The Evolution of Scale Economies in U.S. Banking

David C. Wheelock
and
Paul W. Wilson

Working Paper 2015-021C
https://dx.doi.org/10.20955/wp.2015.021

Revised February, 2017

FEDERAL RESERVE BANK OF ST. LOUIS
Research Division
P.O. Box 442
St. Louis, MO 63166

The views expressed are those of the individual authors and do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis, the Federal Reserve System, or the Board of Governors.

Federal Reserve Bank of St. Louis Working Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Federal Reserve Bank of St. Louis Working Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors.
The Evolution of Scale Economies in U.S. Banking

DAVID C. WHEELOCK       PAUL W. WILSON*

February 2017

Abstract

Continued consolidation of the U.S. banking industry and a general increase in the size of banks has prompted some policymakers to consider policies that discourage banks from getting larger, including explicit caps on bank size. However, limits on the size of banks could entail economic costs if they prevent banks from achieving economies of scale. This paper presents new estimates of returns to scale for U.S. banks based on nonparametric, local-linear estimation of bank cost, revenue and profit functions. We report estimates for both 2006 and 2015 to compare returns to scale some seven years after the financial crisis and five years after enactment of the Dodd-Frank Act with returns to scale before the crisis. We find that a high percentage of banks faced increasing returns to scale in cost in both years, including most of the 10 largest bank holding companies. And, while returns to scale in revenue and profit vary more across banks, we find evidence that the largest four banks operate under increasing returns to scale.

*Wheelock: Research Department, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, MO 63166–0442; wheelock@stls.frb.org. Wilson: Department of Economics and School of Computing, Division of Computer Science, Clemson University, Clemson, South Carolina 29634–1309, USA; email pww@clemson.edu. This research was conducted while Wilson was a visiting scholar in the Research Department of the Federal Reserve Bank of St. Louis. We thank the Cyber Infrastructure Technology Integration group at Clemson University for operating the Palmetto cluster used for our computations. We thank three anonymous referees for comments, and Peter McCrory and Paul Morris for research assistance. The views expressed in this paper do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis or the Federal Reserve System. JEL classification nos.: G21, L11, C12, C13, C14. Keywords: banks, returns to scale, scale economies, nonparametric, regression.
1 Introduction

The financial crisis of 2007–08 raised new concerns about the size and complexity of the world’s largest banking organizations. Many of the largest banks are now considerably bigger than they were before the crisis. For example, on December 31, 2006, the largest U.S. bank holding company (Citigroup) had total consolidated assets of $1.9 trillion, while two others (Bank of America and JPMorgan Chase) also had more than $1 trillion of assets. By contrast, on December 31, 2015, the largest holding company (JPMorgan Chase) had $2.35 trillion of assets and three others had assets in excess of $1.7 trillion.

Are banks destined to become ever larger and, if so, is that cause for concern? The answer to this question depends, in part, on why banks have been getting larger. The policy implications are likely different if banks are growing larger to exploit technologically-driven scale economies than if government policies that encourage large size or excessive risk taking are driving bank growth. Of particular concern is the perception that regulators consider very large banks “too-big-to-fail” (TBTF), which would provide an implicit funding subsidy to banks that exceed a certain size threshold. The Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 was intended to eliminate TBTF by establishing a formal process for resolving failures of large financial institutions, as well as by imposing a tighter financial regulatory regime. However, some economists and policymakers argue that Dodd-Frank does not go far enough to contain TBTF, and that banks should be subject to firm caps on their size (e.g., Fisher and Rosenblum, 2012). The imposition of size limits on banks could have a downside, however, if they prevent banks from achieving economies of scale (as noted, e.g., by Stern and Feldman, 2009). Hence, the extent to which there are scale economies in banking is an important question that has attracted renewed interest among researchers and policymakers.

This paper presents new estimates of returns to scale (RTS) for U.S. bank holding companies (BHCs) and independent (i.e., not BHC owned) commercial banks. The paper makes two main contributions. First, we report estimates for both 2006 and 2015 (as well as for 1986 and 1996) to provide a comparison of RTS for the largest banks some seven years after the financial crisis and five years after the enactment of Dodd-Frank with estimates for 2006 and earlier years. Second, whereas previous studies focus exclusively on scale economies in
terms of cost, we estimate RTS in terms of revenue and profit, as well as cost. Although estimates of RTS from a cost perspective indicate whether society’s resources are employed efficiently in providing banking services, economies of scale in revenue or profit are of concern to bank shareholders, as well as to policymakers interested in the forces driving industry consolidation.

Conventional wisdom, based largely on studies that use data from the 1980s and 1990s to estimate returns to scale from cost functions, holds that banks exhaust scale economies at low levels of output, e.g., $100–$300 million of total assets. However, several recent studies find evidence of increasing returns to scale (IRS) among much larger banks, including banks with more than $1 trillion of assets. Improved estimation methods and data could explain the difference in findings between older studies and more recent ones. However, recent advances in technology are often thought to have favored larger banks, and perhaps increased the size range over which banks could experience IRS (Berger, 2003; Mester, 2005). Wheelock and Wilson (2009) find that larger banks experienced larger gains in productivity over 1985–2004 than did smaller banks. Feng and Serletis (2009) find similar evidence for 1998–2005. These studies suggest that technological advances may have also generated IRS for banks. Indeed, using a variety of methodologies and datasets, several recent studies find more evidence of substantial economies of scale in banking, with some finding that even very large banks operate under IRS (e.g., Wheelock and Wilson, 2012; Hughes and Mester, 2013; and Kovner et al., 2014 for U.S. banks, and Becalli et al., 2015 for European banks). However, other studies are less conclusive (e.g., Feng and Zhang, 2014; Restrepo-Tobón and Kumbhakar, 2015) and questions remain.

Changes in regulation, notably the Dodd-Frank Act of 2010, might also have affected returns to scale by altering the environment in which banks operate. Most studies use data on banks from before the financial crisis of 2007–08 or just shortly thereafter. However, many of the largest U.S. banks have continued to grow even larger since the crisis, perhaps to the point of exhausting potential scale economies. Research using more recent data is

---

1 Studies of scale economies in banking from the 1980s and before typically relied on estimation of translog or other parametric specifications of bank cost functions. However, subsequent studies, including the present paper, find that the translog function is a misspecification of bank cost relationships and therefore can lead to erroneous estimates of returns to scale (RTS). See McAllister and McManus (1993) and Wheelock and Wilson (2001) for discussion and evidence on the bias introduced by estimating bank scale economies from a translog cost function.
thus required to determine whether earlier conclusions about the extent of scale economies in banking are still true.

In addition to providing an update to previous research on scale economies from the perspective of bank costs, we also examine scale economies in revenue and profit. Several studies have estimated revenue and profit relationships for banks to study such topics as revenue economies of scope (Berger et al., 1996), profit efficiency (e.g., Berger and Mester, 1997), and profit productivity (Berger and Mester, 2003). In addition to economies of scope, Berger et al. (1996) estimate revenue ray-scale economies for a sample of banks using data for 1978, 1984 and 1990. That study finds evidence of significant revenue scale economies in 1978 and 1984, especially for banks with less than $500 million of assets, but not in 1990. We are unaware of any other studies that examine revenue or profit scale economies for banks. Berger and Mester (2003) argue, however, that studies that ignore revenues when evaluating bank performance could be misleading. For example, Berger and Mester (2003) find that during the 1990s, banks became less productive in terms of cost (essentially that cost per unit of output rose after controlling for output quantities, input prices, and various environmental conditions), but more productive at generating profits. Berger and Mester (2003) attribute this finding to efforts by banks to increase profits by providing more or better quality services that raise their revenues by more than they increase costs. Similarly, an examination of the evolution of RTS from a revenue or profit perspective could provide a more complete picture of scale economies in banking than a focus solely on economies of scale in terms of cost.

We use a nonparametric, local-linear estimator to estimate cost, revenue and profit relationships from which we derive estimates of RTS. The nonparametric approach avoids the potential for functional-form specification error associated with parametric estimation. Although nonparametric estimators are plagued by the “curse of dimensionality,” i.e., slow convergence rates (compared to parametric estimators) that become exponentially slower with more model dimensions, we take steps to mitigate this problem. Specifically, we estimate our models using a large dataset consisting of over 800,000 observations on all U.S. banks for 1986–2015, and we employ principal components techniques to reduce the dimensions of our empirical models. Our estimation methodology is similar to that of Wheelock and Wilson (2012). However, Wheelock and Wilson (2012) focus exclusively on scale economies
in terms of cost and estimate RTS for U.S. banks in 2006. Here we extend the methodology to the estimation of RTS in terms of revenue and profit, report estimates for both 2006 and 2015 (as well as 1986 and 1996), and test whether changes in RTS between 2006 and 2015 are statistically significant.

We find that, despite the growth in size of many of the largest banks during and since the financial crisis, the very largest banks continued to face IRS in terms of cost in 2015. In fact, our estimates indicate that many of the largest banks experienced statistically significant increases in RTS between 2006 and 2015. Among all banks, approximately 35 percent of banks operated under IRS in 2006, while 43 percent faced IRS in 2015. Among all banks that were in existence in both 2006 and 2015, 27 percent more banks faced IRS in 2015 than in 2006, while only a few banks experienced decreasing returns to scale (DRS) in either period. Our results for revenue and profit economies are more mixed. While overall we find that fewer banks faced IRS in terms of revenue or profit than in terms of cost, we find evidence of IRS among a number of the largest banks in both 2006 and 2015, especially among the four largest U.S. banking organizations.

The next section describes the microeconomic specification of our cost, revenue, and profit functions and the statistics to measure RTS. Section 3 introduces the econometric specification, and Section 4 discusses the nonparametric methods we use for estimation and inference. Sections 5 and 6 present our empirical findings and conclusions. Additional details on data, estimation, and results are provided in separate Appendices A–E, which are available online.

## 2 Microeconomic Specification

To establish notation, let \( x \in \mathbb{R}^p_+ \) and \( y \in \mathbb{R}^q_+ \) denote column-vectors of \( p \) input quantities and \( q \) output quantities, respectively. Let \( w \in \mathbb{R}^p \) denote the column-vector of input prices corresponding to \( x \), and let \( r \in \mathbb{R}^q \) denote the column-vector of output prices corresponding to \( y \). Then variable costs are given by \( C := w'x \), which firms (banks) seek to minimize with respect to \( x \), subject to \( h(x, y) = 0 \) where \( h(\cdot, \cdot) \) represents the product-transformation function that determines the possibilities for transforming input quantities \( x \) into output quantities \( y \). Solution to the constrained minimization problem yields a mapping \( \mathbb{R}^q_+ \times \mathbb{R}^p \mapsto \).
such that \( x = x(y, w) \); substitution into \( C = w'x \) yields

\[
C = w'x = w'x(y, w) = C(y, w)
\]  

(2.1)

where \( C(y, w) \) is the variable cost function.

The story so far is part of the standard microeconomic theory of the firm (e.g., see Varian, 1978). Under perfect competition in output markets, the same body of theory implies that banks maximize revenue \( R := r'y \) with respect to output quantities, again subject to \( h(x, y) = 0 \), yielding the solution \( y = y(r, x) \). Substitution then yields \( R = r'y(r, x) = R^s(x, r) \), i.e., a standard revenue function that maps input quantities and output prices to revenue. Fuss and McFadden (1978) and Laitinen (1980) describe the conditions on \( h(x, y) \) required for existence of the revenue (and profit) function(s).

Banking studies, however, often estimate alternative revenue or profit functions, where revenue (or profit) are functions of output levels and input prices. As discussed, for example, by Berger and Mester (1997), the alternative revenue and profit functions provide a means of controlling for unmeasured differences in output quality across banks, imperfect competition in bank output markets (which gives banks some pricing power), any inability of banks to vary output quantities in the short-run, and inaccuracy in the measurement of output prices.

Estimates of economies of scale from alternative revenue and profit functions provide information about the extent to which revenue (or profit) rises for a given increase in output, holding input prices constant. Berger et al. (1996) describe the assumptions underlying standard and alternative revenue functions, and the validity of those assumptions for banks. The standard form assumes that banks are price takers. The alternative form, by contrast, assumes that banks have some pricing power, and views banks as having greater on-going flexibility in setting output prices than output levels. Based on a review of available evidence, Berger et al. (1996) conclude that some two-thirds of bank revenues are associated with services that reflect a degree of price-setting behavior, and they proceed by viewing banks as negotiating prices and fees, where feasible, to maximize revenues and profits for given levels of output. They argue that this model better represents how banks actually operate than the perfectly-competitive model which underlies standard revenue and profit functions. Berger and Mester (1997, 2003) elaborate further on the advantages of the alternative form of the revenue and profit function. For example, they note that in addition to admitting
the possibility that banks have some degree of pricing power, the alternative form can be informative about bank performance when there are unmeasured differences in the quality of bank services across banks, when banks are unable to adjust their sizes quickly, or when output prices are not measured accurately. Indeed, bank input prices are, for the most part, more readily observed in bank call report data than output prices. The absence of output price information for the vast majority of banks means that standard revenue or profit functions cannot be estimated (unless outputs are aggregated to an even greater degree than they already are in our models).

Following Berger et al. (1996) and others, we assume that banks maximize revenue with respect to output prices $r$, subject to $g(y, w, r) = 0$, where $g()$ is an implicit function representing the bank’s opportunities for transforming given output levels $y$ and input prices $w$ into output prices $r$. Solution of this constrained optimization problem yields a mapping $\mathbb{R}^q_+ \times \mathbb{R}^p \mapsto \mathbb{R}^q$ such that $r = r(y, w)$; then $R = r'y = r(y, w)'y = R(y, w)$, where $R(y, w)$ is the alternative revenue function introduced by Berger et al. (1996).

Turning to profits, let $P = [r' \quad w']'$ and $Q = [y' \quad -x']'$. Standard theory suggests that firms operating in perfectly competitive input and output markets maximize profit $\pi := P'Q$ with respect to $Q$, subject to $h(x, y) = 0$. Solution of the constrained optimization problem yields $Q = Q(P)$; substituting this back into the profit function $\pi = P'Q$ gives $\pi = P'Q(P) = \pi^s(w, r)$, i.e., the standard profit function that maps input and output prices into profit. Under imperfect competition in output markets, however, banks maximize profit with respect to input quantities $x$ and output prices $r$, subject to $h(x, y) = 0$ and $g(y, w, r) = 0$. The solution results in a mapping $\mathbb{R}^q_+ \times \mathbb{R}^p \mapsto \mathbb{R}^p$ such that $x = x(y, w)$, and a mapping $\mathbb{R}^q_+ \times \mathbb{R}^p \mapsto \mathbb{R}^q$ such that $r = r(y, w)$. Substituting these into the profit function gives

$$\pi = P'Q = [r(y, w)' \quad w'] [y' \quad -x(y, w)']' = \pi(y, w)$$

(2.2)

where $\pi(y, w)$ is the alternative profit function that maps output quantities and input prices to profit.

Note that the cost function $C(y, w)$ must be homogeneous of degree one with respect to input prices $w$ since the cost minimization problem implies that factor demand equations must be homogeneous of degree zero in input prices. However, there is no such requirement for the alternative revenue and profit functions. Without additional assumptions, the al-
ternative revenue and profit functions are neither homogeneous with respect to input prices $w$ nor homogeneous with respect to output quantities $y$. See Berger et al. (1996) and Restrepo-Tobón and Kumbhakar (2014) for discussion.

To measure RTS using the cost function, we define

$$\mathcal{E}_{C,i} := \left( \delta C(y_i, w_i) - C(\delta y_i, w_i) \right) \left( \delta C(y_i, w_i) \right)^{-1} \quad (2.3)$$

where $\delta > 1$ is a constant and $y_i$ is the observed vector of output quantities produced by the $i$th bank facing observed input prices $w_i$. Clearly, $\mathcal{E}_{C,i} < 1$. The statistic $\mathcal{E}_{C,i}$ measures expansion-path scale economies as the difference between $\delta$ times the cost of producing output quantities $y_i$ and the cost of producing output quantities scaled by the factor $\delta$. The difference is normalized by dividing by $\delta C(y_i, w_i)$. If $\mathcal{E}_{C,i} > (=, <) 0$ then bank $i$ faces IRS (CRS, DRS) in terms of cost.

To interpret the magnitude of $\mathcal{E}_{C,i}$, rearrange terms in (2.3) to obtain

$$\eta_{C,i} := \delta \left( 1 - \mathcal{E}_{C,i} \right) = C(\delta y_i, w_i)/C(y_i, w_i). \quad (2.4)$$

Hence firm $i$ increases its output by a factor $\delta > 1$, its cost increases by a factor $(1 - \mathcal{E}_{C,i})\delta$. For example, if $\delta = 1.1$ and $\mathcal{E}_{C,i} = 0.05$, then firm $i$ incurs a 4.5-percent increase in cost when it increases its output level by 10 percent since $1.1 \times (1 - 0.05) \approx 1.045$. The measure $\eta_{C,i}$ defined in (2.4) can be interpreted as a “pseudo elasticity.” For $\delta = 1.1$ (i.e., for a 10-percent increase in output levels), costs increase by $(\eta_{C,i} \times 100)$-percent, and the firm faces IRS (CRS, DRS) if $\eta_{C,i} < (=, >) 1.1$.

As in many empirical studies, the revenue measure introduced below in Section 3 consists of net revenues and can take negative values. Of course, profits can also be negative. Therefore, to measure RTS from the revenue and profit functions, we define

$$\mathcal{E}_{R,i} := \left( R(\delta y_i, w_i) - \delta R(y_i, w_i) \right) \left( \delta |R(y_i, w_i)| \right)^{-1} \quad (2.5)$$

and

$$\mathcal{E}_{\pi,i} := \left( \pi(\delta y_i, w_i) - \delta \pi(y_i, w_i) \right) \left( \delta |\pi(y_i, w_i)| \right)^{-1}. \quad (2.6)$$

\footnote{The measure defined in (2.4) has an additional interpretation. Some algebra reveals that $\mathcal{E}_{C,i} (> , = , <) 1$ iff $\mathcal{E}_{C,i} (< , = , >) 1 - \delta^{-1}$. For $\delta = 1.1$, $(1 - \delta^{-1}) \approx 0.09091$. Hence values of $\mathcal{E}_{C,i}$ less than 0.09091 indicate that a 10 percent increase in output levels results in an increase in total (variable) cost, whereas values of $\mathcal{E}_{C,i}$ greater than 0.09091 indicate that a 10 percent increase in output reduces cost. Of course, it is probably unlikely, but perhaps not impossible, for an increase in output to reduce total cost.}
In the definitions of $E_{R,i}$ and $E_{\pi,i}$, the constant factor $\delta$ multiplies output levels $y$ in the first term of the numerator, in contrast to the definition of $E_{C,i}$ in (2.3), where $\delta$ multiplies output levels $y$ in the second numerator term. Similarly, $\delta$ multiplies the second term of the numerators of $E_{R,i}$ and $E_{\pi,i}$, rather than the first term as in (2.3). These differences reflect the fact that banks attempt to maximize revenue and profit but minimize cost. In addition, the denominators in (2.5) and (2.6) involve absolute values to account for the possibility that measured revenue or profit can be negative. Clearly, $E_{R,i} > (=, <) 0$ implies IRS (CRS, DRS) and similarly for values of $E_{\pi,i}$. Moreover, following the logic in footnote 2, it is easy to show that a 10 percent increase in output levels (i.e., $\delta = 1.1$) increases revenue or profit whenever $E_{R,i}$ or $E_{\pi,i}$ is greater than $-0.09091$ (although revenue or profit might increase by less than 10 percent).

To facilitate interpretation by providing a pseudo elasticity measure for revenue and profit analogous to the one given for cost in (2.4), consider the scale measure $E_{\pi,i}$ defined in (2.6) (similar reasoning applies to the scale measure $E_{R,i}$ defined in (2.5)). Suppose $\pi(y_i, w_i) > 0$ and $\pi(\delta y_i, w_i) > 0$, which is the most common (by far) scenario. Then (2.6) can be rearranged to define

$$\eta_{\pi,i} := (1 + E_{\pi,i})\delta = \pi(\delta y_i, w_i)/\pi(y_i, w_i).$$

Clearly, in this case $E_{\pi,i} \geq -1$. Increasing output levels by a factor $\delta$ leads to an $(\eta_{\pi,i} \times 100)$ percent change in profits. Hence, for $\delta = 1.1$, values $\eta_{\pi,i} > (=, <) 1.1$ indicate IRS (CRS, DRS). Moreover, increasing output levels by a factor $\delta > 1$ leads to an increase in profit whenever $\eta_{\pi,i} > 1$. Using similar reasoning, we define $\eta_{R,i} := (1 + E_{R,i})\delta = R(\delta y_i, w_i)/R(y_i, w_i)$, whose interpretation is analogous to $\eta_{\pi,i}$.

The next section describes the models we estimate to obtain the predicted values needed to estimate the returns-to-scale measures defined in (2.3)–(2.6). Subsequently, Section 4 explains how we estimate the models and make inferences.

### 3 Econometric Specification

To obtain estimates of the returns-to-scale measures $E_{C,i}$, $E_{R,i}$, and $E_{\pi,i}$, we must specify versions of the cost function $C(y, w)$, revenue function $R(y, w)$, and profit function $\pi(y, w)$.

---

3 See Appendix A for details about the interpretation of the returns-to-scale measures $E_{R,i}$ and $E_{\pi,i}$ when revenue or profit are negative.
for estimation. We define response and explanatory variables in the present section, and discuss our fully nonparametric estimation methods in Section 4.

Our specification of right-hand-side (RHS) explanatory variables closely follows Wheelock and Wilson (2012) and much of the banking literature. We define four inputs and five outputs that, with one exception (the measure of off-balance sheet output), are those used by Berger and Mester (2003). Specifically, we define the following output quantities: consumer loans \(Y_1\), real estate loans \(Y_2\), business and other loans \(Y_3\), securities \(Y_4\), and off-balance sheet items \(Y_5\) consisting of net non-interest income.\(^4\)

We define three variable input quantities: purchased funds and core deposits, consisting of the sum of total time deposits, foreign deposits, federal funds purchased, demand notes, trading liabilities, other borrowed money, mortgage indebtedness and obligations under capitalized leases, and subordinated notes and debentures \(X_1\); labor services, measured by the number of full-time equivalent employees on payroll at the end of each quarter \(X_2\); and physical capital \(X_3\). The first input quantity, \(X_1\), captures non-equity sources of investment funds for the bank.\(^5\) We measure the corresponding prices \((W_1, \ldots, W_3)\) by dividing total expenditure on the given input by its quantity. We include financial equity capital \((EQUITY)\) as a quasi-fixed input, which controls somewhat for differences in risk across banks (see Berger and Mester (2003) for details).\(^6\) As an additional control for differences in bank risk, we also include a measure of non-performing assets \((NPER)\) consisting of (i) total loans and lease financing receivables past due 30 days or more and still accruing, (ii) total loans and lease financing receivables not accruing, (iii) other real estate owned, and (iv) charge-offs on past-due loans and leases.\(^7\)

\(^4\) Of the commonly used measures of off-balance sheet output, net non-interest income is the most consistently measurable across banks and over time. However, as a net, rather than gross measure of income, it is potentially a biased measure of off-balance sheet output because losses would appear to reduce off-balance sheet output. Data that would permit calculation of a gross measure of non-interest income are not available. See Clark and Siems (2002) for discussion of alternative measures of off-balance sheet activity.

\(^5\) Wheelock and Wilson (2012) treat core deposits (i.e., total deposits less time deposits of \$100,000 or more) and other funding liabilities as a separate inputs. Here, we combine them into a single input due to reporting differences in the FR Y-9C call reports for bank holding companies and the FFIEC call reports for commercial banks prior to 2001.

\(^6\) We define \(EQUITY\) as the sum of the book values of common and preferred stock, surplus, and retained earnings, which are items RCFD3210 and BHCK3210 from the FFIEC and FR Y-9C call reports, respectively.

\(^7\) We thank a referee for pointing out that adding charge-offs to past-due and nonaccrual assets eliminates bias caused by differences in charge-off strategies across banks.
sured as full-time equivalent employees) and off-balance sheet output (which is measured in terms of net flow of income), our inputs and outputs are stocks measured by dollar amounts reported on bank balance sheets, consistent with the widely used intermediation model of Sealey and Lindley (1977).

In addition to the variables defined above, we index quarters 1986.Q4 through 2015.Q4 by setting \( T = 1 \) for 1986.Q4, \( T = 2 \) for 1987.Q1, \ldots, \( T = 117 \) for 2015.Q4. Although \( T \) is an ordered, categorical variable, we treat it as continuous since it can assume a wide range of possible values. The regulatory environment and the production technology of banking changed a great deal over the 30 years covered by our data; including \( T \) as an explanatory covariate allows functional forms to change over time. Two features of our estimation strategy allow a great deal of flexibility. First, because we use a fully nonparametric estimation method, we impose no constraints on how \( T \) might interact with other explanatory variables. Second, the local nature of our estimator means that when we estimate cost at a particular point in time, observations from distant time periods will have little or no effect on the estimate. Typical approaches that involve estimation of a fully parametric translog cost functions by OLS or some other estimation procedure are not local in the sense that when cost is estimated at some point in the data space, all observations contribute to the estimate with equal weight. Moreover, the typical approach requires the imposition of a specific functional form a priori for any interactions among explanatory variables.\(^8\)

Turning to the response variables, we define our cost variable \( C \) as the sum of expenditures on purchased funds and core deposits, labor, and physical capital so that \( C := W_1X_1 + W_2X_2 + W_3X_3 \). We define our revenue variable, \( R \), similarly to Berger and Mester (2003); i.e., \( R := \) total interest income + total non-interest income + realized gains (losses) on held-to-maturity securities + realized gains (losses) on available-for-sale securities – provision for loan and lease losses – provision for allocated transfer risk reserves. Finally, we measure profit (\( \pi \)) as the difference between revenue and cost; i.e., \( \pi := R - C \).

Our cost, revenue, and profit functions include as right-hand side (RHS) variables the vector \( y := [Y_1 \ Y_2 \ Y_3 \ Y_4 \ Y_5] \) of output quantities defined above. When estimating the cost function, we also include \( w_1 := [W_2 \ W_3 \ T \ \text{EQUITY} \ \text{NPER}] \) with the price of purchased funds (\( W_1 \)) serving as the numeraire (we also divide cost on the left-hand side (LHS) by \( W_1 \)).

---

\(^8\) The local nature of our estimator is discussed in more detail below in Section 4 and in Appendix D.
to ensure homogeneity with respect to input prices). As discussed in Section 2, we do not impose linear homogeneity when estimating the revenue and profit functions. Consequently, we include on the RHS (in addition to $y$) $w_2 := [W_1 \ W_2 \ W_3 \ T \ EQUITY \ NPER]$ when estimating revenue and profit functions.

Our cost, revenue and profit functions are each of the form

$$Y = m(y, w) + \varepsilon$$

(3.1)

where $Y$ represents one of our dependent variables (i.e., either $C$, $R$ or $\pi$), $w$ represents either $w_1$ or $w_2$ (depending on the LHS variable), and $\varepsilon$ is a stochastic error term with $E(\varepsilon \mid y, w) = 0$ so that so that $m(\cdot, \cdot)$ is a conditional mean function. In addition, we assume that the densities of the continuous RHS variables are twice continuously differentiable at each point where the conditional mean function is estimated, but otherwise make no functional form assumptions regarding $m(\cdot, \cdot)$. Consistency of our estimator requires that the dependent variable $Y$ must be continuous at $(y, w)$ when the conditional mean function is estimated at $(y, w)$, and that $E(|Y|^{2+\nu} \mid y, w)$ exists for some $\nu > 0$. One may view the conditional mean functions as either parametric but of unknown form, or nonparametric (i.e., infinitely parameterized). We provide details on estimation and inference below in Section 4 and in Appendix D.

Given a set of RHS variables, our minimal assumptions on the response function $m(y, w)$ and inclusion of the time variable $T$ allow far more flexibility than any parametric model. In banking and other industry studies, it has become fashionable in recent years to specify parametric models that allow (to some degree) technological heterogeneity across firms (examples include Orea and Kumbhakar, 2004 and Poghosyan and Kumbhakar, 2010). Although we maintain an assumption of continuity, our nonparametric specification and local estimation method means that $m(y, w)$ can be quite different for different firms. In addition, the interaction of time $T$ in the response function is left unspecified, allowing far more flexibility than in typical parametric specifications.

We estimate the models using a dataset comprised of consolidated balance sheet and income statement observations for all U.S. bank holding companies (BHCs) for 1986.Q3–2015.Q4. We include in our dataset observations for commercial banks that are not owned by holding companies. We use the seasonally adjusted, quarterly gross domestic product
implicit price deflator to convert all dollar amounts to constant 2015 dollars.\textsuperscript{9}

Using data at the level of holding companies (where relevant) permits more accurate tallying of inputs and outputs than is possible at the level of individual commercial banks, for example by accounting for interbank transfers among subsidiaries of a single holding company, as well as expenses incurred at the holding company level. Moreover, our primary interest is in the largest institutions in the industry, and these are typically holding companies. After pooling data across 117 quarters and deleting observations with missing or implausible values, 847,299 observations remain for estimation. Summary statistics are provided in Tables B.2–B.6 of the separate Appendix B.

4 Details on Estimation and Inference

Various approaches exist for estimating conditional mean functions such as those in the models described above in Section 3. A common approach is to specify a fully parametric translog functional form for the conditional mean function and then estimate the parameters via least-squares methods. However, our data easily reject the translog specification using specification tests similar to those used by Wheelock and Wilson (2001, 2012); see Appendix C for details.

Rejection of the translog functional form is hardly surprising. The translog function is merely a quadratic in log-space, which limits the variety of shapes the conditional mean function is permitted to take. Further, the translog is derived from a Taylor expansion of the cost (or revenue, or profit) function around the means of the data; one should not expect it to fit well data that are highly variable and highly skewed, as is the case with U.S. banking data.\textsuperscript{10} Several studies have noted that the parameters of a translog function are unlikely

\textsuperscript{9} BHC data are from Federal Reserve report FR Y-9C, which we downloaded from the website of the Federal Reserve Bank of Chicago. Data for independent commercial banks are from the Federal Financial Institutions Examination Council (FFIEC 031 and 041 reports). The reports record expenses and other flow variables (as opposed to stocks of deposits, etc.) from January 1 to the end of each quarter (March 31, June 30, September 30 and December 31). Hence for quarters 2, 3 or 4 of a given year, the previous quarter’s call report must be used to first-difference flow variables in order to obtain expenses for a particular quarter. Although we use data from the 1986.Q3 reports for this purpose, our final data represent quarters from 1986.Q4 through 2015.Q4.

\textsuperscript{10} The summary statistics for banks’ total assets given in Tables B.2–B.6 in Appendix B reveal that the distribution of banks’ sizes is heavily skewed to the right. In fact, estimates of Pearson’s moment coefficient of skewness for total assets in each of 117 quarters range from 27.49 to 49.03. Moreover, skewness is increasing over time, despite the consolidation in the industry over the years covered by our data. Regressing the
to be stable when the function is fit globally across units of widely varying size; see, for example, Guilkey et al. (1983) and Chalfant and Gallant (1985) for Monte Carlo evidence, and Cooper and McLaren (1996) and Banks et al. (1997) for empirical evidence involving consumer demand, Wilson and Carey (2004) for empirical evidence involving hospitals, and McAllister and McManus (1993), Mitchell and Onvural (1996), and Wheelock and Wilson (2001, 2012) for empirical evidence involving banks. Similarly, Hughes and Mester (2013, 2015) estimate a nonstandard profit function and input demand equations that allow banks to trade profits for reduced risk. Their system reduces to the translog form when parameter restrictions are consistent with profit maximization and cost minimization, but their tests of these restrictions reject the translog function, implying that banks trade profits for lower risk.

We use fully nonparametric methods to avoid likely specification errors. Although nonparametric methods are less efficient than parametric methods in a statistical sense when the true functional form is known, nonparametric estimation avoids the risk of specification error when the true functional form is unknown, as in the present application. We use local-linear estimators described by Fan and Gijbels (1996) to estimate our cost, revenue and profit functions. Both the local-linear estimator as well as the Nadaraya-Watson kernel regression estimator (Nadaraya, 1964; Watson, 1964) are examples of local order-$p$ polynomial estimators with $p = 1$ and $0$, respectively. For a locally-fit polynomial of order $p$ used to estimate a conditional mean function, going from an even value to an odd value of $p$ results in a reduction of bias with no increase in variance (e.g., see Fan and Gijbels, 1996 for discussion). Hence, we use a local-linear estimator to estimate conditional mean functions, resulting in lower asymptotic mean square error than one would obtain with the Nadaraya-Watson estimator.

Nonparametric regression models can be viewed as infinitely parameterized; as such, any parametric regression model (such as an assumed translog functional form) is nested within a nonparametric regression model. Clearly, adding more parameters to a parametric model affords greater flexibility. Nonparametric regression models represent the limiting outcome of adding parameters, and may be viewed as the most general encompassing model that a

---

skewness coefficients for each quarter on the time variable $T$ yields a positive estimate of the slope coefficient, 0.07302 that is significantly different from zero at .1 significance.
particular parametric specification might be tested against.\(^{11}\)

Most nonparametric estimators suffer from the “curse of dimensionality,” i.e., convergence rates fall as the number of model dimensions increases. The convergence rate of our local-linear estimator is \(n^{1/(4+d)}\) where \(d\) is the number of distinct, continuous RHS variables, and there are \(d = 10\) RHS variables in our cost function and \(d = 11\) RHS variables in our revenue and profit functions. The slow convergence rate of our estimator means that for a given sample size, the order (in probability) of the estimation error we incur with our nonparametric estimator will be larger than the order of the estimation error one would achieve using a parametric estimator in a correctly specified model with the usual parametric rate \(n^{1/2}\). However, our nonparametric estimation strategy avoids specification error that would likely render meaningless any results that might be obtained using a misspecified model. We adopt the view of Robinson (1988), who argues that parametric models are likely misspecified and should be viewed as root-\(n\) inconsistent instead of root-\(n\) consistent.\(^{12}\)

To mitigate the curse of dimensionality in our application, we (i) use a large sample with more than 800,000 observations and (ii) employ a simple dimension-reduction method. Multicollinearity among regressors is often viewed as an annoyance, but here we use the multicollinearity in our data to reduce dimensionality, thereby increasing the convergence rate of our estimators and reducing estimation error. We do this by transforming the continuous RHS variables in each model to principal components space. Principal components are orthogonal, and eigensystem analysis can be used to determine the information content of each principal component. In each model we estimate, we sacrifice a small amount of information by using only the six principal components of the continuous RHS variables that correspond to the six largest eigenvalues, hence reducing the number of continuous

\(^{11}\) Several methods for nonparametric regression exist. Cogent descriptions of nonparametric regression and the surrounding issues are given by Fan and Gijbels (1996, chapter 1), Härdle and Linton (1999), and Henderson and Parmeter (2015). Härdle and Mammen (1993) propose a test of a parametric regression against a nonparametric alternative where the test statistic is an estimate of the integrated square difference between the two regressions. Although we do not implement the Härdle and Mammen test in order to avoid computational expense, it seems almost certain the test would reject the translog parametric model in view of the results from our simple specification tests discussed above and in the separate Appendix C.

\(^{12}\) Convergence results for nonparametric estimators are often expressed in terms of order of convergence in probability. Briefly, for a sequence (in \(n\)) of estimators \(\hat{\theta}_n\) of some scalar quantity \(\theta\), we can write \(\hat{\theta} = \theta + O_p(n^{-a})\) when \(\hat{\theta}\) converges to \(\theta\) at rate \(n^a\), and we say that the estimation error is of order in probability \(n^{-a}\). This means that the sequence of values \(n^a|\hat{\theta}_n - \theta|\) is bounded in the limit (as \(n \to \infty\)) in probability. See Serfling (1980) or Simar and Wilson (2008) for additional discussion.
RHS variables in our regressions from 10 or 11 to six. The six principal components account for 92.86 percent of the independent linear information among the RHS variables in our cost function, and 89.70 percent and 88.52 percent in the revenue and profit functions. The transformation to principal-components space can be inverted, and the interpretation of the estimators of the conditional mean functions in each model based on six principal components of the (continuous) RHS variables is straightforward because our estimator is fully nonparametric. Additional details about our principal components transformation and nonparametric estimation strategy are provided in Appendix D.

To implement the local-linear estimator we must select a bandwidth parameter to control the smoothing over the continuous dimensions in the data. We use least-squares cross-validation to optimize an adaptive, $\kappa$-nearest-neighbor bandwidth. In addition, we employ a spherically symmetric Epanechnikov kernel function. This means that when we estimate cost, revenue or profit at any fixed point of interest in the space of the RHS variables, only the $\kappa$ observations closest to that point can influence estimated cost, revenue or profit. In addition, among these $\kappa$ observations, the influence that a particular observation has on estimated cost, revenue or profit diminishes with distance from the point at which the response is being estimated. Our estimator is thus a local estimator, and is very different than typical, parametric, global estimation strategies (e.g., OLS, maximum likelihood, etc.) where all observations in the sample influence (with equal weight) estimation at any given point in the data space. Moreover, because we use nearest-neighbor bandwidths, our bandwidths automatically adapt to variation in the sparseness of data throughout the support of our RHS variables.

For statistical inference about our estimates of RTS, we use the wild bootstrap introduced by Härdle (1990) and Härdle and Mammen (1993), which allows us to avoid making specific distributional assumptions. We estimate confidence intervals using methods described in Wheelock and Wilson (2011, 2012). Although our estimators are asymptotically normal, the asymptotic distributions depend on unknown parameters; the bootstrap allows us to avoid the need to estimate these parameters, which would introduce additional noise.\footnote{Additional details about our inference methods are given in the separate Appendix D.}
5 Empirical Results

We estimate the cost, revenue and profit specifications described in Section 3 using the methods described in Section 4 to obtain estimates of cost, revenue, and profit. We substitute these into the RTS measures defined in Section 2 to obtain for each bank $i$ estimates $\hat{E}_{C,i}$, $\hat{E}_{R,i}$ and $\hat{E}_{\pi,i}$ as well as estimates $\hat{\eta}_{C,i}$, $\hat{\eta}_{R,i}$ and $\hat{\eta}_{\pi,i}$ of the pseudo elasticities defined in Section 2. We use the bootstrap methods discussed in Section 4 and described in Appendix D to make inference about the corresponding true values of the RTS measures and corresponding pseudo elasticities.

Table 1 provides an overview of results from our estimation for 1986.Q4, 1996.Q4, 2006.Q4 and 2015.Q4. The table reports the number of banks for which we reject CRS (at .05 significance) in favor of IRS or DRS, or for which we cannot reject CRS for cost, revenue and profit in each quartile of total assets in each period.\footnote{See Tables E.3 and E.5 in the separate Appendix E for similar counts at .1 and .01 significance levels.}

In each quartile, we find that a large majority of banks faced either CRS or IRS in cost in each period, even though the distribution of banks’ sizes in terms of total assets shifted rightward over time.\footnote{Figure B.1 in Appendix B shows kernel estimates of the density of total assets for 1986.Q4, 1996.Q4, 2006.Q4, and 2015.Q4, where the rightward shift is apparent.} Even among banks in the fourth quartile (the largest 25 percent of banks by assets), we reject CRS in favor of IRS for a substantial number of banks, and in favor of DRS for very few banks. Our results are thus similar to other recent studies finding that even many large banks operate under increasing returns to scale (e.g., Wheelock and Wilson, 2012; Hughes and Mester, 2013; Kovner et al., 2014 and Becalli et al., 2015).\footnote{We estimated returns to scale for two alternative cost specifications, including one that treats physical capital as quasi-fixed, rather than as a variable input, and one that uses total cost, rather than the sum of expenditures on the variable inputs, as the dependent variable. Results of those models, which are reported in the separate Appendix E, are qualitatively very similar to those reported in Table 1.}

With regard to revenue economies, we are unable to reject CRS for a majority of banks in each quartile and period. However, we reject CRS in favor of IRS for more banks than we reject in favor of DRS.\footnote{Results are qualitatively very similar for an alternative specification, reported in the separate Appendix E, in which we define revenue as total unadjusted revenue.} Similarly, for profit economies, we also fail to reject CRS for more banks than not, but generally we reject CRS in favor of IRS for more banks than we reject in favor of DRS. The two exceptions are for banks in the largest-size quartile in 2006.Q4 and 2015.Q4, where we reject in favor of DRS for 420 and 378 banks, respectively, but in favor...
of IRS for only 235 and 206 banks.\footnote{As with cost and revenue economies, results are robust to alternative measures of profit, constructed from different measures of cost and revenue as described in the preceding footnotes. See the separate Appendix E for specific results.}

Because the distribution of bank asset sizes is quite skewed, the largest asset-size quartile represents a much larger range than the other three quartiles. Further, because much of the interest in economies of scale pertains to the very largest banks, we report estimates of returns to scale for the 10 largest banks in each period. Specifically, Tables 2–3 report estimates of the pseudo elasticities defined in Section 2 for each of the 10 largest banks in each period. For the cost model, pseudo elasticity estimates that are significantly less than 1.1 indicates IRS, whereas for the revenue and profit models, estimates that are significantly greater than 1.1 indicate IRS.

For cost economies, the results in Tables 2–3 indicate that we reject CRS in favor of IRS in nearly every case (34 estimates out of 40) among the 10 largest banks in each period. Moreover, we reject CRS in favor of IRS for each of the four largest banks in 1986.Q4, 1996.Q4, and 2015.Q4 (and two of the four largest in 2006.Q4). In no case do we reject CRS in favor of DRS. Thus, the evidence suggests strongly that even the very largest U.S. banks faced increasing returns to scale throughout the sample period.\footnote{A referee suggested that there might be a break in RTS around $50 billion of assets due to regulatory and enforcement differences for banks beyond that threshold. Inspection of pseudo elasticity estimates for the largest 100 banks in each quarter, which are reported in Tables E.6–E.9 in the separate Appendix E, reveal no obvious break at $50 billion of assets.}

In contrast with the substantial evidence that the very largest banks face IRS in cost, the estimates shown in Tables 2–3 indicate that the largest banks mostly face DRS in revenue. We reject CRS in favor of DRS in revenue in 33 of 40 cases, and reject in favor of IRS in only two cases (Citigroup and Wells Fargo in 2015.Q4). However, all but one (Wells Fargo in 2006.Q4) of the revenue pseudo elasticity estimates are greater than 1.0, indicating that even though the largest banks face DRS in revenue, their revenues would still rise with an increase in output levels (though by a less than proportionate amount).

Finally, the estimates of returns to scale in profit reveal the relative importance of cost and revenue economies in determining profit economies for each bank in each period. For 1986.Q4, only two of the profit pseudo elasticity estimates in Table 2 are significantly different from 1.1, and in both cases CRS is rejected in favor of DRS. However, in 1996.Q4, nine
estimates are significantly less than 1.1, indicating DRS. Nonetheless, these nine estimates are greater than 1.0, indicating that profits increase with size for these banks, albeit by a less than proportionate amount.

Whereas we find no indication that any of the 10 largest banks faced IRS in revenue or profit in either 1986.Q4 or 1996.Q4, results reported in Table 3 indicate that the three largest banks (JPMorgan Chase, Bank of America, and Citigroup) operated under IRS in profit in 2006.Q4, and all four of the very largest banks did so in 2015.Q4. Further, the results indicate that both Citigroup and Wells Fargo also faced IRS in revenue in 2015.Q4. By contrast, among the remaining banks in the top 10, we either fail to reject CRS, or reject in favor of DRS for both revenue and profit in both 2006.Q4 and 2015.Q4. Nonetheless, the pseudo elasticity estimates for 2015.Q4 are all greater than 1.0 for these banks, indicating that profit would increase with an increase in output (but by a less-than proportionate amount).

Evidence on the extent to which changes in RTS over time were statistically significant is shown in Table 4. Specifically, for the 10 largest banks in 2015.Q4 that were also in existence in 2006.Q4, we report whether the change in the bank’s pseudo elasticity between those two periods was statistically significant (at the .05 level) and, if so, the direction of the change. Upward arrows indicate significant changes in the direction of greater returns to scale, whereas downward arrows indicate statistically significant decline in returns to scale, and the absence of an arrow indicates that the change in pseudo elasticity between the two periods is not statistically significant. As the table shows, we find statistically significant gains in RTS in terms of cost for seven banks, and a significant decline for only one bank. All of the banks that experienced a significant increase in RTS except Citigroup and JPMorgan Chase, for which we do not reject CRS in 2006.Q4, already faced IRS in 2006.Q4.

Among banks that experienced a significant change in RTS in revenue, as reflected by a statistically significant change in pseudo elasticity, four experienced a significant increase in RTS, while two had a significant decline. Among the banks that experienced significant gains, both Citigroup and Wells Fargo went from facing DRS in 2006.Q4 to IRS in 2015.Q4.

Finally, for profit, three banks, including two of the top four, experienced significant gains in RTS and one had a significant decline, while the change for six banks was not statistically significant. Among the largest four banks in 2015.Q4, the pseudo elasticity estimates in
Table 3 indicate that Citigroup, Bank of America, and JPMorgan Chase already faced IRS in 2006.Q4, whereas we are unable to reject CRS for Wells Fargo, which was the smallest of the four banks in that period. Both Citigroup and Wells Fargo experienced statistically significant gains in RTS between 2006.Q4 and 2015.Q4, and in the latter period we reject CRS in favor of IRS for Wells Fargo.

On the whole, our results are consistent with earlier studies finding that even the largest U.S. banks face IRS in terms of cost. Our findings indicate that this remains true some eight years after the financial crisis and after substantial changes in bank regulation. Further, our results indicate that while many banks face IRS in cost, many fewer operate under IRS in revenue or profit. However, substantial numbers of banks, including the four largest U.S. banks, do appear to face CRS or IRS in revenue and profit. Further, we find that, if anything, the very largest banks faced greater returns to scale in terms of revenue and profit in 2015 than they had in 2006, before the financial crisis and introduction of a new regulatory regime.20

6 Conclusions

As the number of banks has declined since 1986, many banks have grown considerably in size. Despite the growth in bank size, we find considerable evidence that the largest U.S. banks continue to operate under increasing returns to scale in terms of cost, as they did in 2006 and even earlier. It is perhaps not surprising that large banks faced increasing returns in earlier years, given that institutions grew larger, but it is interesting that even in 2015, the largest institutions had not exhausted scale economies in terms of cost.

The evidence for returns to scale in revenue and profit is more mixed. Still, our estimates suggest that relatively few banks with total assets below the largest 25 percent face decreasing returns to scale, while the rest face constant or increasing returns. We find that somewhat

20 In the separate Appendix E, Table E.12 gives counts of firms that experienced a statistically significant change in RTS between 2006.Q4 and 2015.Q4. In addition, Tables E.16–E.24 give transition matrices showing the numbers of institutions facing IRS, CRS, or DRS in 2006.Q4 versus 2015.Q4. The number of banks appearing in our sample in both 2006.Q4 and 2015.Q4 is 4,148. For the cost model described in Section 3, at .05 significance, there are 3,064 significant changes, with 1,686 gains and 1,378 declines in RTS. For the revenue model, there are 2,194 significant changes, with 1,033 increases and 1,161 decreases in RTS. For the profit model, there are 1,210 significant changes, with 493 increases and 717 decreases in RTS. A majority of significant changes in cost RTS are gains, while the numbers of changes in revenue RTS are almost even between increases and decreases, and changes in profit RTS are more often downward.
fewer banks in the largest size quartile operate under increasing returns. Among the largest 10 banks, we find that some operated under increasing returns in revenue and, especially, profit in 2006 and 2015, but others faced constant or decreasing returns. In particular, the largest four U.S. banks—all of which are substantially larger than the next largest banks—faced increasing returns to scale in profit, as well as in cost, in 2015. Thus, it appears that the turmoil of 2007-08 and subsequent changes in regulation have not lessened returns to scale in terms of cost, revenue or profit for most U.S. banks. And, if anything, the largest four banks have seen significant increases in returns to scale since 2006, suggesting that scale economies still provide an impetus to become even larger.
References


### Table 1: Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.05 signif.)

<table>
<thead>
<tr>
<th>LHS</th>
<th>Period</th>
<th>1st quartile</th>
<th>2nd quartile</th>
<th>3rd quartile</th>
<th>4th quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IRS</td>
<td>CRS</td>
<td>DRS</td>
<td>IRS</td>
</tr>
<tr>
<td>Cost</td>
<td>1986.Q4</td>
<td>1138</td>
<td>1439</td>
<td>5</td>
<td>734</td>
</tr>
<tr>
<td></td>
<td>1996.Q4</td>
<td>669</td>
<td>1211</td>
<td>18</td>
<td>524</td>
</tr>
<tr>
<td></td>
<td>2006.Q4</td>
<td>630</td>
<td>932</td>
<td>9</td>
<td>526</td>
</tr>
<tr>
<td></td>
<td>2015.Q4</td>
<td>528</td>
<td>662</td>
<td>20</td>
<td>481</td>
</tr>
<tr>
<td>Revenue</td>
<td>1986.Q4</td>
<td>287</td>
<td>2142</td>
<td>153</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>1996.Q4</td>
<td>245</td>
<td>1549</td>
<td>104</td>
<td>291</td>
</tr>
<tr>
<td></td>
<td>2006.Q4</td>
<td>201</td>
<td>1226</td>
<td>144</td>
<td>249</td>
</tr>
<tr>
<td></td>
<td>2015.Q4</td>
<td>204</td>
<td>822</td>
<td>184</td>
<td>229</td>
</tr>
<tr>
<td>Profit</td>
<td>1986.Q4</td>
<td>637</td>
<td>1914</td>
<td>31</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td>1996.Q4</td>
<td>620</td>
<td>1252</td>
<td>26</td>
<td>444</td>
</tr>
<tr>
<td></td>
<td>2006.Q4</td>
<td>528</td>
<td>1024</td>
<td>19</td>
<td>416</td>
</tr>
<tr>
<td></td>
<td>2015.Q4</td>
<td>327</td>
<td>827</td>
<td>56</td>
<td>269</td>
</tr>
</tbody>
</table>
Table 2: Returns to Scale for Largest Banks by Total Assets, 1986.Q4 and 1996.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Cost</th>
<th>Revenue</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>—1986.Q4—</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CITIBANK</td>
<td>275</td>
<td>1.0371***</td>
<td>1.0147***</td>
<td>0.9834***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>204</td>
<td>1.0928**</td>
<td>1.0558***</td>
<td>1.1622</td>
</tr>
<tr>
<td>CHASE MHTN BK</td>
<td>150</td>
<td>1.0618***</td>
<td>1.0820</td>
<td>1.0616</td>
</tr>
<tr>
<td>MANU. HAN</td>
<td>139</td>
<td>1.0855***</td>
<td>1.0686***</td>
<td>1.1819</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>130</td>
<td>1.0306***</td>
<td>1.0381***</td>
<td>1.0603</td>
</tr>
<tr>
<td>SECURITY PACIFIC</td>
<td>113</td>
<td>1.0982</td>
<td>1.0593***</td>
<td>1.0774</td>
</tr>
<tr>
<td>CHEMICAL NY</td>
<td>109</td>
<td>1.0923***</td>
<td>1.0574***</td>
<td>1.0995</td>
</tr>
<tr>
<td>BANKERS TR NY</td>
<td>100</td>
<td>1.0461***</td>
<td>1.0354***</td>
<td>1.0542***</td>
</tr>
<tr>
<td>FIRST INTRST BC</td>
<td>100</td>
<td>1.0883*</td>
<td>1.0705***</td>
<td>1.0586</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>81</td>
<td>1.0897</td>
<td>1.0488***</td>
<td>1.0622</td>
</tr>
<tr>
<td><strong>—1996.Q4—</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHASE MHTN</td>
<td>469</td>
<td>1.0557***</td>
<td>1.0334***</td>
<td>1.0401***</td>
</tr>
<tr>
<td>CITICORP</td>
<td>394</td>
<td>1.0368***</td>
<td>1.0376***</td>
<td>1.0426***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>352</td>
<td>1.0412***</td>
<td>1.0469***</td>
<td>1.0485***</td>
</tr>
<tr>
<td>NATIONSBANK</td>
<td>266</td>
<td>1.0773***</td>
<td>1.0442***</td>
<td>1.0395***</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>245</td>
<td>1.0539***</td>
<td>1.0126***</td>
<td>0.9942***</td>
</tr>
<tr>
<td>FIRST UNION</td>
<td>195</td>
<td>1.0907**</td>
<td>1.0201***</td>
<td>0.9906***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>155</td>
<td>1.0630***</td>
<td>1.0839***</td>
<td>1.1083</td>
</tr>
<tr>
<td>FIRST NBD</td>
<td>150</td>
<td>1.0663***</td>
<td>1.0392***</td>
<td>1.0440***</td>
</tr>
<tr>
<td>BANC ONE</td>
<td>143</td>
<td>1.0653***</td>
<td>1.0594***</td>
<td>1.0600***</td>
</tr>
<tr>
<td>FLEET FNCL GROUP</td>
<td>123</td>
<td>1.0587***</td>
<td>1.0817***</td>
<td>1.0781***</td>
</tr>
</tbody>
</table>

**NOTE:** For cost model, estimates of \((1 - \varepsilon_{C,i})\delta\) are reported (\(\delta = 1.1\)). For revenue and profit models, estimates of \((1 + \varepsilon_{R,i})\delta\) and \((1 + \varepsilon_{\pi,i})\delta\) are given. For cost model, values less than 1.1 indicate increasing returns to scale, while for revenue and profit models, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table 3: Returns to Scale for Largest Banks by Total Assets, 2006.Q4 and 2015.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Cost</th>
<th>Revenue</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2006.Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>2082</td>
<td>1.1011</td>
<td>1.0808***</td>
<td>1.1355***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>1672</td>
<td>1.0391***</td>
<td>1.0930***</td>
<td>1.1519***</td>
</tr>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>1543</td>
<td>1.1025</td>
<td>1.0982</td>
<td>1.2066***</td>
</tr>
<tr>
<td>WACHOVIA</td>
<td>726</td>
<td>1.0459***</td>
<td>1.0229***</td>
<td>1.0663</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>554</td>
<td>1.0193***</td>
<td>0.9996***</td>
<td>1.0134***</td>
</tr>
<tr>
<td>U S BC</td>
<td>250</td>
<td>1.0585***</td>
<td>1.0493***</td>
<td>1.0656***</td>
</tr>
<tr>
<td>COUNTRYWIDE</td>
<td>225</td>
<td>1.1009</td>
<td>1.0013***</td>
<td>0.9950***</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>210</td>
<td>1.0734***</td>
<td>1.0757***</td>
<td>1.0865</td>
</tr>
<tr>
<td>HSBC BK USA</td>
<td>191</td>
<td>1.0456***</td>
<td>1.0096***</td>
<td>0.9928***</td>
</tr>
<tr>
<td>NATIONAL CITY</td>
<td>160</td>
<td>1.0697***</td>
<td>1.0178***</td>
<td>0.9778***</td>
</tr>
<tr>
<td><strong>2015.Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>2378</td>
<td>1.0151***</td>
<td>1.1007</td>
<td>1.1249***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>2145</td>
<td>1.0140***</td>
<td>1.1030</td>
<td>1.1592***</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>1765</td>
<td>1.0375***</td>
<td>1.1337***</td>
<td>1.1842***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>1764</td>
<td>1.0347***</td>
<td>1.1170***</td>
<td>1.1180***</td>
</tr>
<tr>
<td>U S BC</td>
<td>418</td>
<td>0.9654***</td>
<td>1.0091***</td>
<td>1.0181***</td>
</tr>
<tr>
<td>BK OF NY MELLON</td>
<td>384</td>
<td>1.0697***</td>
<td>1.0451***</td>
<td>1.0348***</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>359</td>
<td>0.9639***</td>
<td>1.0168***</td>
<td>1.0283***</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>246</td>
<td>1.1568</td>
<td>1.0042***</td>
<td>1.0117***</td>
</tr>
<tr>
<td>T D BK</td>
<td>243</td>
<td>1.0527***</td>
<td>1.0666**</td>
<td>1.0717</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>209</td>
<td>1.0483***</td>
<td>1.0795</td>
<td>1.1012</td>
</tr>
</tbody>
</table>

**NOTE:** For cost model, estimates of \((1 - \mathcal{E}_{C,i})\delta\) are reported (\(\delta = 1.1\)). For revenue and profit models, estimates of \((1 + \mathcal{E}_{R,i})\delta\) and \((1 + \mathcal{E}_{\pi,i})\delta\) are given. For cost model, values less than 1.1 indicate increasing returns to scale, while for revenue and profit models, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table 4: Significant Changes in RTS from 2006.Q4 to 2015.Q4 for 10 Largest Banks in 2015.Q4 (.05 Significance)

<table>
<thead>
<tr>
<th>Bank</th>
<th>Model</th>
<th>Cost</th>
<th>Revenue</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
</tr>
<tr>
<td>U S BC</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
</tr>
<tr>
<td>T D BK</td>
<td>↑</td>
<td>↓</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**NOTE:** Upward arrows indicate a significant increase in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Downward arrows indicate significant decrease in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Horizontal dashes indicate no significant change.
The Evolution of Scale Economies in U.S. Banking: Appendices A–E

DAVID C. WHEELOCK       PAUL W. WILSON*

February 2017

*Wheelock: Research Department, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, MO 63166–0442; wheelock@stls.frb.org. Wilson: Department of Economics and School of Computing, Division of Computer Science, Clemson University, Clemson, South Carolina 29634–1309, USA; email pww@clemson.edu. This research was conducted while Wilson was a visiting scholar in the Research Department of the Federal Reserve Bank of St. Louis. We thank the Cyber Infrastructure Technology Integration group at Clemson University for operating the Palmetto cluster used for our computations. We thank Peter McCrory for research assistance. The views expressed in this paper do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis or the Federal Reserve System. JEL classification nos.: G21, L11, C12, C13, C14. Keywords: banks, returns to scale, scale economies, non-parametric, regression.
## Contents

A  Interpretation of Scale Measures when (Net) Revenue or Profit is Negative  

B  Summary Statistics for Data Used for Estimation  

C  Test of Translog Specifications  

D  Details of Non-parametric Estimation and Inference  
   D.1 Dimension reduction  
   D.2 Non-parametric estimation of conditional mean functions  
   D.3 Practical issues for implementation  

E  Additional Results  
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1</td>
<td>Correlation Matrices for Dependent Variables, All Periods</td>
<td>4</td>
</tr>
<tr>
<td>B.2</td>
<td>Quantiles and Means for Variables used in Estimation, 1986.Q4</td>
<td>5</td>
</tr>
<tr>
<td>B.3</td>
<td>Quantiles and Means for Variables used in Estimation, 1996.Q4</td>
<td>6</td>
</tr>
<tr>
<td>B.4</td>
<td>Quantiles and Means for Variables used in Estimation, 2006.Q4</td>
<td>7</td>
</tr>
<tr>
<td>B.5</td>
<td>Quantiles and Means for Variables used in Estimation, 2015.Q4</td>
<td>8</td>
</tr>
<tr>
<td>B.6</td>
<td>Quantiles and Means for Variables used in Estimation, All Quarters</td>
<td>9</td>
</tr>
<tr>
<td>E.1</td>
<td>Quantiles and Means for Estimates of Returns to Scale Indices</td>
<td>19</td>
</tr>
<tr>
<td>E.2</td>
<td>Counts of Institutions Facing IRS, CRS, and DRS</td>
<td>20</td>
</tr>
<tr>
<td>E.3</td>
<td>Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.1 signif.)</td>
<td>21</td>
</tr>
<tr>
<td>E.4</td>
<td>Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.05 signif.)</td>
<td>22</td>
</tr>
<tr>
<td>E.5</td>
<td>Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.01 signif.)</td>
<td>23</td>
</tr>
<tr>
<td>E.6</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4</td>
<td>24</td>
</tr>
<tr>
<td>E.6</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)</td>
<td>25</td>
</tr>
<tr>
<td>E.6</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)</td>
<td>26</td>
</tr>
<tr>
<td>E.6</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)</td>
<td>27</td>
</tr>
<tr>
<td>E.7</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4</td>
<td>28</td>
</tr>
<tr>
<td>E.7</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)</td>
<td>29</td>
</tr>
<tr>
<td>E.7</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)</td>
<td>30</td>
</tr>
<tr>
<td>E.7</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)</td>
<td>31</td>
</tr>
<tr>
<td>E.7</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)</td>
<td>32</td>
</tr>
<tr>
<td>E.8</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4</td>
<td>33</td>
</tr>
<tr>
<td>E.8</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4 (continued)</td>
<td>34</td>
</tr>
<tr>
<td>E.8</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4 (continued)</td>
<td>35</td>
</tr>
<tr>
<td>E.9</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4</td>
<td>36</td>
</tr>
<tr>
<td>E.9</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)</td>
<td>37</td>
</tr>
<tr>
<td>E.9</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)</td>
<td>38</td>
</tr>
<tr>
<td>E.9</td>
<td>Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)</td>
<td>39</td>
</tr>
<tr>
<td>E.10</td>
<td>Returns to Scale for Largest Banks by Total Assets, 1986.Q4 and 1996.Q4</td>
<td>40</td>
</tr>
<tr>
<td>E.11</td>
<td>Returns to Scale for Largest Banks by Total Assets, 2006.Q4 and 2015.Q4</td>
<td>41</td>
</tr>
<tr>
<td>E.12</td>
<td>Numbers of Significant Changes in RTS Elasticities from 2006.Q4 to 2015.Q4</td>
<td>42</td>
</tr>
<tr>
<td>E.17</td>
<td>Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .1 Significance</td>
<td>47</td>
</tr>
<tr>
<td>E.18</td>
<td>Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .1 Significance</td>
<td>48</td>
</tr>
<tr>
<td>E.19</td>
<td>Transition Matrices, 2006.Q4 to 2015.Q4, Cost Models, .05 Significance</td>
<td>49</td>
</tr>
<tr>
<td>E.20</td>
<td>Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .05 Significance</td>
<td>50</td>
</tr>
</tbody>
</table>
E.21 Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .05 Significance . . . 51
E.22 Transition Matrices, 2006.Q4 to 2015.Q4, Cost Models, .01 Significance . . . 52
E.23 Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .01 Significance . . 53
E.24 Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .01 Significance . . . 54
List of Figures

A Interpretation of Scale Measures when (Net) Revenue or Profit is Negative

As noted in Section 2, either \( \pi(y_i, w_i) \) or \( \pi(\delta y_i, w_i) \) or \( R(y_i, w_i) \) or \( R(\delta y_i, w_i) \) might be negative, affecting how the magnitude of estimates of \( E_{\pi,i} \) and \( E_{R,i} \) are interpreted. Thus there are four cases to consider. In the discussion that follows, consider the scale measure \( E_{\pi,i} \) based on the profit function; similar reasoning applies to the scale measure \( E_{R,i} \) based on the revenue function.

In the most common scenario, \( \pi(y_i, w_i) > 0 \) and \( \pi(\delta y_i, w_i) > 0 \), and this case is discussed in Section 2. The other three cases are infrequent, and arise when \( \pi(y_i, w_i) < 0 \) or \( \pi(\delta y_i, w_i) < 0 \). We consider each of the three possible cases here.

1. \( \pi(y_i, w_i) < 0, \pi(\delta y_i, w_i) > 0 \).
   
   In this case, increasing output levels by a factor \( \delta > 1 \) increases profit. Also in this case, (2.6) can be written as \( (1 - E_{\pi,i}) \delta \pi(y_i, w_i) = \pi(\delta y_i, w_i) \), implying \( E_{\pi,i} > 1 \). Hence RTS are increasing in this case. If \( E_{\pi,i} = 1.05 \) and \( \delta = 1.1 \), then increasing output levels by 10 percent leads to profits increasing by \( 100 + (1 - 1.05) \times 100 = 105 \) percent from an initial negative value to a positive value. Alternatively, (2.6) can be rearranged to show the difference \( \pi(\delta y_i, w_i) - \delta \pi(y_i, w_i) > 0 \) equals \( E_{\pi,i} \delta |\pi(y_i, w_i)| \); if \( E_{\pi,i} = 1.05 \) and \( \delta = 1.1 \), then increasing output levels by 10 percent increases profit to a positive level equal to \( (1 - 1.05) \times 1.1 = 0.55 \) times the magnitude of the profits that were negative before the increase. Whether the increase is big or small in absolute terms depends on the starting point, i.e., the magnitude of \( \pi(y_i, w_i) \).

2. \( \pi(y_i, w_i) > 0, \pi(\delta y_i, w_i) < 0 \).
   
   In this case, increasing output levels by a factor \( \delta > 1 \) decreases profit. Since \( \pi(y_i, w_i) > 0 \), (2.6) can again be rewritten as \( (1 + E_{\pi,i}) \delta \pi(y_i, w_i) = \pi(\delta y_i, w_i) \). Clearly, \( E_{\pi,i} < -1 \) since \( \pi(\delta y_i, w_i) < 0 \). Hence RTS are decreasing in this case. If \( E_{\pi,i} = -1.05 \) and \( \delta = 1.1 \), then increasing output levels by 10 percent reduces profit by \( 100 + (1+E_{\pi,i}) \delta \times 100 = 105.5 \) percent. As in the previous case, whether the absolute change in profit is big or small depends on the starting point.

3. \( \pi(y_i, w_i) < 0, \pi(\delta y_i, w_i) < 0 \).
   
   Using reasoning similar to that in footnote 2 in the paper, profit (increases, remains
unchanged, decreases) as $E_{\pi,i}$ ($>,=,<$)$(1 - \delta^{-1} \approx 0.09091$ for $\delta = 1.1$. In this case we also have again $(1 - E_{\pi,i})\delta\pi(y_i, w_i) = \pi(\delta y_i, w_i)$. Since both profit terms are negative, $E_{\pi,i} < 1$ and returns to scale are either increasing, constant, or decreasing depending on whether $E_{\pi,i}$ is greater than, equal to, or less than 0. Increasing output levels by a factor $\delta$ causes profits to fall by a factor $(1 - E_{\pi,i})\delta$; for If $E_{\pi,i} = 0.05$ and $\delta = 1.1$, a 10 percent increase in output levels results in profits that are still negative, but 4.5 percent greater than before the increase in output.
B Summary Statistics for Data Used for Estimation

As mentioned in the paper, we estimate several specifications in addition to the cost, revenue and profit models described in Section 3 of the paper. All together, we estimate 8 different models—2 cost functions, 2 revenue functions, and 4 profit functions. In subsequent appendices, we number these models 1–8, with models 1, 3, and 5 corresponding to the cost, revenue and profit functions described in Section 3. In the tables that follow, we denote the dependent variables for these models as $C_1$, $R_1$, and $\pi_1$ respectively. In model 2, cost ($C_2$) is measured by total interest expense plus total non-interest expense. Similarly, in model 4 revenue ($R_2$) is measured by total interest income plus total non-interest expense. In models 6–8, profit is measured by $\pi_2 = R_1 - C_2$, $\pi_3 = R_2 - C_1$ and $\pi_4 = R_2 - C_2$ (whereas in model 5 profit is measured by $\pi_1 = R_1 - C_1$). Results for estimated returns to scale given below in Appendix E are broadly qualitatively similar across the sets of specifications for cost, revenue and profit functions.

Table B.1 gives correlations for the dependent variables used in each of the 8 models described above. Table B.2–B.5 give summary statistics for left-hand and right-hand side variables used in Models 1–8 over the 4 quarters in which returns-to-scale are estimated (i.e., 1986.Q4, 1996.Q4, 2006.Q4, and 2015.Q4). Table B.6 gives similar summary statistics over the 117 quarters used for estimation (i.e., 1986.Q4–2015.Q4). All dollar amounts have been converted to constant 2015 dollars using the quarterly, seasonally adjusted, gross domestic product implicit price deflator.

Figure B.1 shows kernel density estimates of log total assets for 1986.Q4, 1996.Q4, 2006.Q4 and 2015.Q4. The estimates displayed in Figure B.1 illustrate the evolution of bank sizes over the period covered by our sample; i.e., the distribution of bank sizes has shifted rightward over time.
### Table B.1: Correlation Matrices for Dependent Variables, All Periods

<table>
<thead>
<tr>
<th></th>
<th>$C_1/W_1$</th>
<th>$C_2/W_1$</th>
<th>$R_1$</th>
<th>$R_2$</th>
<th>$\pi_1$</th>
<th>$\pi_2$</th>
<th>$\pi_3$</th>
<th>$\pi_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1/W_1$</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$C_2/W_1$</td>
<td>0.9935</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_1$</td>
<td>0.7106</td>
<td>0.6828</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_2$</td>
<td>0.7031</td>
<td>0.6752</td>
<td>0.9944</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>0.7733</td>
<td>0.7518</td>
<td>0.9577</td>
<td>0.9399</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>0.6431</td>
<td>0.5990</td>
<td>0.7974</td>
<td>0.7585</td>
<td>0.8869</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>0.7571</td>
<td>0.7339</td>
<td>0.9678</td>
<td>0.9757</td>
<td>0.9687</td>
<td>0.8003</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>0.6950</td>
<td>0.6513</td>
<td>0.9092</td>
<td>0.9144</td>
<td>0.9205</td>
<td>0.8986</td>
<td>0.9481</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Homogeneity wrt prices not imposed on revenue, profit variables:
<table>
<thead>
<tr>
<th>Variable</th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_1/W_1 )</td>
<td>1.4285E+04</td>
<td>4.8580E+04</td>
<td>9.0857E+04</td>
<td>7.0159E+05</td>
<td>1.8405E+05</td>
<td>1.1684E+07</td>
</tr>
<tr>
<td>( C_2/W_1 )</td>
<td>1.6762E+04</td>
<td>5.7298E+04</td>
<td>1.0817E+05</td>
<td>8.3290E+05</td>
<td>2.1925E+05</td>
<td>1.4208E+07</td>
</tr>
<tr>
<td>( R_1 )</td>
<td>-3.2161E+03</td>
<td>2.6552E+03</td>
<td>5.3853E+03</td>
<td>4.7041E+04</td>
<td>1.1450E+04</td>
<td>7.2623E+05</td>
</tr>
<tr>
<td>( R_2 )</td>
<td>8.2147E+02</td>
<td>3.3081E+03</td>
<td>6.3493E+03</td>
<td>5.1503E+04</td>
<td>1.2755E+04</td>
<td>7.8661E+05</td>
</tr>
<tr>
<td>( \pi_1 )</td>
<td>-1.1057E+07</td>
<td>-1.7302E+05</td>
<td>-8.5864E+04</td>
<td>-6.5455E+05</td>
<td>-4.5699E+04</td>
<td>-1.3489E+04</td>
</tr>
<tr>
<td>( \pi_2 )</td>
<td>-1.3692E+07</td>
<td>-2.0839E+05</td>
<td>-1.0242E+05</td>
<td>-7.8586E+05</td>
<td>-5.4381E+04</td>
<td>-1.5760E+04</td>
</tr>
<tr>
<td>( \pi_3 )</td>
<td>-1.0964E+07</td>
<td>-1.7129E+05</td>
<td>-8.4585E+04</td>
<td>-6.5009E+05</td>
<td>-4.5199E+04</td>
<td>-1.3274E+04</td>
</tr>
<tr>
<td>( \pi_4 )</td>
<td>-1.3650E+07</td>
<td>-2.0665E+05</td>
<td>-1.0157E+05</td>
<td>-7.8140E+05</td>
<td>-5.4012E+04</td>
<td>-1.5679E+04</td>
</tr>
<tr>
<td>( Y_1 )</td>
<td>9.4970E+01</td>
<td>2.7478E+03</td>
<td>6.5611E+03</td>
<td>5.4197E+04</td>
<td>1.4842E+04</td>
<td>9.4352E+05</td>
</tr>
<tr>
<td>( Y_2 )</td>
<td>6.0057E+02</td>
<td>5.6446E+03</td>
<td>1.1661E+04</td>
<td>1.7275E+05</td>
<td>2.5399E+04</td>
<td>2.4975E+06</td>
</tr>
<tr>
<td>( Y_3 )</td>
<td>2.9062E+02</td>
<td>5.0820E+03</td>
<td>1.2893E+04</td>
<td>9.0136E+04</td>
<td>3.0702E+04</td>
<td>1.4840E+06</td>
</tr>
<tr>
<td>( Y_4 )</td>
<td>3.8996E+03</td>
<td>1.5778E+04</td>
<td>3.1069E+04</td>
<td>1.9748E+05</td>
<td>6.4592E+04</td>
<td>2.8690E+06</td>
</tr>
<tr>
<td>( Y_5 )</td>
<td>2.1739E+01</td>
<td>1.8319E+02</td>
<td>4.0705E+02</td>
<td>8.0615E+03</td>
<td>1.0033E+03</td>
<td>1.1912E+05</td>
</tr>
<tr>
<td>( W_1 )</td>
<td>2.9941E-02</td>
<td>4.7824E-02</td>
<td>5.2315E-02</td>
<td>5.1871E-02</td>
<td>5.6474E-02</td>
<td>6.9519E-02</td>
</tr>
<tr>
<td>( W_2 )</td>
<td>2.4148E+01</td>
<td>3.8039E+01</td>
<td>4.4386E+01</td>
<td>4.8134E+01</td>
<td>5.3449E+01</td>
<td>1.1244E+02</td>
</tr>
<tr>
<td>( W_3 )</td>
<td>5.0803E-02</td>
<td>2.1430E-01</td>
<td>3.2525E-01</td>
<td>5.2831E-01</td>
<td>5.3877E-01</td>
<td>3.2728E+00</td>
</tr>
<tr>
<td>( W_2/W_1 )</td>
<td>4.3850E+02</td>
<td>7.1662E+02</td>
<td>8.6105E+02</td>
<td>9.7204E+02</td>
<td>1.0706E+03</td>
<td>2.6353E+03</td>
</tr>
<tr>
<td>( W_3/W_1 )</td>
<td>9.5988E-01</td>
<td>4.0663E+00</td>
<td>6.3178E+00</td>
<td>1.1330E+01</td>
<td>1.0651E+01</td>
<td>7.5292E+01</td>
</tr>
<tr>
<td>( X_3 )</td>
<td>2.8957E+01</td>
<td>4.4644E+02</td>
<td>1.0862E+03</td>
<td>8.1347E+03</td>
<td>2.5143E+03</td>
<td>1.3590E+05</td>
</tr>
<tr>
<td>( EQUITY )</td>
<td>4.6844E+02</td>
<td>3.0110E+03</td>
<td>5.7012E+03</td>
<td>3.2222E+04</td>
<td>1.1211E+04</td>
<td>5.3512E+05</td>
</tr>
<tr>
<td>( NPER )</td>
<td>3.4032E-04</td>
<td>1.6666E-02</td>
<td>3.1966E-02</td>
<td>4.4938E-02</td>
<td>5.6878E-02</td>
<td>2.1259E-01</td>
</tr>
<tr>
<td>( TIME )</td>
<td>1.0000E+00</td>
<td>1.0000E+00</td>
<td>1.0000E+00</td>
<td>1.0000E+00</td>
<td>1.0000E+00</td>
<td>1.0000E+00</td>
</tr>
<tr>
<td>( ASSETS )</td>
<td>9.3010E+03</td>
<td>3.4814E+04</td>
<td>6.7352E+04</td>
<td>5.1436E+05</td>
<td>1.3537E+05</td>
<td>8.0312E+06</td>
</tr>
</tbody>
</table>

**NOTE:** Dollar figures are given in thousands of constant 2015 dollars.
Table B.3: Quantiles and Means for Variables used in Estimation, 1996.Q4

<table>
<thead>
<tr>
<th></th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1/W_1$</td>
<td>$1.9638E+04$</td>
<td>$6.8268E+04$</td>
<td>$1.3051E+05$</td>
<td>$1.2362E+06$</td>
<td>$2.7415E+05$</td>
<td>$1.2393E+07$</td>
</tr>
<tr>
<td>$C_2/W_1$</td>
<td>$2.4015E+04$</td>
<td>$8.1068E+04$</td>
<td>$1.5610E+05$</td>
<td>$1.5254E+06$</td>
<td>$3.3136E+05$</td>
<td>$1.5835E+07$</td>
</tr>
<tr>
<td>$R_1$</td>
<td>$7.4775E+02$</td>
<td>$3.5114E+03$</td>
<td>$6.9199E+03$</td>
<td>$7.2351E+04$</td>
<td>$1.4604E+04$</td>
<td>$7.1875E+05$</td>
</tr>
<tr>
<td>$R_2$</td>
<td>$8.7486E+02$</td>
<td>$3.6294E+03$</td>
<td>$7.1503E+03$</td>
<td>$7.4768E+04$</td>
<td>$1.5053E+04$</td>
<td>$7.3635E+05$</td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>$-1.1712E+07$</td>
<td>$-2.6014E+05$</td>
<td>$-1.2354E+05$</td>
<td>$-1.1639E+06$</td>
<td>$-6.4618E+04$</td>
<td>$-1.8718E+04$</td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>$-1.5166E+07$</td>
<td>$-3.1585E+05$</td>
<td>$-1.4894E+05$</td>
<td>$-1.4530E+06$</td>
<td>$-7.7392E+04$</td>
<td>$-2.3150E+04$</td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>$-1.1658E+07$</td>
<td>$-2.5979E+05$</td>
<td>$-1.2339E+05$</td>
<td>$-1.1614E+06$</td>
<td>$-6.4476E+04$</td>
<td>$-1.8707E+04$</td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>$-1.5151E+07$</td>
<td>$-3.1585E+05$</td>
<td>$-1.4849E+05$</td>
<td>$-1.4506E+06$</td>
<td>$-7.7178E+04$</td>
<td>$-2.3115E+04$</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>$2.6258E+02$</td>
<td>$2.6478E+03$</td>
<td>$5.8175E+03$</td>
<td>$8.8979E+04$</td>
<td>$1.3725E+04$</td>
<td>$8.9102E+05$</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>$5.0755E+02$</td>
<td>$6.0800E+03$</td>
<td>$1.2481E+04$</td>
<td>$1.9537E+05$</td>
<td>$2.5904E+04$</td>
<td>$1.4277E+06$</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>$7.8824E+02$</td>
<td>$1.0595E+04$</td>
<td>$2.5656E+04$</td>
<td>$2.1970E+06$</td>
<td>$6.4027E+04$</td>
<td>$2.7739E+06$</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>$4.1874E+03$</td>
<td>$1.7792E+04$</td>
<td>$3.3857E+04$</td>
<td>$3.1128E+05$</td>
<td>$7.0037E+04$</td>
<td>$3.0415E+06$</td>
</tr>
<tr>
<td>$Y_5$</td>
<td>$3.3334E+01$</td>
<td>$2.4517E+02$</td>
<td>$5.6283E+02$</td>
<td>$1.6617E+04$</td>
<td>$1.4214E+03$</td>
<td>$1.4524E+05$</td>
</tr>
<tr>
<td>$W_1$</td>
<td>$1.9594E-02$</td>
<td>$3.2982E-02$</td>
<td>$3.7037E-02$</td>
<td>$3.6638E-02$</td>
<td>$4.0576E-02$</td>
<td>$5.0377E-02$</td>
</tr>
<tr>
<td>$W_2$</td>
<td>$3.0004E+01$</td>
<td>$4.4822E+01$</td>
<td>$5.2356E+01$</td>
<td>$5.6208E+01$</td>
<td>$6.2693E+01$</td>
<td>$1.2609E+02$</td>
</tr>
<tr>
<td>$W_3$</td>
<td>$6.3216E-02$</td>
<td>$1.9908E-01$</td>
<td>$2.9122E-01$</td>
<td>$5.2205E-01$</td>
<td>$4.6896E-01$</td>
<td>$2.8226E+00$</td>
</tr>
<tr>
<td>$W_2/W_1$</td>
<td>$7.5975E+02$</td>
<td>$1.9522E+03$</td>
<td>$1.4391E+03$</td>
<td>$1.5908E+03$</td>
<td>$1.8106E+03$</td>
<td>$3.9926E+03$</td>
</tr>
<tr>
<td>$W_3/W_1$</td>
<td>$1.6388E+00$</td>
<td>$5.3958E+00$</td>
<td>$8.1442E+00$</td>
<td>$1.5264E+01$</td>
<td>$1.3369E+01$</td>
<td>$9.0522E+01$</td>
</tr>
<tr>
<td>$X_3$</td>
<td>$3.2608E+01$</td>
<td>$5.1063E+02$</td>
<td>$1.3453E+03$</td>
<td>$1.3182E+04$</td>
<td>$3.5807E+03$</td>
<td>$1.3020E+05$</td>
</tr>
<tr>
<td>$EQUITY$</td>
<td>$1.0588E+03$</td>
<td>$4.5009E+03$</td>
<td>$8.5316E+03$</td>
<td>$6.7813E+04$</td>
<td>$1.7396E+04$</td>
<td>$6.7885E+05$</td>
</tr>
<tr>
<td>$NPER$</td>
<td>$0.0000E+00$</td>
<td>$7.2233E-03$</td>
<td>$1.4046E-02$</td>
<td>$1.8648E-02$</td>
<td>$2.4139E-02$</td>
<td>$8.1476E-02$</td>
</tr>
<tr>
<td>$TIME$</td>
<td>$4.1000E+01$</td>
<td>$4.1000E+01$</td>
<td>$4.1000E+01$</td>
<td>$4.1000E+01$</td>
<td>$4.1000E+01$</td>
<td>$4.1000E+01$</td>
</tr>
<tr>
<td>$ASSETS$</td>
<td>$1.0925E+04$</td>
<td>$4.4322E+04$</td>
<td>$8.5244E+04$</td>
<td>$8.1747E+05$</td>
<td>$1.7826E+05$</td>
<td>$7.7399E+06$</td>
</tr>
</tbody>
</table>

NOTE: Dollar figures are given in thousands of constant 2015 dollars.
Table B.4: Quantiles and Means for Variables used in Estimation, 2006.Q4

<table>
<thead>
<tr>
<th></th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1/W_1$</td>
<td>2.7372E+04</td>
<td>1.0834E+05</td>
<td>2.1287E+05</td>
<td>2.8111E+06</td>
<td>4.7847E+05</td>
<td>1.9688E+07</td>
</tr>
<tr>
<td>$C_2/W_1$</td>
<td>3.4790E+04</td>
<td>1.3144E+05</td>
<td>2.5476E+05</td>
<td>3.3825E+06</td>
<td>5.7645E+05</td>
<td>2.4183E+07</td>
</tr>
<tr>
<td>$R_1$</td>
<td>7.5533E+02</td>
<td>4.1226E+03</td>
<td>8.7530E+03</td>
<td>1.5337E+05</td>
<td>2.0892E+04</td>
<td>8.8074E+05</td>
</tr>
<tr>
<td>$R_2$</td>
<td>8.7438E+02</td>
<td>4.3025E+03</td>
<td>9.1663E+03</td>
<td>1.5918E+05</td>
<td>2.1518E+04</td>
<td>9.0536E+05</td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>-1.8792E+07</td>
<td>-4.588E+05</td>
<td>-2.0425E+05</td>
<td>-2.6578E+06</td>
<td>-1.0416E+05</td>
<td>-2.6562E+04</td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>-2.3032E+07</td>
<td>-5.5530E+05</td>
<td>-2.4635E+05</td>
<td>-3.2292E+06</td>
<td>-1.2709E+05</td>
<td>-3.3546E+04</td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>-1.8769E+07</td>
<td>-4.5843E+05</td>
<td>-2.0379E+05</td>
<td>-2.6520E+06</td>
<td>-1.0410E+05</td>
<td>-2.6551E+04</td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>-2.2999E+07</td>
<td>-5.5446E+05</td>
<td>-2.4571E+05</td>
<td>-3.2233E+06</td>
<td>-1.2677E+05</td>
<td>-3.3524E+04</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>5.4270E+01</td>
<td>2.0337E+03</td>
<td>4.5317E+03</td>
<td>1.3393E+05</td>
<td>1.0605E+04</td>
<td>5.0776E+05</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>6.8023E+02</td>
<td>7.9104E+03</td>
<td>1.7427E+04</td>
<td>3.0917E+05</td>
<td>4.0890E+04</td>
<td>1.8210E+06</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>1.7185E+03</td>
<td>2.2155E+04</td>
<td>5.7937E+04</td>
<td>6.2418E+05</td>
<td>1.5227E+05</td>
<td>5.0291E+06</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>3.7717E+03</td>
<td>1.9683E+04</td>
<td>3.8899E+04</td>
<td>8.8022E+05</td>
<td>8.4208E+04</td>
<td>4.1177E+06</td>
</tr>
<tr>
<td>$Y_5$</td>
<td>2.5222E+01</td>
<td>2.9465E+02</td>
<td>7.6319E+02</td>
<td>4.7674E+04</td>
<td>2.0922E+03</td>
<td>1.7041E+05</td>
</tr>
<tr>
<td>$W_1$</td>
<td>1.2300E+02</td>
<td>2.5134E-02</td>
<td>2.9807E-02</td>
<td>2.9760E-02</td>
<td>3.4539E-02</td>
<td>4.7022E-02</td>
</tr>
<tr>
<td>$W_2$</td>
<td>3.3580E+01</td>
<td>5.1988E+01</td>
<td>6.0842E+01</td>
<td>6.5241E+01</td>
<td>7.3959E+01</td>
<td>1.3351E+02</td>
</tr>
<tr>
<td>$W_3$</td>
<td>5.7326E-02</td>
<td>1.5976E-01</td>
<td>2.4101E-01</td>
<td>4.3295E-01</td>
<td>4.0730E-01</td>
<td>2.6102E-00</td>
</tr>
<tr>
<td>$W_2/W_1$</td>
<td>1.0786E+03</td>
<td>1.7139E+03</td>
<td>2.0858E+03</td>
<td>2.3338E+03</td>
<td>2.6522E+03</td>
<td>6.0909E+03</td>
</tr>
<tr>
<td>$W_3/W_1$</td>
<td>1.6144E+00</td>
<td>5.3063E+00</td>
<td>8.4498E+00</td>
<td>1.6224E+01</td>
<td>1.4996E+01</td>
<td>1.0431E+02</td>
</tr>
<tr>
<td>$X_3$</td>
<td>4.0038E+01</td>
<td>7.9635E+02</td>
<td>2.3097E+03</td>
<td>1.9033E+04</td>
<td>6.0625E+03</td>
<td>1.9300E+05</td>
</tr>
<tr>
<td>$\text{EQUITY}$</td>
<td>1.5462E+03</td>
<td>7.1660E+03</td>
<td>1.3890E+04</td>
<td>1.7695E+05</td>
<td>2.9155E+04</td>
<td>1.1112E+06</td>
</tr>
<tr>
<td>$\text{NPER}$</td>
<td>0.0000E+00</td>
<td>5.2085E-03</td>
<td>1.1642E-02</td>
<td>1.6275E-02</td>
<td>2.2149E-02</td>
<td>7.7390E-02</td>
</tr>
<tr>
<td>$\text{TIME}$</td>
<td>8.1000E+01</td>
<td>8.1000E+01</td>
<td>8.1000E+01</td>
<td>8.1000E+01</td>
<td>8.1000E+01</td>
<td>8.1000E+01</td>
</tr>
<tr>
<td>$\text{ASSETS}$</td>
<td>1.3424E+04</td>
<td>6.3182E+04</td>
<td>1.2914E+05</td>
<td>1.9531E+06</td>
<td>2.9528E+05</td>
<td>1.2084E+07</td>
</tr>
</tbody>
</table>

**NOTE:** Dollar figures are given in thousands of constant 2015 dollars.
Table B.5: Quantiles and Means for Variables used in Estimation, 2015.Q4

<table>
<thead>
<tr>
<th>Variable</th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1/W_1$</td>
<td>1.0626E+05</td>
<td>5.2067E+05</td>
<td>1.1119E+06</td>
<td>1.8666E+07</td>
<td>2.7318E+06</td>
<td>1.4240E+08</td>
</tr>
<tr>
<td>$C_2/W_1$</td>
<td>1.5534E+05</td>
<td>7.2978E+05</td>
<td>1.5695E+06</td>
<td>2.7335E+07</td>
<td>3.8389E+06</td>
<td>2.1414E+08</td>
</tr>
<tr>
<td>$R_1$</td>
<td>5.8014E+02</td>
<td>3.8511E+03</td>
<td>7.8937E+03</td>
<td>1.2840E+05</td>
<td>1.7659E+04</td>
<td>7.9773E+05</td>
</tr>
<tr>
<td>$R_2$</td>
<td>7.1519E+02</td>
<td>3.9455E+03</td>
<td>8.1673E+03</td>
<td>1.3408E+05</td>
<td>1.8168E+04</td>
<td>8.5243E+05</td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>-1.4195E+08</td>
<td>-2.7055E+06</td>
<td>-1.1025E+06</td>
<td>-1.8539E+07</td>
<td>-5.1543E+05</td>
<td>-1.0493E+05</td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>-2.1285E+08</td>
<td>-3.8207E+06</td>
<td>-1.5020E+06</td>
<td>-2.7206E+07</td>
<td>-7.2466E+05</td>
<td>-1.5326E+05</td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>-1.4187E+08</td>
<td>-2.7056E+06</td>
<td>-1.1027E+06</td>
<td>-1.8532E+07</td>
<td>-5.1549E+05</td>
<td>-1.0491E+05</td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>-2.1272E+08</td>
<td>-3.8207E+06</td>
<td>-1.5591E+06</td>
<td>-2.7201E+07</td>
<td>-7.2453E+05</td>
<td>-1.5328E+05</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>4.9869E+00</td>
<td>1.4729E+03</td>
<td>3.4275E+03</td>
<td>1.9185E+05</td>
<td>8.1038E+03</td>
<td>6.7945E+05</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>8.2713E+02</td>
<td>9.3589E+03</td>
<td>2.1943E+04</td>
<td>5.5048E+05</td>
<td>5.3645E+04</td>
<td>3.8193E+06</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>2.5233E+03</td>
<td>3.2677E+04</td>
<td>8.0097E+04</td>
<td>7.3225E+05</td>
<td>1.9746E+05</td>
<td>7.1351E+06</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>5.4605E+03</td>
<td>2.9490E+04</td>
<td>5.8854E+04</td>
<td>1.5083E+06</td>
<td>1.2884E+05</td>
<td>5.0939E+06</td>
</tr>
<tr>
<td>$Y_5$</td>
<td>3.5752E+01</td>
<td>3.5377E+02</td>
<td>9.8589E+02</td>
<td>5.0507E+04</td>
<td>2.8920E+03</td>
<td>2.2895E+05</td>
</tr>
<tr>
<td>$W_1$</td>
<td>7.9080E-04</td>
<td>2.6526E-03</td>
<td>3.9677E-03</td>
<td>4.3177E-03</td>
<td>5.6056E-03</td>
<td>1.1163E-02</td>
</tr>
<tr>
<td>$W_2$</td>
<td>3.9563E+01</td>
<td>5.9819E+01</td>
<td>7.0071E+01</td>
<td>7.4142E+01</td>
<td>8.4415E+01</td>
<td>1.3954E+02</td>
</tr>
<tr>
<td>$W_3$</td>
<td>5.9994E-02</td>
<td>1.5105E-01</td>
<td>2.2741E-01</td>
<td>4.4754E-01</td>
<td>3.9024E-01</td>
<td>3.7542E+00</td>
</tr>
<tr>
<td>$W_2/W_1$</td>
<td>5.9063E+03</td>
<td>1.2661E+04</td>
<td>1.8070E+04</td>
<td>2.4135E+04</td>
<td>2.7267E+04</td>
<td>1.1704E+05</td>
</tr>
<tr>
<td>$W_3/W_1$</td>
<td>9.7897E+00</td>
<td>3.5035E+01</td>
<td>6.2436E+01</td>
<td>1.4857E+02</td>
<td>1.2599E+02</td>
<td>1.5046E+03</td>
</tr>
<tr>
<td>$X_3$</td>
<td>3.5086E+01</td>
<td>8.9979E+02</td>
<td>2.7917E+03</td>
<td>2.2944E+04</td>
<td>7.0597E+03</td>
<td>2.4833E+05</td>
</tr>
<tr>
<td>$EQUITY$</td>
<td>1.8127E+03</td>
<td>9.7273E+03</td>
<td>1.9529E+04</td>
<td>3.4081E+05</td>
<td>4.1706E+04</td>
<td>2.0533E+06</td>
</tr>
<tr>
<td>$NPER$</td>
<td>0.0000E+00</td>
<td>5.9330E-03</td>
<td>1.2205E-02</td>
<td>1.8037E-02</td>
<td>2.2530E-02</td>
<td>1.1501E-01</td>
</tr>
<tr>
<td>$TIME$</td>
<td>1.1700E+02</td>
<td>1.1700E+02</td>
<td>1.1700E+02</td>
<td>1.1700E+02</td>
<td>1.1700E+02</td>
<td>1.1700E+02</td>
</tr>
<tr>
<td>$ASSETS$</td>
<td>1.8508E+04</td>
<td>8.8917E+04</td>
<td>1.7926E+05</td>
<td>2.9854E+06</td>
<td>3.9060E+05</td>
<td>1.8417E+07</td>
</tr>
</tbody>
</table>

**NOTE:** Dollar figures are given in thousands of constant 2015 dollars.
Table B.6: Quantiles and Means for Variables used in Estimation, All Quarters

<table>
<thead>
<tr>
<th>Variable</th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1/W_1$</td>
<td>1.758E+04</td>
<td>7.764E+04</td>
<td>1.712E+05</td>
<td>3.409E+06</td>
<td>4.450E+05</td>
<td>2.337E+07</td>
</tr>
<tr>
<td>$C_2/W_1$</td>
<td>2.099E+04</td>
<td>9.305E+04</td>
<td>2.087E+05</td>
<td>4.808E+06</td>
<td>5.621E+05</td>
<td>3.069E+07</td>
</tr>
<tr>
<td>$R_1$</td>
<td>5.590E+02</td>
<td>3.414E+03</td>
<td>6.942E+03</td>
<td>8.501E+04</td>
<td>1.517E+04</td>
<td>7.248E+05</td>
</tr>
<tr>
<td>$R_2$</td>
<td>8.046E+02</td>
<td>3.641E+03</td>
<td>7.271E+03</td>
<td>9.167E+04</td>
<td>1.588E+04</td>
<td>7.727E+05</td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>-2.259E+07</td>
<td>-4.285E+05</td>
<td>-1.629E+05</td>
<td>-3.324E+06</td>
<td>-7.340E+06</td>
<td>-1.651E+04</td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>-3.002E+07</td>
<td>-5.446E+05</td>
<td>-2.004E+05</td>
<td>-4.723E+06</td>
<td>-8.867E+06</td>
<td>-1.990E+04</td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>-2.254E+07</td>
<td>-4.276E+05</td>
<td>-1.626E+05</td>
<td>-3.318E+06</td>
<td>-7.320E+06</td>
<td>-1.647E+04</td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>-2.996E+07</td>
<td>-5.437E+05</td>
<td>-1.993E+05</td>
<td>-4.717E+06</td>
<td>-8.849E+06</td>
<td>-1.986E+04</td>
</tr>
<tr>
<td>$Y_1$</td>
<td>7.981E+01</td>
<td>2.216E+03</td>
<td>5.151E+03</td>
<td>9.652E+04</td>
<td>1.202E+04</td>
<td>7.074E+05</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>5.693E+02</td>
<td>6.308E+03</td>
<td>1.355E+04</td>
<td>2.420E+05</td>
<td>3.115E+04</td>
<td>1.864E+06</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>7.185E+02</td>
<td>1.136E+04</td>
<td>3.141E+04</td>
<td>3.450E+05</td>
<td>8.762E+04</td>
<td>3.347E+06</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>4.191E+03</td>
<td>1.896E+04</td>
<td>3.740E+04</td>
<td>5.637E+05</td>
<td>8.059E+04</td>
<td>3.647E+06</td>
</tr>
<tr>
<td>$Y_5$</td>
<td>2.904E+01</td>
<td>2.406E+02</td>
<td>5.922E+02</td>
<td>2.561E+04</td>
<td>1.603E+03</td>
<td>1.483E+05</td>
</tr>
<tr>
<td>$W_1$</td>
<td>2.154E+03</td>
<td>1.928E+02</td>
<td>3.310E+02</td>
<td>3.266E+02</td>
<td>4.524E+02</td>
<td>6.660E+02</td>
</tr>
<tr>
<td>$W_2$</td>
<td>2.880E+01</td>
<td>4.385E+01</td>
<td>5.251E+01</td>
<td>5.615E+01</td>
<td>6.404E+01</td>
<td>1.204E+02</td>
</tr>
<tr>
<td>$W_3$</td>
<td>6.522E+02</td>
<td>1.821E+01</td>
<td>2.699E+01</td>
<td>4.671E+01</td>
<td>4.394E+01</td>
<td>2.828E+00</td>
</tr>
<tr>
<td>$W_2/W_1$</td>
<td>5.278E+02</td>
<td>1.049E+03</td>
<td>1.629E+03</td>
<td>3.777E+03</td>
<td>3.204E+03</td>
<td>3.289E+04</td>
</tr>
<tr>
<td>$W_3/W_1$</td>
<td>1.578E+00</td>
<td>5.475E+00</td>
<td>9.449E+00</td>
<td>2.936E+00</td>
<td>1.983E+01</td>
<td>2.901E+02</td>
</tr>
<tr>
<td>$X_3$</td>
<td>3.066E+01</td>
<td>5.468E+02</td>
<td>1.543E+03</td>
<td>1.445E+04</td>
<td>4.148E+03</td>
<td>1.613E+05</td>
</tr>
<tr>
<td>$EQUITY$</td>
<td>8.640E+02</td>
<td>4.717E+03</td>
<td>9.573E+03</td>
<td>1.172E+05</td>
<td>2.051E+04</td>
<td>8.542E+05</td>
</tr>
<tr>
<td>$NPER$</td>
<td>0.000E+00</td>
<td>7.881E+03</td>
<td>1.663E+02</td>
<td>2.523E-02</td>
<td>3.135E-01</td>
<td>1.506E-01</td>
</tr>
<tr>
<td>$TIME$</td>
<td>1.000E+00</td>
<td>2.200E+01</td>
<td>4.800E+01</td>
<td>5.190E+01</td>
<td>8.000E+01</td>
<td>1.160E+02</td>
</tr>
<tr>
<td>$ASSETS$</td>
<td>1.098E+04</td>
<td>4.817E+04</td>
<td>9.783E+04</td>
<td>1.246E+05</td>
<td>2.177E+05</td>
<td>9.923E+06</td>
</tr>
</tbody>
</table>

**NOTE:** Dollar figures are given in thousands of constant 2015 dollars.

C Test of Translog Specifications

In order to provide a simple test of the translog specification for our cost, revenue, and profit equations, we divide our data for each of 117 quarters (1986.Q4–2015.Q4) into two mutually exclusive, collectively exhaustive subsamples containing (i) observations on banks with total assets up to the median of total assets, and (ii) observations on banks with total assets greater than the median of total assets (medians are over all banks within a given group). Thus for each quarter we have two subsamples. For each model $m \in \{1, \ldots, 8\}$, we specify a translog form for the conditional mean function after omitting the time ($T$) variable from the RHSs of the models. For each subsample in each quarter, we estimate via ordinary least squares (OLS) each of 8 models with translog specifications.

For a given quarter and a given model $m$, we obtain parameter estimates $\hat{\beta}_{mj}$ and corresponding covariance matrix estimates

$$
\hat{\Sigma}_{mj} = \left(\frac{n_{mj}}{n_{mj} - K_m}\right)(X'_{mj}X_{mj})^{-1}X'_{mj}\text{diag}(\hat{\varepsilon}_{mji}^2)X_{mj}(X'_{mj}X_{mj})^{-1},
$$

(C.1)

where $j \in \{1, 2\}$, $X_{mj}$ is the $(n_{mj} \times K_m)$ matrix of RHS variables (including interaction terms) used in the translog specification and the $\hat{\varepsilon}_{mji}$ are the OLS residuals for model $m$, subset $j$. The factor $\left(\frac{n_{mj}}{n_{mj} - K_m}\right)$ scales up the usual White (1980) heteroskedasticity-consistent covariance estimator as suggested by Davidson and MacKinnon (1993) to account for the fact that squared OLS-estimated residuals tend to underestimate squares of true residuals.

Finally, for a given quarter and model $m$, we compute the Wald statistic

$$
\hat{W} = (\hat{\beta}_{m1} - \hat{\beta}_{m2})'(\hat{\Sigma}_{m1} + \hat{\Sigma}_{m2})^{-1}(\hat{\beta}_{m1} - \hat{\beta}_{m2})
$$

(C.2)

to test the null hypothesis $H_0: \beta_{m1} = \beta_{m2}$ versus the alternative hypothesis $H_1: \beta_{m1} \neq \beta_{m2}$. Rejection of the null provides evidence against the translog specification within a given group.

Using the sample described in Section 3, we obtain $p$-values for the $117 \times 8 = 936$ Wald tests ranging from $10^{-85.456}$ to 0.0514. Only 1 out of 936 $p$-values are greater than 0.05, and only 4 are greater than 0.01. The median $p$-value is $10^{-13.723}$ (i.e., essentially zero). Splitting the data into $117 \times 2 = 234$ cells allows the translog parameters to vary across quarters as well as across bank-size. Even so, we find overwhelming evidence against the translog specification.
Details of Non-parametric Estimation and Inference

D.1 Dimension reduction

Non-parametric regression methods typically suffer from the well-known curse of dimensionality, a phenomenon that causes rates of convergence to become slower, and estimation error to increase dramatically, as the number of continuous right-hand side variables increases (the presence of discrete dummy variables does not affect the convergence rate of our estimator). We use eigensystem analysis and principal components to help mitigate this problem. The idea is to sacrifice a relatively small amount of information in the data to permit a reduction in dimensionality that will have a large (and favorable) impact on estimation error.

We begin by applying marginal transformations to the continuous right-hand side RHS variables in each model. The marginal transformations are chosen to yield distributions that are approximately normal. For output quantities $Y_1$, $Y_2$, $Y_3$ and $Y_5$ we add 1 and then take the (natural) logarithm. For $Y_4$ we take the logarithm without adding 1. For the physical capital variable $X_4$ used in the first model, and for the normalized input price variables used in each of the cost models, we take logarithms. We similarly take logarithms of the input price variables (that are not normalized) in the revenue and profit models.

For an $(n \times 1)$ vector $V$ define the function $\psi_1(\cdot): \mathbb{R}^n \mapsto \mathbb{R}^n$ such that

$$\psi_1(V) \equiv (V - n^{-1}i'V) \left[ n^{-1}V'V - n^{-2}V'i'i'V \right]^{-1/2}$$

where $i$ denotes an $(n \times 1)$ vector of ones. The function $\psi_1(\cdot)$ standardizes a variable by subtracting its sample mean and then dividing by its sample standard deviation. We apply this function to marginal transformations of the continuous RHS variables in each model.

For model $j \in \{1, \ldots, 8\}$, let $K_j$ be the number of continuous RHS variables, and let $A_j$ be the $(n \times K_j)$ matrix with columns containing the standardized, marginal transformations of the continuous RHS variables in the given model. Let $\Lambda_j$ be the $(K_j \times K_j)$ matrix whose columns are the eigenvectors of the correlation matrix of Pearson correlation coefficients for pairs of columns of $A_j$, and let $\lambda_{jk}$ be the eigenvalue corresponding to the $k$th eigenvector in the $k$th column of $\Lambda_j$, where the columns of $\Lambda_j$, and their corresponding eigenvalues, have been sorted so that $\lambda_{j1} \geq \ldots \geq \lambda_{jK_j}$. Then let $P_j = A_j\Lambda_j$. The matrix $P_j$ has dimensions $(n \times K_j)$, and its columns are the principal components of $A_j$. It is well-known that principal
components are orthogonal. Moreover, for each \( k \in \{1, 2, \ldots, K_j\} \), the quantity
\[
\phi_{jk} = \frac{\sum_{\ell=1}^{k} \lambda_{j\ell}}{\sum_{i=1}^{K} \lambda_{ji}}
\]  
represents the proportion of the independent linear information in \( A_j \) that is contained in the first \( k \) principal components, i.e., the first \( k \) columns of \( P_j \).

Using the dataset described in Section 3, for models \( j \in \{1, 2\} \) and \( k \in \{1, \ldots, 10\} \) we find \( \phi_{j,k} = 0.4004706, 0.6409254, 0.7411243, 0.8358076, 0.8875271, 0.9285652, 0.9551966, 0.9735527, 0.9886108 \) and \( 1.0000000 \). For the revenue and cost models \( (j \in \{3, \ldots, 8\}) \) and \( k \in \{1, \ldots, 11\} \) we find \( \phi_{j,k} = 0.3714919, 0.5653879, 0.6641117, 0.7547991, 0.8381867, 0.8969946, 0.9292129, 0.9531239, 0.9751464, 0.9888575 \) and \( 1.0000000 \). As discussed in Section 3, we use the first 6 principal components in each case, omitting the last 4 in models 1–2, and the last 5 in models 3–8. In doing so, we sacrifice a relatively small amount of information, while retaining 89.7 to 93.2 percent of the independent linear information in the sample, in order to reduce the dimensionality of our estimation problem by 6 or 7 dimensions in the space of the continuous covariates. We regard this as a worthwhile trade-off given the curse of dimensionality.

Now write model \( j, j \in \{1, \ldots, 8\} \) from the list of models given in Section 3 as
\[
Y_{ji} = m_j(X_{ji}) + \varepsilon_i
\]  
where \( Y_{ji} \) is the \( i \)th observation, \( i = 1, \ldots, n \) on left-hand side (LHS) variable in model \( j \) and \( X_{ji} \) is the vector of \( i \)th observations on \( K_j \) continuous RHS variables in model \( j \). Let \( Y_j = [Y_{j1} \ldots Y_{jn}]' \). Define functions \( \psi_2(\cdot) : \mathbb{R}^n \mapsto \mathbb{R}^n \) such that
\[
\psi_2(V) := \psi_1(\log(V - \min(V) + 1))
\]  
and \( \psi_3(\cdot) : \mathbb{R}^n \mapsto \mathbb{R}^n \) such that
\[
\psi_3(V) := V / \text{IQR}(V)
\]  
where \( \text{IQR}(V) \) gives the inter-quartile range of the elements of \( V \).

Instead of estimating (D.3) directly, we estimate the model
\[
Y_{ji}^+ = m_j^+(X_{ji}^+) + \xi_i
\]
where \( E(\xi_i) = 0, \text{VAR}(\xi_i) = \sigma^2(\xi_i) \), \( \mathbf{y}_j^{+} = \mathbf{y}_j \) is the \( i \)th element of the \((n \times 1)\) vector \( \mathbf{y}_j^{+} = \mathbf{y}_2(\mathbf{y}_{ji}) \) for the cost models \((j \in \{1, 2\})\) or \( \mathbf{y}_j^{+} = \mathbf{y}_3(\mathbf{y}_{ji}) \) for the revenue and profit models \((j \in \{3, \ldots, 8\})\), \( \mathbf{x}_i^{+} \) is the row vector containing the \( i \)th observations on \( \psi_4(P_j, \mathbf{1}) \), ..., \( \psi_4(P_j, \mathbf{6}) \), with \( P_{j,k} \) denoting the \( k \)th column of the principal component matrix \( P_j \) and \( \psi_4(\cdot): \mathbb{R}^n \rightarrow \mathbb{R}^n \) such that

\[
\psi_4(P_{j,k}) := P_{j,k} \left( n^{-1} P'_{j,k} P_{j,k} - n^{-2} P'_{j,k} P_{j,k} P'_{j,k} \right)^{-1/2}.
\]  

The transformation \( \psi_4(P_{j,k}) \) of \( P_{j,k} \) has (constant) unit variance. Moreover, all of the transformations that have been introduced can be inverted. Hence, given estimated values \( \mathbf{M}^{+} = [\mathbf{m}_1^{+}(\mathbf{x}_{j1}) \ldots \mathbf{m}_n^{+}(\mathbf{x}_{jn})]' \), straightforward algebra yields estimated or predicted values

\[
\mathbf{\hat{y}}_{ji} = [\mathbf{\hat{y}}_{j1} \ldots \mathbf{\hat{y}}_{jn}]' = \psi_2^{-1}(\mathbf{\hat{y}}^{+}).
\]  

As discussed below, we use a local linear estimator to estimate \( m_j^{+}(\mathbf{x}_{ji}) \). Although this estimator is weakly consistent, it is asymptotically biased. Moreover, even if \( \mathbf{\hat{m}}_j^{+}(\mathbf{x}_{ji}) \) were unbiased, use of the nonlinear transformation in (D.8) means that \( \mathbf{\hat{y}}_{ji} \) obtained from (D.8) would not, in general, be unbiased because of the linearity of the expectations operator. Furthermore, even if an unbiased estimator of \( \mathbf{\hat{y}}_{ji} \) were available, plugging such an estimator into the returns-to-scale measures \( E_{C,i}, E_{R,i}, \) and \( E_{\pi,i} \) defined in Section 2 to obtain estimators \( \hat{E}_{C,i}, \hat{E}_{R,i}, \) and \( \hat{E}_{\pi,i} \) involves additional nonlinear transformations. Fortunately, any bias in the resulting estimates \( \hat{E}_{C,i}, \hat{E}_{R,i}, \) and \( \hat{E}_{\pi,i} \) can be corrected while making inference about returns to scale; as discussed below in Section D.3, we employ a bias-corrected bootstrap method when estimating confidence intervals for our returns-to-scale measures.

### D.2 Non-parametric estimation of conditional mean functions

Local polynomial estimators are discussed by Fan and Gijbels (1996), and are a generalization of the Nadaraya-Watson (Nadaraya, 1964; Watson, 1964) kernel estimator which amounts to fitting locally a polynomial of order \( p = 0 \). The local-linear estimator that we employ has less bias, but no more variance than the Nadaraya-Watson estimator; see Fan and Gijbels for explanation.

We specify the kernel function \( \mathcal{K}(\cdot): \mathbb{R}^\ell \rightarrow \mathbb{R}^1_+ \) needed by the local linear estimator as an
\( \ell \)-variate, spherically symmetric Epanechnikov kernel with a single, scalar bandwidth \( h_0 \); i.e.,

\[
K(t) = \frac{\ell(\ell + 2)}{2S_\ell}(1 - tt')1(tt' \leq 1)
\]

(D.9)

where \( 1(\cdot) \) again represents the indicator function, \( S_\ell = 2\pi^{\ell/2}/\Gamma(\ell/2) \), and \( \Gamma(\cdot) \) denotes the gamma function (recall that for each of the transformed models represented by (D.6), \( \ell = 6 \)).

The spherically symmetric Epanechnikov kernel is optimal in terms of asymptotic minimax risk; see Fan et al. (1997) for details and a proof.

Note that the principal components transformation pre-whitens the data; in addition, the principal components are orthogonal. These two facts allow us to work with a single bandwidth rather than a vector or matrix of bandwidths. Moreover, we use an adaptive, scalar-valued bandwidth \( h(X_0^+) \) that depends on the point \( (X_0^+) \) in the space of the continuous, transformed RHS variables where the conditional mean function is to be evaluated as explained below.

**D.3 Practical issues for implementation**

To implement our estimator, optimize the bandwidth \( h(X_0^+) \). All of the right-hand side variables \( X_0^+ \) are continuous, but the sparseness of the data varies. Hence we use an adaptive, nearest-neighbor bandwidth. We define \( h(X_0^+) \) for any particular point \( X_0^+ \in \mathbb{R}^\ell \) as the maximum Euclidean distance between \( X_0^+ \) and the \( \kappa \) nearest points in the observed sample \( \{X_{ji}^+\}_{j=1}^n, \kappa \in \{2, 3, 4, \ldots\} \). Thus, given the data and the point \( X_0^+ \), the bandwidth \( h(X_0^+) \) is determined by \( \kappa \), and varies depending on the density of the continuous explanatory variables locally around the point \( X_0^+ \in \mathbb{R}^\ell \) at which the conditional mean function is estimated. This results in a bandwidth that is increasing with decreasing density of the data around the point of interest, \( X_0^+ \). More smoothing is required where data are sparse than where data are dense; our nearest-neighbor bandwidth adapts automatically to the density of the data.

Note that we use a nearest-neighbor bandwidth rather than a nearest-neighbor estimator. The bandwidth is used inside a kernel function, and the kernel function integrates to unity. Loftsgaarden and Quesenberry (1965) use this approach in the density estimation context to avoid nearest-neighbor density estimates (as opposed to bandwidths) that do not integrate to unity (see Pagan and Ullah, 1999, pp. 11-12 for additional discussion). Fan and Gijbels (1994; 1996, pp. 151–152) discuss nearest-neighbor bandwidths in the regression context.
As a practical matter, for models \( j \in \{1, \ldots, 8 \} \) we optimize \( \kappa_j \) by minimizing a least-squares cross-validation function; i.e., we select

\[
\kappa_j = \arg\min_{\kappa_j} \sum_{i=1}^{n} \left( y_{ji}^+ - \hat{m}_{j-i}(x_{ji}^+) \right)^2, \tag{D.10}
\]

where \( \hat{m}_{j-i}(x_{ji}^+) \) is computed the same way as \( \hat{m}_j^+(x_{ji}^+) \), except that the \( i \)th observation is omitted. The least-squares cross validation function approximates the part of mean integrated square error that depends on the bandwidths.\(^1\)

Once appropriate values of the bandwidth parameters have been selected, the conditional mean function can be estimated at any point \( x_0^+ \in \mathbb{R}^\ell \). We then estimate the returns-to-scale measures defined in the text by replacing the cost terms with estimates obtained from the relation (D.8). To make inferences about returns to scale, we use the wild bootstrap proposed by Härdle (1990) and Härdle and Mammen (1993).\(^2\) After \( B \) replications, we obtain a set bootstrap estimates \( \{ \hat{m}_{j,b}^*(\cdot) \}_{b=1}^{B} \), which we substitute into the definitions of the returns-to-scale measures given in the text. Letting \( \mathcal{S} \) denote the relevant returns-to-scale measure, we have the original estimate \( \hat{S} \) and the bootstrap estimates \( \{ \hat{S}_b \}_{b=1}^{B} \) to obtain bootstrap values \( \hat{S}_b^* \) and \( \hat{E}_b^* \) for particular values of \( x^+ \), with \( b = 1, \ldots, B \).

To make inference about \( \mathcal{S} \), we use the bias-correction method described by Efron and Tibshirani (1993). In particular, we estimate \((1 - \alpha) \times 100\)-percent confidence intervals by \( \left( \hat{S}_{(\alpha_1)}, \hat{S}_{(\alpha_2)} \right) \), where \( \hat{S}_{(\alpha)} \) denotes the \( \alpha \)-quantile of the bootstrap values \( \hat{S}_b^*, \, b = 1, \ldots, B \), and

\[
\alpha_1 = \Phi \left( \frac{\hat{\varphi}_0 + \varphi(\alpha/2)}{1 - \hat{\varphi}_0 + \varphi(\alpha/2)} \right), \tag{D.11}
\]
\[
\alpha_2 = \Phi \left( \frac{\hat{\varphi}_0 + \varphi(1-\alpha/2)}{1 - \hat{\varphi}_0 + \varphi(1-\alpha/2)} \right), \tag{D.12}
\]

\(^1\) Choice of \( \kappa \) by cross validation has been proposed by Fan and Gijbels (1996) and has been used by Wheelock and Wilson (2001, 2001, 2011, and 2012), Wilson and Carey (2004), and others. Time required to compute the cross validation function \( \text{once} \) is of order \( O(n^2) \), and it must be computed many times in order to find optimal values of the bandwidths. With almost one million observations, this presents a formidable computational burden. However, the problem is trivially parallel; using \( n_p \) CPUs, the computation time required for each evaluation of the cross-validation function is only slightly more than \( 1/n_p \) times the time that would be required on a single processor. We performed all computations on the Palmetto cluster operated by Clemson University’s Cyber Infrastructure Technology Integration (CITI) group.

\(^2\) Ordinary bootstrap methods are inconsistent in our context due to the asymptotic bias of the estimator; see Mammen (1992) for additional discussion.
Φ(·) denotes the standard normal distribution function, ϕ^{(α)} is the (α × 100)-th percentile of the standard normal distribution, and

\[ \hat{ϕ}_0 = \Phi^{-1}\left( \frac{\#\{\hat{S}_b < \hat{S}\}}{B} \right), \]  

(D.13)

with Φ^{-1}(·) denoting the standard normal quantile function (e.g., Φ^{-1}(0.95) ≈ 1.6449).
E Additional Results

Tables E.1–E.24 show additional results not appearing in the paper. To facilitate comparison, Tables E.4 and E.14 are included here, even though the same tables appear as Tables 1 and 4 in the paper.

Tables E.1 gives percentiles and means for estimates of the returns to scale indices $\varepsilon_{C,i}$, $\varepsilon_{R,i}$ and $\varepsilon_{\pi,i}$ for quarters 1986.Q4, 1996.Q4, 2006.Q4 and 2015.Q4. Table E.2 gives counts of institutions facing IRS, CRS, or DRS in each of the four quarters examined. Results are given for .1, .05 and .01 significance; counts of institutions facing CRS include those for which CRS could not be rejected in favor of either IRS or DRS. Tables E.3–E.5 give counts at .1, .05 and .01 significance similar to those in Table E.2, but broken into quartiles of institutions’ sizes as measured by their total assets.

Tables E.6–E.9 give estimates of the pseudo-elasticities given by $(1-\varepsilon_{C,i})\delta$, $(1+\varepsilon_{R,i})\delta$ and $(1+\varepsilon_{\pi,i})\delta$ for the 100 largest banks in each quarter 1986.Q4, 1996.Q4, 2006.Q4 and 2015.Q4 instead of only the 10 largest banks as in in Tables 2–3 of the paper.

Tables E.10–E.11 give the estimates of the RTS statistics $\varepsilon_{C,i}$, $\varepsilon_{R,i}$ and $\varepsilon_{\pi,i}$ or the 10 largest institutions in each of the four quarters examined. These estimates correspond to the estimates of the pseudo-elasticities given by $(1-\varepsilon_{C,i})\delta$, $(1+\varepsilon_{R,i})\delta$ and $(1+\varepsilon_{\pi,i})\delta$ displayed in Tables 2–3 of the paper.

Table E.12 gives, for significance levels .1, .05 and .01, counts of institutions appearing in both 2006.Q3 and 2015.Q4 and which have a statistically significant change in their estimated RTS. These counts are broken down by direction, i.e., whether institutions increased or decreased their RTS. Tables E.13–E.15 give similar information for the 10 largest institutions (in terms of total assets) for significance levels .1, .05 and .01.

Tables E.16–E.24 show transition matrices for each of the 8 models estimated and giving the numbers of institutions facing IRS, CRS, or DRS in 2006.Q4 versus 2015.Q4.
<table>
<thead>
<tr>
<th>Model</th>
<th>LHS</th>
<th>Period</th>
<th>0.01</th>
<th>0.25</th>
<th>0.50</th>
<th>Mean</th>
<th>0.75</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$C_1/W_1$</td>
<td>1986.Q4</td>
<td>-0.0482</td>
<td>-0.0059</td>
<td>0.0060</td>
<td>0.0062</td>
<td>0.0180</td>
<td>0.0626</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.0842</td>
<td>-0.0160</td>
<td>0.0054</td>
<td>0.0047</td>
<td>0.0262</td>
<td>0.0895</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.0866</td>
<td>-0.0154</td>
<td>0.0059</td>
<td>0.0060</td>
<td>0.0273</td>
<td>0.0917</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1026</td>
<td>-0.0156</td>
<td>0.0117</td>
<td>0.0106</td>
<td>0.0388</td>
<td>0.1140</td>
</tr>
<tr>
<td>2</td>
<td>$C_2/W_1$</td>
<td>1986.Q4</td>
<td>-0.0505</td>
<td>-0.0069</td>
<td>0.0065</td>
<td>0.0066</td>
<td>0.0198</td>
<td>0.0667</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.0945</td>
<td>-0.0193</td>
<td>0.0046</td>
<td>0.0036</td>
<td>0.0275</td>
<td>0.0973</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.0960</td>
<td>-0.0172</td>
<td>0.0067</td>
<td>0.0059</td>
<td>0.0293</td>
<td>0.0966</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1089</td>
<td>-0.0155</td>
<td>0.0135</td>
<td>0.0120</td>
<td>0.0419</td>
<td>0.1181</td>
</tr>
<tr>
<td>3</td>
<td>$R_1$</td>
<td>1986.Q4</td>
<td>-0.1210</td>
<td>-0.0186</td>
<td>-0.0055</td>
<td>0.0050</td>
<td>0.0086</td>
<td>0.2587</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.0930</td>
<td>-0.0152</td>
<td>-0.0036</td>
<td>0.0058</td>
<td>0.0080</td>
<td>0.0820</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.1029</td>
<td>-0.0190</td>
<td>-0.0041</td>
<td>-0.0047</td>
<td>0.0007</td>
<td>0.0892</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.0933</td>
<td>-0.0217</td>
<td>-0.0064</td>
<td>-0.0058</td>
<td>0.0088</td>
<td>0.0893</td>
</tr>
<tr>
<td>4</td>
<td>$R_2$</td>
<td>1986.Q4</td>
<td>-0.1023</td>
<td>-0.0182</td>
<td>-0.0049</td>
<td>0.0018</td>
<td>0.0082</td>
<td>0.1343</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.1003</td>
<td>-0.0171</td>
<td>-0.0032</td>
<td>-0.0028</td>
<td>0.0108</td>
<td>0.0867</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.1073</td>
<td>-0.0212</td>
<td>-0.0043</td>
<td>-0.0021</td>
<td>0.0127</td>
<td>0.1011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1016</td>
<td>-0.0225</td>
<td>-0.0053</td>
<td>-0.0028</td>
<td>0.0114</td>
<td>0.1201</td>
</tr>
<tr>
<td>5</td>
<td>$\pi_1$</td>
<td>1986.Q4</td>
<td>-0.7191</td>
<td>-0.0357</td>
<td>-0.0011</td>
<td>0.0771</td>
<td>0.0405</td>
<td>1.0819</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.1329</td>
<td>-0.0193</td>
<td>0.0009</td>
<td>0.0163</td>
<td>0.0236</td>
<td>0.3351</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.1731</td>
<td>-0.0228</td>
<td>0.0028</td>
<td>0.0306</td>
<td>0.0301</td>
<td>0.5844</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1144</td>
<td>-0.0244</td>
<td>-0.0039</td>
<td>-0.0011</td>
<td>0.0170</td>
<td>0.1303</td>
</tr>
<tr>
<td>6</td>
<td>$\pi_2$</td>
<td>1986.Q4</td>
<td>-0.7718</td>
<td>-0.0365</td>
<td>0.0034</td>
<td>0.0456</td>
<td>0.0562</td>
<td>1.8145</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.1862</td>
<td>-0.0197</td>
<td>0.0047</td>
<td>0.0407</td>
<td>0.0314</td>
<td>0.7837</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.2652</td>
<td>-0.0203</td>
<td>0.0072</td>
<td>0.0764</td>
<td>0.0431</td>
<td>1.1727</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1420</td>
<td>-0.0212</td>
<td>0.0048</td>
<td>0.0158</td>
<td>0.0309</td>
<td>0.5001</td>
</tr>
<tr>
<td>7</td>
<td>$\pi_3$</td>
<td>1986.Q4</td>
<td>-0.1529</td>
<td>-0.0256</td>
<td>-0.0017</td>
<td>-0.0245</td>
<td>0.0246</td>
<td>0.3762</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.1117</td>
<td>-0.0198</td>
<td>0.0019</td>
<td>0.0134</td>
<td>0.0254</td>
<td>0.2419</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.1326</td>
<td>-0.0217</td>
<td>0.0044</td>
<td>0.0205</td>
<td>0.0324</td>
<td>0.3601</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1219</td>
<td>-0.0244</td>
<td>-0.0030</td>
<td>0.0002</td>
<td>0.0204</td>
<td>0.1666</td>
</tr>
<tr>
<td>8</td>
<td>$\pi_4$</td>
<td>1986.Q4</td>
<td>-0.2791</td>
<td>-0.0229</td>
<td>0.0026</td>
<td>0.0539</td>
<td>0.0346</td>
<td>1.0055</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>-0.1232</td>
<td>-0.0141</td>
<td>0.0059</td>
<td>0.0547</td>
<td>0.0278</td>
<td>0.6802</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>-0.1442</td>
<td>-0.0144</td>
<td>0.0089</td>
<td>0.0800</td>
<td>0.0366</td>
<td>0.9155</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>-0.1240</td>
<td>-0.0178</td>
<td>0.0056</td>
<td>0.0341</td>
<td>0.0313</td>
<td>0.4635</td>
</tr>
</tbody>
</table>
### Table E.2: Counts of Institutions Facing IRS, CRS, and DRS

<table>
<thead>
<tr>
<th>Model</th>
<th>LHS</th>
<th>Period</th>
<th>.1 signif.</th>
<th>.05 signif.</th>
<th>.01 signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IRS</td>
<td>CRS</td>
<td>DRS</td>
<td>IRS</td>
</tr>
<tr>
<td>1</td>
<td>C/W1</td>
<td>1986.Q4</td>
<td>4774 5477 74</td>
<td>3830 6445 50</td>
<td>2278 8019 28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>3076 4313 202</td>
<td>2465 4987 139</td>
<td>1453 6053 85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2697 3432 153</td>
<td>2209 3952 121</td>
<td>1406 4794 82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>2371 2275 192</td>
<td>2088 2590 160</td>
<td>1542 3183 113</td>
</tr>
<tr>
<td>2</td>
<td>C/W1</td>
<td>1986.Q4</td>
<td>4680 5567 78</td>
<td>3733 6539 53</td>
<td>2136 8157 32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>2929 4455 207</td>
<td>2302 5136 153</td>
<td>1307 6195 89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2657 3465 160</td>
<td>2184 3983 115</td>
<td>1377 4821 84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>2442 2215 181</td>
<td>2136 2558 144</td>
<td>1576 3170 92</td>
</tr>
<tr>
<td>3</td>
<td>R1</td>
<td>1986.Q4</td>
<td>2065 7462 798</td>
<td>1419 8240 666</td>
<td>672 9113 540</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>1725 5408 458</td>
<td>1197 6028 366</td>
<td>560 6757 274</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>1474 4231 577</td>
<td>1030 4781 471</td>
<td>517 5401 364</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>1195 2635 1008</td>
<td>957 2968 913</td>
<td>577 3475 786</td>
</tr>
<tr>
<td>4</td>
<td>R2</td>
<td>1986.Q4</td>
<td>2120 7380 825</td>
<td>1466 8177 682</td>
<td>720 9057 548</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>1811 5389 391</td>
<td>1300 5975 316</td>
<td>607 6745 239</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>1584 4213 485</td>
<td>1164 4707 411</td>
<td>551 5404 327</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>1286 2688 864</td>
<td>1038 3026 774</td>
<td>653 3507 678</td>
</tr>
<tr>
<td>5</td>
<td>π1</td>
<td>1986.Q4</td>
<td>2852 7198 275</td>
<td>1933 8160 232</td>
<td>817 9319 189</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>2354 4990 247</td>
<td>1727 5663 201</td>
<td>780 6649 162</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2102 3941 239</td>
<td>1699 4476 197</td>
<td>814 5318 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>1396 2785 657</td>
<td>1103 3147 588</td>
<td>643 3703 492</td>
</tr>
<tr>
<td>6</td>
<td>π2</td>
<td>1986.Q4</td>
<td>3371 6643 311</td>
<td>2504 7557 264</td>
<td>1248 8861 216</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>2838 4385 368</td>
<td>2177 5102 312</td>
<td>1220 6120 251</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2552 3446 284</td>
<td>2061 3982 239</td>
<td>1293 4785 204</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>1956 2326 556</td>
<td>1615 2721 502</td>
<td>1039 3359 440</td>
</tr>
<tr>
<td>7</td>
<td>π3</td>
<td>1986.Q4</td>
<td>2789 7119 417</td>
<td>1980 7989 356</td>
<td>930 9121 274</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>2473 4895 223</td>
<td>1823 5584 184</td>
<td>872 6568 151</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2257 3790 235</td>
<td>1736 4346 200</td>
<td>878 5246 158</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>1524 2738 576</td>
<td>1230 3096 512</td>
<td>759 3628 451</td>
</tr>
<tr>
<td>8</td>
<td>π4</td>
<td>1986.Q4</td>
<td>3452 6390 483</td>
<td>2699 7302 414</td>
<td>1429 8552 344</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>3076 4170 345</td>
<td>2422 4873 296</td>
<td>1402 5938 251</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>2834 3149 299</td>
<td>2352 3665 265</td>
<td>1498 4561 223</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>2110 2188 540</td>
<td>1803 2554 481</td>
<td>1216 3192 430</td>
</tr>
</tbody>
</table>
Table E.3: Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.1 signif.)

<table>
<thead>
<tr>
<th>Model</th>
<th>LHS</th>
<th>Period</th>
<th>1st quartile</th>
<th>2nd quartile</th>
<th>3rd quartile</th>
<th>4th quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>IRS</td>
<td>CRS</td>
<td>DRS</td>
<td>IRS</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1376</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>817</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>759</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>616</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1432</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>824</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>767</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>622</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>334</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>290</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>262</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>456</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>379</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>309</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>297</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>884</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>787</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>658</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>402</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1286</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1093</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>944</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>715</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>822</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>757</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>642</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>436</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>1986.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1264</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td></td>
<td></td>
<td></td>
<td>1117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td></td>
<td></td>
<td></td>
<td>960</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td></td>
<td></td>
<td></td>
<td>739</td>
</tr>
<tr>
<td>Model</td>
<td>LHS</td>
<td>Period</td>
<td>1st quartile</td>
<td>2nd quartile</td>
<td>3rd quartile</td>
<td>4th quartile</td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
<td>---------</td>
<td>--------------</td>
<td>--------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IRS</td>
<td>CRS</td>
<td>DRS</td>
<td>IRS</td>
</tr>
<tr>
<td>1</td>
<td>C₁ / W₁</td>
<td>1986.Q4</td>
<td>1138</td>
<td>1439</td>
<td>5</td>
<td>734</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>669</td>
<td>1211</td>
<td>18</td>
<td>524</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>630</td>
<td>932</td>
<td>9</td>
<td>526</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>528</td>
<td>662</td>
<td>20</td>
<td>481</td>
</tr>
<tr>
<td>2</td>
<td>C₂ / W₁</td>
<td>1986.Q4</td>
<td>1189</td>
<td>1390</td>
<td>3</td>
<td>757</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>644</td>
<td>1233</td>
<td>21</td>
<td>529</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>637</td>
<td>925</td>
<td>9</td>
<td>533</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>544</td>
<td>645</td>
<td>21</td>
<td>509</td>
</tr>
<tr>
<td>3</td>
<td>R₁</td>
<td>1986.Q4</td>
<td>287</td>
<td>2142</td>
<td>153</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>245</td>
<td>1549</td>
<td>104</td>
<td>291</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>201</td>
<td>1226</td>
<td>144</td>
<td>249</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>204</td>
<td>822</td>
<td>184</td>
<td>229</td>
</tr>
<tr>
<td>4</td>
<td>R₂</td>
<td>1986.Q4</td>
<td>318</td>
<td>2095</td>
<td>169</td>
<td>344</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>270</td>
<td>1546</td>
<td>82</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>227</td>
<td>1220</td>
<td>124</td>
<td>292</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>235</td>
<td>830</td>
<td>145</td>
<td>260</td>
</tr>
<tr>
<td>5</td>
<td>π₁</td>
<td>1986.Q4</td>
<td>637</td>
<td>1914</td>
<td>31</td>
<td>463</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>620</td>
<td>1252</td>
<td>26</td>
<td>444</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>528</td>
<td>1024</td>
<td>19</td>
<td>416</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>327</td>
<td>827</td>
<td>56</td>
<td>269</td>
</tr>
<tr>
<td>6</td>
<td>π₂</td>
<td>1986.Q4</td>
<td>1032</td>
<td>1530</td>
<td>20</td>
<td>720</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>919</td>
<td>958</td>
<td>21</td>
<td>635</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>815</td>
<td>745</td>
<td>11</td>
<td>620</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>609</td>
<td>582</td>
<td>19</td>
<td>476</td>
</tr>
<tr>
<td>7</td>
<td>π₃</td>
<td>1986.Q4</td>
<td>591</td>
<td>1947</td>
<td>44</td>
<td>474</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>583</td>
<td>1285</td>
<td>30</td>
<td>469</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>496</td>
<td>1053</td>
<td>22</td>
<td>473</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>356</td>
<td>803</td>
<td>51</td>
<td>302</td>
</tr>
<tr>
<td>8</td>
<td>π₄</td>
<td>1986.Q4</td>
<td>1020</td>
<td>1534</td>
<td>28</td>
<td>712</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>956</td>
<td>916</td>
<td>26</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>836</td>
<td>719</td>
<td>16</td>
<td>728</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>655</td>
<td>537</td>
<td>18</td>
<td>536</td>
</tr>
</tbody>
</table>
Table E.5: Counts of Institutions Facing IRS, CRS, and DRS by Size Quartile (.01 signif.)

<table>
<thead>
<tr>
<th>Model</th>
<th>LHS</th>
<th>Period</th>
<th>1st quartile</th>
<th>2nd quartile</th>
<th>3rd quartile</th>
<th>4th quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>IRS CRS DRS</td>
<td>IRS CRS DRS</td>
<td>IRS CRS DRS</td>
<td>IRS CRS DRS</td>
</tr>
<tr>
<td>1</td>
<td>C1/WI</td>
<td>1986.Q4</td>
<td>712 1868 2</td>
<td>375 2202 4</td>
<td>411 2164 6</td>
<td>780 1785 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>381 1508 9</td>
<td>273 1619 6</td>
<td>282 1599 16</td>
<td>517 1327 54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>411 1154 6</td>
<td>326 1238 6</td>
<td>243 1319 8</td>
<td>426 1083 62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>372 827 11</td>
<td>340 848 21</td>
<td>333 852 24</td>
<td>497 656 57</td>
</tr>
<tr>
<td>2</td>
<td>C2/WI</td>
<td>1986.Q4</td>
<td>754 1825 3</td>
<td>349 2230 2</td>
<td>363 2114 4</td>
<td>670 1888 23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>364 1523 11</td>
<td>258 1632 8</td>
<td>260 1616 21</td>
<td>425 1424 49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>424 1143 4</td>
<td>328 1234 8</td>
<td>249 1313 8</td>
<td>376 1131 64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>387 811 12</td>
<td>366 829 14</td>
<td>342 852 15</td>
<td>481 678 51</td>
</tr>
<tr>
<td>3</td>
<td>R1</td>
<td>1986.Q4</td>
<td>148 2314 120</td>
<td>145 2378 58</td>
<td>169 2372 40</td>
<td>210 2049 322</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>106 1721 71</td>
<td>129 1747 22</td>
<td>125 1752 20</td>
<td>200 1537 161</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>98 1367 106</td>
<td>112 1413 45</td>
<td>127 1416 27</td>
<td>180 1205 186</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>128 937 145</td>
<td>109 954 146</td>
<td>174 939 96</td>
<td>166 645 399</td>
</tr>
<tr>
<td>4</td>
<td>R2</td>
<td>1986.Q4</td>
<td>169 2288 125</td>
<td>149 2368 64</td>
<td>173 2351 57</td>
<td>229 2050 302</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>117 1718 63</td>
<td>135 1746 17</td>
<td>143 1732 22</td>
<td>212 1549 137</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>102 1374 95</td>
<td>123 1409 38</td>
<td>140 1398 32</td>
<td>186 1223 162</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>151 938 121</td>
<td>140 950 119</td>
<td>181 936 92</td>
<td>181 683 346</td>
</tr>
<tr>
<td>5</td>
<td>π1</td>
<td>1986.Q4</td>
<td>297 2264 21</td>
<td>187 2380 14</td>
<td>153 2147 11</td>
<td>180 2258 143</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>303 1573 22</td>
<td>198 1690 10</td>
<td>144 1746 7</td>
<td>135 1640 123</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>309 1246 16</td>
<td>196 1370 4</td>
<td>163 1395 12</td>
<td>146 1307 118</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>213 964 33</td>
<td>133 1021 55</td>
<td>163 993 53</td>
<td>134 725 351</td>
</tr>
<tr>
<td>6</td>
<td>π2</td>
<td>1986.Q4</td>
<td>623 1945 14</td>
<td>324 2247 10</td>
<td>180 2394 7</td>
<td>121 2275 185</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>617 1264 17</td>
<td>343 1550 5</td>
<td>158 1733 6</td>
<td>102 1573 223</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>570 993 8</td>
<td>378 1189 3</td>
<td>245 1315 10</td>
<td>100 1288 183</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>429 766 15</td>
<td>296 888 25</td>
<td>224 952 33</td>
<td>90 753 367</td>
</tr>
<tr>
<td>7</td>
<td>π3</td>
<td>1986.Q4</td>
<td>291 2259 32</td>
<td>196 2364 21</td>
<td>201 2356 24</td>
<td>242 2142 197</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>312 1561 25</td>
<td>191 1698 9</td>
<td>172 1719 6</td>
<td>197 1590 111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>272 1282 17</td>
<td>231 1330 9</td>
<td>175 1383 12</td>
<td>200 1251 120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>244 928 38</td>
<td>165 994 50</td>
<td>193 961 55</td>
<td>157 745 308</td>
</tr>
<tr>
<td>8</td>
<td>π4</td>
<td>1986.Q4</td>
<td>623 1936 23</td>
<td>367 2197 17</td>
<td>236 2331 14</td>
<td>203 2088 290</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1996.Q4</td>
<td>648 1228 22</td>
<td>394 1497 7</td>
<td>209 1681 7</td>
<td>151 1532 215</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006.Q4</td>
<td>614 948 9</td>
<td>461 1107 2</td>
<td>284 1276 10</td>
<td>139 1230 202</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015.Q4</td>
<td>477 720 13</td>
<td>361 820 28</td>
<td>276 899 34</td>
<td>102 753 355</td>
</tr>
</tbody>
</table>
Table E.6: Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CITIBANK</td>
<td>275</td>
<td>1.0371***</td>
<td>1.0405***</td>
<td>1.0147***</td>
<td>1.0251***</td>
<td>0.9834***</td>
<td>0.9760***</td>
<td>1.0205***</td>
<td>0.9982***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>204</td>
<td>1.0928***</td>
<td>1.0956</td>
<td>1.0558***</td>
<td>1.0481***</td>
<td>1.1622</td>
<td>1.2975(3)</td>
<td>1.0466***</td>
<td>1.0339***</td>
</tr>
<tr>
<td>CHASE MHTN BK</td>
<td>150</td>
<td>1.0618***</td>
<td>1.0595**</td>
<td>1.0820</td>
<td>1.0892</td>
<td>1.0616</td>
<td>1.0513</td>
<td>1.1124</td>
<td>1.0779**</td>
</tr>
<tr>
<td>MANU HAN</td>
<td>139</td>
<td>1.0855***</td>
<td>1.0870**</td>
<td>1.0686**</td>
<td>1.0570**</td>
<td>1.1819</td>
<td>1.1124</td>
<td>1.0611**</td>
<td>1.0459**</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>130</td>
<td>1.0306***</td>
<td>1.0269*</td>
<td>1.0381***</td>
<td>1.0598***</td>
<td>1.0603</td>
<td>1.0498</td>
<td>1.0994</td>
<td>1.0347**</td>
</tr>
<tr>
<td>SECURITY PACIFIC</td>
<td>113</td>
<td>1.0982</td>
<td>1.1066</td>
<td>1.0593***</td>
<td>1.0542***</td>
<td>1.0774</td>
<td>1.0697</td>
<td>1.0376**</td>
<td>1.0315**</td>
</tr>
<tr>
<td>CHEMICAL NY</td>
<td>109</td>
<td>1.0923***</td>
<td>1.0927***</td>
<td>1.0574***</td>
<td>1.0613***</td>
<td>1.0995</td>
<td>1.1203</td>
<td>1.0577</td>
<td>1.0587**</td>
</tr>
<tr>
<td>BANKERS TR NY</td>
<td>100</td>
<td>1.0961***</td>
<td>1.0422**</td>
<td>1.0354**</td>
<td>1.0409**</td>
<td>1.0542**</td>
<td>1.0433</td>
<td>1.0699**</td>
<td>1.0496**</td>
</tr>
<tr>
<td>FIRST INTRST DC</td>
<td>100</td>
<td>1.0883</td>
<td>1.0904</td>
<td>1.0705**</td>
<td>1.0675**</td>
<td>1.0586</td>
<td>0.9843</td>
<td>1.0484**</td>
<td>1.0084**</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>81</td>
<td>1.0897</td>
<td>1.0920</td>
<td>1.0488**</td>
<td>1.0463**</td>
<td>1.0622</td>
<td>1.0662</td>
<td>1.0405**</td>
<td>1.0417**</td>
</tr>
<tr>
<td>FIRST</td>
<td>74</td>
<td>1.0796***</td>
<td>1.0869**</td>
<td>1.0415***</td>
<td>1.0392***</td>
<td>1.0946</td>
<td>1.0494</td>
<td>1.0825**</td>
<td>1.0619**</td>
</tr>
<tr>
<td>BK OF BOSTON</td>
<td>62</td>
<td>1.0662***</td>
<td>1.0716**</td>
<td>1.0799***</td>
<td>1.0870***</td>
<td>1.1007</td>
<td>0.9894</td>
<td>1.1076</td>
<td>1.0370**</td>
</tr>
<tr>
<td>CONTINENTAL IL NB &amp; TC C</td>
<td>56</td>
<td>1.0571***</td>
<td>1.0505**</td>
<td>1.0637</td>
<td>1.0755</td>
<td>1.2408</td>
<td>1.0085</td>
<td>1.2889***</td>
<td>1.0601***</td>
</tr>
<tr>
<td>FIRST BK SY</td>
<td>51</td>
<td>1.0815***</td>
<td>1.0892**</td>
<td>1.0862**</td>
<td>1.0963***</td>
<td>1.1041</td>
<td>1.0630</td>
<td>1.1129</td>
<td>1.0593**</td>
</tr>
<tr>
<td>NCBF</td>
<td>49</td>
<td>1.1071</td>
<td>1.1153</td>
<td>1.0742**</td>
<td>1.0748**</td>
<td>1.0461***</td>
<td>1.0272**</td>
<td>1.0422**</td>
<td>1.0334**</td>
</tr>
<tr>
<td>MELLON BK</td>
<td>46</td>
<td>1.0816***</td>
<td>1.0847**</td>
<td>1.0477**</td>
<td>1.0715**</td>
<td>1.0663</td>
<td>0.9056</td>
<td>1.0865</td>
<td>1.0517**</td>
</tr>
<tr>
<td>FIRST UNION</td>
<td>45</td>
<td>1.0827</td>
<td>1.0924</td>
<td>1.0372***</td>
<td>1.0409***</td>
<td>1.0872</td>
<td>1.0282**</td>
<td>1.1041</td>
<td>1.0622**</td>
</tr>
<tr>
<td>PNC FCCL</td>
<td>45</td>
<td>1.0948</td>
<td>1.1083</td>
<td>1.0401***</td>
<td>1.0472**</td>
<td>1.0750</td>
<td>1.0318***</td>
<td>1.1090</td>
<td>1.0529**</td>
</tr>
<tr>
<td>IRVING BK</td>
<td>44</td>
<td>1.0803***</td>
<td>1.0806**</td>
<td>1.0600***</td>
<td>1.0731***</td>
<td>1.1016</td>
<td>0.9462***</td>
<td>1.1295</td>
<td>1.0295***</td>
</tr>
<tr>
<td>SUNTRUST BANKS</td>
<td>43</td>
<td>1.0743***</td>
<td>1.0676***</td>
<td>1.0309***</td>
<td>1.0333***</td>
<td>1.0701</td>
<td>1.0484</td>
<td>1.0821**</td>
<td>1.0644**</td>
</tr>
<tr>
<td>MCO</td>
<td>42</td>
<td>1.0528**</td>
<td>1.0736**</td>
<td>1.0031***</td>
<td>1.0507***</td>
<td>0.7969(3)</td>
<td>1.0856(3)</td>
<td>1.0764</td>
<td>1.0227**</td>
</tr>
<tr>
<td>MARINE MIDLAND BANK</td>
<td>41</td>
<td>1.0776***</td>
<td>1.0731***</td>
<td>1.0090***</td>
<td>1.0834***</td>
<td>1.1785***</td>
<td>1.2700</td>
<td>1.0843***</td>
<td>1.0449**</td>
</tr>
<tr>
<td>REPUBLIC BANK ORATION</td>
<td>40</td>
<td>1.0587***</td>
<td>1.0521***</td>
<td>1.0979</td>
<td>1.0943</td>
<td>1.2439</td>
<td>-1.4827(2)</td>
<td>1.0936</td>
<td>1.0142**</td>
</tr>
<tr>
<td>BK OF NEW ENGLAND</td>
<td>40</td>
<td>1.1036</td>
<td>1.1157</td>
<td>1.0779***</td>
<td>1.0856***</td>
<td>1.0540***</td>
<td>1.0217***</td>
<td>1.0707</td>
<td>1.0447**</td>
</tr>
<tr>
<td>NBDBANCORP INC</td>
<td>39</td>
<td>1.1078</td>
<td>1.1015</td>
<td>1.0699***</td>
<td>1.0992***</td>
<td>1.0790***</td>
<td>1.0370***</td>
<td>1.0872</td>
<td>1.0675**</td>
</tr>
</tbody>
</table>

Dep Var. | $C_1/W_1$ (y, w) | $C_2/W_1$ (y, w) | $R_1$ (y, w) | $R_2$ (y, w) | $R_1 - C_1$ (y, w) | $R_2 - C_2$ (y, w) |
RHS Vars. | $y$ | $w$ |

**NOTE:** For Models 1–2, estimates of $(1 - \varepsilon_C)\delta$ are reported ($\delta = 1.1$). For Models 3–4 and Models 5–8, estimates of $(1 + \varepsilon_C)\delta$ and $(1 + \varepsilon_C)\delta$ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table E.6: Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORWEST</td>
<td>38</td>
<td>1.0749***</td>
<td>1.0690***</td>
<td>1.0698***</td>
<td>1.0766***</td>
<td>1.1433</td>
<td>0.9912</td>
<td>1.1069</td>
<td>1.0477***</td>
</tr>
<tr>
<td>BK OF NY CO</td>
<td>37</td>
<td>1.064**</td>
<td>1.0699***</td>
<td>1.0690***</td>
<td>1.0745***</td>
<td>1.0751</td>
<td>1.0300</td>
<td>1.0962</td>
<td>1.0402***</td>
</tr>
<tr>
<td>TEXAS CMBC BSHRS</td>
<td>36</td>
<td>1.0747***</td>
<td>1.0819***</td>
<td>1.0405***</td>
<td>1.0694***</td>
<td>0.8976</td>
<td>1.0006(3)</td>
<td>1.0976</td>
<td>0.9913**</td>
</tr>
<tr>
<td>CITIZENS &amp; SOUTHERN</td>
<td>34</td>
<td>1.084***</td>
<td>1.0875***</td>
<td>1.0587***</td>
<td>1.0631***</td>
<td>1.0486***</td>
<td>1.0024***</td>
<td>1.0763**</td>
<td>1.038***</td>
</tr>
<tr>
<td>BARNETT BK OF FL</td>
<td>34</td>
<td>1.1076</td>
<td>1.1138</td>
<td>0.9959***</td>
<td>0.9931***</td>
<td>0.9930***</td>
<td>0.9964***</td>
<td>0.9955**</td>
<td>0.9929**</td>
</tr>
<tr>
<td>INTERFIRST ORATION</td>
<td>34</td>
<td>1.0707***</td>
<td>1.0793***</td>
<td>1.0427***</td>
<td>1.0708***</td>
<td>1.1122(3)</td>
<td>1.1306(3)</td>
<td>1.1232</td>
<td>1.0534***</td>
</tr>
<tr>
<td>FIRST WACHOVIA</td>
<td>34</td>
<td>1.0929***</td>
<td>1.0892***</td>
<td>1.0517***</td>
<td>1.0569***</td>
<td>1.0262***</td>
<td>0.9892***</td>
<td>1.0162***</td>
<td>1.0084***</td>
</tr>
<tr>
<td>REPUBLIC NB OF NY</td>
<td>31</td>
<td>1.0339***</td>
<td>1.0343***</td>
<td>1.0242***</td>
<td>1.0478***</td>
<td>1.1062***</td>
<td>0.9667***</td>
<td>1.0710***</td>
<td>0.9689***</td>
</tr>
<tr>
<td>FIRST FIDELITY BC</td>
<td>27</td>
<td>1.1232</td>
<td>1.1284</td>
<td>1.0663***</td>
<td>1.0623***</td>
<td>1.0387***</td>
<td>0.9965***</td>
<td>1.0357***</td>
<td>1.0112***</td>
</tr>
<tr>
<td>SOVRAN</td>
<td>27</td>
<td>1.0748***</td>
<td>1.0731***</td>
<td>1.0679***</td>
<td>1.0778***</td>
<td>1.1022***</td>
<td>1.1017***</td>
<td>1.0326**</td>
<td>1.0633***</td>
</tr>
<tr>
<td>BANC ONE</td>
<td>27</td>
<td>1.0919**</td>
<td>1.0968***</td>
<td>1.0417***</td>
<td>1.0597***</td>
<td>1.0789***</td>
<td>0.9947</td>
<td>1.0912</td>
<td>1.0265***</td>
</tr>
<tr>
<td>MIDLANTIC BK</td>
<td>27</td>
<td>1.0949</td>
<td>1.0852***</td>
<td>1.0537***</td>
<td>1.0622***</td>
<td>1.0799***</td>
<td>1.0633</td>
<td>1.0860***</td>
<td>1.0486***</td>
</tr>
<tr>
<td>FIRST CITY BANCORPORATION T</td>
<td>26</td>
<td>1.0856***</td>
<td>1.0929</td>
<td>1.0689***</td>
<td>1.0801***</td>
<td>1.2113(3)**</td>
<td>1.1569**</td>
<td>1.0833***</td>
<td>1.0942***</td>
</tr>
<tr>
<td>NATIONAL CITY</td>
<td>25</td>
<td>1.0643***</td>
<td>1.0640***</td>
<td>1.0723***</td>
<td>1.0799***</td>
<td>1.0581***</td>
<td>0.9925***</td>
<td>1.0604***</td>
<td>1.0244***</td>
</tr>
<tr>
<td>CORESTATES FNCL</td>
<td>25</td>
<td>1.0876**</td>
<td>1.0875***</td>
<td>1.0444***</td>
<td>1.0487***</td>
<td>1.0761***</td>
<td>1.0690</td>
<td>1.0817***</td>
<td>1.0591***</td>
</tr>
<tr>
<td>HARTFORD T</td>
<td>23</td>
<td>1.1024</td>
<td>1.1081</td>
<td>0.9883***</td>
<td>0.9968***</td>
<td>0.9855***</td>
<td>0.9859***</td>
<td>0.9824***</td>
<td>0.9932***</td>
</tr>
<tr>
<td>BOATMENS BSHRS</td>
<td>23</td>
<td>1.0888***</td>
<td>1.0857***</td>
<td>1.0450***</td>
<td>1.0464***</td>
<td>1.0617***</td>
<td>1.0567</td>
<td>1.0623***</td>
<td>1.0447***</td>
</tr>
<tr>
<td>SOUTHEAST BKG</td>
<td>22</td>
<td>1.1248</td>
<td>1.1283</td>
<td>1.0602***</td>
<td>1.0770***</td>
<td>1.0618***</td>
<td>0.9751***</td>
<td>1.0955</td>
<td>1.0190***</td>
</tr>
<tr>
<td>Fleet FNCL GROUP</td>
<td>21</td>
<td>1.0865***</td>
<td>1.0913***</td>
<td>1.1303***</td>
<td>1.1107***</td>
<td>1.1098***</td>
<td>1.0303</td>
<td>1.0816</td>
<td>1.0473***</td>
</tr>
<tr>
<td>NATIONAL WESTMINSTER BANK USA</td>
<td>20</td>
<td>1.0296***</td>
<td>1.0321***</td>
<td>1.0268***</td>
<td>1.0564***</td>
<td>1.0917***</td>
<td>0.9417***</td>
<td>0.8855***</td>
<td>0.9859***</td>
</tr>
<tr>
<td>VALLEY T</td>
<td>20</td>
<td>1.0599***</td>
<td>1.0559</td>
<td>1.0846**</td>
<td>1.1051***</td>
<td>1.0491***</td>
<td>0.7828</td>
<td>1.0801</td>
<td>1.0355***</td>
</tr>
<tr>
<td>FIDELCOR</td>
<td>19</td>
<td>1.0455***</td>
<td>1.0486***</td>
<td>1.0195***</td>
<td>1.0171***</td>
<td>1.0179***</td>
<td>1.0199***</td>
<td>0.9941***</td>
<td>1.0057***</td>
</tr>
<tr>
<td>AMERITRUST</td>
<td>19</td>
<td>1.0732***</td>
<td>1.0764***</td>
<td>1.0914***</td>
<td>1.1084***</td>
<td>1.1137 ***</td>
<td>1.0848</td>
<td>1.1539***</td>
<td>1.0756***</td>
</tr>
<tr>
<td>SHAWMUT</td>
<td>19</td>
<td>1.0905***</td>
<td>1.0911***</td>
<td>1.0632***</td>
<td>1.0449***</td>
<td>1.0888***</td>
<td>1.0603</td>
<td>1.0877</td>
<td>1.0833***</td>
</tr>
<tr>
<td>ALLIED BANCSHARES</td>
<td>18</td>
<td>1.0769***</td>
<td>1.0879***</td>
<td>1.0791***</td>
<td>1.0657***</td>
<td>0.6345</td>
<td>1.0846(3)</td>
<td>1.0877</td>
<td>0.9945***</td>
</tr>
</tbody>
</table>

**NOTE:** For Models 1–2, estimates of \((1 - \varepsilon_{C_2})\) are reported (\(\delta = 1.1\)). For Models 3–4 and Models 5–8, estimates of \((1 + \varepsilon_{C_2})\) and \((1 + \varepsilon_{C_1})\) are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table E.6: Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMERICA INC</td>
<td>18</td>
<td>1.1068</td>
<td>1.1031</td>
<td>1.0791**</td>
<td>1.0926</td>
<td>1.0847</td>
<td>1.0242*</td>
<td>1.1204***</td>
<td>1.0575*</td>
</tr>
<tr>
<td>CITIBANK SOUTH DAKOTA</td>
<td>18</td>
<td>1.0483***</td>
<td>1.0616***</td>
<td>0.9883***</td>
<td>0.9934***</td>
<td>0.9216***</td>
<td>0.7559</td>
<td>0.9728***</td>
<td>0.9380***</td>
</tr>
<tr>
<td>SIGNET BKG</td>
<td>17</td>
<td>1.0617***</td>
<td>1.0561***</td>
<td>1.0714***</td>
<td>1.0693**</td>
<td>1.0713</td>
<td>1.0268</td>
<td>1.0962</td>
<td>1.0613</td>
</tr>
<tr>
<td>UNION BK</td>
<td>17</td>
<td>1.0836***</td>
<td>1.0961</td>
<td>1.0666**</td>
<td>1.0855</td>
<td>1.0227</td>
<td>0.9265</td>
<td>1.0967</td>
<td>1.0296***</td>
</tr>
<tr>
<td>U.S. BC</td>
<td>17</td>
<td>1.0971*</td>
<td>1.0944**</td>
<td>1.0978</td>
<td>1.1129**</td>
<td>1.0392</td>
<td>1.0934</td>
<td>1.0451***</td>
<td>1.0954</td>
</tr>
<tr>
<td>MARYLAND T</td>
<td>17</td>
<td>1.0848</td>
<td>1.0913</td>
<td>1.0940***</td>
<td>1.0925</td>
<td>1.1256</td>
<td>1.0916</td>
<td>1.1227**</td>
<td>1.0970</td>
</tr>
<tr>
<td>SOCIETY</td>
<td>17</td>
<td>1.1082</td>
<td>1.1086</td>
<td>1.0754**</td>
<td>1.0809</td>
<td>1.0937</td>
<td>0.9958**</td>
<td>1.1167**</td>
<td>1.1336**</td>
</tr>
<tr>
<td>UNITED VA BSHRS</td>
<td>17</td>
<td>1.0766***</td>
<td>1.0727***</td>
<td>1.0801***</td>
<td>1.0771**</td>
<td>1.0461***</td>
<td>0.9581***</td>
<td>1.0441***</td>
<td>0.9883***</td>
</tr>
<tr>
<td>NORTHERN TR</td>
<td>16</td>
<td>1.0463***</td>
<td>1.0424***</td>
<td>1.0452**</td>
<td>1.0526**</td>
<td>1.0563**</td>
<td>1.0461***</td>
<td>1.0799</td>
<td>1.0600</td>
</tr>
<tr>
<td>KEYCORP</td>
<td>16</td>
<td>1.1305</td>
<td>1.1304</td>
<td>1.0640**</td>
<td>1.0685**</td>
<td>1.0840</td>
<td>1.0206**</td>
<td>1.0724***</td>
<td>1.0722***</td>
</tr>
<tr>
<td>HARRIS T&amp;SB</td>
<td>15</td>
<td>1.0396***</td>
<td>1.0596***</td>
<td>1.0319**</td>
<td>1.0401**</td>
<td>1.0281**</td>
<td>1.0007**</td>
<td>1.0407***</td>
<td>1.0225***</td>
</tr>
<tr>
<td>RAINIER NB</td>
<td>15</td>
<td>1.0796***</td>
<td>1.0854***</td>
<td>1.1013</td>
<td>1.1062</td>
<td>1.1474*</td>
<td>1.1653</td>
<td>1.1295***</td>
<td>1.1049</td>
</tr>
<tr>
<td>MICHIGAN T</td>
<td>15</td>
<td>1.0730***</td>
<td>1.0830**</td>
<td>1.1082</td>
<td>1.1015</td>
<td>1.1296*</td>
<td>1.0590</td>
<td>1.1409***</td>
<td>1.0646***</td>
</tr>
<tr>
<td>MANUFACTURERS TIONAL .</td>
<td>14</td>
<td>1.0356***</td>
<td>1.0405**</td>
<td>1.0674**</td>
<td>1.0757**</td>
<td>1.0707</td>
<td>1.0685</td>
<td>1.0863</td>
<td>1.0840</td>
</tr>
<tr>
<td>BAYBANKS</td>
<td>14</td>
<td>1.1452</td>
<td>1.1440</td>
<td>1.0588**</td>
<td>1.0577**</td>
<td>1.0948</td>
<td>1.0295**</td>
<td>1.0974</td>
<td>1.0142**</td>
</tr>
<tr>
<td>HUNTINGTON BSHRS</td>
<td>14</td>
<td>1.0789***</td>
<td>1.0917**</td>
<td>1.0734**</td>
<td>1.0803</td>
<td>1.0682</td>
<td>1.0350</td>
<td>1.0743</td>
<td>1.0643***</td>
</tr>
<tr>
<td>UNITED JERSEY BANKS</td>
<td>13</td>
<td>1.0697***</td>
<td>1.0841**</td>
<td>1.0686**</td>
<td>1.0729**</td>
<td>1.1179</td>
<td>1.1069</td>
<td>1.1110</td>
<td>1.0803***</td>
</tr>
<tr>
<td>FLORIDA NB OF FL</td>
<td>13</td>
<td>1.0585***</td>
<td>1.0673**</td>
<td>1.0419**</td>
<td>1.0462**</td>
<td>1.0013**</td>
<td>0.3775**</td>
<td>1.0200***</td>
<td>0.9844***</td>
</tr>
<tr>
<td>EUROPEAN AMER BC</td>
<td>13</td>
<td>1.1112</td>
<td>1.1222</td>
<td>1.0487**</td>
<td>1.0399**</td>
<td>0.7176**</td>
<td>0.4863**</td>
<td>0.4906***</td>
<td>0.9571***</td>
</tr>
<tr>
<td>STATE STREET BOSTON</td>
<td>12</td>
<td>1.0399**</td>
<td>1.0449**</td>
<td>1.0602**</td>
<td>1.0631**</td>
<td>1.0539**</td>
<td>1.0382**</td>
<td>1.0407***</td>
<td>1.0445**</td>
</tr>
<tr>
<td>MERIDIAN BC</td>
<td>12</td>
<td>1.0938**</td>
<td>1.0993</td>
<td>1.0066**</td>
<td>1.0119**</td>
<td>1.0144**</td>
<td>0.9963**</td>
<td>1.0210**</td>
<td>0.9996**</td>
</tr>
<tr>
<td>MERCANTILE BANCORPORATION</td>
<td>12</td>
<td>1.0757***</td>
<td>1.0753**</td>
<td>1.0909</td>
<td>1.0766**</td>
<td>1.0513</td>
<td>0.9414</td>
<td>1.0399***</td>
<td>1.0354***</td>
</tr>
<tr>
<td>TEXAS AMERICAN BANCHARES INC.</td>
<td>11</td>
<td>1.0974</td>
<td>1.1450</td>
<td>1.0612**</td>
<td>1.0709**</td>
<td>0.7144</td>
<td>1.0556**</td>
<td>1.0301***</td>
<td>0.4288**(3)</td>
</tr>
<tr>
<td>RIGGS T</td>
<td>11</td>
<td>1.0803***</td>
<td>1.0789**</td>
<td>1.0438**</td>
<td>1.0652**</td>
<td>1.0490**</td>
<td>1.0829**</td>
<td>1.0809</td>
<td>1.0323**</td>
</tr>
<tr>
<td>BK OF TOKYO TC</td>
<td>11</td>
<td>1.0459***</td>
<td>1.0455**</td>
<td>1.0919**</td>
<td>1.0352**</td>
<td>1.2171**</td>
<td>1.0423**</td>
<td>1.1024</td>
<td>1.0359**</td>
</tr>
</tbody>
</table>

**NOTE:** For Models 1-2, estimates of \((1 - \varepsilon_D)\delta\) are reported (\(d = 1.1\)). For Models 3-4 and Models 5-8, estimates of \((1 + \varepsilon_D)\delta\) and \((1 + \varepsilon_S)\delta\) are given. For Models 1-2, values less than 1.1 indicate increasing returns to scale, while for Models 3-8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.6: Returns to Scale for 100 Largest Banks by Total Assets, 1986.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALIFORNIA FIRST BK</td>
<td>11</td>
<td>1.1202***</td>
<td>1.1144***</td>
<td>1.0490***</td>
<td>1.0784***</td>
<td>0.9597***</td>
<td>-6.7887***</td>
<td>(3)</td>
<td>1.0795***</td>
</tr>
<tr>
<td>FIRST PENNSYLVANIA ORATION</td>
<td>11</td>
<td>1.0597***</td>
<td>1.0624***</td>
<td>1.0476***</td>
<td>1.0670***</td>
<td>1.0201***</td>
<td>1.0146***</td>
<td>1.0462***</td>
<td>1.0073***</td>
</tr>
<tr>
<td>AMSOUTH BC</td>
<td>11</td>
<td>1.0859***</td>
<td>1.1002***</td>
<td>1.0416***</td>
<td>1.0296***</td>
<td>1.0316***</td>
<td>1.0298***</td>
<td>1.0844***</td>
<td>1.0165***</td>
</tr>
<tr>
<td>DOMINION BSHRS</td>
<td>11</td>
<td>1.1229***</td>
<td>1.1302***</td>
<td>1.0849***</td>
<td>1.0860***</td>
<td>1.0387***</td>
<td>1.0664***</td>
<td>1.0753***</td>
<td>1.0719***</td>
</tr>
<tr>
<td>FIRST AMER</td>
<td>11</td>
<td>1.1165***</td>
<td>1.1167***</td>
<td>0.9547***</td>
<td>0.9566***</td>
<td>0.7152***</td>
<td>0.6247***</td>
<td>0.7580***</td>
<td>0.7951***</td>
</tr>
<tr>
<td>FIRST TENNESSEE T</td>
<td>10</td>
<td>1.0705***</td>
<td>1.0696***</td>
<td>1.0599***</td>
<td>1.0489***</td>
<td>1.0343***</td>
<td>1.0420***</td>
<td>1.0469***</td>
<td>1.0975***</td>
</tr>
<tr>
<td>MARSHALL &amp; MILSLEY</td>
<td>10</td>
<td>1.0454***</td>
<td>1.0443***</td>
<td>1.0503***</td>
<td>1.0647***</td>
<td>1.0680***</td>
<td>1.0599***</td>
<td>1.0892***</td>
<td>1.0679***</td>
</tr>
<tr>
<td>OLD KENT</td>
<td>10</td>
<td>1.0569***</td>
<td>1.0651***</td>
<td>1.0484***</td>
<td>1.0515***</td>
<td>1.0481***</td>
<td>1.0367***</td>
<td>1.0580***</td>
<td>1.0286***</td>
</tr>
<tr>
<td>CENTERE BANCORPORATION</td>
<td>10</td>
<td>1.0596***</td>
<td>1.0519***</td>
<td>1.0872***</td>
<td>1.0944***</td>
<td>1.0836***</td>
<td>0.8734***</td>
<td>1.1269***</td>
<td>1.0608***</td>
</tr>
<tr>
<td>CITHANK NY ST</td>
<td>10</td>
<td>1.0951***</td>
<td>1.1011***</td>
<td>1.0676***</td>
<td>1.0774***</td>
<td>1.0316***</td>
<td>0.6968***</td>
<td>1.0846***</td>
<td>1.0232***</td>
</tr>
<tr>
<td>CONTINENTAL BC</td>
<td>10</td>
<td>1.0472***</td>
<td>1.0222***</td>
<td>1.0800***</td>
<td>1.0690***</td>
<td>1.2140***</td>
<td>17.3225</td>
<td>1.0814***</td>
<td>1.1284***</td>
</tr>
<tr>
<td>MELLON BK EAST</td>
<td>10</td>
<td>1.1097***</td>
<td>1.1146***</td>
<td>1.0615***</td>
<td>1.0438***</td>
<td>1.0513***</td>
<td>1.0139***</td>
<td>1.0113***</td>
<td>1.0182***</td>
</tr>
<tr>
<td>COMMERCE BSHRS</td>
<td>10</td>
<td>1.1100***</td>
<td>1.1122***</td>
<td>1.0643***</td>
<td>1.0626***</td>
<td>0.9944***</td>
<td>0.8215***</td>
<td>1.0363***</td>
<td>0.9707***</td>
</tr>
<tr>
<td>BANCORP HI</td>
<td>9</td>
<td>1.0885***</td>
<td>1.0875***</td>
<td>1.1024***</td>
<td>1.1084***</td>
<td>1.0684***</td>
<td>1.0636***</td>
<td>1.0811***</td>
<td>1.0545***</td>
</tr>
<tr>
<td>FIRST SCTY</td>
<td>9</td>
<td>1.0843***</td>
<td>1.0961***</td>
<td>1.0812***</td>
<td>1.0891***</td>
<td>0.7777***</td>
<td>0.9886***</td>
<td>1.0653***</td>
<td>0.9081***</td>
</tr>
<tr>
<td>CHASE MTHN BK USA</td>
<td>9</td>
<td>1.1093***</td>
<td>1.1203***</td>
<td>1.0237***</td>
<td>1.0190***</td>
<td>0.9816***</td>
<td>0.9696***</td>
<td>1.0146***</td>
<td>0.9977***</td>
</tr>
<tr>
<td>INB FNCL</td>
<td>9</td>
<td>1.0782***</td>
<td>1.0818***</td>
<td>1.0825***</td>
<td>1.0865***</td>
<td>1.0688***</td>
<td>1.0697***</td>
<td>1.0663***</td>
<td>1.0524***</td>
</tr>
<tr>
<td>SOUTHWESTRUST</td>
<td>9</td>
<td>1.1294***</td>
<td>1.1306***</td>
<td>1.0612***</td>
<td>1.0670***</td>
<td>1.0343***</td>
<td>0.9937***</td>
<td>1.0396***</td>
<td>1.0104***</td>
</tr>
<tr>
<td>FIRST KENTUCKY T</td>
<td>9</td>
<td>1.0866***</td>
<td>1.0905***</td>
<td>1.0653***</td>
<td>1.0563***</td>
<td>1.0867***</td>
<td>1.0813***</td>
<td>1.0438***</td>
<td>1.0597***</td>
</tr>
<tr>
<td>SANWA BK CALIFORNIA</td>
<td>9</td>
<td>1.1011***</td>
<td>1.1004***</td>
<td>1.0781***</td>
<td>1.0882***</td>
<td>1.0444***</td>
<td>1.0225***</td>
<td>1.1099***</td>
<td>1.0470***</td>
</tr>
<tr>
<td>UNITED BK OF CO</td>
<td>9</td>
<td>1.0630***</td>
<td>1.0615***</td>
<td>1.0591***</td>
<td>1.0798***</td>
<td>0.9726***</td>
<td>0.6716***</td>
<td>1.0271***</td>
<td>1.0244***</td>
</tr>
<tr>
<td>LOUISIANA BSHRS</td>
<td>9</td>
<td>1.0968***</td>
<td>1.0954***</td>
<td>1.0815***</td>
<td>1.0293***</td>
<td>1.0839***</td>
<td>1.1280***</td>
<td>1.0375***</td>
<td>1.0258***</td>
</tr>
<tr>
<td>FIRST NB OF MD</td>
<td>9</td>
<td>1.0322***</td>
<td>1.0454***</td>
<td>1.0581***</td>
<td>1.0580***</td>
<td>1.0227***</td>
<td>1.0212***</td>
<td>1.0379***</td>
<td>1.0570***</td>
</tr>
<tr>
<td>FIRST FLORIDA BK</td>
<td>9</td>
<td>1.1070***</td>
<td>1.1080***</td>
<td>1.0603***</td>
<td>1.0652***</td>
<td>1.0377***</td>
<td>1.0218***</td>
<td>1.0548***</td>
<td>1.0214***</td>
</tr>
<tr>
<td>SOUTH CAROLINA T</td>
<td>9</td>
<td>1.0722***</td>
<td>1.0813***</td>
<td>1.0748***</td>
<td>1.0965***</td>
<td>1.0418***</td>
<td>1.1222***</td>
<td>1.0395***</td>
<td>1.0766***</td>
</tr>
</tbody>
</table>

**NOTE:** For Models 1–2, estimates of $(1 - \varepsilon_{\alpha})\delta$ are reported (δ = 1.1). For Models 3–4 and Models 5–8, estimates of $(1 + \varepsilon_{R_{i}})\delta$ and $(1 + \varepsilon_{\alpha})\delta$ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.7: Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHASE MHTN</td>
<td>469</td>
<td>1.0557***</td>
<td>1.0480***</td>
<td>1.0344***</td>
<td>1.0328***</td>
<td>1.0401***</td>
<td>1.0521***</td>
<td>1.0038***</td>
<td>1.0448***</td>
</tr>
<tr>
<td>CITICORP</td>
<td>394</td>
<td>1.0369***</td>
<td>1.0364***</td>
<td>1.0376***</td>
<td>1.0399***</td>
<td>1.0426***</td>
<td>1.0698***</td>
<td>1.0293***</td>
<td>1.0490***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>352</td>
<td>1.0412***</td>
<td>1.0435***</td>
<td>1.0469***</td>
<td>1.0446***</td>
<td>1.0485***</td>
<td>1.0641***</td>
<td>1.0379***</td>
<td>1.0533***</td>
</tr>
<tr>
<td>NATIONS BANK TC</td>
<td>266</td>
<td>1.0773***</td>
<td>1.0621***</td>
<td>1.0442***</td>
<td>1.0589***</td>
<td>1.0395***</td>
<td>1.0446***</td>
<td>1.0616***</td>
<td>1.0460***</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>245</td>
<td>1.0536***</td>
<td>1.0475***</td>
<td>1.0126***</td>
<td>1.0144***</td>
<td>0.9942***</td>
<td>0.9881***</td>
<td>1.0025***</td>
<td>0.9977***</td>
</tr>
<tr>
<td>FIRST UNION</td>
<td>195</td>
<td>1.0907**</td>
<td>1.0930**</td>
<td>1.0201***</td>
<td>1.0209***</td>
<td>0.9906**</td>
<td>0.9925**</td>
<td>0.9875**</td>
<td>0.9982**</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>155</td>
<td>1.0630***</td>
<td>1.0523***</td>
<td>1.0839***</td>
<td>1.0823***</td>
<td>1.1083***</td>
<td>1.0796***</td>
<td>1.0910***</td>
<td>1.0549***</td>
</tr>
<tr>
<td>FIRST NBD</td>
<td>150</td>
<td>1.0663***</td>
<td>1.0627***</td>
<td>1.0392***</td>
<td>1.0423***</td>
<td>1.0440***</td>
<td>1.0150***</td>
<td>1.0431***</td>
<td>1.0138***</td>
</tr>
<tr>
<td>BANC ONE</td>
<td>143</td>
<td>1.0653***</td>
<td>1.0725***</td>
<td>1.0594***</td>
<td>1.0593***</td>
<td>1.0600***</td>
<td>1.0476***</td>
<td>1.0377***</td>
<td>1.0454***</td>
</tr>
<tr>
<td>FLEET FNCL GROUP</td>
<td>133</td>
<td>1.0587***</td>
<td>1.0569***</td>
<td>1.0817***</td>
<td>1.0917***</td>
<td>1.0784***</td>
<td>1.0720***</td>
<td>1.0836***</td>
<td>1.0657***</td>
</tr>
<tr>
<td>NORWEST</td>
<td>113</td>
<td>1.0324***</td>
<td>1.0335***</td>
<td>1.0742***</td>
<td>1.0868***</td>
<td>1.0637***</td>
<td>1.0637***</td>
<td>1.0838***</td>
<td>1.0698***</td>
</tr>
<tr>
<td>PNC BC</td>
<td>102</td>
<td>1.0965</td>
<td>1.1134</td>
<td>1.0939***</td>
<td>1.0992***</td>
<td>1.0830***</td>
<td>1.0913***</td>
<td>1.1039***</td>
<td>1.1016***</td>
</tr>
<tr>
<td>KEYCORP</td>
<td>95</td>
<td>1.0792***</td>
<td>1.0929**</td>
<td>1.0896***</td>
<td>1.0965***</td>
<td>1.0830***</td>
<td>1.0623***</td>
<td>1.0985***</td>
<td>1.0709***</td>
</tr>
<tr>
<td>BK OF BOSTON</td>
<td>88</td>
<td>1.0736***</td>
<td>1.0872***</td>
<td>1.0817***</td>
<td>1.0942***</td>
<td>1.1079***</td>
<td>1.0929***</td>
<td>1.1025***</td>
<td>1.1013***</td>
</tr>
<tr>
<td>BK OF NY CO</td>
<td>77</td>
<td>1.0763***</td>
<td>1.0935***</td>
<td>1.0378***</td>
<td>1.0742***</td>
<td>1.0461***</td>
<td>1.0176***</td>
<td>1.0993***</td>
<td>1.0169***</td>
</tr>
<tr>
<td>SUN TRUST BK</td>
<td>73</td>
<td>1.0717***</td>
<td>1.0916***</td>
<td>1.1247***</td>
<td>1.1264***</td>
<td>1.1271***</td>
<td>1.0957***</td>
<td>1.1428***</td>
<td>1.1054***</td>
</tr>
<tr>
<td>NATIONAL CITY</td>
<td>72</td>
<td>1.0866**</td>
<td>1.0827***</td>
<td>1.1089***</td>
<td>1.1247***</td>
<td>1.0825***</td>
<td>1.0429***</td>
<td>1.1209***</td>
<td>1.0575***</td>
</tr>
<tr>
<td>WACHOVIA</td>
<td>67</td>
<td>1.0700***</td>
<td>1.0713***</td>
<td>1.1018***</td>
<td>1.0922***</td>
<td>1.1066***</td>
<td>1.0295***</td>
<td>1.1098***</td>
<td>1.0531***</td>
</tr>
<tr>
<td>REPUBLIC NB OF NY</td>
<td>66</td>
<td>1.0206***</td>
<td>1.0246***</td>
<td>1.0505***</td>
<td>1.0440***</td>
<td>1.0391***</td>
<td>1.0347***</td>
<td>1.0324***</td>
<td>1.0455***</td>
</tr>
<tr>
<td>CORESTATES FNCL</td>
<td>65</td>
<td>1.0630***</td>
<td>1.0630***</td>
<td>1.1132***</td>
<td>1.1132***</td>
<td>1.0988***</td>
<td>1.0579***</td>
<td>1.1007***</td>
<td>1.0725***</td>
</tr>
<tr>
<td>MELLON BC</td>
<td>61</td>
<td>1.1136***</td>
<td>1.1066***</td>
<td>1.1049***</td>
<td>1.1134***</td>
<td>1.0801***</td>
<td>1.0496***</td>
<td>1.0916***</td>
<td>1.0657***</td>
</tr>
<tr>
<td>BARNETT BK</td>
<td>59</td>
<td>1.1161***</td>
<td>1.1126***</td>
<td>1.0804***</td>
<td>1.0804***</td>
<td>1.1014***</td>
<td>1.0861***</td>
<td>1.0991***</td>
<td>1.0341***</td>
</tr>
<tr>
<td>BOATMEN'S BSRS</td>
<td>58</td>
<td>1.0419***</td>
<td>1.0410***</td>
<td>1.0814***</td>
<td>1.0835***</td>
<td>1.0974***</td>
<td>1.0197***</td>
<td>1.0991***</td>
<td>1.0427***</td>
</tr>
<tr>
<td>FIRST BK SYSTEM</td>
<td>52</td>
<td>1.0942</td>
<td>1.1156***</td>
<td>1.0777***</td>
<td>1.0857***</td>
<td>1.0933***</td>
<td>1.0447***</td>
<td>1.0990***</td>
<td>1.0639***</td>
</tr>
<tr>
<td>COMERICA</td>
<td>49</td>
<td>1.0444***</td>
<td>1.0446***</td>
<td>1.0612***</td>
<td>1.0658***</td>
<td>1.0648***</td>
<td>1.0325***</td>
<td>1.0711***</td>
<td>1.0500***</td>
</tr>
</tbody>
</table>

Dep. Var. C1/W1 (y_w1) C2/W1 (y_w2) R1 (y_w2) R2 (y_w2) R1 - C1 (y_w2) R1 - C2 (y_w2) R2 - C1 (y_w2) R2 - C2 (y_w2)

NOTE: For Models 1–2, estimates of (1 - \( \xi_{C1} \)) are reported \((\delta = 1.1)\). For Models 3–4 and Models 5–8, estimates of \((1 + \xi_{R1})\delta\) and \((1 + \xi_{R2})\delta\) are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.7: Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. BC</td>
<td>48</td>
<td>1.0608**</td>
<td>1.1188</td>
<td>1.0698**</td>
<td>1.0743**</td>
<td>1.0695(')</td>
<td>1.0311**</td>
<td>1.0720**</td>
<td>1.0496**</td>
</tr>
<tr>
<td>STATE STREET BOSTON</td>
<td>43</td>
<td>1.0901**</td>
<td>1.0969</td>
<td>1.0131**</td>
<td>1.0225**</td>
<td>1.0214**</td>
<td>1.0239**</td>
<td>1.0297**</td>
<td>1.0258**</td>
</tr>
<tr>
<td>UNION BK OF CA</td>
<td>41</td>
<td>1.1224**</td>
<td>1.1501</td>
<td>1.0647**</td>
<td>1.0638**</td>
<td>1.0345**</td>
<td>1.0157**</td>
<td>1.0401**</td>
<td>1.0633**</td>
</tr>
<tr>
<td>SOUTHTRUST</td>
<td>36</td>
<td>1.1704**</td>
<td>1.1343</td>
<td>1.0455**</td>
<td>1.0582**</td>
<td>1.0731**</td>
<td>0.9546**</td>
<td>1.1141**</td>
<td>0.9742**</td>
</tr>
<tr>
<td>MARINE MIDLAND BK</td>
<td>32</td>
<td>1.1156**</td>
<td>1.1351*</td>
<td>1.0658**</td>
<td>1.0729**</td>
<td>1.0891**</td>
<td>1.0382**</td>
<td>1.0937**</td>
<td>1.0503**</td>
</tr>
<tr>
<td>FIRST OF AMER BK</td>
<td>31</td>
<td>1.0675**</td>
<td>1.1199</td>
<td>1.0788**</td>
<td>1.0683**</td>
<td>1.1018**</td>
<td>0.9796**</td>
<td>1.0503**</td>
<td>0.9962**</td>
</tr>
<tr>
<td>NORTHERN TR</td>
<td>31</td>
<td>1.0843**</td>
<td>1.0691**</td>
<td>1.0528**</td>
<td>1.0011**</td>
<td>1.0801**</td>
<td>1.1390**</td>
<td>1.1459**</td>
<td>1.0408**</td>
</tr>
<tr>
<td>SOUTHERN T</td>
<td>30</td>
<td>1.0483*</td>
<td>1.0780*</td>
<td>1.0513**</td>
<td>1.0370**</td>
<td>1.0513**</td>
<td>1.0299**</td>
<td>1.0519**</td>
<td>1.0341**</td>
</tr>
<tr>
<td>HUNTINGTON BSHRS</td>
<td>29</td>
<td>1.0556**</td>
<td>1.0624**</td>
<td>1.0741**</td>
<td>1.0785**</td>
<td>1.0373**</td>
<td>0.9915**</td>
<td>1.0446**</td>
<td>1.0070**</td>
</tr>
<tr>
<td>FIFTH THIRD BC</td>
<td>29</td>
<td>1.0368**</td>
<td>1.1143</td>
<td>1.0699**</td>
<td>1.0811</td>
<td>1.0379**</td>
<td>0.9947**</td>
<td>1.0473**</td>
<td>1.0070**</td>
</tr>
<tr>
<td>FIRSTAR</td>
<td>28</td>
<td>1.0677**</td>
<td>1.1079</td>
<td>1.0640**</td>
<td>1.0740**</td>
<td>1.0858**</td>
<td>1.0405**</td>
<td>1.0878**</td>
<td>1.0488**</td>
</tr>
<tr>
<td>SUMMIT BK</td>
<td>28</td>
<td>1.0782**</td>
<td>1.0970</td>
<td>1.0884**</td>
<td>1.0887**</td>
<td>1.0820**</td>
<td>1.0679**</td>
<td>1.0907**</td>
<td>1.0770**</td>
</tr>
<tr>
<td>REGIONS</td>
<td>27</td>
<td>1.0476**</td>
<td>1.0535**</td>
<td>1.0721**</td>
<td>1.0721**</td>
<td>1.0631**</td>
<td>0.9940**</td>
<td>1.0407**</td>
<td>1.0370**</td>
</tr>
<tr>
<td>MERCANTILE BANCORPORATION</td>
<td>27</td>
<td>1.0719**</td>
<td>1.0566**</td>
<td>1.0653**</td>
<td>1.0502**</td>
<td>1.0752**</td>
<td>1.0037**</td>
<td>1.0544**</td>
<td>1.0133**</td>
</tr>
<tr>
<td>CRESTAR</td>
<td>26</td>
<td>1.0590**</td>
<td>1.0650**</td>
<td>1.0767**</td>
<td>1.0878**</td>
<td>1.0391**</td>
<td>0.9762**</td>
<td>1.0476**</td>
<td>1.0005**</td>
</tr>
<tr>
<td>AMSOUTH BC</td>
<td>26</td>
<td>1.0717**</td>
<td>1.1050</td>
<td>1.0591**</td>
<td>1.0810**</td>
<td>1.0735**</td>
<td>1.0627**</td>
<td>1.0842**</td>
<td>1.0643**</td>
</tr>
<tr>
<td>BANPONCE</td>
<td>24</td>
<td>1.0725**</td>
<td>1.0597**</td>
<td>1.0834**</td>
<td>1.0870**</td>
<td>1.0372**</td>
<td>0.9807**</td>
<td>1.0524**</td>
<td>1.0034**</td>
</tr>
<tr>
<td>MBNA</td>
<td>23</td>
<td>1.1125*</td>
<td>1.1174**</td>
<td>0.9745**</td>
<td>0.9744**</td>
<td>0.9454**</td>
<td>0.9556**</td>
<td>0.9474**</td>
<td>0.9672**</td>
</tr>
<tr>
<td>HARRIS T&amp;SB</td>
<td>21</td>
<td>1.0964</td>
<td>1.1381</td>
<td>1.0938**</td>
<td>1.1222**</td>
<td>1.1361**</td>
<td>1.0410**</td>
<td>1.1861**</td>
<td>1.0516**</td>
</tr>
<tr>
<td>MARSHALL &amp; ISLEY</td>
<td>21</td>
<td>1.0819**</td>
<td>1.1059</td>
<td>1.0738**</td>
<td>1.0680**</td>
<td>1.0916**</td>
<td>1.0542**</td>
<td>1.0904**</td>
<td>1.0592**</td>
</tr>
<tr>
<td>FIRST SCTY</td>
<td>20</td>
<td>1.0686**</td>
<td>1.0703**</td>
<td>1.0637**</td>
<td>1.0629**</td>
<td>1.0471**</td>
<td>1.0174**</td>
<td>1.0622**</td>
<td>1.0270**</td>
</tr>
<tr>
<td>BANCORP III</td>
<td>20</td>
<td>1.0902**</td>
<td>1.0953</td>
<td>1.0604**</td>
<td>1.0317**</td>
<td>0.9928**</td>
<td>0.9931**</td>
<td>1.0020**</td>
<td>0.9875**</td>
</tr>
<tr>
<td>UNION PLANTERS</td>
<td>19</td>
<td>1.0641**</td>
<td>1.0961**</td>
<td>1.0762**</td>
<td>1.0790**</td>
<td>1.1253**</td>
<td>1.0670**</td>
<td>1.0848**</td>
<td>1.0924**</td>
</tr>
<tr>
<td>FIRST TENNESSEE T</td>
<td>18</td>
<td>1.1080</td>
<td>1.1283</td>
<td>1.0916**</td>
<td>1.0949**</td>
<td>1.0956**</td>
<td>1.0626**</td>
<td>1.0940**</td>
<td>1.0652**</td>
</tr>
<tr>
<td>LASALLE NB</td>
<td>18</td>
<td>1.0603**</td>
<td>1.0905**</td>
<td>1.0695**</td>
<td>1.0826**</td>
<td>1.0662**</td>
<td>1.0234**</td>
<td>1.0702**</td>
<td>1.0424**</td>
</tr>
</tbody>
</table>

**Note:** For Models 1–2, estimates of \((1 - \varepsilon_{C_{ij}})\) based on (1.1) for Models 3–8 and estimates of \((1 + \varepsilon_{R_{ij}})\) and \((1 + \varepsilon_{w_{ij}})\) are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.7: Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST EMPIRE ST</td>
<td>18</td>
<td>1.0921**</td>
<td>1.0856**</td>
<td>1.0875**</td>
<td>1.0794**</td>
<td>1.1155**</td>
<td>1.0841**</td>
<td>1.1017</td>
<td>1.0716**</td>
</tr>
<tr>
<td>OLD KENT</td>
<td>18</td>
<td>1.1079</td>
<td>1.0856**</td>
<td>1.0702**</td>
<td>1.0757**</td>
<td>1.0873**</td>
<td>1.0611**</td>
<td>1.0973</td>
<td>1.0615**</td>
</tr>
<tr>
<td>COMPASS BSHRS</td>
<td>17</td>
<td>1.0749**</td>
<td>1.0785**</td>
<td>1.0691**</td>
<td>1.0640**</td>
<td>1.0619**</td>
<td>1.0645**</td>
<td>1.0603</td>
<td>1.0531**</td>
</tr>
<tr>
<td>SIGNET BK</td>
<td>17</td>
<td>1.0920**</td>
<td>1.0575**</td>
<td>1.0945**</td>
<td>1.1131**</td>
<td>1.1270**</td>
<td>1.0624**</td>
<td>1.1321</td>
<td>1.0641**</td>
</tr>
<tr>
<td>CENTRAL FIDELITY BK</td>
<td>15</td>
<td>1.0562**</td>
<td>1.0589**</td>
<td>1.0516**</td>
<td>1.0599**</td>
<td>1.1233**</td>
<td>1.0763**</td>
<td>1.1643</td>
<td>1.0929</td>
</tr>
<tr>
<td>FIRST AMER</td>
<td>15</td>
<td>1.0695**</td>
<td>1.0789**</td>
<td>1.0844**</td>
<td>1.0904**</td>
<td>1.1171**</td>
<td>1.0846**</td>
<td>1.1090</td>
<td>1.0812**</td>
</tr>
<tr>
<td>STAR BC</td>
<td>14</td>
<td>1.0844**</td>
<td>1.0923**</td>
<td>1.0785**</td>
<td>1.0764**</td>
<td>1.1025**</td>
<td>1.0409**</td>
<td>1.0988</td>
<td>1.0530**</td>
</tr>
<tr>
<td>COMMERCE BSHRS</td>
<td>14</td>
<td>1.0694**</td>
<td>1.0672**</td>
<td>1.0654**</td>
<td>1.0596**</td>
<td>1.0574**</td>
<td>1.0330**</td>
<td>1.0622</td>
<td>1.0421**</td>
</tr>
<tr>
<td>EUROPEAN AMER BK</td>
<td>13</td>
<td>1.0752**</td>
<td>1.1045**</td>
<td>1.0431**</td>
<td>1.0458**</td>
<td>1.0450**</td>
<td>1.0310**</td>
<td>1.0488</td>
<td>1.0458**</td>
</tr>
<tr>
<td>MICHIGAN NB</td>
<td>13</td>
<td>1.1298**</td>
<td>1.1348**</td>
<td>1.1288**</td>
<td>1.1644**</td>
<td>1.0979**</td>
<td>1.0891**</td>
<td>1.1249</td>
<td>1.1051**</td>
</tr>
<tr>
<td>FIRST CMRC</td>
<td>13</td>
<td>1.0562**</td>
<td>1.0561**</td>
<td>1.0661**</td>
<td>1.0690**</td>
<td>1.1214**</td>
<td>1.0663**</td>
<td>1.1173</td>
<td>1.0705**</td>
</tr>
<tr>
<td>FIRST NB OF MD</td>
<td>13</td>
<td>1.0172**</td>
<td>1.0301**</td>
<td>1.0516**</td>
<td>1.0419**</td>
<td>1.0462**</td>
<td>1.0508**</td>
<td>1.0361</td>
<td>1.0603**</td>
</tr>
<tr>
<td>HIBERNIA</td>
<td>13</td>
<td>1.0763**</td>
<td>1.0799**</td>
<td>1.0517**</td>
<td>1.0473**</td>
<td>1.0723**</td>
<td>1.0632**</td>
<td>1.0830</td>
<td>1.0758**</td>
</tr>
<tr>
<td>FIRST VA BK</td>
<td>12</td>
<td>1.0655**</td>
<td>1.0672**</td>
<td>1.0606**</td>
<td>1.0597**</td>
<td>1.0738**</td>
<td>1.0470**</td>
<td>1.0752</td>
<td>1.0402**</td>
</tr>
<tr>
<td>FIRST HAWAIIAN</td>
<td>12</td>
<td>1.0324**</td>
<td>1.0843**</td>
<td>0.9718**</td>
<td>0.9724**</td>
<td>0.9001**</td>
<td>0.9371**</td>
<td>0.9004</td>
<td>0.9421**</td>
</tr>
<tr>
<td>FIRST CITIZENS BSHRS</td>
<td>11</td>
<td>1.1013</td>
<td>1.1142**</td>
<td>1.0776**</td>
<td>1.0762**</td>
<td>1.0649**</td>
<td>1.0244**</td>
<td>1.0538</td>
<td>1.0334**</td>
</tr>
<tr>
<td>SANWA BK CA</td>
<td>11</td>
<td>1.0871**</td>
<td>1.1072**</td>
<td>1.0570**</td>
<td>1.1008**</td>
<td>1.0736**</td>
<td>1.0156**</td>
<td>1.1214</td>
<td>1.0359**</td>
</tr>
<tr>
<td>PROVIDENT BC</td>
<td>10</td>
<td>1.0604**</td>
<td>1.0669**</td>
<td>1.0398**</td>
<td>1.0217**</td>
<td>1.0607**</td>
<td>1.0591**</td>
<td>1.0461</td>
<td>1.0576**</td>
</tr>
<tr>
<td>FIRST T OF NE</td>
<td>9</td>
<td>1.0422**</td>
<td>1.0724**</td>
<td>1.0587**</td>
<td>1.0629**</td>
<td>1.0521**</td>
<td>0.9889**</td>
<td>1.0853</td>
<td>1.0486**</td>
</tr>
<tr>
<td>ZIONS BC</td>
<td>9</td>
<td>1.0888</td>
<td>1.0923**</td>
<td>1.1084**</td>
<td>1.0751**</td>
<td>1.0539**</td>
<td>1.0284**</td>
<td>1.0546</td>
<td>1.0402**</td>
</tr>
<tr>
<td>MERCANTILE BSHRS</td>
<td>9</td>
<td>1.1198</td>
<td>1.1355**</td>
<td>1.1100**</td>
<td>1.1043**</td>
<td>1.0781**</td>
<td>1.0125**</td>
<td>1.0609</td>
<td>1.0236**</td>
</tr>
<tr>
<td>DEPOSIT GUARANTY</td>
<td>9</td>
<td>1.1329</td>
<td>1.1329**</td>
<td>1.0802**</td>
<td>1.0984**</td>
<td>1.0601**</td>
<td>1.0410**</td>
<td>1.0849</td>
<td>1.0525**</td>
</tr>
<tr>
<td>UMB</td>
<td>9</td>
<td>1.0730**</td>
<td>1.0769**</td>
<td>1.1009**</td>
<td>1.1127**</td>
<td>1.1092**</td>
<td>1.1024**</td>
<td>1.1352</td>
<td>1.1120**</td>
</tr>
<tr>
<td>CENTURA BANKS</td>
<td>9</td>
<td>0.9353**</td>
<td>0.9630**</td>
<td>1.0681**</td>
<td>1.0921**</td>
<td>1.0709**</td>
<td>1.0412**</td>
<td>1.0355</td>
<td>1.0637**</td>
</tr>
<tr>
<td>DAUPHIN DEPOSIT</td>
<td>8</td>
<td>1.1190</td>
<td>1.1337**</td>
<td>1.0880**</td>
<td>1.0958**</td>
<td>1.1055**</td>
<td>1.0956**</td>
<td>1.1122</td>
<td>1.1150**</td>
</tr>
</tbody>
</table>

Dep. Var.  
C1/W1  
(y, w1)  
R1  
(y, w2)  
R2  
(y, w2)  
R1 – C1  
(y, w2)  
R2 – C1  
(y, w2)  
R3 – C2  
(y, w2)  
R4 – C2  
(y, w2)  
R5 – C2  
(y, w2)  
R6 – C2  
(y, w2)  
R7 – C2  
(y, w2)  
R8 – C2  
(y, w2)

NOTE: For Models 1–2, estimates of \((1 - \varepsilon_{C1})\delta\) are reported (\(\delta = 1.1\)). For Models 3–4 and Models 5–8, estimates of \((1 + \varepsilon_{R1})\delta\) and \((1 + \varepsilon_{R2})\delta\) are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.7: Returns to Scale for 100 Largest Banks by Total Assets, 1996.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>WILMINGTON TR</td>
<td>1.0626***</td>
<td>1.0846***</td>
<td>1.0578***</td>
<td>1.0676***</td>
<td>1.1062</td>
<td>1.0344***</td>
<td>1.1037</td>
<td>1.0478***</td>
</tr>
<tr>
<td>MAGNA GROUP</td>
<td>1.0793***</td>
<td>1.1044</td>
<td>1.0956</td>
<td>1.0957</td>
<td>1.1013</td>
<td>1.0740***</td>
<td>1.1019</td>
<td>1.0861</td>
</tr>
<tr>
<td>FIRST COMMERCIAL</td>
<td>1.0694*</td>
<td>1.1197</td>
<td>1.0912</td>
<td>1.0940</td>
<td>1.0766</td>
<td>1.0382***</td>
<td>1.0668***</td>
<td>1.0430***</td>
</tr>
<tr>
<td>ONBANCORP</td>
<td>1.0802***</td>
<td>1.0699***</td>
<td>1.0705**</td>
<td>1.0611**</td>
<td>1.0870</td>
<td>1.0319**</td>
<td>1.0642**</td>
<td>1.0266**</td>
</tr>
<tr>
<td>FIRSTMERIT</td>
<td>1.1015**</td>
<td>1.0942**</td>
<td>1.0989*</td>
<td>1.1141</td>
<td>1.1081**</td>
<td>1.0949</td>
<td>1.1203**</td>
<td>1.1180</td>
</tr>
<tr>
<td>CCB</td>
<td>1.0628***</td>
<td>1.0933**</td>
<td>1.0749**</td>
<td>1.0799**</td>
<td>1.0503**</td>
<td>1.0237**</td>
<td>1.0592**</td>
<td>1.0298**</td>
</tr>
<tr>
<td>OLD T BC</td>
<td>1.0797***</td>
<td>1.0982**</td>
<td>1.0574**</td>
<td>1.0663**</td>
<td>1.0262**</td>
<td>1.0311</td>
<td>1.0399**</td>
<td>1.0434**</td>
</tr>
<tr>
<td>KEYSTONE FNCL</td>
<td>1.1217**</td>
<td>1.1351**</td>
<td>1.0995**</td>
<td>1.0896</td>
<td>1.1296***</td>
<td>1.0851</td>
<td>1.1518***</td>
<td>1.1139</td>
</tr>
<tr>
<td>TRUSTMARK</td>
<td>1.1264***</td>
<td>1.1407***</td>
<td>1.1340***</td>
<td>1.1143**</td>
<td>1.1414**</td>
<td>1.1054</td>
<td>1.1276**</td>
<td>1.1317**</td>
</tr>
<tr>
<td>INDUSTRIAL BK OF JAPAN TC</td>
<td>1.0935**</td>
<td>1.1057**</td>
<td>1.0131**</td>
<td>1.0161**</td>
<td>1.0100**</td>
<td>1.0064**</td>
<td>1.0175**</td>
<td>1.0128**</td>
</tr>
<tr>
<td>BK OF THE WEST</td>
<td>1.0871**</td>
<td>1.0821**</td>
<td>1.0660***</td>
<td>1.0688***</td>
<td>1.0317**</td>
<td>1.0284**</td>
<td>1.0404**</td>
<td>1.0390**</td>
</tr>
<tr>
<td>SUMITOMO BK OF CA</td>
<td>0.9845***</td>
<td>0.9875***</td>
<td>1.0722**</td>
<td>1.0504**</td>
<td>1.1051</td>
<td>1.0660**</td>
<td>1.0804</td>
<td>1.0685**</td>
</tr>
<tr>
<td>PEOPLES HERITAGE FNCL GROUP</td>
<td>1.0459***</td>
<td>1.0683**</td>
<td>1.0913**</td>
<td>1.0820</td>
<td>1.0917</td>
<td>1.0606</td>
<td>1.0819</td>
<td>1.0767</td>
</tr>
<tr>
<td>RIGGS T</td>
<td>1.1231**</td>
<td>1.1208**</td>
<td>1.0208***</td>
<td>1.0107**</td>
<td>0.9559**</td>
<td>0.9944**</td>
<td>1.0116**</td>
<td>1.0412**</td>
</tr>
<tr>
<td>NORTH FORK BC</td>
<td>1.0872***</td>
<td>1.0846***</td>
<td>0.9898***</td>
<td>0.9943**</td>
<td>0.9886**</td>
<td>0.9790**</td>
<td>0.9969**</td>
<td>0.9773**</td>
</tr>
<tr>
<td>COLONIAL BANCGROUP</td>
<td>1.1659**</td>
<td>1.1826**</td>
<td>1.0812**</td>
<td>1.0858</td>
<td>1.1077**</td>
<td>1.1076</td>
<td>1.1096</td>
<td>1.1031</td>
</tr>
<tr>
<td>CULLEN/FROST BKR</td>
<td>1.0819**</td>
<td>1.1038**</td>
<td>1.0905**</td>
<td>1.0956</td>
<td>1.0836</td>
<td>1.0560**</td>
<td>1.0879</td>
<td>1.0661**</td>
</tr>
<tr>
<td>VALLEY NBC</td>
<td>1.1584***</td>
<td>1.1467***</td>
<td>1.1073**</td>
<td>1.0545**</td>
<td>1.0596**</td>
<td>1.0362**</td>
<td>1.0263**</td>
<td>1.0285**</td>
</tr>
<tr>
<td>BOK</td>
<td>1.0716**</td>
<td>1.0777**</td>
<td>1.0416***</td>
<td>1.0800</td>
<td>1.0871**</td>
<td>1.0814**</td>
<td>1.0949</td>
<td>1.0364**</td>
</tr>
<tr>
<td>UNITED CAROLINA BSHRS</td>
<td>1.1217***</td>
<td>1.1355***</td>
<td>1.1051**</td>
<td>1.0998</td>
<td>1.1126</td>
<td>1.0706**</td>
<td>1.1106**</td>
<td>1.0794**</td>
</tr>
<tr>
<td>ASSOCIATED BANC-CORP</td>
<td>1.1046*</td>
<td>1.1010**</td>
<td>1.0786**</td>
<td>1.0750**</td>
<td>1.0584**</td>
<td>1.1078**</td>
<td>1.0460**</td>
<td>1.0499**</td>
</tr>
<tr>
<td>ONE VALLEY BKC</td>
<td>1.0872***</td>
<td>1.0613***</td>
<td>1.1074**</td>
<td>1.0814**</td>
<td>1.0260**</td>
<td>1.0178**</td>
<td>1.0228**</td>
<td>1.0283**</td>
</tr>
<tr>
<td>CITIZENS BC</td>
<td>1.0803***</td>
<td>0.9903**</td>
<td>1.0220**</td>
<td>1.0360**</td>
<td>1.0130**</td>
<td>1.0262**</td>
<td>1.0318**</td>
<td>1.0324**</td>
</tr>
<tr>
<td>CNY BHSRS</td>
<td>1.0508***</td>
<td>1.0587**</td>
<td>1.0341**</td>
<td>1.0328**</td>
<td>1.0318</td>
<td>1.0425**</td>
<td>1.0539</td>
<td>1.0341**</td>
</tr>
</tbody>
</table>

Dep. Var.  \(C_1/W_1\)  \(C_2/W_1\)  \(R_1\)  \(R_2\)  \(R_1 - C_1\)  \(R_2 - C_2\)  \(R_2 - C_2\)
RHS Vars. \((y, w_1)\) \((y, w_2)\) \((y, w_2)\) \((y, w_2)\) \((y, w_2)\) \((y, w_2)\) \((y, w_2)\)

NOTE: For Models 1–2, estimates of \((1 - \varepsilon_{C_1})\delta\) are reported (\(\delta = 1.1\)). For Models 3–4 and Models 5–8, estimates of \((1 + \varepsilon_{R_1})\delta\) and \((1 + \varepsilon_{R_2})\delta\) are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.8: Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CITIGROUP</td>
<td>2092</td>
<td>1.101</td>
<td>1.0925</td>
<td>1.0868**</td>
<td>1.0773**</td>
<td>1.1355**</td>
<td>1.1124</td>
<td>1.1105**</td>
<td>1.0648**</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>1672</td>
<td>1.091***</td>
<td>1.0956**</td>
<td>1.0930**</td>
<td>1.1136</td>
<td>1.1519**</td>
<td>1.1721**</td>
<td>1.1498**</td>
<td>1.1049</td>
</tr>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>1545</td>
<td>1.1025</td>
<td>1.1001</td>
<td>1.0982</td>
<td>1.0958</td>
<td>1.2066**</td>
<td>1.1376</td>
<td>1.1774**</td>
<td>1.0789**</td>
</tr>
<tr>
<td>WACHOVIA</td>
<td>726</td>
<td>1.0459**</td>
<td>1.1073</td>
<td>1.0292**</td>
<td>1.0697</td>
<td>1.0673</td>
<td>1.0825</td>
<td>1.1057</td>
<td>1.0402**</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>554</td>
<td>1.0193**</td>
<td>1.0256**</td>
<td>0.9966**</td>
<td>1.0357**</td>
<td>1.0154**</td>
<td>1.0408</td>
<td>1.0245**</td>
<td>1.0271**</td>
</tr>
<tr>
<td>U S BC</td>
<td>250</td>
<td>1.0585**</td>
<td>1.0554**</td>
<td>1.0493</td>
<td>1.0566**</td>
<td>1.0556**</td>
<td>1.0701**</td>
<td>1.0707**</td>
<td>1.0656**</td>
</tr>
<tr>
<td>COUNTRYWIDE</td>
<td>225</td>
<td>1.1009</td>
<td>1.1131</td>
<td>1.0013</td>
<td>1.0023**</td>
<td>0.9950**</td>
<td>0.9910</td>
<td>1.0002**</td>
<td>0.9958**</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>210</td>
<td>1.0714**</td>
<td>1.0731**</td>
<td>1.0737**</td>
<td>1.0774**</td>
<td>1.0765</td>
<td>1.0560**</td>
<td>1.0947**</td>
<td>1.0472**</td>
</tr>
<tr>
<td>HSBC BK USA</td>
<td>191</td>
<td>1.0456**</td>
<td>1.0436**</td>
<td>1.0096</td>
<td>1.0161**</td>
<td>0.9928**</td>
<td>0.9851**</td>
<td>1.0234**</td>
<td>1.0027**</td>
</tr>
<tr>
<td>NATIONAL CITY</td>
<td>160</td>
<td>1.0097**</td>
<td>1.0657**</td>
<td>1.0178</td>
<td>1.0273**</td>
<td>0.9778**</td>
<td>1.0039</td>
<td>0.9967**</td>
<td>1.0138**</td>
</tr>
<tr>
<td>CAPITAL ONE</td>
<td>140</td>
<td>1.0599**</td>
<td>1.0493**</td>
<td>1.0958</td>
<td>1.0712**</td>
<td>1.1366**</td>
<td>1.0891</td>
<td>1.0535**</td>
<td>1.0013**</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>138</td>
<td>1.0653**</td>
<td>1.0628**</td>
<td>1.0384</td>
<td>1.0406**</td>
<td>1.0414**</td>
<td>1.0242**</td>
<td>1.0668**</td>
<td>1.0294**</td>
</tr>
<tr>
<td>REGIONS</td>
<td>132</td>
<td>1.0712**</td>
<td>1.0605**</td>
<td>1.0212**</td>
<td>1.0026**</td>
<td>0.9968**</td>
<td>1.0274**</td>
<td>0.9694**</td>
<td>1.0247**</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>126</td>
<td>1.1016</td>
<td>1.1009</td>
<td>1.0012**</td>
<td>1.0003**</td>
<td>0.9959**</td>
<td>0.9993**</td>
<td>0.9946**</td>
<td>0.9980**</td>
</tr>
<tr>
<td>BK OF NY CO</td>
<td>121</td>
<td>1.0316**</td>
<td>1.0496**</td>
<td>0.9897</td>
<td>0.9056**</td>
<td>0.9861**</td>
<td>0.9735**</td>
<td>0.9979**</td>
<td>0.9926**</td>
</tr>
<tr>
<td>FIFTH THIRD BC</td>
<td>118</td>
<td>1.0887**</td>
<td>1.0862**</td>
<td>1.0409**</td>
<td>1.0522**</td>
<td>1.0265**</td>
<td>1.0240**</td>
<td>1.0496**</td>
<td>1.0250**</td>
</tr>
<tr>
<td>PNC FNLC SVC GROUP</td>
<td>115</td>
<td>1.0960**</td>
<td>1.0778**</td>
<td>1.0402**</td>
<td>1.0571**</td>
<td>1.0377**</td>
<td>1.0126**</td>
<td>1.0891</td>
<td>1.0178**</td>
</tr>
<tr>
<td>KEYCORP</td>
<td>108</td>
<td>1.0104**</td>
<td>1.0161**</td>
<td>1.0566**</td>
<td>1.0646**</td>
<td>1.0711**</td>
<td>1.0577**</td>
<td>1.0878**</td>
<td>1.0608**</td>
</tr>
<tr>
<td>LASALLE BK</td>
<td>83</td>
<td>1.0681**</td>
<td>1.0594**</td>
<td>1.0661**</td>
<td>1.0359**</td>
<td>1.0951**</td>
<td>1.0023**</td>
<td>1.0555**</td>
<td>1.0211**</td>
</tr>
<tr>
<td>COMERICA</td>
<td>68</td>
<td>1.0480**</td>
<td>1.0416**</td>
<td>1.0460**</td>
<td>1.0454**</td>
<td>1.0432**</td>
<td>1.0491**</td>
<td>1.0533**</td>
<td>1.0482**</td>
</tr>
<tr>
<td>NORTHERN TR</td>
<td>66</td>
<td>1.0372**</td>
<td>1.0623**</td>
<td>1.0207**</td>
<td>1.0024**</td>
<td>1.0271**</td>
<td>1.0377**</td>
<td>1.0003**</td>
<td>1.0453**</td>
</tr>
<tr>
<td>BK OF THE WEST</td>
<td>64</td>
<td>1.1092**</td>
<td>1.1023**</td>
<td>1.0919**</td>
<td>1.1058**</td>
<td>1.1235**</td>
<td>1.0506**</td>
<td>1.1442**</td>
<td>1.0667**</td>
</tr>
<tr>
<td>MANUFACTURERS &amp; TRADERS TC</td>
<td>64</td>
<td>1.0691**</td>
<td>1.0661**</td>
<td>1.0855**</td>
<td>1.0898**</td>
<td>1.0958</td>
<td>1.0900</td>
<td>1.1017</td>
<td>1.0962**</td>
</tr>
<tr>
<td>MARSHALL &amp; HSLEY</td>
<td>64</td>
<td>1.0586**</td>
<td>1.0543**</td>
<td>1.0482**</td>
<td>1.0683**</td>
<td>1.0543**</td>
<td>1.0425**</td>
<td>1.0965</td>
<td>1.0462**</td>
</tr>
<tr>
<td>UNION BK OF CA</td>
<td>59</td>
<td>0.9759**</td>
<td>0.9673**</td>
<td>1.0263**</td>
<td>1.0168**</td>
<td>1.0209**</td>
<td>1.0469**</td>
<td>1.0068**</td>
<td>1.0438**</td>
</tr>
</tbody>
</table>

**NOTE:** For Models 1–2, estimates of $(1 - \xi_{C,k})\delta$ are reported ($\delta = 1.1$). For Models 3–4 and Models 5–8, estimates of $(1 + \xi_{R,k})\delta$ and $(1 + \xi_{C,k})\delta$ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table E.8: Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPULAR</td>
<td>54</td>
<td>1.0844***</td>
<td>1.0875***</td>
<td>1.0795***</td>
<td>1.0876***</td>
<td>1.0801</td>
<td>1.0113***</td>
<td>1.0861</td>
<td>1.0321***</td>
</tr>
<tr>
<td>ZIONS BC</td>
<td>53</td>
<td>1.0919***</td>
<td>1.0921***</td>
<td>1.0542***</td>
<td>1.0503***</td>
<td>1.0653***</td>
<td>1.0628***</td>
<td>1.0842***</td>
<td>1.0614***</td>
</tr>
<tr>
<td>CHARTER ONE BK</td>
<td>53</td>
<td>1.1178</td>
<td>1.1083</td>
<td>1.1241***</td>
<td>1.1227***</td>
<td>1.1989***</td>
<td>1.1201</td>
<td>1.1751***</td>
<td>1.1376***</td>
</tr>
<tr>
<td>COMMERCE BC</td>
<td>51</td>
<td>1.0732***</td>
<td>1.0740***</td>
<td>1.0337***</td>
<td>1.0361***</td>
<td>1.0449***</td>
<td>1.0552***</td>
<td>1.0546***</td>
<td>1.0638***</td>
</tr>
<tr>
<td>HARRIS</td>
<td>47</td>
<td>1.1334***</td>
<td>1.1337***</td>
<td>1.0632***</td>
<td>1.0864***</td>
<td>1.0133***</td>
<td>1.0573***</td>
<td>0.9955***</td>
<td>0.9299***</td>
</tr>
<tr>
<td>TD BANKNORTH</td>
<td>46</td>
<td>1.1111***</td>
<td>1.1007</td>
<td>1.1713***</td>
<td>1.1966***</td>
<td>1.2452***</td>
<td>1.2089***</td>
<td>1.2863***</td>
<td>1.2148***</td>
</tr>
<tr>
<td>FIRST HORIZON T</td>
<td>45</td>
<td>1.0543***</td>
<td>1.0443***</td>
<td>1.0503***</td>
<td>1.0779</td>
<td>1.0618***</td>
<td>1.0631***</td>
<td>1.1190</td>
<td>1.0524***</td>
</tr>
<tr>
<td>HUNTINGTON BSRs</td>
<td>41</td>
<td>1.1154***</td>
<td>1.1144</td>
<td>1.0244***</td>
<td>1.0473***</td>
<td>1.0312***</td>
<td>1.0475***</td>
<td>1.0510***</td>
<td>1.0532***</td>
</tr>
<tr>
<td>CITIZENS BK OF MA</td>
<td>41</td>
<td>1.0523***</td>
<td>1.0272***</td>
<td>1.1014</td>
<td>1.1726***</td>
<td>1.1086</td>
<td>1.0514***</td>
<td>1.1550</td>
<td>1.0582***</td>
</tr>
<tr>
<td>COMPASS BSRs</td>
<td>39</td>
<td>1.1033</td>
<td>1.0938***</td>
<td>1.0316***</td>
<td>1.0256***</td>
<td>1.0421***</td>
<td>1.0378***</td>
<td>1.0483***</td>
<td>1.0449***</td>
</tr>
<tr>
<td>SYNOVUS</td>
<td>36</td>
<td>1.0882***</td>
<td>1.0855***</td>
<td>1.0951</td>
<td>1.1067</td>
<td>1.0951</td>
<td>1.0945</td>
<td>1.1165</td>
<td>1.0884***</td>
</tr>
<tr>
<td>NEW YORK CMNTY BC</td>
<td>33</td>
<td>1.0449***</td>
<td>1.0463***</td>
<td>1.0355***</td>
<td>1.0201***</td>
<td>1.0402***</td>
<td>1.0574***</td>
<td>1.0233***</td>
<td>1.0633***</td>
</tr>
<tr>
<td>MELLON BK</td>
<td>31</td>
<td>1.1076</td>
<td>1.0839***</td>
<td>1.0441***</td>
<td>1.0444***</td>
<td>1.0730***</td>
<td>1.0746***</td>
<td>1.0739***</td>
<td>1.0749***</td>
</tr>
<tr>
<td>COLONIAL BANCGROUP</td>
<td>26</td>
<td>1.0923***</td>
<td>1.0968</td>
<td>1.0919***</td>
<td>1.0942***</td>
<td>1.0834***</td>
<td>1.0457***</td>
<td>1.0693***</td>
<td>1.0549***</td>
</tr>
<tr>
<td>RBC CENTURA BK</td>
<td>25</td>
<td>1.1032</td>
<td>1.1144***</td>
<td>1.0632***</td>
<td>1.0680***</td>
<td>1.1125***</td>
<td>1.1441</td>
<td>1.1259***</td>
<td>1.1120***</td>
</tr>
<tr>
<td>ASSOCIATED BANC</td>
<td>24</td>
<td>1.0809***</td>
<td>1.0859***</td>
<td>1.0496***</td>
<td>1.0430***</td>
<td>1.0672***</td>
<td>1.0954***</td>
<td>1.0796***</td>
<td>1.1077***</td>
</tr>
<tr>
<td>BOK</td>
<td>20</td>
<td>1.0456***</td>
<td>1.0532***</td>
<td>1.0631***</td>
<td>1.0435***</td>
<td>1.1000***</td>
<td>1.0865***</td>
<td>1.0756***</td>
<td>1.0752***</td>
</tr>
<tr>
<td>MERCANTILE BSRs</td>
<td>20</td>
<td>1.0557***</td>
<td>1.0356***</td>
<td>1.0980***</td>
<td>1.1373***</td>
<td>1.1237***</td>
<td>1.0917***</td>
<td>1.1513***</td>
<td>1.0944***</td>
</tr>
<tr>
<td>WEBSTER FNCL</td>
<td>20</td>
<td>1.0748***</td>
<td>1.0792***</td>
<td>1.0084***</td>
<td>0.9925***</td>
<td>1.0517***</td>
<td>1.0349***</td>
<td>1.0603***</td>
<td>1.0345***</td>
</tr>
<tr>
<td>CITIZENS BK</td>
<td>19</td>
<td>1.1007</td>
<td>1.1015</td>
<td>1.1647***</td>
<td>1.1917***</td>
<td>1.3255***</td>
<td>1.2915***</td>
<td>1.3406***</td>
<td>1.2613***</td>
</tr>
<tr>
<td>SKY FNCL GROUP</td>
<td>19</td>
<td>1.0631***</td>
<td>1.0622***</td>
<td>1.0967***</td>
<td>1.0907***</td>
<td>1.1108***</td>
<td>1.1074***</td>
<td>1.1062***</td>
<td>1.1010***</td>
</tr>
<tr>
<td>FIRST CITIZENS BSRs</td>
<td>18</td>
<td>1.0589***</td>
<td>1.0514***</td>
<td>1.0659***</td>
<td>1.0713***</td>
<td>1.0603***</td>
<td>1.0624***</td>
<td>1.0796***</td>
<td>1.0601***</td>
</tr>
<tr>
<td>COMMERCE BSRs</td>
<td>17</td>
<td>1.1478***</td>
<td>1.1735***</td>
<td>1.0766***</td>
<td>1.0901***</td>
<td>1.0888***</td>
<td>1.0834***</td>
<td>1.1123***</td>
<td>1.1058***</td>
</tr>
<tr>
<td>FULTON FNCL</td>
<td>17</td>
<td>1.0992</td>
<td>1.0988</td>
<td>1.0408***</td>
<td>1.0460***</td>
<td>1.1043***</td>
<td>1.0758***</td>
<td>1.0888***</td>
<td>1.0885***</td>
</tr>
<tr>
<td>CITY T</td>
<td>17</td>
<td>1.2171***</td>
<td>1.2179***</td>
<td>1.0880***</td>
<td>0.9777***</td>
<td>1.1356***</td>
<td>1.0924***</td>
<td>1.1202***</td>
<td>1.0885***</td>
</tr>
</tbody>
</table>

**Dep. Var.**
- $C_i/W_1$(y, w_1)
- $C_2/W_1$(y, w_1)
- $R_1$(y, w_2)
- $R_2$(y, w_2)
- $R_1 - C_1$(y, w_2)
- $R_2 - C_2$(y, w_2)

**RHS Vars.**
- $(y, w_1)$
- $(y, w_2)$

**Note:** For Models 1–2, estimates of $(1 - E C_i)/(1 - E C_i)$ are reported $(\delta = 1.1)$. For Models 3–4 and Models 5–8, estimates of $(1 + \delta E R_i)$ and $(1 + \delta E R_i)$ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.8: Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCF</td>
<td>17</td>
<td>1.0986</td>
<td>1.1015</td>
<td>1.1417</td>
<td>1.1735</td>
<td>1.1410</td>
<td>1.1257</td>
<td>1.1621</td>
<td>1.1172</td>
</tr>
<tr>
<td>SOUTH FNCL GROUP</td>
<td>16</td>
<td>1.1092</td>
<td>1.1054</td>
<td>1.0031</td>
<td>1.0212</td>
<td>1.0477</td>
<td>1.0630</td>
<td>1.0725</td>
<td>1.0504</td>
</tr>
<tr>
<td>CITIZENS BK RI</td>
<td>16</td>
<td>1.0626</td>
<td>1.0171</td>
<td>1.0337</td>
<td>1.0336</td>
<td>1.0267</td>
<td>1.0282</td>
<td>1.0345</td>
<td>1.0331</td>
</tr>
<tr>
<td>FBOP</td>
<td>16</td>
<td>1.0911</td>
<td>1.0642</td>
<td>0.9747</td>
<td>0.9718</td>
<td>0.9554</td>
<td>0.9706</td>
<td>0.9852</td>
<td>0.9999</td>
</tr>
<tr>
<td>CULLEN/FROST BKR</td>
<td>14</td>
<td>1.0775</td>
<td>1.0773</td>
<td>1.0274</td>
<td>1.0015</td>
<td>1.0774</td>
<td>1.0643</td>
<td>1.0478</td>
<td>1.0494</td>
</tr>
<tr>
<td>VALLEY T BC</td>
<td>14</td>
<td>1.1521</td>
<td>1.1609</td>
<td>1.0634</td>
<td>1.0722</td>
<td>1.0947</td>
<td>1.0720</td>
<td>1.1184</td>
<td>1.0780</td>
</tr>
<tr>
<td>BANCORPSOUTH</td>
<td>14</td>
<td>1.1461</td>
<td>1.1636</td>
<td>1.0544</td>
<td>1.0485</td>
<td>1.0527</td>
<td>1.0536</td>
<td>1.0598</td>
<td>1.0567</td>
</tr>
<tr>
<td>FIRST HAWAIIAN BK</td>
<td>14</td>
<td>1.1066</td>
<td>1.1012</td>
<td>1.0817</td>
<td>1.0771</td>
<td>1.0621</td>
<td>1.0607</td>
<td>1.0618</td>
<td>1.0374</td>
</tr>
<tr>
<td>INVESTORS FNCL SVC</td>
<td>13</td>
<td>1.0873</td>
<td>1.0866</td>
<td>1.0102</td>
<td>1.0051</td>
<td>1.0086</td>
<td>1.0062</td>
<td>1.0084</td>
<td>1.0060</td>
</tr>
<tr>
<td>WILMINGTON TR</td>
<td>13</td>
<td>1.0806</td>
<td>1.0809</td>
<td>1.0912</td>
<td>1.1011</td>
<td>1.1523</td>
<td>1.0925</td>
<td>1.1393</td>
<td>1.0931</td>
</tr>
<tr>
<td>CITIZENS BKG</td>
<td>12</td>
<td>1.1025</td>
<td>1.1056</td>
<td>1.1381</td>
<td>1.2009</td>
<td>1.1388</td>
<td>1.1285</td>
<td>1.1796</td>
<td>1.1314</td>
</tr>
<tr>
<td>EAST W BC</td>
<td>12</td>
<td>1.0456</td>
<td>1.0579</td>
<td>1.1054</td>
<td>1.0758</td>
<td>1.0548</td>
<td>1.1015</td>
<td>1.0843</td>
<td>1.0837</td>
</tr>
<tr>
<td>INTERNATIONAL BSHRS</td>
<td>12</td>
<td>1.1174</td>
<td>1.1318</td>
<td>1.0751</td>
<td>1.0760</td>
<td>1.0385</td>
<td>1.0056</td>
<td>1.0371</td>
<td>1.0065</td>
</tr>
<tr>
<td>BK OF HI</td>
<td>12</td>
<td>1.0758</td>
<td>1.0636</td>
<td>1.0612</td>
<td>1.0545</td>
<td>1.0548</td>
<td>1.1015</td>
<td>1.0843</td>
<td>1.0837</td>
</tr>
<tr>
<td>FIRSTMERIT</td>
<td>12</td>
<td>1.1206</td>
<td>1.1195</td>
<td>1.0825</td>
<td>1.0880</td>
<td>1.1185</td>
<td>1.1436</td>
<td>1.1140</td>
<td>1.1010</td>
</tr>
<tr>
<td>WHITNEY BC</td>
<td>12</td>
<td>1.0883</td>
<td>1.0770</td>
<td>1.0652</td>
<td>1.0629</td>
<td>1.0724</td>
<td>1.0774</td>
<td>1.0752</td>
<td>1.0585</td>
</tr>
<tr>
<td>CORUS BSHRS</td>
<td>11</td>
<td>1.0535</td>
<td>1.0542</td>
<td>0.9804</td>
<td>0.9377</td>
<td>0.9794</td>
<td>0.9732</td>
<td>0.9598</td>
<td>0.9811</td>
</tr>
<tr>
<td>FIRST BKS</td>
<td>11</td>
<td>1.0951</td>
<td>1.0945</td>
<td>0.9958</td>
<td>0.9649</td>
<td>1.0182</td>
<td>1.0686</td>
<td>0.9993</td>
<td>1.0602</td>
</tr>
<tr>
<td>WINTERTRUST</td>
<td>11</td>
<td>1.0813</td>
<td>1.0811</td>
<td>0.9872</td>
<td>0.9903</td>
<td>0.9841</td>
<td>0.9689</td>
<td>1.0087</td>
<td>1.0054</td>
</tr>
<tr>
<td>STERLING</td>
<td>11</td>
<td>1.1576</td>
<td>1.1652</td>
<td>1.0776</td>
<td>1.0788</td>
<td>1.1071</td>
<td>1.0499</td>
<td>1.1141</td>
<td>1.0497</td>
</tr>
<tr>
<td>UCBH HOLD</td>
<td>11</td>
<td>1.0069</td>
<td>1.0547</td>
<td>1.0229</td>
<td>1.0213</td>
<td>0.9872</td>
<td>0.9424</td>
<td>0.9863</td>
<td>0.9489</td>
</tr>
<tr>
<td>ISRAEL DISCOUNT BK OF NY</td>
<td>10</td>
<td>1.1099</td>
<td>1.1156</td>
<td>1.0572</td>
<td>1.0551</td>
<td>1.1084</td>
<td>1.0511</td>
<td>1.0922</td>
<td>1.0335</td>
</tr>
<tr>
<td>TRUSTMARK</td>
<td>10</td>
<td>1.1242</td>
<td>1.1340</td>
<td>1.0808</td>
<td>1.0826</td>
<td>1.0745</td>
<td>1.0809</td>
<td>1.0910</td>
<td>1.0870</td>
</tr>
<tr>
<td>ARVEST BK GRP</td>
<td>10</td>
<td>1.1360</td>
<td>1.1373</td>
<td>1.0538</td>
<td>1.0567</td>
<td>1.0467</td>
<td>1.0513</td>
<td>1.0637</td>
<td>1.0625</td>
</tr>
<tr>
<td>FIRST MIDWEST BC</td>
<td>10</td>
<td>1.1208</td>
<td>1.1168</td>
<td>1.0651</td>
<td>1.0624</td>
<td>1.0657</td>
<td>1.0637</td>
<td>1.0470</td>
<td>1.0622</td>
</tr>
</tbody>
</table>

**Dep. Var.**
- C1/W1
- C2/W1
- R1
- R2
- R1 – C1
- R1 – C2
- R2 – C1
- R2 – C2

**RHS Vars.**
- (y, w1)
- (y, w2)
- (y, w3)
- (y, w4)
- (y, w5)
- (y, w6)
- (y, w7)
- (y, w8)

**NOTE:** For Models 1–2, estimates of \((1 - \varepsilon_{C1,i})\)δ are reported (δ = 1.1). For Models 3–4 and Models 5–8, estimates of \((1 + \varepsilon_{R,i})\)δ and \((1 + \varepsilon_{w,i})\)δ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.8: Returns to Scale for 100 Largest Banks by Total Assets, 2006.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>UMB</td>
<td>10</td>
<td>1.1228</td>
<td>1.1142</td>
<td>1.1489**</td>
<td>1.2149**</td>
<td>1.1477**</td>
<td>1.1286</td>
<td>1.2258**</td>
<td>1.1335</td>
</tr>
<tr>
<td>SUSQUEHANNA BSHRS</td>
<td>9</td>
<td>1.1567**</td>
<td>1.1637**</td>
<td>1.0468**</td>
<td>1.0688**</td>
<td>1.0741</td>
<td>1.0874</td>
<td>1.0595**</td>
<td>1.0863**</td>
</tr>
<tr>
<td>OLD T BC</td>
<td>9</td>
<td>1.1288</td>
<td>1.1263</td>
<td>1.0670**</td>
<td>1.0556**</td>
<td>1.1009</td>
<td>1.0682**</td>
<td>1.0793</td>
<td>1.0561**</td>
</tr>
<tr>
<td>MB FNCL</td>
<td>9</td>
<td>1.0239**</td>
<td>1.0272**</td>
<td>1.0288**</td>
<td>1.0140</td>
<td>1.0238**</td>
<td>0.9586**</td>
<td>1.0039**</td>
<td>0.9771**</td>
</tr>
<tr>
<td>CATHAY GEN BC</td>
<td>9</td>
<td>1.0437**</td>
<td>1.0568**</td>
<td>1.0750**</td>
<td>1.0589**</td>
<td>1.0428**</td>
<td>1.0273**</td>
<td>1.0148**</td>
<td>1.0294**</td>
</tr>
<tr>
<td>FIRSTBANK HC</td>
<td>9</td>
<td>1.0874**</td>
<td>1.0762**</td>
<td>1.0361**</td>
<td>1.0861</td>
<td>1.0273**</td>
<td>1.0088**</td>
<td>1.025**</td>
<td>1.0138**</td>
</tr>
<tr>
<td>GREATER BAY BC</td>
<td>8</td>
<td>1.1129</td>
<td>1.1261</td>
<td>1.0753**</td>
<td>1.0857</td>
<td>1.0961</td>
<td>1.0904**</td>
<td>1.1427**</td>
<td>1.0669**</td>
</tr>
<tr>
<td>PACIFIC CAP BC</td>
<td>8</td>
<td>1.0978</td>
<td>1.1091</td>
<td>1.0424**</td>
<td>1.0027**</td>
<td>1.0582**</td>
<td>1.0967</td>
<td>1.0436**</td>
<td>1.0876**</td>
</tr>
<tr>
<td>UMPQUA HC</td>
<td>8</td>
<td>1.0712**</td>
<td>1.0774**</td>
<td>1.0275**</td>
<td>1.0359**</td>
<td>0.9837**</td>
<td>0.9746**</td>
<td>0.9838**</td>
<td>0.9781**</td>
</tr>
<tr>
<td>ALABAMA NBC</td>
<td>8</td>
<td>1.0644**</td>
<td>1.0677**</td>
<td>1.0396**</td>
<td>1.0243**</td>
<td>1.0418**</td>
<td>1.0128**</td>
<td>1.0249**</td>
<td>1.0030**</td>
</tr>
<tr>
<td>CENTRAL BANKCOMPANY</td>
<td>8</td>
<td>1.0999</td>
<td>1.1123</td>
<td>1.0643**</td>
<td>1.0725**</td>
<td>1.0465**</td>
<td>1.0315**</td>
<td>1.0455**</td>
<td>1.0344**</td>
</tr>
<tr>
<td>UNITED CMTY BK</td>
<td>8</td>
<td>1.0868**</td>
<td>1.0862**</td>
<td>1.0410**</td>
<td>1.0528**</td>
<td>1.0497**</td>
<td>1.0532**</td>
<td>1.0684**</td>
<td>1.0550**</td>
</tr>
<tr>
<td>UNITED BSHRS</td>
<td>8</td>
<td>1.1273</td>
<td>1.1282</td>
<td>1.0741**</td>
<td>1.0689**</td>
<td>1.0692</td>
<td>1.0715</td>
<td>1.0535</td>
<td>1.0539**</td>
</tr>
<tr>
<td>CHITTENDEN</td>
<td>8</td>
<td>1.0248**</td>
<td>1.0090**</td>
<td>1.0477**</td>
<td>1.0892**</td>
<td>1.0498**</td>
<td>1.0424**</td>
<td>1.0566</td>
<td>1.0525**</td>
</tr>
<tr>
<td>PROVIDENT BSHRS</td>
<td>7</td>
<td>1.1496*</td>
<td>1.1530**</td>
<td>1.0554**</td>
<td>1.0505**</td>
<td>1.1066</td>
<td>1.0582**</td>
<td>1.0872</td>
<td>1.0462**</td>
</tr>
<tr>
<td>IRWIN</td>
<td>7</td>
<td>1.1107</td>
<td>1.1108</td>
<td>1.0799**</td>
<td>1.0766**</td>
<td>1.1196**</td>
<td>1.1185</td>
<td>1.1231**</td>
<td>1.0781**</td>
</tr>
<tr>
<td>HANCOCK HC</td>
<td>7</td>
<td>1.1547**</td>
<td>1.1716**</td>
<td>1.0853**</td>
<td>1.0717**</td>
<td>1.0628**</td>
<td>1.0287**</td>
<td>1.0631**</td>
<td>1.0385**</td>
</tr>
<tr>
<td>FIRST COMMONWEALTH FNCL</td>
<td>7</td>
<td>1.1495**</td>
<td>1.1825</td>
<td>1.1228**</td>
<td>1.1231**</td>
<td>1.1440**</td>
<td>1.1030</td>
<td>1.1405**</td>
<td>1.1053**</td>
</tr>
<tr>
<td>FNB</td>
<td>7</td>
<td>1.1405**</td>
<td>1.1641**</td>
<td>1.1563**</td>
<td>1.1043</td>
<td>1.1095**</td>
<td>1.1209**</td>
<td>1.0774</td>
<td>1.1210**</td>
</tr>
<tr>
<td>CVB</td>
<td>7</td>
<td>1.0657**</td>
<td>1.0788**</td>
<td>1.0378**</td>
<td>1.0506**</td>
<td>0.9989**</td>
<td>0.9552**</td>
<td>1.0176**</td>
<td>0.9407**</td>
</tr>
<tr>
<td>OCEAN BSHRS</td>
<td>7</td>
<td>1.0386**</td>
<td>1.0407**</td>
<td>1.0767**</td>
<td>1.0967**</td>
<td>1.0471**</td>
<td>0.9911**</td>
<td>1.0651**</td>
<td>1.0035**</td>
</tr>
<tr>
<td>FIRST CITIZENS BC</td>
<td>7</td>
<td>1.1342**</td>
<td>1.1446**</td>
<td>1.0445**</td>
<td>1.0777**</td>
<td>1.0422**</td>
<td>1.0036**</td>
<td>1.0315**</td>
<td>1.0221**</td>
</tr>
<tr>
<td>BANK LEUMI USA</td>
<td>7</td>
<td>1.0395**</td>
<td>1.0341**</td>
<td>1.0494**</td>
<td>1.0398**</td>
<td>1.0092**</td>
<td>0.9887**</td>
<td>1.0078**</td>
<td>1.0154**</td>
</tr>
<tr>
<td>CENTRAL PACIFIC FNCL</td>
<td>6</td>
<td>1.1250**</td>
<td>1.1241</td>
<td>1.0989**</td>
<td>1.1355**</td>
<td>1.0603**</td>
<td>1.0933**</td>
<td>1.0870**</td>
<td>1.0622**</td>
</tr>
<tr>
<td>PARK T</td>
<td>6</td>
<td>1.0987</td>
<td>1.0990</td>
<td>1.0807**</td>
<td>1.0703**</td>
<td>1.0684**</td>
<td>1.0719**</td>
<td>1.0598**</td>
<td>1.0641**</td>
</tr>
</tbody>
</table>

Dep. Var. | $C_1/W_1$ | $C_2/W_1$ | $R_1$ | $R_2$ | $R_1 - C_1$ | $R_1 - C_2$ | $R_2 - C_1$ | $R_2 - C_2$

RHS Vars. | $(y, w_1)$ | $(y, w_1)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$

**Note:** For Models 1-2, estimates of $(1 - \varepsilon_{C_i})\delta$ are reported ($\delta = 1.1$). For Models 3-4 and Models 5-8, estimates of $(1 + \varepsilon_{R_i})\delta$ and $(1 + \varepsilon_{C_i})\delta$ are given. For Models 1-2, values less than 1.1 indicate increasing returns to scale, while for Models 3-8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.9: Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPMorgan Chase &amp; Co</td>
<td>2378</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Citigroup</td>
<td>1764</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Wells Fargo &amp; Co</td>
<td>2384</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bank of NY Mellon</td>
<td>2145</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SunTrust</td>
<td>209</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fifth Third BK</td>
<td>139</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BofA West</td>
<td>75</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>KeyCorp</td>
<td>95</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M&amp;I</td>
<td>1139</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>COMPASS BK</td>
<td>85</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>National BK</td>
<td>70</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>First Niagara FNL Group</td>
<td>40</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTE: For Models 1–2, estimates of $E_\delta^{\pi,i}$ are reported ($E_\delta = 1$). For Models 3–8, estimates of $E_\delta^{\pi,i}$ are given. For Models 1–2, values greater than 1 indicate increasing returns to scale, while for Models 3–8, values greater than 1 indicate increasing returns to scale. Statistical significance (difference from 1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.9: Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOPLES UNITED FNCL INC</td>
<td>38</td>
<td>1.1334***</td>
<td>1.1154</td>
<td>1.0496***</td>
<td>1.0493***</td>
<td>1.0563***</td>
<td>1.0433***</td>
<td>1.0489***</td>
<td>1.0297***</td>
</tr>
<tr>
<td>POPULAR</td>
<td>36</td>
<td>1.0997</td>
<td>1.0107</td>
<td>1.0478***</td>
<td>1.0801***</td>
<td>1.0925***</td>
<td>1.0675</td>
<td>1.0619***</td>
<td>1.0763</td>
</tr>
<tr>
<td>EAST WEST BC</td>
<td>32</td>
<td>1.1034***</td>
<td>1.0372***</td>
<td>1.0350***</td>
<td>1.0293***</td>
<td>1.0203***</td>
<td>1.0379***</td>
<td>0.9997***</td>
<td>1.0361***</td>
</tr>
<tr>
<td>FIRST CITIZENS BSHRS</td>
<td>31</td>
<td>1.2064***</td>
<td>1.2111***</td>
<td>1.0512***</td>
<td>1.0546***</td>
<td>1.0461</td>
<td>1.0253***</td>
<td>1.0492***</td>
<td>1.0337***</td>
</tr>
<tr>
<td>BBK</td>
<td>31</td>
<td>1.1142</td>
<td>1.1215</td>
<td>1.0292***</td>
<td>1.0279***</td>
<td>1.0240***</td>
<td>1.0330***</td>
<td>1.0240***</td>
<td>1.0332***</td>
</tr>
<tr>
<td>CULLEN/FROST BKR</td>
<td>28</td>
<td>1.1812***</td>
<td>1.1352</td>
<td>1.0423***</td>
<td>1.0448***</td>
<td>1.0334***</td>
<td>1.0638***</td>
<td>1.0345***</td>
<td>1.0082***</td>
</tr>
<tr>
<td>SYNOVUS</td>
<td>28</td>
<td>1.1381</td>
<td>1.1565</td>
<td>1.0378***</td>
<td>1.0422***</td>
<td>1.0406</td>
<td>1.0191</td>
<td>1.0418***</td>
<td>1.0232***</td>
</tr>
<tr>
<td>ASSOCIATED BANC-CORP</td>
<td>28</td>
<td>1.0712***</td>
<td>1.0556***</td>
<td>1.0348***</td>
<td>1.0294***</td>
<td>1.0394***</td>
<td>1.0358***</td>
<td>1.0364***</td>
<td>1.0356***</td>
</tr>
<tr>
<td>FIRST HORIZON T</td>
<td>26</td>
<td>1.1276</td>
<td>1.1358</td>
<td>1.0304***</td>
<td>1.0290***</td>
<td>1.0143***</td>
<td>1.0441***</td>
<td>1.0021***</td>
<td>1.0413***</td>
</tr>
<tr>
<td>FIRSTMERIT</td>
<td>25</td>
<td>1.2250***</td>
<td>1.2220***</td>
<td>1.0311***</td>
<td>1.0307***</td>
<td>1.0347***</td>
<td>1.1115</td>
<td>1.0342***</td>
<td>1.1031</td>
</tr>
<tr>
<td>WEBSTER FNCL</td>
<td>24</td>
<td>1.1596</td>
<td>1.1715</td>
<td>1.0381***</td>
<td>1.0254***</td>
<td>1.0267***</td>
<td>1.0402***</td>
<td>1.0306***</td>
<td>1.0426***</td>
</tr>
<tr>
<td>COMMERCE BSHRS</td>
<td>24</td>
<td>1.1767***</td>
<td>1.1988***</td>
<td>1.0553***</td>
<td>1.0596***</td>
<td>1.0496***</td>
<td>1.0330***</td>
<td>1.0555***</td>
<td>1.0388***</td>
</tr>
<tr>
<td>UMPQUA H C</td>
<td>23</td>
<td>1.0683***</td>
<td>1.0712***</td>
<td>1.0263***</td>
<td>1.0273***</td>
<td>1.0291***</td>
<td>1.0961</td>
<td>1.0332***</td>
<td>1.0863</td>
</tr>
<tr>
<td>BANKUNITED</td>
<td>23</td>
<td>1.0605***</td>
<td>1.0617***</td>
<td>1.0451***</td>
<td>1.0394***</td>
<td>1.0319***</td>
<td>1.0628</td>
<td>1.0236***</td>
<td>1.0454</td>
</tr>
<tr>
<td>WINTRUST</td>
<td>22</td>
<td>1.1496***</td>
<td>1.1393</td>
<td>1.0669***</td>
<td>1.0694***</td>
<td>1.0515***</td>
<td>1.0123***</td>
<td>1.0601***</td>
<td>1.0247***</td>
</tr>
<tr>
<td>HANCOCK H C</td>
<td>22</td>
<td>1.1404</td>
<td>1.1680***</td>
<td>1.0629***</td>
<td>1.0752***</td>
<td>1.0596***</td>
<td>1.0275***</td>
<td>1.0757***</td>
<td>1.0401***</td>
</tr>
<tr>
<td>PROSPERITY BSHRS</td>
<td>22</td>
<td>1.0660***</td>
<td>1.0616***</td>
<td>1.0240***</td>
<td>1.0304***</td>
<td>1.0167***</td>
<td>0.9989***</td>
<td>1.0161***</td>
<td>0.9988***</td>
</tr>
<tr>
<td>VALLEY T BC</td>
<td>21</td>
<td>1.1443***</td>
<td>1.1336</td>
<td>1.0896***</td>
<td>1.0863***</td>
<td>1.0983</td>
<td>1.0773***</td>
<td>1.1207***</td>
<td>1.0884***</td>
</tr>
<tr>
<td>TCF</td>
<td>20</td>
<td>1.2352***</td>
<td>1.2725***</td>
<td>1.0588***</td>
<td>1.0761***</td>
<td>1.0513***</td>
<td>1.0814</td>
<td>1.0682***</td>
<td>1.0846</td>
</tr>
<tr>
<td>IBERIABANK</td>
<td>19</td>
<td>1.1017</td>
<td>1.1342***</td>
<td>1.0354***</td>
<td>1.0347***</td>
<td>1.0163***</td>
<td>1.0024***</td>
<td>1.0063***</td>
<td>1.0020***</td>
</tr>
<tr>
<td>FIRST HAWAIIAN BK</td>
<td>19</td>
<td>1.2031***</td>
<td>1.2039</td>
<td>1.0468***</td>
<td>1.0408***</td>
<td>1.0322***</td>
<td>0.9977</td>
<td>1.0344***</td>
<td>0.1010***</td>
</tr>
<tr>
<td>PACIFIC WESTERN BK</td>
<td>19</td>
<td>1.0818</td>
<td>1.0521***</td>
<td>1.0292***</td>
<td>1.0237***</td>
<td>1.0152***</td>
<td>1.0152***</td>
<td>1.0131***</td>
<td>1.0276***</td>
</tr>
<tr>
<td>UMB</td>
<td>19</td>
<td>1.0990</td>
<td>1.0734</td>
<td>1.0492***</td>
<td>1.0416***</td>
<td>1.0446***</td>
<td>1.0584***</td>
<td>1.0405***</td>
<td>1.0494***</td>
</tr>
<tr>
<td>TEXAS CAP BK</td>
<td>19</td>
<td>1.1783***</td>
<td>1.1525***</td>
<td>1.0497***</td>
<td>1.0432***</td>
<td>1.0179***</td>
<td>1.0015***</td>
<td>1.0367***</td>
<td>1.0062***</td>
</tr>
<tr>
<td>FIRST NB OF OMAHA</td>
<td>18</td>
<td>1.2206***</td>
<td>1.2119***</td>
<td>1.0709***</td>
<td>1.0732***</td>
<td>1.0640***</td>
<td>1.0421***</td>
<td>1.0788***</td>
<td>1.0452***</td>
</tr>
</tbody>
</table>

**Dep. Var.** | **C1/W1** | **C2/W1** | **R1** | **R2** | **R1 − C1** | **R1 − C2** | **R2 − C1** | **R2 − C2**
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(y, w₁)</td>
<td>(y, w₂)</td>
<td>(y, w₁)</td>
<td>(y, w₂)</td>
<td>(y, w₁)</td>
<td>(y, w₂)</td>
<td>(y, w₁)</td>
<td>(y, w₂)</td>
<td>(y, w₁)</td>
</tr>
</tbody>
</table>

**RHS Vars.**

**NOTE:** For Models 1–2, estimates of (1 − ξC₁/y)δ are reported (δ = 1.1). For Models 3–4 and Models 5–8, estimates of (1 + ξR₁/y)δ and (1 + ξR₂/y)δ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
### Table E.9: Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>FULTON FNCL</td>
<td>18</td>
<td>1.0416***</td>
<td>1.0311***</td>
<td>1.0577***</td>
<td>1.0557***</td>
<td>1.0430***</td>
<td>1.0689***</td>
<td>1.0352***</td>
<td>1.0639***</td>
</tr>
<tr>
<td>FNB</td>
<td>17</td>
<td>1.1844***</td>
<td>1.2074***</td>
<td>1.0596***</td>
<td>1.0557***</td>
<td>1.0430***</td>
<td>1.0689***</td>
<td>1.0352***</td>
<td>1.0639***</td>
</tr>
<tr>
<td>ARVEST BK GRP</td>
<td>16</td>
<td>1.1408***</td>
<td>1.1565***</td>
<td>1.0704***</td>
<td>1.0754***</td>
<td>1.0680***</td>
<td>1.0299***</td>
<td>1.0648***</td>
<td>1.0369***</td>
</tr>
<tr>
<td>BK OF HI</td>
<td>15</td>
<td>1.1899***</td>
<td>1.2277***</td>
<td>1.0642***</td>
<td>1.0662***</td>
<td>1.0627***</td>
<td>1.0466***</td>
<td>1.0660***</td>
<td>1.0499***</td>
</tr>
<tr>
<td>FIRSTBANK HC</td>
<td>15</td>
<td>0.9904***</td>
<td>1.0139***</td>
<td>1.0136***</td>
<td>1.0045***</td>
<td>1.0039***</td>
<td>0.9827***</td>
<td>1.0021***</td>
<td>0.9781***</td>
</tr>
<tr>
<td>RAYMOND JAMES BK</td>
<td>15</td>
<td>1.3002***</td>
<td>1.2036***</td>
<td>1.0469***</td>
<td>1.0170***</td>
<td>1.0250***</td>
<td>1.0389***</td>
<td>1.0215***</td>
<td>1.0402***</td>
</tr>
<tr>
<td>MB FNC</td>
<td>15</td>
<td>1.0488***</td>
<td>1.0404***</td>
<td>1.0400***</td>
<td>1.0348***</td>
<td>1.0406***</td>
<td>1.0078***</td>
<td>0.9874***</td>
<td>1.0096***</td>
</tr>
<tr>
<td>RABOBANK</td>
<td>15</td>
<td>1.0949</td>
<td>1.0924</td>
<td>1.0548***</td>
<td>1.0669***</td>
<td>1.0821</td>
<td>1.1396</td>
<td>1.1080</td>
<td>1.1555</td>
</tr>
<tr>
<td>WASHINGTON FED INC</td>
<td>15</td>
<td>1.0982</td>
<td>1.1108</td>
<td>1.0144***</td>
<td>1.0224***</td>
<td>1.0158***</td>
<td>0.9979***</td>
<td>1.0323***</td>
<td>1.0064***</td>
</tr>
<tr>
<td>WESTERN ALLI BC</td>
<td>14</td>
<td>1.0242***</td>
<td>1.0066***</td>
<td>1.0648***</td>
<td>1.0685***</td>
<td>1.0555***</td>
<td>1.0634</td>
<td>1.0053***</td>
<td>1.0701</td>
</tr>
<tr>
<td>BANCORP SOUTHWEST</td>
<td>14</td>
<td>1.0480***</td>
<td>1.0519***</td>
<td>1.0455***</td>
<td>1.0484***</td>
<td>1.0220***</td>
<td>0.9883***</td>
<td>1.0168***</td>
<td>0.9937***</td>
</tr>
<tr>
<td>CATHAY GEN BC</td>
<td>13</td>
<td>1.0718***</td>
<td>1.0875</td>
<td>1.0265***</td>
<td>1.0598***</td>
<td>1.0621***</td>
<td>0.9792</td>
<td>1.0525***</td>
<td>0.9924</td>
</tr>
<tr>
<td>UNITED BSHS</td>
<td>13</td>
<td>1.1754***</td>
<td>1.1753***</td>
<td>1.0502***</td>
<td>1.0567***</td>
<td>1.0330***</td>
<td>1.0296***</td>
<td>1.0302***</td>
<td>1.0300***</td>
</tr>
<tr>
<td>TRUSTMARK</td>
<td>12</td>
<td>1.0396***</td>
<td>1.0198</td>
<td>1.0466***</td>
<td>1.0457***</td>
<td>1.0367***</td>
<td>1.0193***</td>
<td>1.0838***</td>
<td>1.0267***</td>
</tr>
<tr>
<td>OLD T BC</td>
<td>12</td>
<td>1.1921***</td>
<td>1.2112***</td>
<td>1.0844</td>
<td>1.1030</td>
<td>1.0805***</td>
<td>1.0548***</td>
<td>1.0933***</td>
<td>1.0673***</td>
</tr>
<tr>
<td>INTERNATIONAL BSHS</td>
<td>12</td>
<td>1.0787***</td>
<td>1.0710***</td>
<td>1.0448***</td>
<td>1.0451***</td>
<td>1.0191***</td>
<td>0.9921***</td>
<td>1.0178***</td>
<td>0.9987***</td>
</tr>
<tr>
<td>CENTRAL BANK COMPANY INC</td>
<td>12</td>
<td>1.1054</td>
<td>1.1121</td>
<td>1.0706***</td>
<td>1.0800***</td>
<td>1.0528***</td>
<td>1.0114***</td>
<td>1.0537***</td>
<td>1.0140***</td>
</tr>
<tr>
<td>STERLING BC</td>
<td>12</td>
<td>1.1057</td>
<td>1.0889</td>
<td>1.0564</td>
<td>1.0629</td>
<td>1.0302***</td>
<td>1.0702</td>
<td>1.0409***</td>
<td>1.0733</td>
</tr>
<tr>
<td>BREMER BK</td>
<td>10</td>
<td>1.1821***</td>
<td>1.1796</td>
<td>1.0535***</td>
<td>1.0596***</td>
<td>1.0336***</td>
<td>0.9664***</td>
<td>1.0213***</td>
<td>0.9635***</td>
</tr>
<tr>
<td>GREAT WESTERN BC</td>
<td>10</td>
<td>1.0876***</td>
<td>1.0765***</td>
<td>1.0566***</td>
<td>1.0624***</td>
<td>1.0287***</td>
<td>1.0029***</td>
<td>1.0255***</td>
<td>1.0035***</td>
</tr>
<tr>
<td>FIRST MW BC</td>
<td>10</td>
<td>1.1090</td>
<td>1.1100</td>
<td>1.0638***</td>
<td>1.0917***</td>
<td>1.0474***</td>
<td>0.9810***</td>
<td>1.0603***</td>
<td>0.9799***</td>
</tr>
<tr>
<td>BK OF THE OZARKS</td>
<td>10</td>
<td>1.1063</td>
<td>1.0945</td>
<td>0.9920***</td>
<td>0.9808***</td>
<td>0.9633***</td>
<td>0.9534***</td>
<td>0.9680***</td>
<td>0.9680***</td>
</tr>
<tr>
<td>ISRAEL DISCOUNT BK OF NY</td>
<td>10</td>
<td>1.0679***</td>
<td>1.0421***</td>
<td>1.0981</td>
<td>1.0729</td>
<td>1.1023</td>
<td>1.0572***</td>
<td>1.0792</td>
<td>1.0519***</td>
</tr>
<tr>
<td>EASTERN BSHS</td>
<td>10</td>
<td>1.1816***</td>
<td>1.1733</td>
<td>1.0490***</td>
<td>1.0457***</td>
<td>1.0410***</td>
<td>1.0156***</td>
<td>1.0132***</td>
<td>1.0110***</td>
</tr>
<tr>
<td>NATIONAL PENN BSHS</td>
<td>10</td>
<td>1.0719</td>
<td>1.0586***</td>
<td>1.0679***</td>
<td>1.0622***</td>
<td>1.0540***</td>
<td>1.0183***</td>
<td>1.0699***</td>
<td>1.0216***</td>
</tr>
</tbody>
</table>

**Dep. Var.**

- $C_1/W_1$ 
- $C_2/W_1$ 
- $R_1$ 
- $R_2$ 
- $R_1 - C_1$ 
- $R_1 - C_2$ 
- $R_2 - C_1$ 
- $R_2 - C_2$

**RHS Vars.**

- $(y, w_1)$ 
- $(y, w_2)$ 
- $(y, w_2)$ 
- $(y, w_2)$ 
- $(y, w_2)$ 
- $(y, w_2)$ 
- $(y, w_2)$ 
- $(y, w_2)$

**NOTE:** For Models 1-2, estimates of $(1 - \varepsilon_{C_1})\delta$ are reported ($\delta = 1.1$). For Models 3-4 and Models 5-8, estimates of $(1 + \varepsilon_{R_1})\delta$ and $(1 + \varepsilon_{R_2})\delta$ are given. For Models 1-2, values less than 1.1 indicate increasing returns to scale, while for Models 3-8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.9: Returns to Scale for 100 Largest Banks by Total Assets, 2015.Q4 (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITED CMNTY BK</td>
<td></td>
<td>1.1072</td>
<td>1.1065</td>
<td>1.0663**</td>
<td>1.0779**</td>
<td>1.0532**</td>
<td>1.0328**</td>
<td>1.0197**</td>
<td>0.9189**</td>
</tr>
<tr>
<td>CHEMICAL</td>
<td>9</td>
<td>1.0103**</td>
<td>1.0022**</td>
<td>1.0933**</td>
<td>1.1146</td>
<td>1.0621**</td>
<td>1.0175**</td>
<td>1.0685**</td>
<td>1.0118**</td>
</tr>
<tr>
<td>PREFERRED BC</td>
<td></td>
<td>1.0612**</td>
<td>1.0724**</td>
<td>1.0270**</td>
<td>1.0944**</td>
<td>0.9977**</td>
<td>0.9809**</td>
<td>0.9902**</td>
<td>0.9715**</td>
</tr>
<tr>
<td>GLACIER BC</td>
<td></td>
<td>1.0388**</td>
<td>1.0514**</td>
<td>1.0330**</td>
<td>1.0092</td>
<td>1.0065**</td>
<td>0.9666**</td>
<td>0.9942**</td>
<td>0.9620**</td>
</tr>
<tr>
<td>HOME BSHRS</td>
<td>9</td>
<td>1.0770**</td>
<td>1.0573**</td>
<td>1.0240**</td>
<td>1.0101**</td>
<td>1.0112**</td>
<td>0.9646**</td>
<td>0.9887**</td>
<td>0.9530**</td>
</tr>
<tr>
<td>COLUMBIA BK SYS</td>
<td>9</td>
<td>1.4461***</td>
<td>1.4280**</td>
<td>1.0280**</td>
<td>1.1012**</td>
<td>1.0270**</td>
<td>1.0079**</td>
<td>1.0171**</td>
<td>1.0106**</td>
</tr>
<tr>
<td>FIRST INTTRST BANCSYSTEM</td>
<td>9</td>
<td>1.0351**</td>
<td>1.0622**</td>
<td>1.0874**</td>
<td>1.1070</td>
<td>1.0498**</td>
<td>1.0265**</td>
<td>1.0439**</td>
<td>1.0264**</td>
</tr>
<tr>
<td>PINNACLE FNC/LP</td>
<td>9</td>
<td>1.0744**</td>
<td>1.0079**</td>
<td>1.0260**</td>
<td>1.0102**</td>
<td>0.9966**</td>
<td>0.9980**</td>
<td>0.9824**</td>
<td>1.0141**</td>
</tr>
<tr>
<td>PLAINSCAPITAL BK</td>
<td>9</td>
<td>1.1097</td>
<td>1.0749**</td>
<td>1.0534**</td>
<td>1.0623**</td>
<td>1.0484**</td>
<td>1.0531**</td>
<td>1.0555**</td>
<td>1.0571**</td>
</tr>
<tr>
<td>CADENCE BC LLC</td>
<td>9</td>
<td>1.0690**</td>
<td>1.0719**</td>
<td>1.0782**</td>
<td>1.0549**</td>
<td>1.0751**</td>
<td>1.1326</td>
<td>1.1367</td>
<td>1.1198</td>
</tr>
<tr>
<td>SOUTH ST</td>
<td>9</td>
<td>1.1581**</td>
<td>1.1357</td>
<td>1.0434**</td>
<td>1.0274**</td>
<td>1.0199**</td>
<td>1.0071**</td>
<td>1.0081**</td>
<td>1.0123**</td>
</tr>
<tr>
<td>WESBANCO</td>
<td></td>
<td>1.1274</td>
<td>1.1166</td>
<td>1.0615**</td>
<td>1.0415**</td>
<td>1.0440**</td>
<td>1.0021**</td>
<td>1.0296**</td>
<td>0.9978**</td>
</tr>
<tr>
<td>COMMUNITY BK SYS</td>
<td>8</td>
<td>0.9961**</td>
<td>0.9918**</td>
<td>1.0567**</td>
<td>1.0592**</td>
<td>1.0379**</td>
<td>1.0082**</td>
<td>1.0413**</td>
<td>1.0062**</td>
</tr>
<tr>
<td>NOT BC</td>
<td>8</td>
<td>1.0229**</td>
<td>1.0133**</td>
<td>1.0719**</td>
<td>1.0679**</td>
<td>1.0553**</td>
<td>1.0468**</td>
<td>1.0504**</td>
<td>1.0557**</td>
</tr>
<tr>
<td>MERCANTIL COMMERCEBANK</td>
<td>8</td>
<td>1.0158**</td>
<td>0.9840**</td>
<td>1.0157**</td>
<td>0.9944</td>
<td>0.9840**</td>
<td>0.9959</td>
<td>0.9445**</td>
<td>1.0049**</td>
</tr>
<tr>
<td>FIRST FNC/LP</td>
<td>8</td>
<td>1.0441**</td>
<td>1.0322**</td>
<td>1.0622**</td>
<td>1.0533**</td>
<td>1.0649**</td>
<td>1.0980**</td>
<td>1.0602**</td>
<td>1.0559**</td>
</tr>
<tr>
<td>CUSTOMERS BC</td>
<td>8</td>
<td>1.0300**</td>
<td>1.0339**</td>
<td>1.0681**</td>
<td>1.0968</td>
<td>1.0335**</td>
<td>1.1102</td>
<td>1.0637</td>
<td>1.1112</td>
</tr>
<tr>
<td>RENASANT</td>
<td>8</td>
<td>1.0637**</td>
<td>1.0709**</td>
<td>1.0548**</td>
<td>1.0576**</td>
<td>1.0240**</td>
<td>0.9672**</td>
<td>1.0212**</td>
<td>0.9629**</td>
</tr>
<tr>
<td>BERKSHIRE HILLS BC</td>
<td>8</td>
<td>1.0685**</td>
<td>1.0756**</td>
<td>1.1609</td>
<td>1.1694**</td>
<td>1.1113</td>
<td>1.0199**</td>
<td>1.1484**</td>
<td>1.0217**</td>
</tr>
<tr>
<td>BBCN BC</td>
<td>8</td>
<td>1.1027</td>
<td>1.1048</td>
<td>1.0780</td>
<td>1.1245**</td>
<td>1.0356**</td>
<td>1.0595</td>
<td>1.0595</td>
<td>1.0650</td>
</tr>
<tr>
<td>BANC OF CA</td>
<td>8</td>
<td>1.0444**</td>
<td>1.0347**</td>
<td>1.0813**</td>
<td>1.1359</td>
<td>1.0683**</td>
<td>1.0755</td>
<td>1.0909</td>
<td>1.0407</td>
</tr>
<tr>
<td>UNION BSHRS</td>
<td>8</td>
<td>1.1024</td>
<td>1.0927**</td>
<td>1.0693**</td>
<td>1.0434**</td>
<td>1.0173**</td>
<td>1.0014**</td>
<td>1.0193**</td>
<td>1.0060**</td>
</tr>
<tr>
<td>CVB</td>
<td>8</td>
<td>1.3245***</td>
<td>1.2981**</td>
<td>1.0377**</td>
<td>1.0438**</td>
<td>0.9938**</td>
<td>0.9658**</td>
<td>1.0176**</td>
<td>0.9763**</td>
</tr>
<tr>
<td>SIMMONS FIRST T</td>
<td>8</td>
<td>1.0951**</td>
<td>1.1105</td>
<td>1.0970**</td>
<td>1.0266**</td>
<td>0.9993**</td>
<td>0.9556**</td>
<td>0.9880**</td>
<td>0.9656**</td>
</tr>
<tr>
<td>BANNER</td>
<td>8</td>
<td>1.1028</td>
<td>1.1034</td>
<td>1.0767</td>
<td>1.1019**</td>
<td>1.0451**</td>
<td>1.0573</td>
<td>1.0808**</td>
<td>1.0851**</td>
</tr>
</tbody>
</table>

Dep. Var. | $C_1/W_1$ | $C_2/W_1$ | $R_1$ | $R_2$ | $R_1 - C_1$ | $R_2 - C_2$ | $R_2 - C_2$
RHS Vars. | (y, w_1) | (y, w_1) | (y, w_2) | (y, w_2) | (y, w_2) | (y, w_2) | (y, w_2)

**NOTE:** For Models 1–2, estimates of $(1 - \varepsilon_{C_1})$ are reported ($\delta = 1.1$). For Models 3–4 and Models 5–8, estimates of $(1 + \varepsilon_{R_1})\delta$ and $(1 + \varepsilon_{R_2})\delta$ are given. For Models 1–2, values less than 1.1 indicate increasing returns to scale, while for Models 3–8, values greater than 1.1 indicate increasing returns to scale. Statistical significance (difference from 1.1) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.10: Returns to Scale for Largest Banks by Total Assets, 1986.Q4 and 1996.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>— 1986. Q4 —</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CITIBANK</td>
<td>275</td>
<td>0.0572***</td>
<td>0.0541***</td>
<td>−0.0775***</td>
<td>−0.0679***</td>
<td>−0.1060***</td>
<td>−0.1128***</td>
<td>−0.0722***</td>
<td>−0.0926***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>204</td>
<td>0.0065**</td>
<td>0.0040</td>
<td>−0.0402***</td>
<td>−0.0472***</td>
<td>0.0566</td>
<td>0.1795(3)</td>
<td>−0.0486***</td>
<td>−0.0619***</td>
</tr>
<tr>
<td>CHASE MHTN BK</td>
<td>150</td>
<td>0.0348***</td>
<td>0.0368***</td>
<td>−0.0163</td>
<td>−0.0099</td>
<td>−0.0349</td>
<td>−0.0442</td>
<td>0.0112</td>
<td>−0.0201***</td>
</tr>
<tr>
<td>MANU. HAN</td>
<td>139</td>
<td>0.0132***</td>
<td>0.0118**</td>
<td>−0.0286***</td>
<td>−0.0391***</td>
<td>0.0744</td>
<td>0.0113</td>
<td>−0.0354***</td>
<td>−0.0491***</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>130</td>
<td>0.0631***</td>
<td>0.0664***</td>
<td>−0.0563***</td>
<td>−0.0366***</td>
<td>−0.0361</td>
<td>−0.0457</td>
<td>−0.0087</td>
<td>−0.0594***</td>
</tr>
<tr>
<td>SECURITY PACIFIC</td>
<td>113</td>
<td>0.0016</td>
<td>−0.0006</td>
<td>−0.0370***</td>
<td>−0.0417***</td>
<td>−0.0206</td>
<td>−0.0275</td>
<td>−0.0567***</td>
<td>−0.0623***</td>
</tr>
<tr>
<td>CHEMICAL NY</td>
<td>109</td>
<td>0.0070***</td>
<td>0.0067**</td>
<td>−0.0387***</td>
<td>−0.0352***</td>
<td>−0.0094</td>
<td>0.0185</td>
<td>0.0385***</td>
<td>−0.0376***</td>
</tr>
<tr>
<td>BANKERS TR NY</td>
<td>100</td>
<td>0.0490***</td>
<td>0.0525***</td>
<td>−0.0588***</td>
<td>−0.0538***</td>
<td>−0.0416***</td>
<td>−0.0516</td>
<td>−0.0350***</td>
<td>−0.0513***</td>
</tr>
<tr>
<td>FIRST INTRST BC</td>
<td>100</td>
<td>0.0106*</td>
<td>0.0087</td>
<td>−0.0269***</td>
<td>−0.0295***</td>
<td>−0.0376</td>
<td>−0.1052</td>
<td>−0.0460***</td>
<td>−0.0892***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>81</td>
<td>0.0093</td>
<td>0.0072</td>
<td>−0.0465***</td>
<td>−0.0488***</td>
<td>−0.0343</td>
<td>−0.0307</td>
<td>−0.0541***</td>
<td>−0.0530***</td>
</tr>
<tr>
<td><strong>— 1996. Q4 —</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHASE MHTN</td>
<td>469</td>
<td>0.0403***</td>
<td>0.0473***</td>
<td>−0.0605***</td>
<td>−0.0611***</td>
<td>−0.0545***</td>
<td>−0.0435***</td>
<td>−0.0629***</td>
<td>−0.0502***</td>
</tr>
<tr>
<td>CITICORP</td>
<td>394</td>
<td>0.0575***</td>
<td>0.0578***</td>
<td>−0.0556***</td>
<td>−0.0628***</td>
<td>−0.0522***</td>
<td>−0.0274***</td>
<td>−0.0643***</td>
<td>−0.0458***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>352</td>
<td>0.0535***</td>
<td>0.0514***</td>
<td>−0.0485***</td>
<td>−0.0504***</td>
<td>−0.0468***</td>
<td>−0.0327***</td>
<td>−0.0564***</td>
<td>−0.0425***</td>
</tr>
<tr>
<td>NATIONSBANK</td>
<td>266</td>
<td>0.0207***</td>
<td>0.0344***</td>
<td>−0.0507***</td>
<td>−0.0374***</td>
<td>−0.0550***</td>
<td>−0.0503***</td>
<td>−0.0349***</td>
<td>−0.0491***</td>
</tr>
<tr>
<td>MORGAN GNTY TC</td>
<td>245</td>
<td>0.0419***</td>
<td>0.0477***</td>
<td>−0.0794***</td>
<td>−0.0778***</td>
<td>−0.0962***</td>
<td>−0.1018***</td>
<td>−0.0886***</td>
<td>−0.0932***</td>
</tr>
<tr>
<td>FIRST UNION</td>
<td>195</td>
<td>0.0085**</td>
<td>0.0064**</td>
<td>−0.0720***</td>
<td>−0.0719***</td>
<td>−0.0994***</td>
<td>−0.0977***</td>
<td>−0.1023***</td>
<td>−0.0925***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>155</td>
<td>0.0537***</td>
<td>0.0434***</td>
<td>−0.0146***</td>
<td>−0.0163***</td>
<td>0.0075</td>
<td>−0.0212***</td>
<td>−0.0082</td>
<td>−0.0410***</td>
</tr>
<tr>
<td>FIRST NBD</td>
<td>150</td>
<td>0.0307***</td>
<td>0.0330***</td>
<td>−0.0553***</td>
<td>−0.0525***</td>
<td>−0.0599***</td>
<td>−0.0772***</td>
<td>−0.0517***</td>
<td>−0.0763***</td>
</tr>
<tr>
<td>BANC ONE</td>
<td>143</td>
<td>0.0316***</td>
<td>0.0250***</td>
<td>−0.0369***</td>
<td>−0.0370***</td>
<td>−0.0364***</td>
<td>−0.0477***</td>
<td>−0.0566***</td>
<td>−0.0496***</td>
</tr>
<tr>
<td>FLEET FNCL GROUP</td>
<td>123</td>
<td>0.0076***</td>
<td>0.0374***</td>
<td>−0.0166***</td>
<td>−0.0076***</td>
<td>−0.0200***</td>
<td>−0.0254***</td>
<td>−0.0149</td>
<td>−0.0312***</td>
</tr>
</tbody>
</table>

Dep. Var. : \( C_1/W_1 \)
RHS Vars. : \( (y, w_1) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)
\( (y, w_2) \)

**NOTE:** For Models 1–2, estimates of \( \varphi_C,i \) are reported. For Models 3–4 and Models 5–8, estimates of \( \varphi_R,i \) and \( \varphi_T,i \) are given. In all cases, values greater than (equal to, less than) 0 indicate increasing (constant, decreasing) returns to scale. Statistical significance (difference from 0) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.11: Returns to Scale for Largest Banks by Total Assets, 2006.Q4 and 2015.Q4

<table>
<thead>
<tr>
<th>Name</th>
<th>Assets</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2006.Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>2082</td>
<td>-0.0010</td>
<td>0.0068***</td>
<td>-0.0175***</td>
<td>-0.0206***</td>
<td>0.0323***</td>
<td>0.0113</td>
<td>0.0095**</td>
<td>-0.0320***</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>1672</td>
<td>0.0553***</td>
<td>0.0549***</td>
<td>-0.0064***</td>
<td>0.0124</td>
<td>0.0472***</td>
<td>0.0656***</td>
<td>0.0453***</td>
<td>0.0081</td>
</tr>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>1543</td>
<td>-0.0023</td>
<td>-0.0001</td>
<td>-0.0016</td>
<td>-0.0038</td>
<td>0.0969***</td>
<td>0.0342</td>
<td>0.0704***</td>
<td>-0.0192***</td>
</tr>
<tr>
<td>WACHOVIA</td>
<td>726</td>
<td>0.0492***</td>
<td>-0.0066</td>
<td>-0.0701***</td>
<td>-0.0309***</td>
<td>-0.0306</td>
<td>-0.0159</td>
<td>0.0247</td>
<td>-0.0544***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>554</td>
<td>0.0734***</td>
<td>0.0676***</td>
<td>-0.0913***</td>
<td>-0.0566***</td>
<td>-0.0787***</td>
<td>-0.0472</td>
<td>-0.0687***</td>
<td>-0.0663***</td>
</tr>
<tr>
<td>U S BC</td>
<td>250</td>
<td>0.0378***</td>
<td>0.0405***</td>
<td>-0.0461***</td>
<td>-0.0394***</td>
<td>-0.0313***</td>
<td>-0.0272***</td>
<td>-0.0267***</td>
<td>-0.0313***</td>
</tr>
<tr>
<td>COUNTRYWIDE</td>
<td>225</td>
<td>-0.0008</td>
<td>-0.0119</td>
<td>-0.0897***</td>
<td>-0.0888***</td>
<td>-0.0955***</td>
<td>-0.0990***</td>
<td>-0.0907***</td>
<td>-0.0945***</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>210</td>
<td>0.0241***</td>
<td>0.0245***</td>
<td>-0.0221***</td>
<td>-0.0202***</td>
<td>-0.0123</td>
<td>-0.0400***</td>
<td>-0.0089</td>
<td>-0.0480***</td>
</tr>
<tr>
<td>HSBC BK USA</td>
<td>191</td>
<td>0.0495***</td>
<td>0.0513***</td>
<td>-0.0821***</td>
<td>-0.0763***</td>
<td>-0.0975***</td>
<td>-0.1045***</td>
<td>-0.0696***</td>
<td>-0.0885***</td>
</tr>
<tr>
<td>NATIONAL CITY</td>
<td>160</td>
<td>0.0276***</td>
<td>0.0312***</td>
<td>-0.0748***</td>
<td>-0.0661***</td>
<td>-0.1111***</td>
<td>-0.0873***</td>
<td>-0.0994***</td>
<td>-0.0784***</td>
</tr>
<tr>
<td><strong>2015.Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>2378</td>
<td>0.0772***</td>
<td>0.0948***</td>
<td>0.0007</td>
<td>-0.0056</td>
<td>0.0226***</td>
<td>0.0556***</td>
<td>0.0401***</td>
<td>0.0315</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>2145</td>
<td>0.0782***</td>
<td>0.0953***</td>
<td>0.0027</td>
<td>-0.0081</td>
<td>0.0539***</td>
<td>0.1841***</td>
<td>0.0835***</td>
<td>0.0966***</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>1765</td>
<td>0.0568***</td>
<td>0.0811***</td>
<td>0.0306***</td>
<td>0.0064</td>
<td>0.0765***</td>
<td>0.1851***</td>
<td>0.0789***</td>
<td>0.0624***</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>1764</td>
<td>0.0594***</td>
<td>0.0677***</td>
<td>0.0154***</td>
<td>0.0050**</td>
<td>0.0163***</td>
<td>0.0158</td>
<td>0.0466***</td>
<td>0.0044</td>
</tr>
<tr>
<td>U S BC</td>
<td>418</td>
<td>0.1224***</td>
<td>0.1159***</td>
<td>-0.0827***</td>
<td>-0.1021***</td>
<td>-0.0744***</td>
<td>-0.0585***</td>
<td>-0.0869***</td>
<td>-0.0683***</td>
</tr>
<tr>
<td>BK OF NY MELLON</td>
<td>384</td>
<td>0.0275***</td>
<td>0.0319***</td>
<td>-0.0499***</td>
<td>-0.0420***</td>
<td>-0.0592***</td>
<td>-0.0409***</td>
<td>-0.0448***</td>
<td>-0.0457***</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>359</td>
<td>0.1237***</td>
<td>0.1173***</td>
<td>-0.0756***</td>
<td>-0.1024***</td>
<td>-0.0652***</td>
<td>-0.0508***</td>
<td>-0.0849***</td>
<td>-0.0573***</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>246</td>
<td>-0.0516</td>
<td>-0.0522</td>
<td>-0.0871***</td>
<td>-0.0928***</td>
<td>-0.0803***</td>
<td>-0.0013</td>
<td>-0.0851***</td>
<td>-0.0159</td>
</tr>
<tr>
<td>T D BK</td>
<td>243</td>
<td>0.0430***</td>
<td>0.0797***</td>
<td>-0.0394***</td>
<td>-0.0287***</td>
<td>-0.0257</td>
<td>-0.0071</td>
<td>-0.0188***</td>
<td>-0.0076***</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>209</td>
<td>0.0470***</td>
<td>0.0797***</td>
<td>-0.0187</td>
<td>-0.0398***</td>
<td>0.0011</td>
<td>-0.0057</td>
<td>-0.0377***</td>
<td>-0.0164***</td>
</tr>
</tbody>
</table>

**Dep. Var.** | $C_1/W_1$ | $C_2/W_1$ | $R_1$ | $R_2$ | $\pi_1$ | $\pi_2$ | $\pi_3$ | $\pi_4$
**RHS Vars.** | $(y, w_1)$ | $(y, w_1)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$ | $(y, w_2)$

**NOTE:** For Models 1–2, estimates of $\xi_{C_i,j}$ are reported. For Models 3–4 and Models 5–8, estimates of $\xi_{R_i,j}$ and $\xi_{\pi_i,j}$ are given. In all cases, values greater than (equal to, less than) 0 indicate increasing (constant, decreasing) returns to scale. Statistical significance (difference from 0) at the ten, five, or one percent levels is denoted by one, two, or three asterisks, respectively. Assets are given in millions of constant 2015 dollars.
Table E.12: Numbers of Significant Changes in RTS Elasticities from 2006.Q4 to 2015.Q4

<table>
<thead>
<tr>
<th>Model</th>
<th>Change</th>
<th>.1 signif. RTS↑</th>
<th>.1 signif. RTS↓</th>
<th>.05 signif. RTS↑</th>
<th>.05 signif. RTS↓</th>
<th>.01 signif. RTS↑</th>
<th>.01 signif. RTS↓</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3228</td>
<td>1765</td>
<td>1463</td>
<td>3064</td>
<td>1686</td>
<td>1378</td>
<td>2791</td>
</tr>
<tr>
<td>2</td>
<td>3195</td>
<td>1784</td>
<td>1411</td>
<td>3031</td>
<td>1704</td>
<td>1327</td>
<td>2702</td>
</tr>
<tr>
<td>3</td>
<td>2444</td>
<td>1162</td>
<td>1282</td>
<td>2194</td>
<td>1033</td>
<td>1161</td>
<td>1805</td>
</tr>
<tr>
<td>4</td>
<td>2653</td>
<td>1260</td>
<td>1393</td>
<td>2448</td>
<td>1155</td>
<td>1293</td>
<td>2123</td>
</tr>
<tr>
<td>5</td>
<td>1427</td>
<td>589</td>
<td>838</td>
<td>1210</td>
<td>493</td>
<td>717</td>
<td>896</td>
</tr>
<tr>
<td>6</td>
<td>1483</td>
<td>702</td>
<td>781</td>
<td>1260</td>
<td>594</td>
<td>666</td>
<td>935</td>
</tr>
<tr>
<td>7</td>
<td>2260</td>
<td>956</td>
<td>1304</td>
<td>2004</td>
<td>849</td>
<td>1155</td>
<td>1593</td>
</tr>
<tr>
<td>8</td>
<td>2108</td>
<td>995</td>
<td>1113</td>
<td>1843</td>
<td>860</td>
<td>983</td>
<td>1485</td>
</tr>
</tbody>
</table>

NOTE: For each level of significance, “Change” gives the number of cases among 4148 banks in 2015.Q4 that also appear in 2006.Q4 and for which the estimated elasticities in Table 3 significantly differ between 2006.Q4 and 2015.Q4. Columns labelled “RTS↑” and “RTS↓” give counts of banks where returns to scale improve and worsen, respectively.
<table>
<thead>
<tr>
<th>Bank</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>—</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>U S BC</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>T D BK</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>↑</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>—</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

| Dep. Var. | $C_{1}/W_{1}$ | $C_{2}/W_{1}$ | $R_{1}$ | $R_{2}$ | $R_{1}-C_{1}$ | $R_{1}-C_{2}$ | $R_{2}-C_{1}$ | $R_{2}-C_{2}$ |
| RHS Vars. | $(y, w_{1})$  | $(y, w_{1})$  | $(y, w_{2})$ | $(y, w_{2})$ | $(y, w_{2})$ | $(y, w_{2})$ | $(y, w_{2})$ | $(y, w_{2})$ |

**NOTE:** Upward arrows indicate a significant increase in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Downward arrows indicate significant decrease in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Horizontal dashes indicate no significant change.
Table E.14: Significant Changes in RTS from 2006.Q4 to 2015.Q4 for 10 Largest Banks in 2015.Q4 (.05 Significance)

<table>
<thead>
<tr>
<th>Bank</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>◁</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>—</td>
<td>—</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>U S BC</td>
<td>↑</td>
<td>↑</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>↑</td>
<td>↑</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
<td>◁</td>
</tr>
<tr>
<td>T D BK</td>
<td>↑</td>
<td>↑</td>
<td>◁</td>
<td>◁</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>—</td>
<td>—</td>
<td>◁</td>
<td>◁</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dep. Var.</th>
<th>$C_1/W_1$</th>
<th>$C_2/W_1$</th>
<th>$R_1$</th>
<th>$R_2$</th>
<th>$R_1-C_1$</th>
<th>$R_1-C_2$</th>
<th>$R_2-C_1$</th>
<th>$R_2-C_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHS Vars.</td>
<td>(y, w₁)</td>
<td>(y, w₁)</td>
<td>(y, w₂)</td>
<td>(y, w₂)</td>
<td>(y, w₂)</td>
<td>(y, w₂)</td>
<td>(y, w₂)</td>
<td>(y, w₂)</td>
</tr>
</tbody>
</table>

**NOTE:** Upward arrows indicate a significant increase in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Downward arrows indicate significant decrease in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Horizontal dashes indicate no significant change.
Table E.15: Significant Changes in RTS from 2006.Q4 to 2015.Q4 for 10 Largest Banks in 2015.Q4 (.01 Significance)

<table>
<thead>
<tr>
<th>Bank</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPMORGAN CHASE &amp; CO</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BK OF AMER</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>↑</td>
</tr>
<tr>
<td>CITIGROUP</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>WELLS FARGO &amp; CO</td>
<td>—</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>U S BC</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>PNC FNCL SVC GROUP</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>STATE STREET</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>T D BK</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>—</td>
<td>—</td>
<td>↓</td>
<td>—</td>
</tr>
<tr>
<td>BB&amp;T</td>
<td>—</td>
<td>↑</td>
<td>↑</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>SUNTRUST BK</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Dep. Var. $C_1/W_1$ $C_2/W_1$ $R_1$ $R_2$ $R_1 - C_1$ $R_1 - C_2$ $R_2 - C_1$ $R_2 - C_2$
RHS Vars. $(y, w_1)$ $(y, w_1)$ $(y, w_2)$ $(y, w_2)$ $(y, w_2)$ $(y, w_2)$ $(y, w_2)$ $(y, w_2)$

**NOTE:** Upward arrows indicate a significant increase in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Downward arrows indicate significant decrease in RTS pseudo-elasticity from 2006.Q4 to 2015.Q4. Horizontal dashes indicate no significant change.
**Table E.16:** Transition Matrices, 2006.Q4 to 2015.Q4, Cost Models, .1 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>866</td>
<td>803</td>
<td>47</td>
<td>1716</td>
</tr>
<tr>
<td>CRS</td>
<td>1085</td>
<td>1143</td>
<td>96</td>
<td>2324</td>
</tr>
<tr>
<td>DRS</td>
<td>52</td>
<td>45</td>
<td>11</td>
<td>108</td>
</tr>
<tr>
<td>Total</td>
<td>2003</td>
<td>1991</td>
<td>154</td>
<td>4148</td>
</tr>
</tbody>
</table>

Model 2 (dep. var. \( C_2 \)):

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>883</td>
<td>752</td>
<td>49</td>
<td>1684</td>
</tr>
<tr>
<td>CRS</td>
<td>1130</td>
<td>1138</td>
<td>88</td>
<td>2356</td>
</tr>
<tr>
<td>DRS</td>
<td>51</td>
<td>45</td>
<td>12</td>
<td>108</td>
</tr>
<tr>
<td>Total</td>
<td>2064</td>
<td>1935</td>
<td>149</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.17: Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .1 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>295</td>
<td>536</td>
<td>182</td>
<td>1013</td>
</tr>
<tr>
<td>CRS</td>
<td>714</td>
<td>1601</td>
<td>485</td>
<td>2800</td>
</tr>
<tr>
<td>DRS</td>
<td>53</td>
<td>143</td>
<td>139</td>
<td>335</td>
</tr>
<tr>
<td>Total</td>
<td>1062</td>
<td>2280</td>
<td>806</td>
<td>4148</td>
</tr>
</tbody>
</table>

Model 4 (dep. var. $R_2$):

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>327</td>
<td>611</td>
<td>145</td>
<td>1083</td>
</tr>
<tr>
<td>CRS</td>
<td>761</td>
<td>1607</td>
<td>426</td>
<td>2794</td>
</tr>
<tr>
<td>DRS</td>
<td>44</td>
<td>114</td>
<td>113</td>
<td>271</td>
</tr>
<tr>
<td>Total</td>
<td>1132</td>
<td>2332</td>
<td>684</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.18: Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .1 Significance

<table>
<thead>
<tr>
<th>Model 5 (dep. var. $\pi_1$):</th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>441</td>
<td>793</td>
<td>145</td>
<td>1379</td>
</tr>
<tr>
<td>CRS</td>
<td>783</td>
<td>1566</td>
<td>296</td>
<td>2645</td>
</tr>
<tr>
<td>DRS</td>
<td>16</td>
<td>38</td>
<td>70</td>
<td>124</td>
</tr>
<tr>
<td>Total</td>
<td>1240</td>
<td>2397</td>
<td>511</td>
<td>4148</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 6 (dep. var. $\pi_2$):</th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>787</td>
<td>767</td>
<td>106</td>
<td>1660</td>
</tr>
<tr>
<td>CRS</td>
<td>963</td>
<td>1144</td>
<td>213</td>
<td>2320</td>
</tr>
<tr>
<td>DRS</td>
<td>15</td>
<td>51</td>
<td>102</td>
<td>168</td>
</tr>
<tr>
<td>Total</td>
<td>1765</td>
<td>1962</td>
<td>421</td>
<td>4148</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 7 (dep. var. $\pi_3$):</th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>524</td>
<td>877</td>
<td>131</td>
<td>1532</td>
</tr>
<tr>
<td>CRS</td>
<td>799</td>
<td>1441</td>
<td>252</td>
<td>2492</td>
</tr>
<tr>
<td>DRS</td>
<td>19</td>
<td>33</td>
<td>72</td>
<td>124</td>
</tr>
<tr>
<td>Total</td>
<td>1342</td>
<td>2351</td>
<td>455</td>
<td>4148</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 8 (dep. var. $\pi_4$):</th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>943</td>
<td>806</td>
<td>111</td>
<td>1860</td>
</tr>
<tr>
<td>CRS</td>
<td>927</td>
<td>1002</td>
<td>198</td>
<td>2127</td>
</tr>
<tr>
<td>DRS</td>
<td>16</td>
<td>43</td>
<td>102</td>
<td>161</td>
</tr>
<tr>
<td>Total</td>
<td>1886</td>
<td>1851</td>
<td>411</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.19: Transition Matrices, 2006.Q4 to 2015.Q4, Cost Models, .05 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>640</td>
<td>716</td>
<td>30</td>
<td>1386</td>
</tr>
<tr>
<td>CRS</td>
<td>1073</td>
<td>1514</td>
<td>88</td>
<td>2675</td>
</tr>
<tr>
<td>DRS</td>
<td>41</td>
<td>37</td>
<td>9</td>
<td>87</td>
</tr>
<tr>
<td>Total</td>
<td>1754</td>
<td>2267</td>
<td>127</td>
<td>4148</td>
</tr>
</tbody>
</table>

Model 2 (dep. var. $C_2$):

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>645</td>
<td>690</td>
<td>28</td>
<td>1363</td>
</tr>
<tr>
<td>CRS</td>
<td>1124</td>
<td>1500</td>
<td>82</td>
<td>2706</td>
</tr>
<tr>
<td>DRS</td>
<td>35</td>
<td>38</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td>Total</td>
<td>1804</td>
<td>2228</td>
<td>116</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
### Table E.20: Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .05 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>167</td>
<td>427</td>
<td>112</td>
<td>706</td>
</tr>
<tr>
<td>CRS</td>
<td>645</td>
<td>2032</td>
<td>494</td>
<td>3171</td>
</tr>
<tr>
<td>DRS</td>
<td>33</td>
<td>120</td>
<td>118</td>
<td>271</td>
</tr>
<tr>
<td>Total</td>
<td>845</td>
<td>2579</td>
<td>724</td>
<td>4148</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>197</td>
<td>509</td>
<td>92</td>
<td>798</td>
</tr>
<tr>
<td>CRS</td>
<td>692</td>
<td>2004</td>
<td>426</td>
<td>3122</td>
</tr>
<tr>
<td>DRS</td>
<td>30</td>
<td>103</td>
<td>95</td>
<td>228</td>
</tr>
<tr>
<td>Total</td>
<td>919</td>
<td>2616</td>
<td>613</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.21: Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .05 Significance

<table>
<thead>
<tr>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>266</td>
<td>688</td>
<td>93</td>
</tr>
<tr>
<td>CRS</td>
<td>709</td>
<td>1994</td>
<td>296</td>
</tr>
<tr>
<td>DRS</td>
<td>11</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>986</td>
<td>2713</td>
<td>449</td>
</tr>
</tbody>
</table>

Model 6 (dep. var. $\pi_2$):

<table>
<thead>
<tr>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>531</td>
<td>723</td>
<td>72</td>
</tr>
<tr>
<td>CRS</td>
<td>918</td>
<td>1545</td>
<td>217</td>
</tr>
<tr>
<td>DRS</td>
<td>7</td>
<td>44</td>
<td>91</td>
</tr>
<tr>
<td>Total</td>
<td>1456</td>
<td>2312</td>
<td>380</td>
</tr>
</tbody>
</table>

Model 7 (dep. var. $\pi_3$):

<table>
<thead>
<tr>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>319</td>
<td>753</td>
<td>88</td>
</tr>
<tr>
<td>CRS</td>
<td>756</td>
<td>1878</td>
<td>249</td>
</tr>
<tr>
<td>DRS</td>
<td>10</td>
<td>29</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>1085</td>
<td>2660</td>
<td>403</td>
</tr>
</tbody>
</table>

Model 8 (dep. var. $\pi_4$):

<table>
<thead>
<tr>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>681</td>
<td>798</td>
<td>73</td>
</tr>
<tr>
<td>CRS</td>
<td>923</td>
<td>1329</td>
<td>198</td>
</tr>
<tr>
<td>DRS</td>
<td>10</td>
<td>40</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>1614</td>
<td>2167</td>
<td>367</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
**Table E.22:** Transition Matrices, 2006.Q4 to 2015.Q4, Cost Models, .01 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>311</td>
<td>526</td>
<td>13</td>
<td>850</td>
</tr>
<tr>
<td>CRS</td>
<td>952</td>
<td>2215</td>
<td>73</td>
<td>3240</td>
</tr>
<tr>
<td>DRS</td>
<td>22</td>
<td>28</td>
<td>8</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>1285</td>
<td>2769</td>
<td>94</td>
<td>4148</td>
</tr>
</tbody>
</table>

Model 2 (dep. var. $C_2$):

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>313</td>
<td>507</td>
<td>11</td>
<td>831</td>
</tr>
<tr>
<td>CRS</td>
<td>975</td>
<td>2226</td>
<td>58</td>
<td>3259</td>
</tr>
<tr>
<td>DRS</td>
<td>19</td>
<td>34</td>
<td>5</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>1307</td>
<td>2767</td>
<td>74</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.23: Transition Matrices, 2006.Q4 to 2015.Q4, Revenue Models, .01 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>52</td>
<td>234</td>
<td>52</td>
<td>338</td>
</tr>
<tr>
<td>CRS</td>
<td>449</td>
<td>2693</td>
<td>458</td>
<td>3600</td>
</tr>
<tr>
<td>DRS</td>
<td>7</td>
<td>100</td>
<td>103</td>
<td>210</td>
</tr>
<tr>
<td>Total</td>
<td>508</td>
<td>3027</td>
<td>613</td>
<td>4148</td>
</tr>
</tbody>
</table>

Model 4 (dep. var. $R_2$):

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS</td>
<td>63</td>
<td>259</td>
<td>46</td>
<td>368</td>
</tr>
<tr>
<td>CRS</td>
<td>498</td>
<td>2697</td>
<td>406</td>
<td>3601</td>
</tr>
<tr>
<td>DRS</td>
<td>11</td>
<td>86</td>
<td>82</td>
<td>179</td>
</tr>
<tr>
<td>Total</td>
<td>572</td>
<td>3042</td>
<td>534</td>
<td>4148</td>
</tr>
</tbody>
</table>

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
Table E.24: Transition Matrices, 2006.Q4 to 2015.Q4, Profit Models, .01 Significance

<table>
<thead>
<tr>
<th></th>
<th>IRS</th>
<th>CRS</th>
<th>DRS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 5 (dep. var. $\pi_1$):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRS</td>
<td>84</td>
<td>396</td>
<td>43</td>
<td>523</td>
</tr>
<tr>
<td>CRS</td>
<td>480</td>
<td>2793</td>
<td>276</td>
<td>3549</td>
</tr>
<tr>
<td>DRS</td>
<td>4</td>
<td>19</td>
<td>53</td>
<td>76</td>
</tr>
<tr>
<td>Total</td>
<td>568</td>
<td>3208</td>
<td>372</td>
<td>4148</td>
</tr>
</tbody>
</table>

| Model 6 (dep. var. $\pi_2$): |     |       |     |       |
| IRS               | 232 | 546   | 36  | 814   |
| CRS               | 705 | 2291  | 219 | 3215  |
| DRS               | 1   | 38    | 80  | 119   |
| Total             | 938 | 2875  | 335 | 4148  |

| Model 7 (dep. var. $\pi_3$): |     |       |     |       |
| IRS               | 110 | 417   | 44  | 571   |
| CRS               | 554 | 2692  | 247 | 3493  |
| DRS               | 4   | 21    | 59  | 84    |
| Total             | 668 | 3130  | 350 | 4148  |

| Model 8 (dep. var. $\pi_4$): |     |       |     |       |
| IRS               | 318 | 607   | 40  | 965   |
| CRS               | 777 | 2077  | 202 | 3056  |
| DRS               | 5   | 36    | 86  | 127   |
| Total             | 1100| 2720  | 328 | 4148  |

**NOTE:** For each transition matrix, rows correspond to RTS in 2006.Q4 and columns correspond to RTS in 2015.Q4.
References


