Community Bank Efficiency and Economies of Scale

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Introduction

A bank's efficiency ratio is defined as the ratio of a bank's non-interest expense to revenues. Higher efficiency ratios indicate less efficient banks. While there are many slightly modified definitions of the efficiency ratio, this basic ratio measures a bank's ability to generate revenues from its non-funding-related expense base.

The FDIC Community Banking Study finds that the efficiency ratios of community and noncommunity banks have diverged over time, especially since the late 1990s.[1] The analysis in the FDIC Community Bank Study compares asset-weighted average efficiency ratios for community banks (CBs) and noncommunity banks (NCBs) over the period 1984-2011. Over this period, the banking system experienced a substantial wave of consolidation, including the formation of very large NCB institutions over the second half of the 1990s and again more recently during the financial crisis. The consolidation among NCBs has led to a high concentration of banking system assets in relatively few large institutions.

An implication of the consolidation trend is that NCB asset-weighted average efficiency ratios are heavily influenced by the efficiency ratios of the very largest NCBs, especially since the late 1990s. The largest NCBs often have very different business models compared with smaller institutions (both CBs and NCBs). These business models include wholesale banking, capital markets, and derivative market making, which are often only conducted in the largest financial institutions. These activities may give rise to a very different efficiency ratio profile compared with smaller CB and NCB institutions, making it important to control for the shift in asset concentration toward the largest NCBs when analyzing the trends in the efficiency ratios of CBs and NCBs.

In the first section of this paper, we control for this consolidation trend by examining the median efficiency ratios of CBs and NCBs over time. Our analysis shows that asset concentration in the largest NCBs does affect the efficiency performance comparison between CBs and NCBs. Still, after correcting for the increase in asset concentration among the largest NCBs, the overall conclusions of the FDIC Community Banking Study remain; CB efficiency ratios have increased relative to NCBs over the 1984-2011 time period.

In the second section of this paper, we provide additional detail regarding the estimates on CB economies of scale reported in the FDIC Community Banking Study. Economies of scale are often thought to be an important factor that encourages consolidation among smaller financial institutions. There is a large literature on measuring cost economies of scale in banking, but the literature that relates to community bank-sized institutions mostly uses data from the 1980s and early 1990s. We revisit the important issue of cost economies of scale using more recent CB data and newer estimation techniques than are typically found in the existing literature. Still, our findings are broadly consistent with historical literature that focuses on banks in the size range of modern community banks. While our specific results on economies of scale depend on a CB's lending specialization, our estimates provide no indication of any significant scale benefits beyond $500 million in asset size for most lending specializations. Further, our estimates suggest that, in many cases, most of the cost benefits from scale appear to be achieved for CBs as small as $100 million. While economies of scale are important for community banks, historical trends in the size distribution of community banks that have survived over the last quarter century do not suggest that economies of scale require a community bank to grow or merge to asset sizes larger than $1 billion. Of the community banks that have survived the last quarter century, 60 percent remain under $200 million and many remain under $100 million in asset size.

Trends in Median Efficiency Ratios for CBs and NCBs

Figure 1 shows the historical median efficiency ratios for CBs and NCBs.[2] Our analysis focuses on median efficiency ratios because these statistics provide the best representation of the typical CB and NCB. The inset box "Why Use

[1] FDIC Community Banking Study, December 2012, http://www.fdic.gov/regulations/resources/cbi/report/cbi-full.pdf.

[2] This figure and those that follow use the FDIC Community Banking Study research definition of CBs and NCBs.

Median Values?" discusses the calculation of median sample statistics and the advantages of using medians for this analysis. Figure 1 shows that the asset-weighted average efficiency ratio divergence reported in the FDIC Community Banking Study carries over when the median efficiency ratios for CBs and NCBs are compared over the same period.

After controlling for the effects of industry consolidation, it is still possible that because banks enjoy economies of scale benefits, we might expect larger institutions to exhibit higher efficiency (a lower efficiency ratio). Efficiency ratios for larger institutions would improve because a dollar of non-interest cost could support higher revenue if scale economies are present. The inset box "What Are Economies of Scale?" provides more detail on measuring economies of scale in banking. Before we analyze the components of median bank efficiency ratios, it is useful to consider whether the observed trends in CB and NCB efficiency ratios could be driven by economies of scale and a change in the relative size of CB and NCB institutions over the sample period.

Figure 2 compares the size of the median CBs and NCBs over time after adjusting for the effects of inflation and shows that the median size of a CB almost doubled over the period of analysis whereas the median size of an NCB increased by about 10 percent. If the efficiency benefits from growing in size are strongest for smaller institutions (a pattern suggested by our subsequent economies of scale estimates), a typical CB should have gained efficiency relative to typical NCBs. This prediction is inconsistent with observed trends in efficiency ratios. While not a formal test, the analysis suggests that economies of scale have probably not been an important factor causing the observed divergence in CB and NCB efficiency ratios.

Why Use Median Values?

We choose to analyze median values rather than averages weighted by assets or simple average values in order to portray the experience of the typical CB and NCB. Especially for NCBs, the size distribution of institutions is very heavily skewed, with a very few extremely large institutions, so the use of weighted average statistics may give a misleading characterization of the changes that a typical institution has experienced.

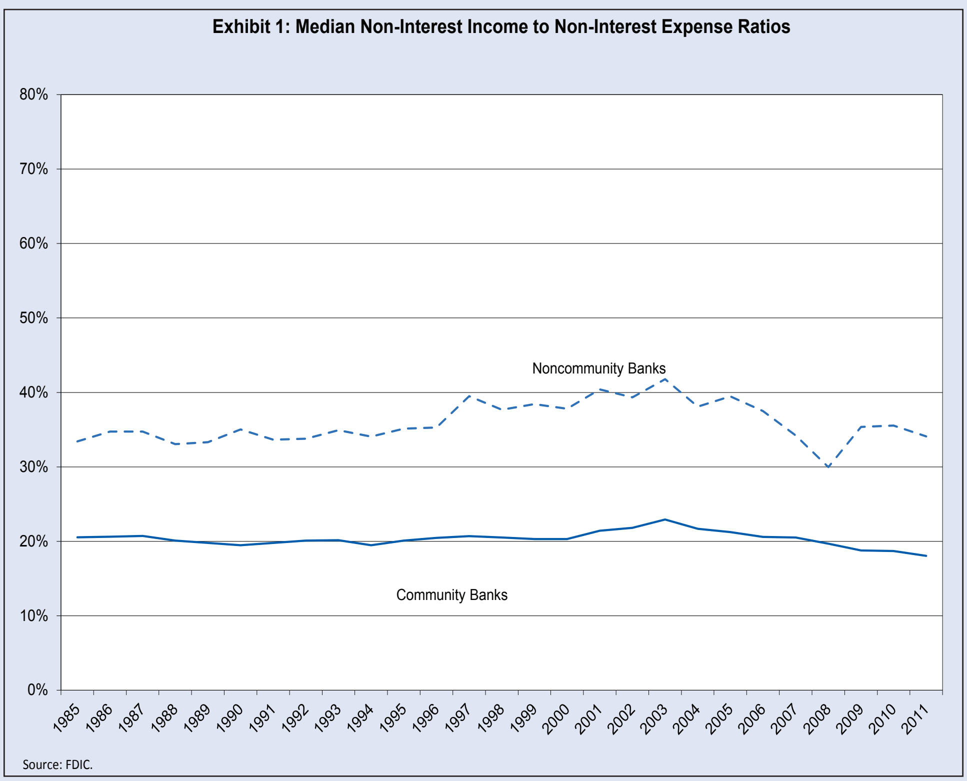
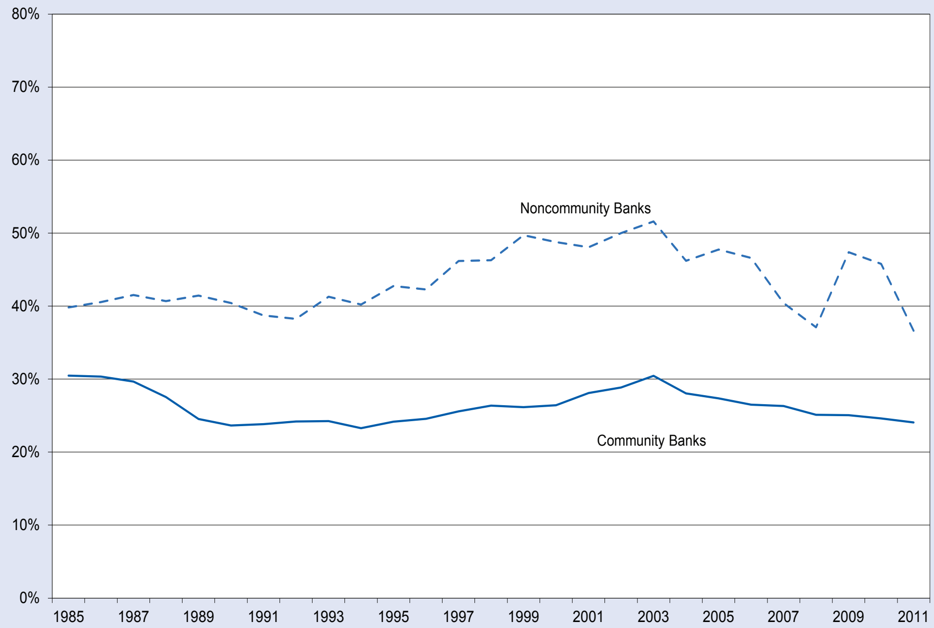
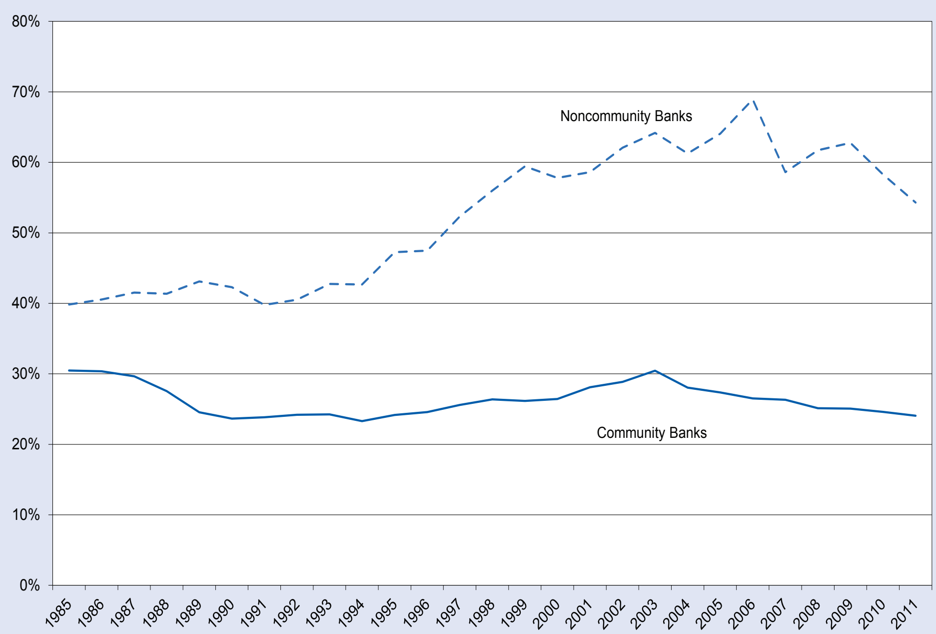


Exhibit 2: Weighted Averages Non-Interest Income to Non-Interest Expense Ratios (Excluding Banks > $500B)



Source: FDIC.

Exhibit 3: Weighted Averages Non-Interest Income to Non-Interest Expense Ratios (All Banks Included)



Source: FDIC.

The median value of a distribution is the value that is halfway between the smallest and the largest value when the data are ranked by magnitude. Unlike simple and weighted average values, median values are not influenced by a distribution's skewness, for example, when a distribution has a very small number of very large-valued observations.

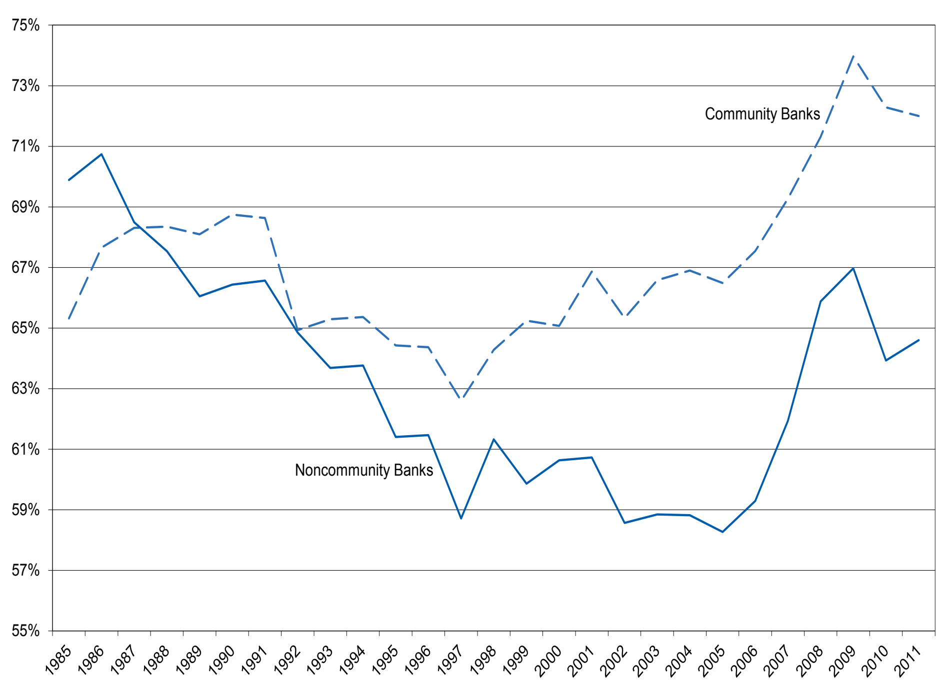
Given the extremely skewed distribution of assets among the population of banks, weighted averages generate statistics that are driven by the top few banks alone. In 2011, the median bank of the CB sample has about $160 million in assets. The largest CB has $14.66 billion (90 times larger than the median CB). In contrast, in the same year, the largest NCB in the sample has $1.6 trillion in assets, which is more than 300 times larger than the median NCB (at $5.5 billion).

When we plot a time series of median values, the plot represents the trend experienced by a typical CB and NCB. The analysis is little changed if we compare trends using simple average statistics, but it is very different if we compare trends using asset-weighted average statistics. When asset-weighted averages are used, NCB data trends follow the experiences of only a very small number of very large institutions with extensive capital market activities and other unique characteristics. Such comparisons contrast CB efficiency trends with the efficiency trends experienced by the very largest NCBs and not NCBs that are closer in size and scope to CBs.

For this sample data, medians generate very similar results to weighted averages provided that the largest banks (outliers) are removed from the sample. Exhibits 1 and 2 show median and asset-weighted average values for the sample banks' noninterest income to noninterest expense, where the asset-weighted average statistics are calculated after excluding the very largest banks. Exhibit 3 plots the asset-weighted average statistics for all banks in the sample. A comparison of Exhibits 1, 2 and 3 show that, for these data, using the median is roughly equivalent to using the average or the asset-weighted average, provided outliers are removed.

In the analysis that follows, we show that the divergence in median efficiency ratios between CBs and NCBs can be attributed to a decline in the spread between the yields on loans and the costs of deposits at CBs. CBs once enjoyed a large advantage over NCBs in this important spread, but the advantage has dissipated over time. CBs now earn less on their loan portfolios and pay slightly more than NCBs for funding. The importance of the decline in this spread has been magnified because CBs have also increased their loan-to-asset ratios over time. In addition to the decline in the loan-to-deposit spread, CBs also experienced a sizable decline in the ratio of their non-interest income to non-interest expense. In contrast, NCBs' non-interest income to non-interest expense ratio was fairly steady over the period from 1985 through the second quarter 2012.

Figure 1: Median Efficiency Ratio at Community Banks and Other Depository Institutions



Source: FDIC.

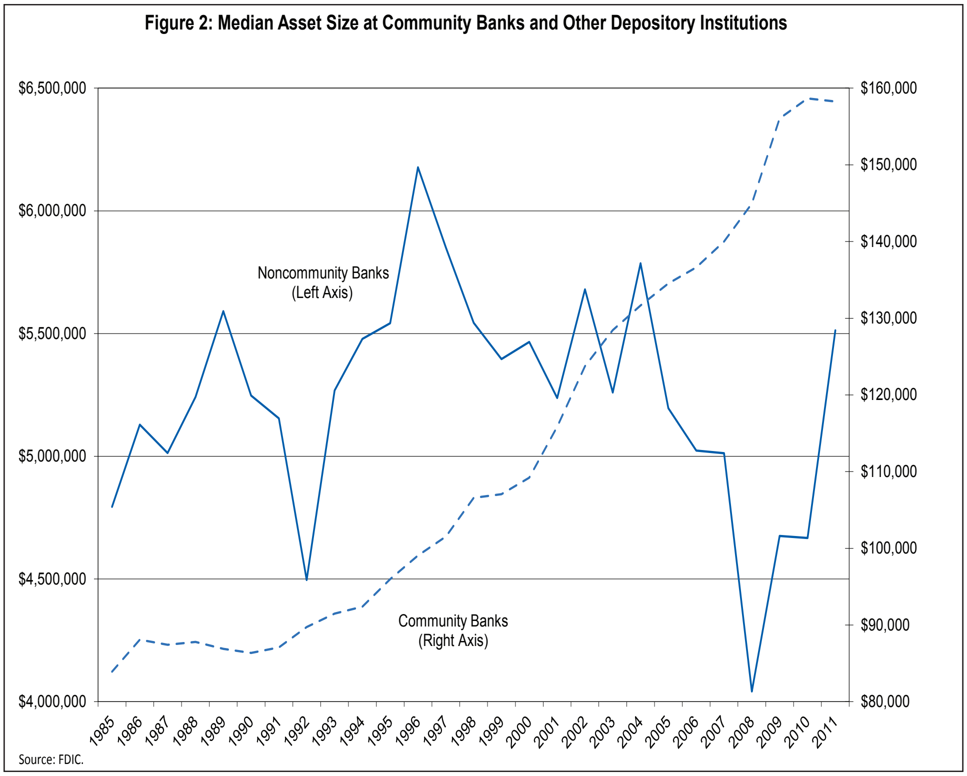


Figure 2: Median Asset Size at Community Banks and Other Depository Institutions
$6,500,000
$6,000,000
$5,500,000
$5,000,000
$4,500,000
$4,000,000
$160,000
$150,000
$140,000
$130,000
$120,000
$110,000
$100,000
$90,000
$80,000
Noncommunity Banks
(Left Axis)
Community Banks
(Right Axis)
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Source: FDIC.

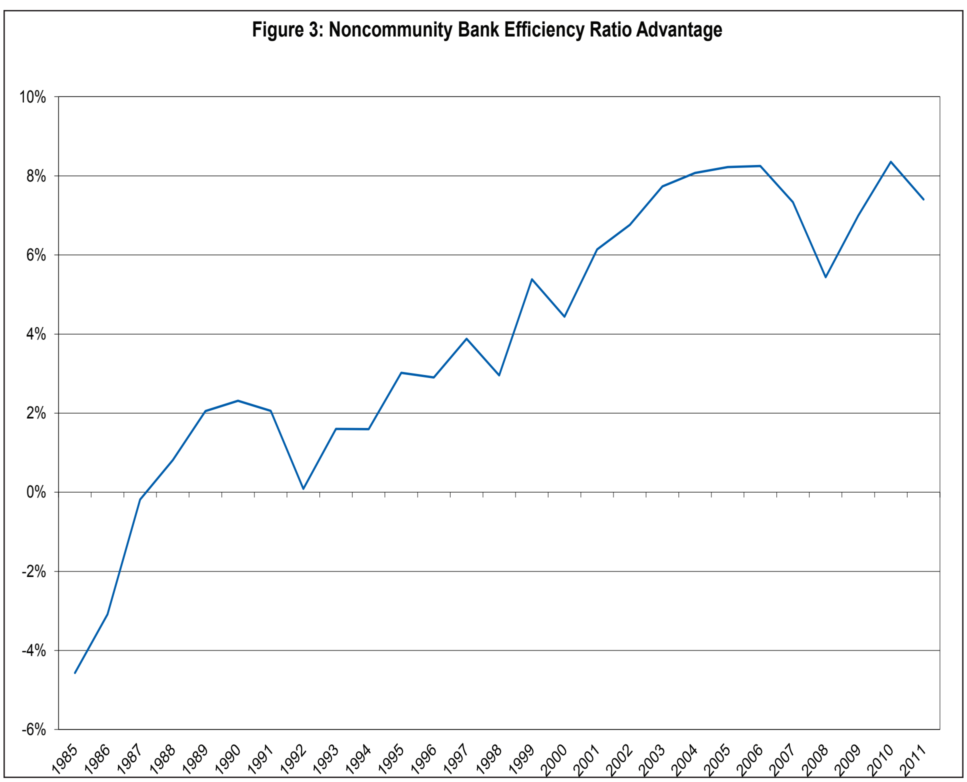


Figure 3: Noncommunity Bank Efficiency Ratio Advantage
10%
8%
6%
4%
2%
0%
-2%
-4%
-6%
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

What Are Economies of Scale?

Economies of scale measure the relationship between the cost of producing a unit of output and the level of output. When the average cost of producing a unit of output declines as output increases, the activity is said to have (increasing) economies of scale. Economies of scale can be "local," meaning that average costs may decline for some levels of output and then stabilize or increase, or economies of scale can be "global" meaning that average costs continue to decline as output increases.

In manufacturing and agriculture, measuring outputs and inputs is conceptually straightforward. However, when measuring scale economies for service firms, the appropriate measure of output is often less clear. Consider, for example, health care. Should output be measured by the number office visits, the number of prescriptions written, or the number of illnesses cured? Or perhaps it should be measured by some combination of these and other observable measures? The problem of measuring output is also difficult in the case of banking due to difficulties in measuring output and distinguishing outputs from inputs. For example, banks provide loans, take deposits, and provide other services. Deposits are also used to fund bank activities. Are bank deposits a bank output or an input? Banks also provide cash management services. Should the services provided be measured by the dollar volume or the number of transactions processed? A similar question arises with bank loans and loan commitments. Is output measured by the number of loans or the dollar volume of lending? And how does one add up all these different service outputs?

There is no consensus as to the best measure of bank output. Bank output has been measured in many ways in the academic literature (e.g., loans, deposits, assets, loans plus deposits). In this study, we measure bank output using total bank balance sheet assets. That is, we measure banks' average cost of producing output as total bank costs divided by bank balance sheet assets. We define total costs as the sum of interest expenses, provisions for loan and lease losses, and non-interest expenses. Our measure accounts for all expenses, with the exception of extraordinary items and income taxes.

Using average bank cost per dollar of bank assets is a simplification that sidesteps the complex issue of defining a bank's output. If the average cost ratio declines as bank size increases, then economies of scale exist. Using the average cost per dollar of assets implicitly assumes that banks' "true" output is a constant fraction of assets, regardless of a bank's size. If, however, a bank's output mix changes as it grows larger or it can use different technologies that allow the bank to produce more services per dollar of bank assets without a decline in total cost, then using the implicit assumption that all banks' output is a constant fraction of assets will give misleading results. In our analysis, we focus on estimating economies of scale separately for each CB specialty lending group because the mix of services provided by a CB specialty lender probably does not change in a systematic way as CBs grow in size.

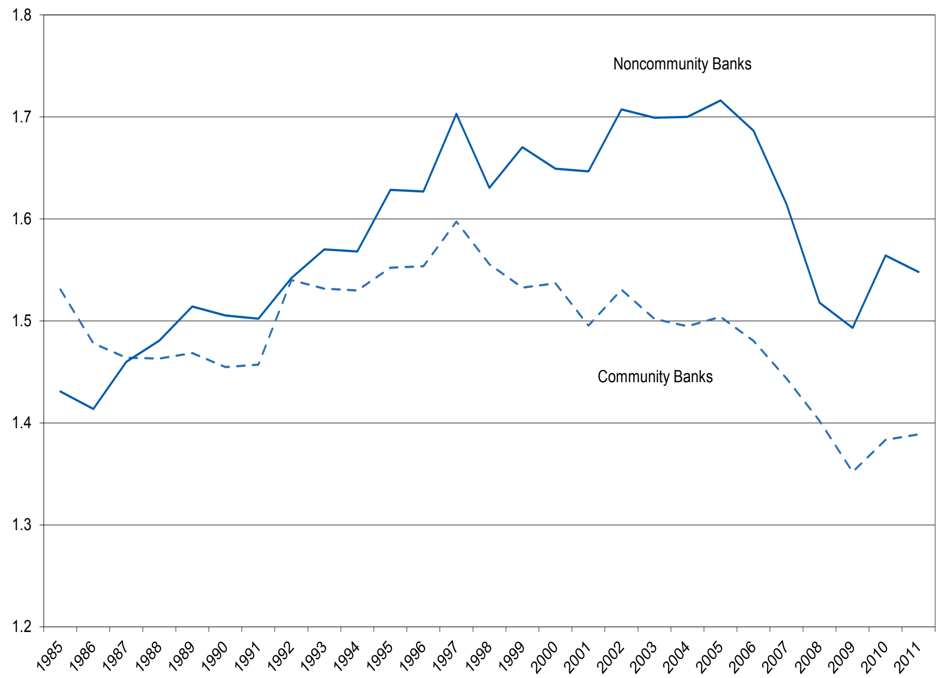
Expense patterns also explain some of the changes in the relative efficiency of CBs and NCBs. CBs have experienced slower productivity gains (in terms of assets per employee) compared with NCBs. Employee-related expenses increased at both CBs and NCBs, but the increase in employee expenses at NCBs was offset by higher productivity gains while the increase at CBs was not. Since employee-related expense is the largest non-interest expense for both groups, this factor explains a significant amount of the relative increase in non-interest expense at CBs.

What Explains the Increase in Community Bank Efficiency Ratios?

Figure 3 shows the difference in median efficiency ratios of CBs and NCBs between 1985 and 2012. CBs had an advantage in the beginning of the period, but by the early 1990s, CB efficiency began to deteriorate relative to the efficiency ratio of NCBs. While both groups have lost efficiency since the financial crisis, NCBs maintained their efficiency advantage throughout the crisis.

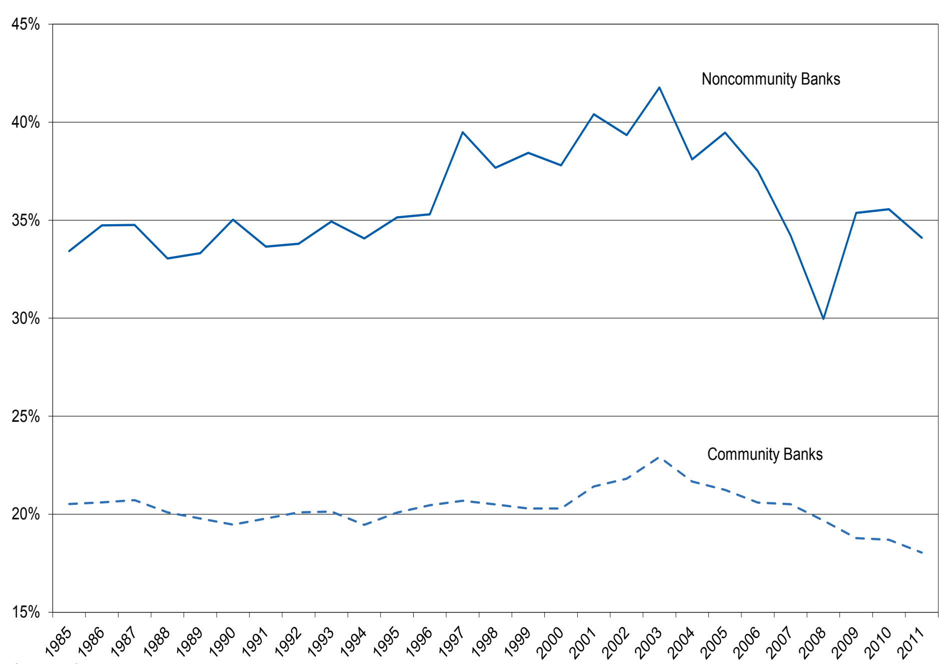
To explain the divergence in CBs' efficiency, we analyze the behavior of the inverse of the efficiency ratio, or the ratio of bank revenues to non-interest expense. This

Figure 4: Median of the Inverse Efficiency Ratio of Community and Noncommunity Banks



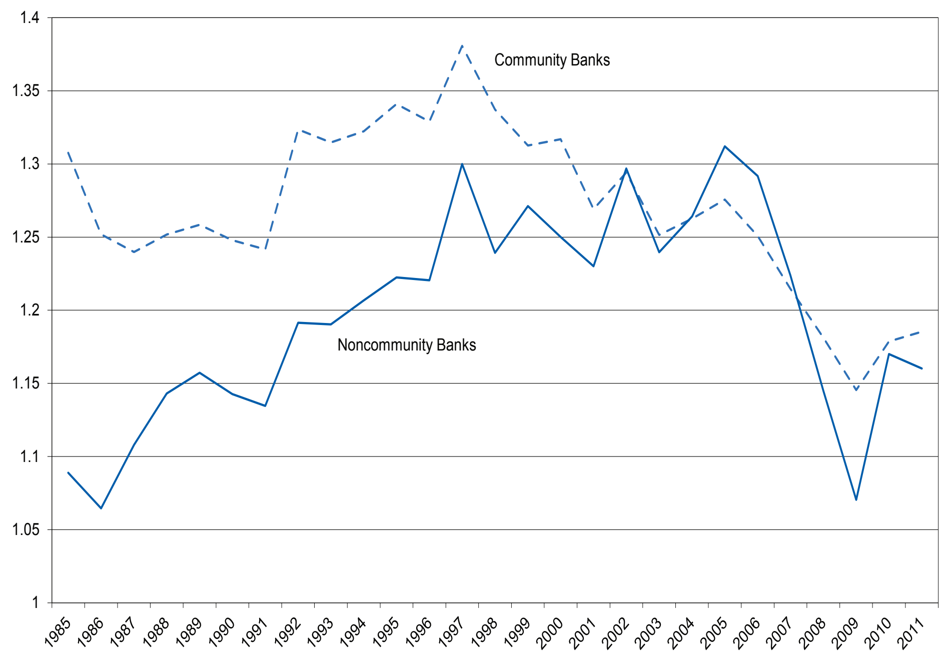
Source: FDIC.

Figure 5: Median Ratio of Non-Interest Income to Non-Interest Expense for Community and Noncommunity Banks



Source: FDIC.

Figure 6: Median Ratio of Net Interest Income to Non-Interest Expense for Community and Noncommunity Banks



Source: FDIC.

approach enables us to begin to understand the reasons for changes in the efficiency ratio by separating changes into those related to trends in non-interest income and those related to net interest income. Figure 4 plots the median of the inverse efficiency ratios for CBs and NCBs. When looking at the inverse of the efficiency ratio, higher values imply more favorable bank efficiency.

The inverse of the efficiency ratio is the sum of two component ratios: the net interest income to non-interest expense ratio and the non-interest income to non-interest expense ratio.[3] Figure 5 plots the median ratio of non-interest income to non-interest expense (NonII-NIE ratio) for CBs and NCBs. Over the historical period, the CB median NonII-NIE ratio declined from about 21 percent to about 18 percent in 2011. The comparable ratio for NCBs was roughly unchanged in 2011 versus 1985. So, while a decline in the NonII-NIE ratio contributed to the deterioration in CBs' relative efficiency over the past decades, it is not the most important cause of the observed decline.

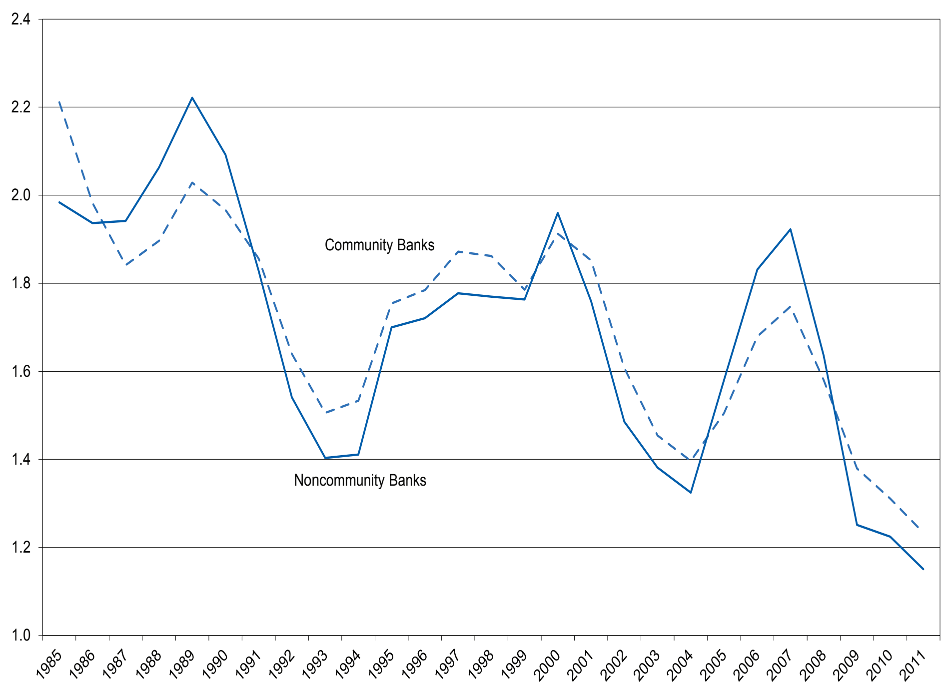
Much of the relative change in efficiency between the two groups can be attributed to trends in these respective institutions' net interest income (NII). Figure 6 shows the median ratios of NII to non-interest expense (NII-NIE ratio) for CBs and NCBs over time. CBs had a substantial advantage in this component of the efficiency ratio early in the sample period, but this advantage disappeared steadily over time. Meanwhile, the median value of the NII-NIE ratio among NCBs posted sizable gains, catching up to CBs and even surpassing them during the mid-2000s. By 2011, there was no significant difference between the median NII-NIE ratio for CBs and NCBs.

NII can be decomposed into interest income and interest expense. Figure 7 shows the interest income from loans as a fraction of non-interest expense. This ratio behaves similarly for CBs and NCBs over time; interest income from loans has become substantially smaller relative to non-interest expense for both CBs and NCBs.

A large part of the net interest income difference between CBs and NCBs can be explained by differences in these institutions' cost of funds (interest expense over liabilities), shown in Figure 8. For much of the sample period, CBs enjoyed a funding cost advantage over NCBs, although there were times when funding costs for CBs and NCBs converged. In some periods, the CB funding cost advantage was as large as 1 percentage point. From 2007, the cost of funds advantage enjoyed by CBs dissipated and now CBs fund themselves at a slight cost disadvantage compared to NCBs.

[3] The median of a sum is not generally the sum of the medians. A similar analysis using means, after we remove outliers, produces results that are very similar to the results based on median values.

Figure 7: Interest Income From Loans versus Non-Interest Expense



Source: FDIC.

A Closer Examination of the Trends in CB Net Interest Margins

CBs' lending margins closely track the decline in the level of short-term interest rates, but other important and related determinants may also have changed over the sample period. In the lending process, banks provide maturity transformation by borrowing demandable deposits and funding longer maturity loans, so their lending rates should be related to the slope of the risk-free term structure of interest rates. Lending also involves exposure to credit risk for which CBs must be compensated. A typical market-based measure of credit risk used in many studies is the yield spread between BAA-rated corporate bonds and 10-year U.S. Treasury bonds.

In addition to financial factors, we expect CBs' net interest margins to be related to loan demand conditions in these banks' local markets. We expect net interest margin at CBs to be higher when there is strong loan demand from their local lending market, and lower when local market demand conditions are weak. A final factor we consider is the degree of concentration in the local banking market. When banks operate in a concentrated market, they may be able to exercise market power, paying depositors slightly less for their deposits and charging borrowers slightly more for loans. If this is true, trends toward increased competition in local markets might result in lower CB interest margins as competition forces CBs to raise deposit rates and reduce the interest rates they charge for their loans.

We use panel regression analysis to explore what factors might have influenced the decline in CBs' net interest margins over time. We estimate our model using a sample of institutions that operate in a specific geographic market for which we can measure bank concentration and also control for local economic effects. We use FDIC Summary Deposit data to identify banks that collect 100 percent of their deposits in a single county. Our data sample period begins in the second quarter of 1994, when SOD data are first available, and ends at the end of 2011.

We measure banks' local competitive conditions in each quarter in each county using the Herfendahl-Hirshman index (HHI) for bank deposit concentration.[1] We include separate dummy variables for moderately and highly concentrated

[1] The Herfindahl-Hirschman (HHI) Index is a commonly accepted measure of market concentration calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. The HHI measures the relative size distribution of the firms in a market and takes a value close to zero when a market has a large number of approximately equal-sized firms and a maximum value of 10,000 when a market is controlled by a single firm.

counties. The assumption that high HHI deposit concentration values may be an indication of monopoly power is common in the bank market structure antitrust banking literature.

We estimate separate models for the components of CBs' net interest income, average cost of funds (cost of funds to total liabilities), and average interest earned on loans (interest on loans to total loans). We control for market conditions in a CB's local county market by including county-level unemployment rates, the share of credit card accounts within a county that are 60-days past due, the county-level home price index, and bank fixed effects in our estimations.[2]

Exhibit 4 shows the estimation results for our sample. Generally, the Federal Funds rate, the slope of the term structure, and the credit risk yield have the largest impacts on the two components of CBs' net interest margin, the average cost of funds, and the average interest on loans. While there is some evidence that CBs can benefit in concentrated markets (markets with high HHIs), changes in HHIs do not appear to explain very much of the overall trend in CBs' net interest margin over this time period. The inclusion of time-invariant bank fixed effects explains a large share of the observed variation in net interet margins, suggesting that some banks have more profitable customer relationships that are not explained by the competitive nature of the banks' local markets as measured by a HHI deposit index.

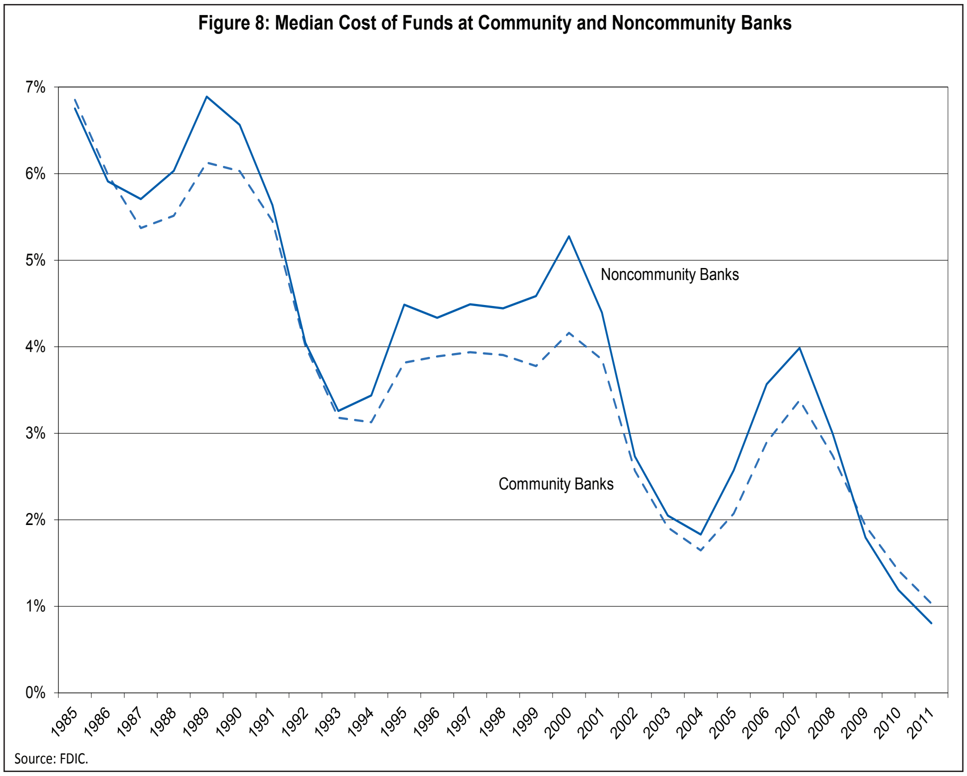
Exhibit 4: OLS Estimates, Community Banks with 100% of Deposits in One County

Outcome	Cost of Funds to Liabilities (in percentage points)	Interest on Loans to Loans (in percentage points)
Federal Funds Rate	0.17***	0.61***
	(0.00)	(0.00)
10Y T-Bond vs. 3M T-Bill Spread	0.09***	0.45***
	(0.00)	(0.01)
BAA Bond Yield vs. 10Y T-Bond	0.13***	0.35***
	(0.00)	(0.01)
=1 if Moderately Concentrated	0.00	0.05**
	(0.00)	(0.02)
=1 if Concentrated	-0.01***	0.03
	(0.00)	(0.03)
County Unemployment Rate (Pct)	0.00***	0.01***
	(0.00)	(0.00)
County Credit Card 60 Days DQ Rate (Pct)	0.03***	0.25***
	(0.00)	(0.00)
County HPI Growth Rate (Pct)	0.00	0.00
	(0.00)	(0.00)
Constant	-0.40***	3.34***
	(0.00)	(0.04)
Quarterly Fixed Effects	N	N
County Fixed Effects	N	N
Bank Fixed Effects	Y	Y
N	246614	64843
R-sq	0.87	0.72

Source: FDIC.

[2] Our county-level unemployment rate is from the U.S. Bureau of Labor Statistics. House price growth rates are based on Case Schiller indexes adjusted for inflation using the consumer price index for consumers less shelter. For counties without reported house price index (HPI) values, we substitute the state HPI. County-level data on percentage of credit card accounts more than 60 days past due are from Trendata.

The difference between the CB and NCB NII-NIE ratio medians over time is linked to changes in the loan-to-asset ratios and the yields these groups of institutions earn on their loans. Figure 9 is a time-series plot of the median loan-to-asset ratio for CBs and NCBs. Early in the sample period, the median loan-to-asset ratio for CBs was about 4 percentage points lower than the median for NCBs. Generally, until the recent crisis, both groups of banks increased their lending exposure over the sample period, but CBs increased their loan exposure at a faster pace. From 1985 to 2011, the median loan-to-asset ratio for CBs



increased by over 7 percentage points, to within 1 percentage point of the median loan-to-asset ratio for NCBs.

Both CBs and NCBs increased their loan exposure while the average returns they earned on their loans declined. Figure 10 shows the median of average yields earned by CBs and NCBs on their loan portfolios. Both CBs and NCBs experienced large declines in the yield they earned on their loans. While CBs continue to have an advantage in the yield on loans, the differential they once enjoyed declined from 130 basis points in 1985 to about 60 basis points in 2011.

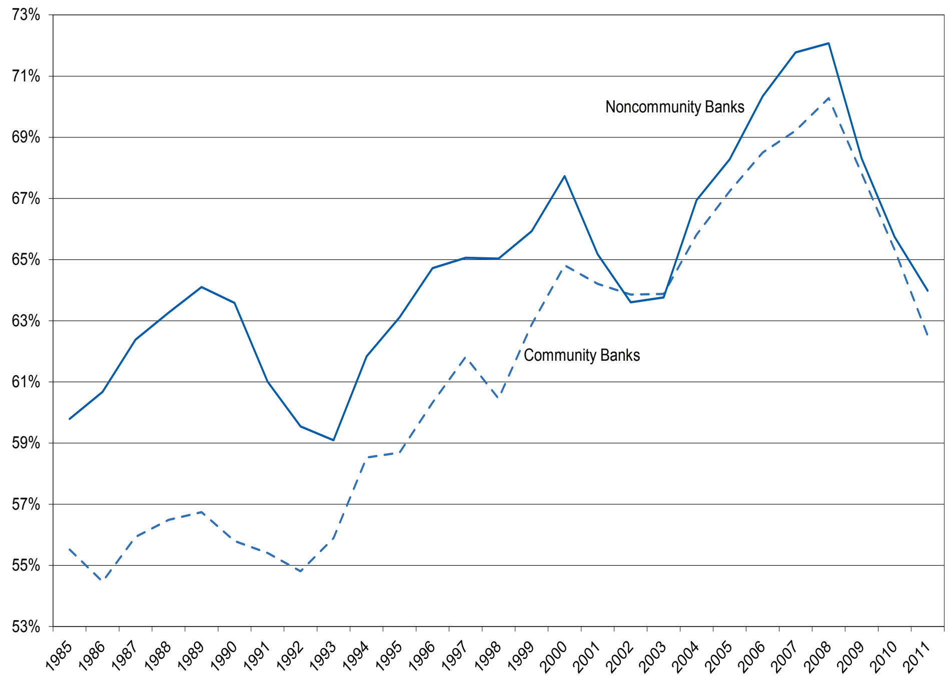
Figure 11 shows the difference between CBs and NCBs in terms of the spread between loan yields and deposit costs. CBs initially, and through much of the sample period, had a greater than 100 basis point spread advantage over NCBs, but this advantage declined to about 35 basis points by 2011. Figure 11 also shows that the decline in CBs' loan-to-deposit spread advantage over NCBs roughly tracks the path of the Federal Funds rate since late 1999, suggesting that lending margin compression may in part be related to the level of interest rates over this period. Inset box "A Closer Examination of the Trends in CB Net Interest Margins," provides a deeper analysis of factors that may have affected CBs' average borrowing and lending rates over this sample period.

The relative decrease in CBs loan–to-deposit spread tells only part of the comparative efficiency story. Non-interest expense trends are also a factor. Employee salaries are the largest single contributor to non-interest expenses at both CBs and NCBs (see Figure 12). However, unlike NCBs, the majority of CB non-interest expense is derived from employee-related expenses.

The amount of assets managed per bank employee is a measure of labor productivity efficiency. This measure has also changed substantially over the last two and a half decades, after adjusting for inflation. Figure 13 shows that, in 1985, the amount of assets per employee was similar at CBs and NCBs. In 1985, NCBs managed around $3.25 million in assets (in 2011 dollars) per employee, or about 8 percent more assets per employee than CBs. In 2011, NCBs experienced significant efficiency gains in this respect, managing just under $5.5 million in assets per employee, an increase of almost 70 percent. Over the same period, growth in assets per employee at CBs was more modest, moving from around $3 million to just over $4 million, or a 30 percent increase. This implies that NCBs are now able to manage more than 35 percent more assets per employee than CBs.

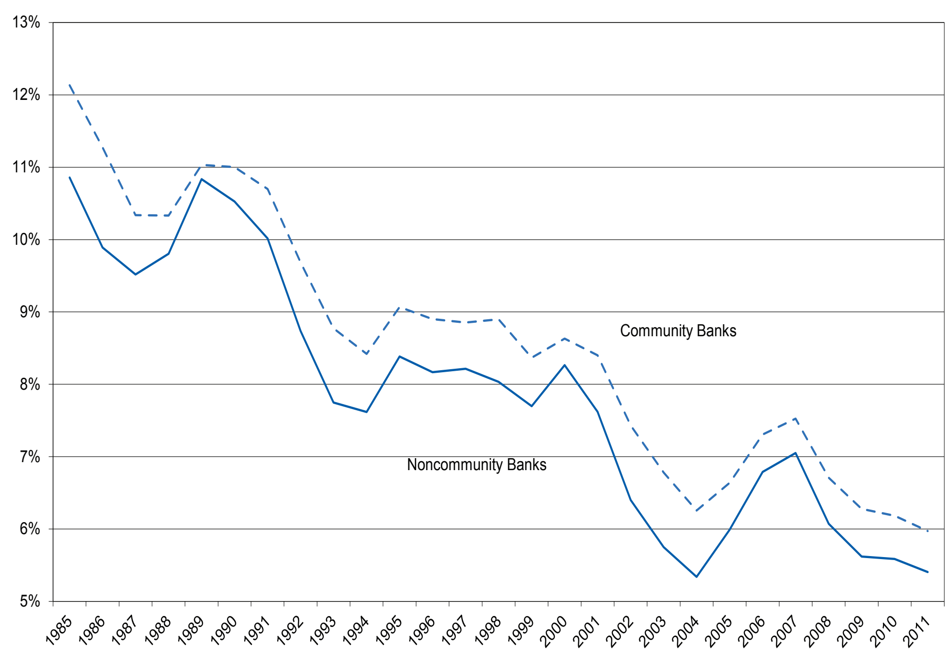
Even though a greater portion of CBs' expenses is derived from employee compensation, CBs tend to pay less per employee. Using Call Report data on employee expenses

Figure 9: Median Loans-to-Assets Ratio for Community and Noncommunity Banks



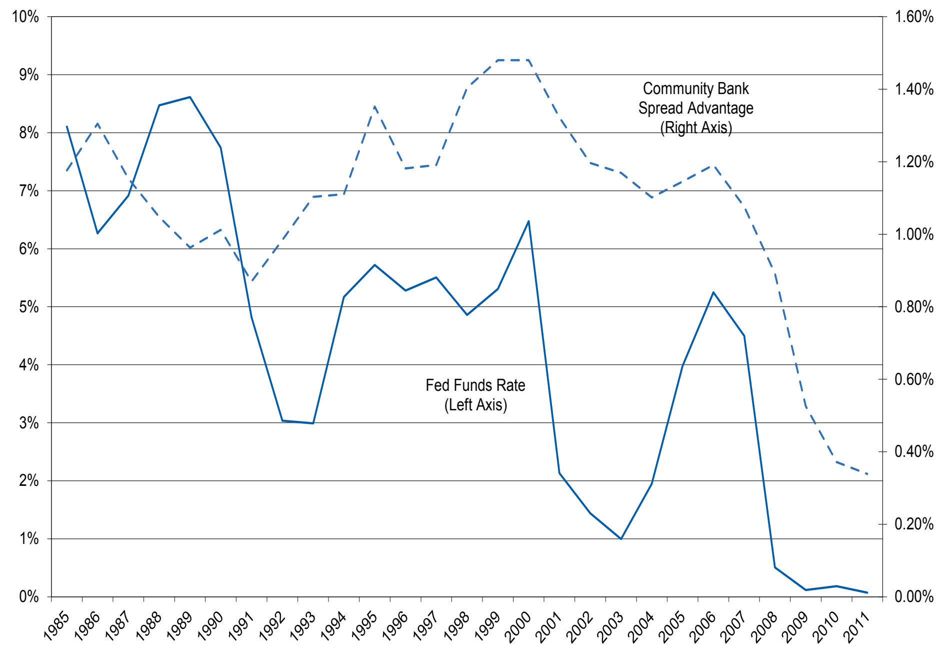
Source: FDIC.

Figure 10: Median Average Yield on Loans at Community and Noncommunity Banks



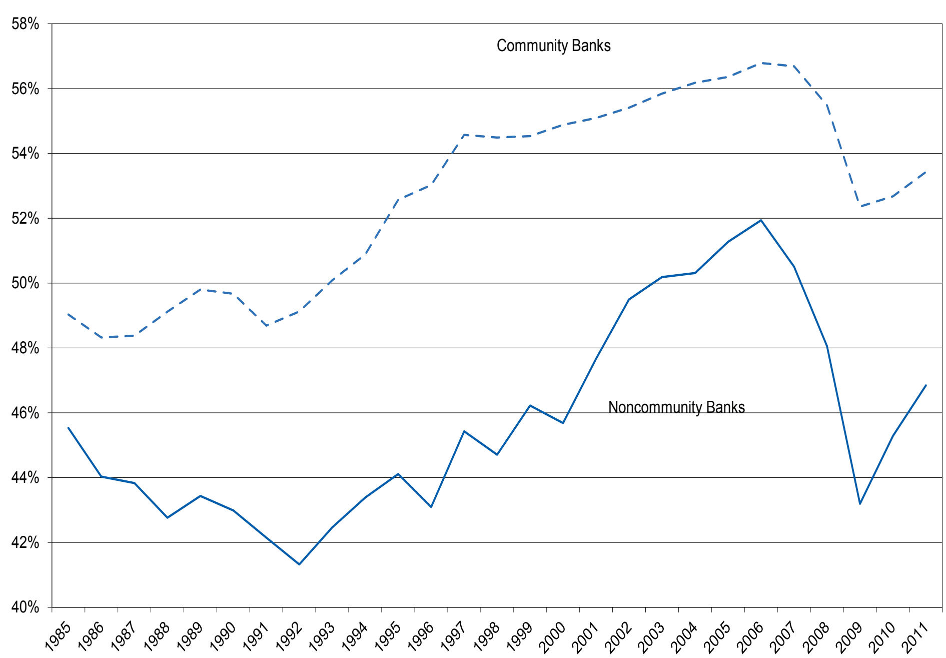
Source: FDIC.

Figure 11: Difference in Median Loan/Deposit Interest Spread between Community and Noncommunity Banks



Source: FDIC.

Figure 12: Median Employee Related Expense to Total Non-Interest Expense Ratios for Community and Noncommunity Banks



Source: FDIC.

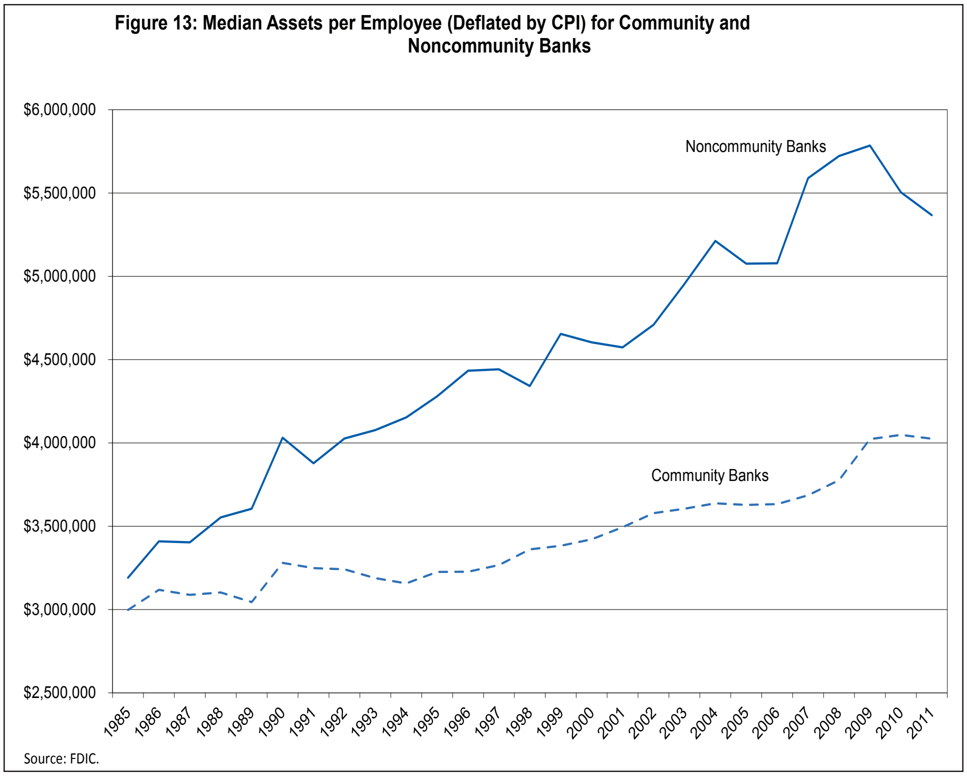


Figure 13: Median Assets per Employee (Deflated by CPI) for Community and Noncommunity Banks
$6,000,000
$5,500,000
$5,000,000
$4,500,000
$4,000,000
$3,500,000
$3,000,000
$2,500,000
Noncommunity Banks
Community Banks
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Source: FDIC.

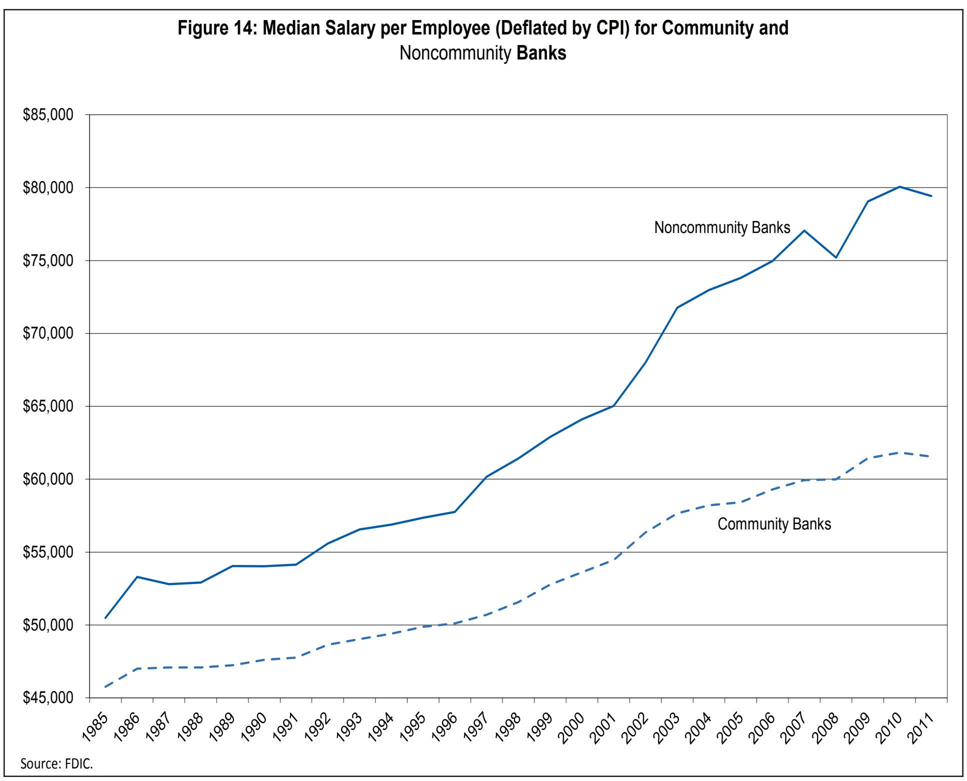


Figure 14: Median Salary per Employee (Deflated by CPI) for Community and Noncommunity Banks
$85,000
$80,000
$75,000
$70,000
$65,000
$60,000
$55,000
$50,000
$45,000
Noncommunity Banks
Community Banks
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Source: FDIC.

(which include the cost of benefits), after adjusting for inflation, median compensation at NCBs was around $50,000 per employee in 1985 (see Figure 14). Median compensation at NCBs increased to around $80,000 in 2011, a 60 percent increase. The median compensation at CBs, in contrast, increased from $45,000 in 1985 to around $60,000 in 2011, an increase of 33 percent.

Figure 15 shows the historical behavior of another ratio that can help explain trends in labor efficiency at CBs relative to NCBs. This figure shows the median ratio of total employee expenses to total assets at CBs and NCBs. The labor cost per dollar of assets at CBs has increased over the past decades, while it has decreased slightly for NCBs. In 1985, CBs had a slight advantage according to this measure, with CBs paying $1.42 in employee expenses per $100 in assets and NCBs paying $1.47. In contrast, by 2011, NCBs' labor expenses per $100 of assets declined to $1.37, while CBs labor expenses per $100 of assets rose to $1.54. Over the sample period, CBs have not matched NCBs in managing labor cost per dollar of assets.

Difference in Costs and Economies of Scale

Economies of scale describe the relationship between average costs and the output of a firm (see inset box "What Are Economies of Scale?"). A firm exhibits economies of scale if its average cost of producing output declines as output increases. An extensive literature from the 1980s and 1990s finds that there is potential for generating cost saving from economies of scale in banking. Typical findings suggest banks face a relatively shallow U-shaped average cost curve, with a minimum average cost estimate occurring for banks somewhere between $75 million and $300 million in asset value (Berger, Hunter, Timme (1993)). Numerous early studies find evidence of diseconomies of scale (increasing average costs) for the largest institutions in their sample time frame.

Many early studies use a translog cost function specification to estimate economies of scale. This methodology subsequently has been shown to have important shortcomings. McAllister and McManus (1993) find that the translog function does not work well unless all the banks analyzed have a nearly homogeneous product mix and do not differ greatly in size. Therefore, the evidence of bank diseconomies found in early studies may have been a consequence of the translog methodology and large banks may not be as inefficient as these early studies have suggested.

After these shortcomings were identified, researchers developed alternative approaches for estimating bank efficiency. Newer approaches shift from models in which banks were assumed to simply minimize costs to models that assumed banks maximized profits or even the bank manager's utility.[4] Many of these newer approaches retain a translog cost model but modify other model assumptions to improve performance. Some researchers have abandoned the translog model entirely in favor of using nonparametric methods with more flexible cost curve shape specifications to estimate banking sector efficiencies. In the analysis that follows, we estimate an average cost model for banks using a nonparametric approach that does not suffer the methodological shortcomings of the translog approach.

We measure bank output as total assets and bank total costs as the sum of interest expenses, provisions for loan and lease losses, and non-interest expenses. Our measure accounts for all expenses with the exceptions of extraordinary items and income taxes. Because both the numerator and the denominator of the average cost ratio (bank total costs divided by bank total assets) are expressed in nominal dollars, the ratio is unaffected by changes in the price level over the sample period.

To avoid making overly restrictive assumptions on the form and shape of the average cost curve, we employ a nonparametric method called kernel regression to estimate the relationship between bank size and average cost. Kernel regression is discussed in more detail in inset box "How re Kernel Regression Estimates Calculated?" We provide separate estimates for specialty lender designations (mortgage specialists, commercial real estate (CRE) specialists, agriculture specialists, etc.) because each form of specialty lending may have unique cost and technologies that lead to different scale economy characteristics.[5]

We estimate the relationship between size and average cost for two years, 2006 and 2009 (where size is measured in 2011 dollars). The first year is among the most profitable years for the banking industry while 2009 is a year of crisis

[4] See, for example, Hughes and Mester (2011), Hughes (2011), Wheelock and Wilson (2009) and references therein.

[5] Definitions of lending specialties can be found in the FDIC Community Banking Study.

How Are Kernel Regression Estimates Calculated?

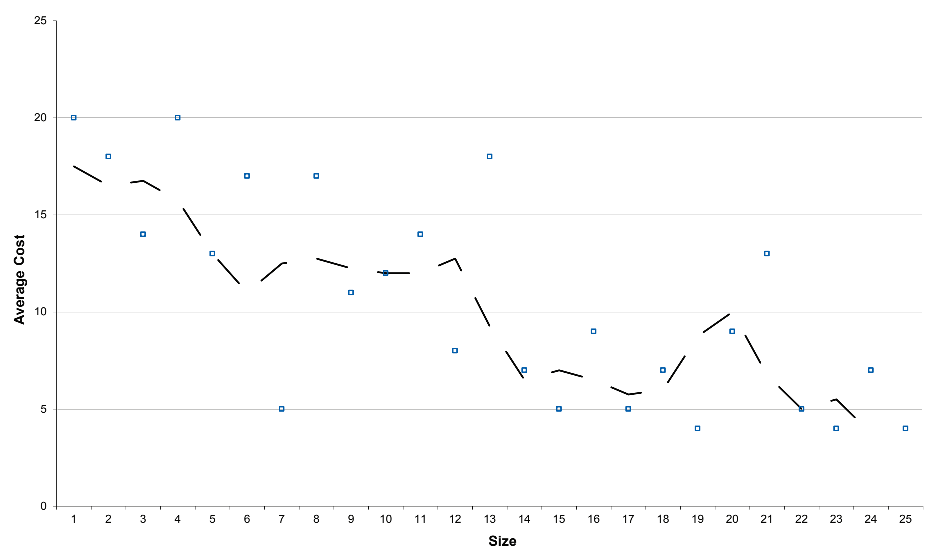
Kernel regression can be thought of as a simple histogram that has been "smoothed." The kernel regression approach we use assumes that the average cost is a constant in a local region for a given bank size, and estimates the constant average cost value using a Gaussian kernel. The kernel function defines the weight given to observations in the local region that are used to calculate the average cost estimate for that region.

To provide some intuition for kernel regression, we present a simplified example. Consider the relationship between bank size and observed bank average costs. If we arrange banks according to size from smallest to largest and plot these banks' average costs, we would have a plot that looks something like the points in Exhibit 5. While there appears to be a general pattern of declining average costs as size increases, there is a lot of "noise" and some banks close to each other in size have widely varying average costs. The kernel regression technique defines a local region of adjacent points, then takes a weighted average of the cost observations within this region to arrive at an estimate that smoothes out the "noise" in the data.

To simplify, our kernel regression example will use a band width of 2 units and a "triangle kernel" to calculate weights. So, for example, for a bank of size 10, our kernel estimate will use data from adjacent banks as well; that is, it will use the cost data for banks with sizes 9 through 11. The kernel regression estimate for a bank of size 10 is calculated by taking the weighted average of the costs of banks 9, 10, and 11. The estimate weights bank 9 and bank 11 costs by 25 percent (each), and the cost observation for bank 10 receives a weight of 50 percent. This simple triangle kernel regression estimate is illustrated by the dashed line in Exhibit 1. Notice that kernel estimator uses the observed data to produce a smoother function for the average cost-bank size relationship in the data.

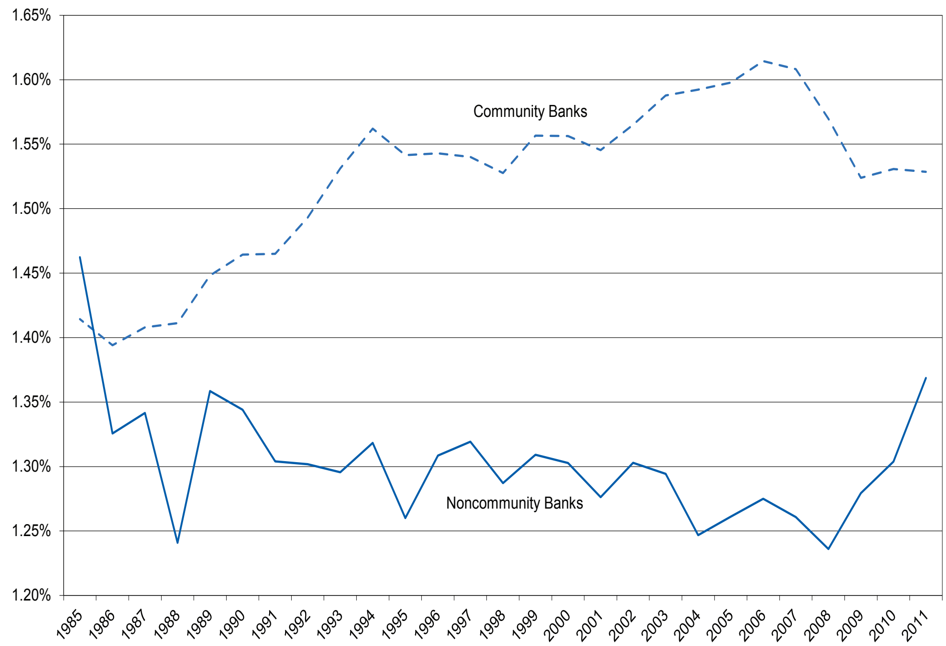
In the actual estimation we perform, the size of the local region over which we average observations is called "the bandwidth," and for this we use a statistical rule of thumb suggested by Silverman (1986). Instead of using a "triangle distribution" to weight observations within the bandwidth, we use weights determined by a normal (or Gaussian) distribution. The results do not depend on the specific choices we made in applying this estimation technique. The same analysis was performed using a generalized additive model using splines for the nonlinear components of the scale economy estimates, and the results are very similar.

Exhibit 5: Simplified Kernal Regression Example



Source: FDIC.

Figure 15: Median Employee Expense-to-Asset Ratio at Community and Noncommunity Banks



Source: FDIC.

and industry losses.[6] To eliminate outlier observations, this analysis is restricted to CBs with a cost of less than one dollar per dollar of bank assets. Further, technical considerations associated with the kernel regression method lead us to examine only specialty groups with more than 500 observations.

Figure 16a shows the estimated average cost as a function of bank asset size for CB mortgage lending specialists in 2006. The outer lines show the 95 percent confidence interval around the estimated conditional mean average cost. For mortgage lending specialists, these estimates provide evidence for economies of scale up to around $500 million in assets. The conditional mean average cost curve drops by about 150 basis points (bps) from the 6.25 percent average costs estimate for the smallest banks to around 4.75 percent for the large institutions. Even accounting for a 95 percent confidence level, the estimates show at least a small drop in average costs for larger institutions. Significant gains in efficiency (as measured by average cost) are exhausted by around $500 million in assets. Figure 16b shows a similar shape for the average cost curve in 2009 for CB mortgage specialists, but the estimated level of average costs declines somewhat more in 2009 for the largest banks. Still, accounting for the confidence bands around the average cost estimates, statistically significant benefits from scale economies for CB mortgage specialists are exhausted by about $500 million in assets.

In Figures 17 through 19, we show the results of the average cost curve kernel regression estimates for three other CB specialty groups. Among the specialist groups we examine, CRE specialists (Figure 17a and 17b) appear to have the largest potential benefit from economies of scale. Average cost estimates decline by about 400 bps between the smallest and largest lenders. Our estimates suggest little difference in average costs among banks between $100 million and $1 billion and only small additional economies of scale benefits beyond $1 billion. Overall, the estimates show that the majority of efficiency gains to scale are achieved by $100 million, with little significant average cost advantages above that level. Figure 17b shows crisis estimates for CRE specialists. Compared to 2006 estimates, CRE lending specialists had a substantially different cost structure in 2009. These changes are not surprising as the characteristics of CRE lenders were themselves altered by the crisis. The average cost estimate is flat above $500 million, suggesting no significant difference in the scale efficiencies among banks beyond $500 million in asset size.

[6] Confidence intervals for the average cost estimates are estimated using a bootstrap technique (with 1,000 bootstraps) described in Davidson and Flachaire (2001). A bootstrap process estimates confidence intervals by re-sampling the actual data many times, at each stage producing a new random sample. For each new sample, the model's parameters are re-estimated. The distribution of the parameter values from these re-sampling estimates is used to construct confidence intervals for the model's parameter estimates.

Figure 16a: "Mortgage Lending Specialization" Estimated Average Cost Curve 2006

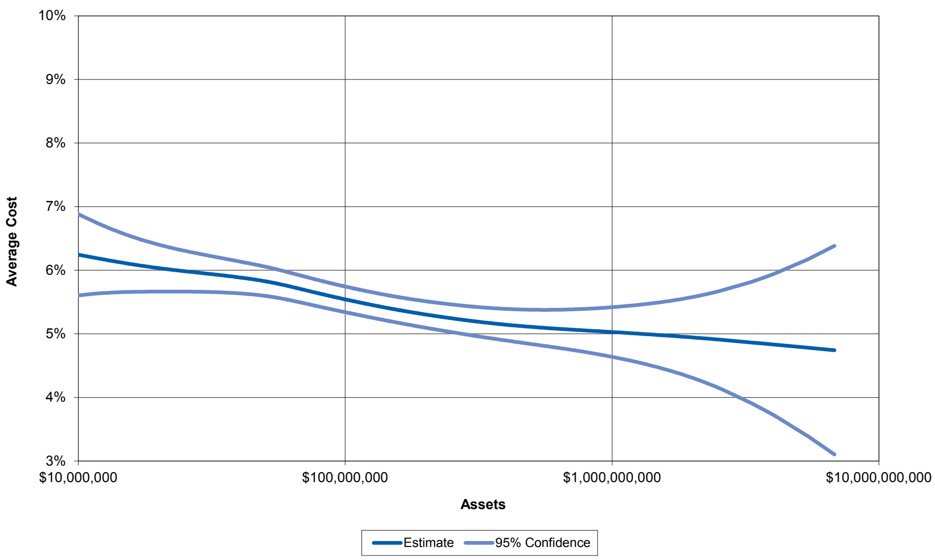


Figure 16b: "Mortgage Lending Specialization" Estimated Average Cost Curve 2009

Source: FDIC.

Figures 18a and 18b show the economies of scale estimates for CB agricultural lending specialists. For this group, there is little evidence of economies of scale. Figure 18a shows that estimated mean average costs differ very little from the smallest agricultural lenders to the largest. Further, the results indicate no statistically significant cost advantages beyond $100 million. Since the estimated cost curve is flat, agricultural specialists appear to have a smaller cost incentive to grow in terms of assets. Figure 18b shows estimates from 2009. The general shape of the average cost curve is similar to 2006, but the level of average cost decreases slightly at lower asset levels.

Figures 19a and 19b plot kernel regression estimates for the CB no specialty lending group. Figure 19a shows that the no specialty lending group had some statistically significant evidence of economies of scale in 2006. The estimated mean average cost drops by almost 150 bps at the largest banks compared with the smallest banks within this group. Taking statistical confidence into account, our estimates suggest that significant economies of scale are exhausted when an institution reaches about $100 million in assets.

Figure 17a: "Commercial Real Estate Lending" Specialization Estimated Average Cost Curves 2006

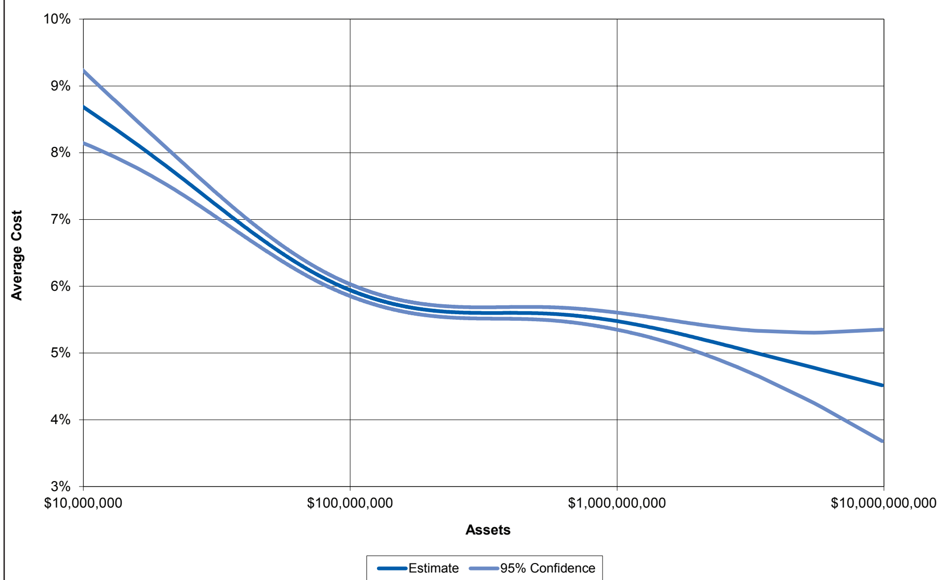
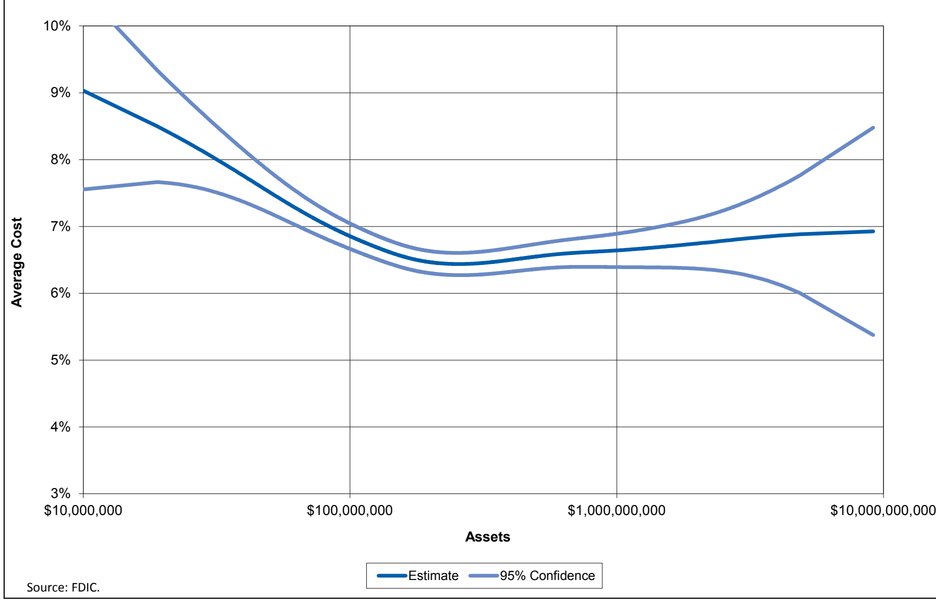


Figure 17b: "Commercial Real Estate Lending" Specialization Estimated Average Cost Curves 2009



Source: FDIC.

Figure 18a: "Agricultural Lending" Specialization Estimated Average Cost Curves 2006

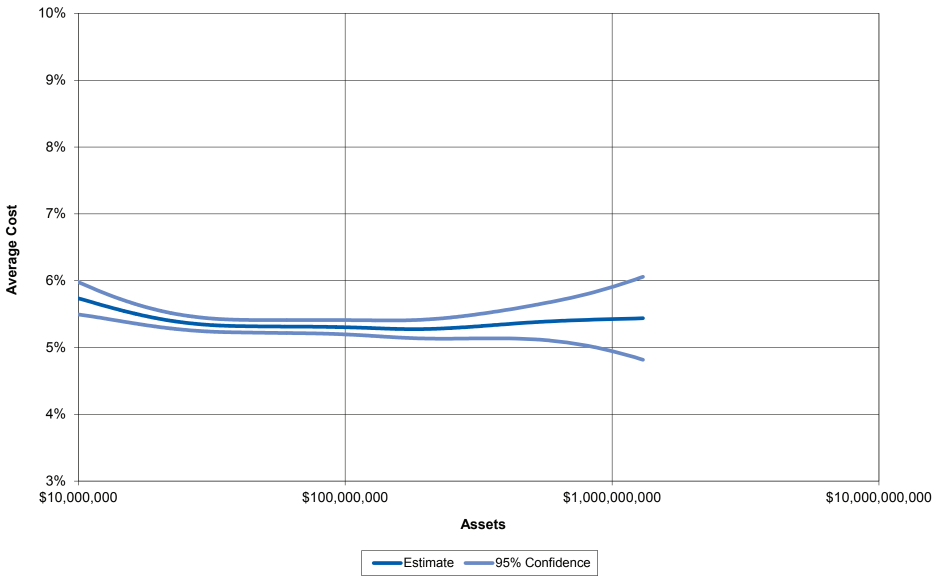
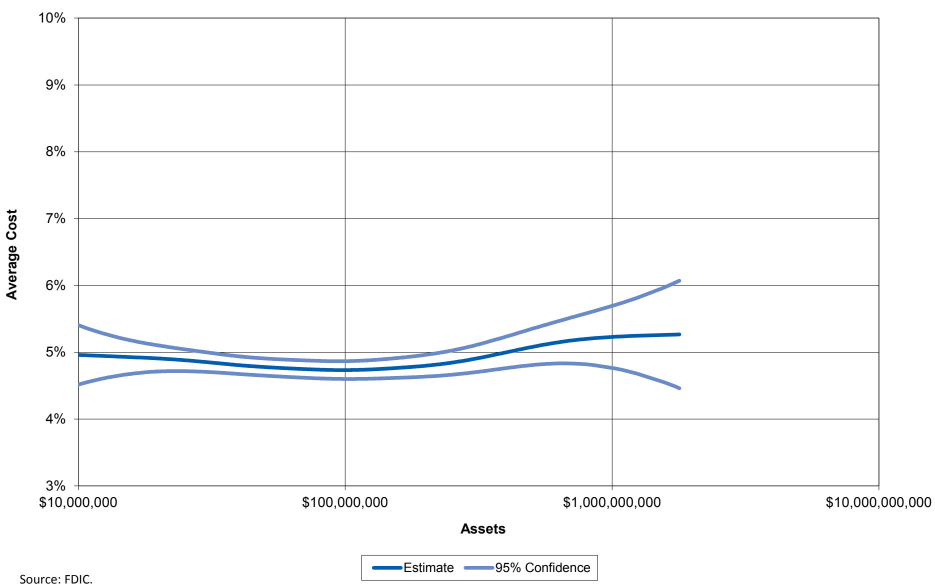


Figure 18b: "Agricutural Lending" Specialization Estimated Average Cost Curves 2009



Source: FDIC.

Figure 19a: "No Specialty" Group Estimated Average Cost Curves 2006

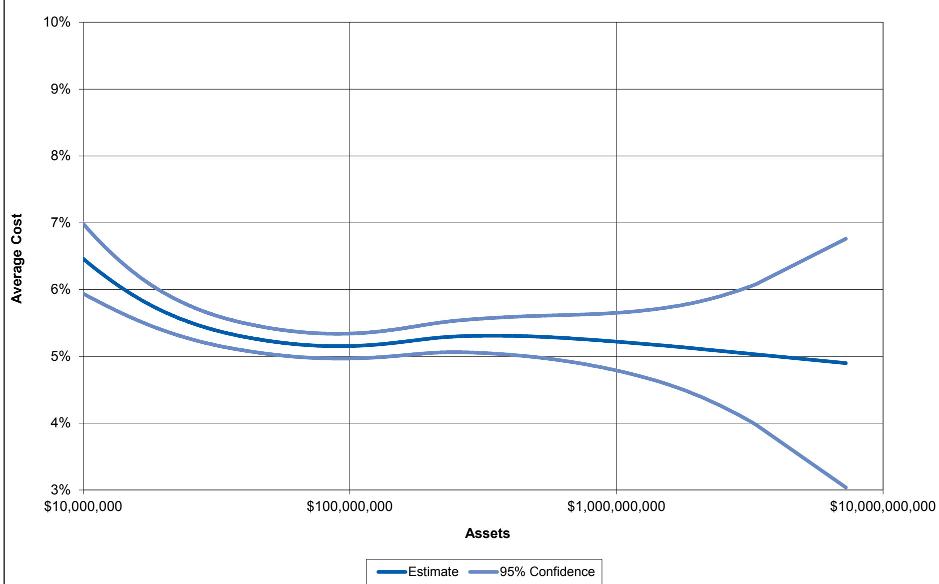
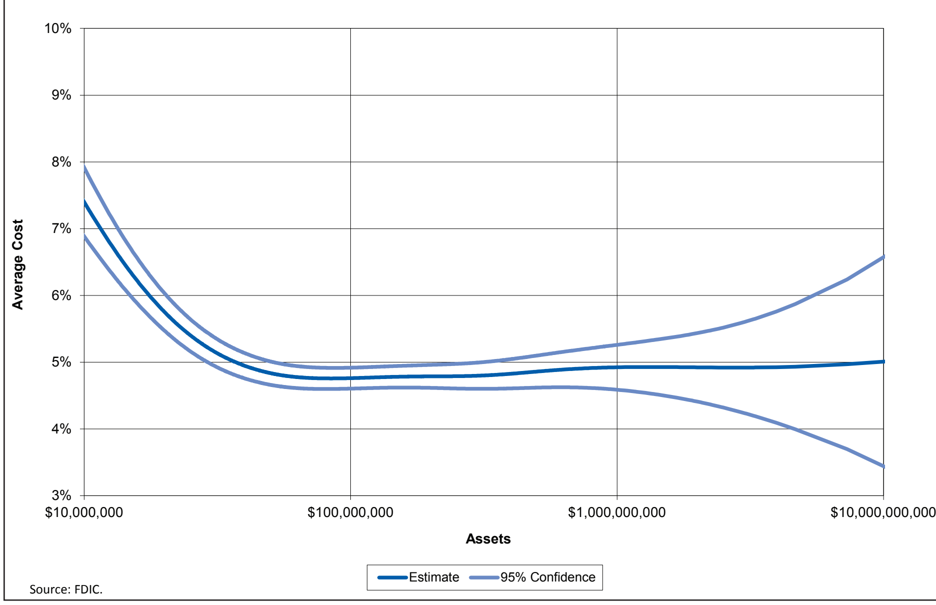


Figure 19b: "No Specialty" Group Estimated Average Cost Curves 2009



Source: FDIC.

Figure 20a: Average Costs Relative to the Regional Mean (2006) at Mortgage Lending Specialists

Figure 20b: Average Costs Relative to the Regional Mean (2006) at Commercial Real Estate Lending Specialists

Source: FDIC.

Does Location Affect Cost Differences?

Just as costs of living vary across the nation, banks may have inherently higher operating costs in some regions of the country than in others. If operational costs vary by region in a systematic way, it may cause us to misestimate the potential for economies of scale in the prior analysis. For example, if smaller banks are more often located in more expensive areas of the country, they may appear to have higher average costs irrespective of any economies of scale and the previous analysis would overstate the importance of scale economies. In contrast, if large banks are more likely to be located in expensive regions, the importance of their true scale economies will be understated by the prior analysis.

We control for differences in the level of regional costs by subtracting the appropriate regional mean average cost from each observation. Figure 20 and Figure 21 show the relationship between size and average cost relative to regional average costs for different CB specialty lender categories in 2006 and 2009 respectively. These figures show economies of scale characteristics that are similar to those calculated in the prior analysis, even after we adjust for regional difference in costs. These results provide a

Figure 21a: Average Costs Relative to the Regional Mean (2006) at Agricultural Lending Specialists

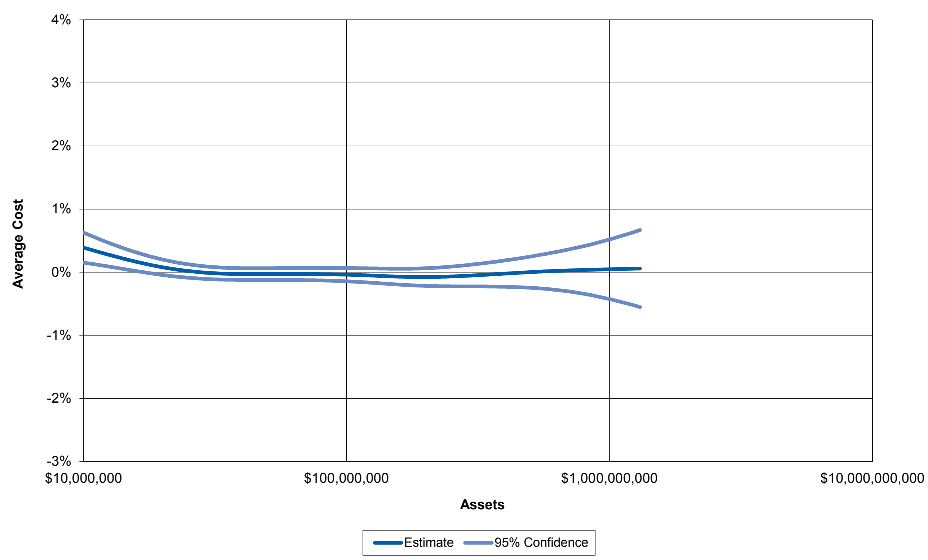
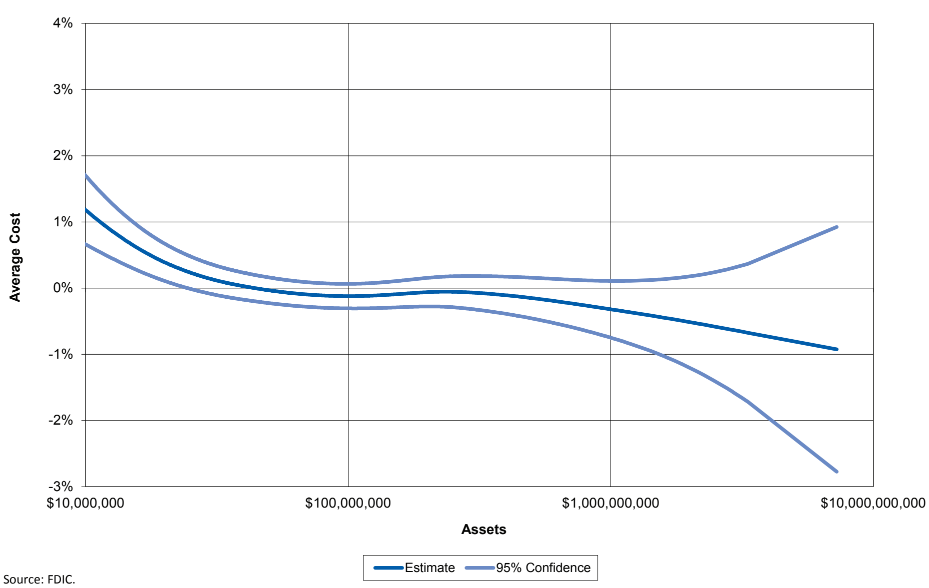
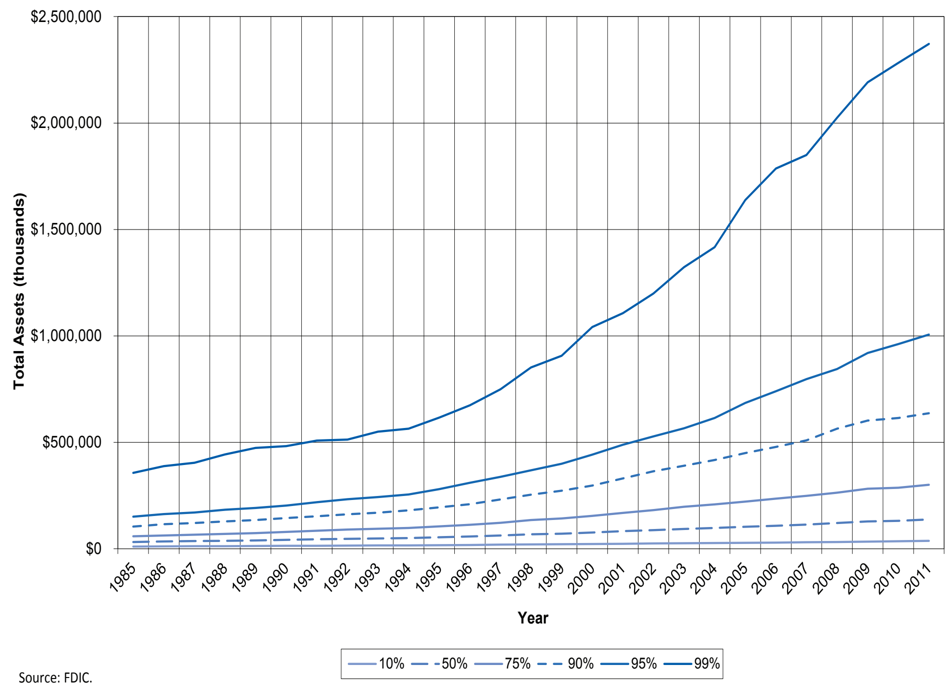


Figure 21b: Average Costs Relative to the Regional Mean (2006) at the "No Specialty" Group



Source: FDIC.

Figure 22: Evolution of the Size Distribution of Surviving Community Banks



Source: FDIC.

check on our earlier analysis and show that our results for economies of scale are not distorted by the existence of a systematic relationship between bank size and location-specific costs characteristics.

Is There a Minimum Viable Size for a Community Bank?

The viability of small banks is an important issue within the community banking industry. Are there important economies of scale that push the smallest institutions to merge or exit the industry? While the estimates suggest that community banks do experience reductions in average cost as they grow in size, the importance of these economies of scale should not be overstated. The estimates indicate that most scale benefits are exhausted at asset levels far smaller than $1 billion, and for many specialty lender groups, much of the benefit can be achieved at a scale as small as $100 million.

While economies of scale may create incentives for community banks to grow toward $100 million in assets and beyond, economies of scale are probably not the most important factor that determines the viability of smaller institutions. Consider the size and growth history of all the CBs that have survived the last quarter century. Figure 22 plots the evolution of the size distribution of all CBs that existed in 1985 and survive through 2011; more than 60 percent of CBs (3,212) have weathered two banking crises and finished 2011 with less than $200 million in assets. Therefore, community banks of relatively modest size appear to be not only viable, but resilient. While a very few CBs grew to over $1 billion in asset size, about 85 percent of CBs (4,419 banks) that survived have less than $500 million in assets at year-end 2011.

Conclusion

This analysis has identified factors that help to explain why NCB and CB efficiency ratios have changed over time. Overall, a large part of the change in the relative efficiency of CBs versus NCBs can be explained by two general trends. First, CBs once held a distinct advantage in net interest income over community banks, which has since evaporated. On the expense side of the efficiency ratio, NCBs have been able to increase the amount of assets they manage per employee relative to CBs. While both CBs and NCBs have increased their salary expenses per employee, CBs have lost ground on employee expenses after accounting for productivity trends.

Finally, we estimate the average cost curve as a function of bank size for various CB specialty lender groups for two separate years: 2006, a very profitable year; and 2009, a crisis year. The results show that the average cost structure of banks varies across specialization groups. CRE specialists, in particular, exhibit potentially important economies of scale. In contrast, the agricultural lending group displays little potential for economies of scale. Further analysis shows that the estimates of relationship between size and average cost among lending specialties is not driven by regional differences in costs. Importantly, while the results show that community banks may benefit from economies of scale, there is no indication of any significant benefit beyond $500 million in asset size, and much of the benefits from scale appear to be achieved for CBs as small as $100 million. Large size and economies of scale are unlikely to be the most important factor in determining bank viability as analysis of the last quarter century of community bank data reveals that more than 60 percent of community banks that survived the last 25 years have less than $200 million in assets.

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