a higher proportion of loans in SBL is associated with lower best-practice nonperformance. Note that the negative coefficient, $\boldsymbol{\beta_2}$, on the interaction of market concentration with *ln*(total loans) is consistent with the Petersen-Rajan hypothesis, but it is not statistically significant.

Table 8 in the main body of the paper compares loan performance efficiency and best-practice nonperformance for banks in the lowest and highest thirds by Tobin's *q* ratio for each size category.