REGIONAL ECONOMIC ISSUES

Working Paper Series

Regional Regulatory Effects on Bank Efficiency

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FEDERAL RESERVE BANK
OF CHICAGO

WP - 1990 / 4

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1. Introduction

Although economists have recognized the importance of regional variations in production processes [Samuelson (1952), Arrow, Chenery, Minhas and Solow (1961), Lande (1978), Luger and Evans (1988)], they have generally been ignored in analysis of the banking industry. This is particularly surprising given the perceived important role of banking in influencing real economic activity and regional growth [Cameron, et al (1967), Bernake (1981, 1983), Calomiris, et al (1986), and Williamson (1987)]. As a result of this role the industry has been subject to significant regulation to insure that consumers receive adequate banking services. Thus, in addition to differing production technologies, regional differences may also result from alterations to the production process induced by regulatory constraints.

This study provides evidence of regional variations in production characteristics for large commercial banks. Additionally, differences resulting from regulatory constraints are found. The presence of regional variations from either of these dimensions of production renders the national model — a special case of the multiregional model — used in previous bank cost studies inappropriate.[1]

2. Regional Production Differences: Technology, Binding Regulation, and Inefficiencies

There are numerous reasons for expecting regional differences in production processes. In addition to input price differences, unique regional technologies can result from differing regional environments. These may result from institutional arrangements, legal environments, or management-labor relationships (Luger and Evans).

Regulation is very influential in banking and can also be expected to have a significant influence on the production process. Banks are regulated in nearly all aspects of the product including price constraints, product restrictions, promotional limitations, and distribution restrictions. Although intended to improve welfare, and the proposed benefits are obvious, there are also costs associated with regulation which are not as evident and are commonly ignored. For example, price restrictions on deposits may be imposed to provide banks with an inexpensive source

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of funds; however, evidence suggests they result in disintermediation, and non-pecuniary costs aimed at circumventing the restrictions [e.g., Startz (1979), Pyle (1974)]. Entry barriers and distribution restrictions may be implemented to insure that local market participants are not forced from the market as a result of "excessive" competition; however, evidence suggests this results in inferior service levels, entry deterance behavior via space packing, and excessive investments in physical capital [(e.g., Baer, et al (1988), Evanoff (1988)]. It is important that these regulatory induced distortions also be accounted for.

Although the basic regulatory framework for banks is established at the federal level, much is left to the discretion of the states, e.g., branching guidelines, allowable organizational structures and usury laws.[2] These differences in state regulations can obviously affect the degree of bank competitiveness. We account for the extent of regulatory induced distortions at the regional level.

The potential interaction between technology and regulatory differences creates an array of potential effects on costs. Obviously we can test directly for technology and/or regulatory differences. However, additional possibilities occur because of their interaction. Differences in the estimated effect of regulation between regions may partially be due to the technological differences. That is, although the regulatory distortion to factor prices is the same, the impact on costs may differ across regions because different shaped isoquants exist. Therefore the question of whether the effect of regulation is different across regions should be addressed under the condition that the estimated technology is the same. Analogously, questions about differences in regional technologies should be addressed assuming equal distortions from the regulatory process.

To evaluate regional cost differences, four models are employed. The first model is the most general allowing regional variations in both production technologies and regulatory stringency. The remaining three models are nested within this most general one. The second model allows for variations in regional technologies, but restricts the regulatory effects in both regions to be the same. The third model allows for regional variations in regulatory effects, but imposes equivalent regional technologies. The last, and most restrictive model, is the conventional national model in which both technologies and regulatory constraints are assumed to be the same across regions.[3]

Three tests are performed with the four models. In each, the more restrictive models are compared to the most general model. These tests are summarized in Table 1, where C denotes the set of cost function parameters, and subscripts identify the set of restrictions imposed on parameters — with R and T denoting two subsets of regulatory and technology related parameters, respectively. Regional parameters

Table 1

Tests For Regulatory and Technology Differences Across Regions

Test 1	$C_{R_m \neq R_r \cup T_m \neq T_r} - C_{R_m = R_r \cup T_m = T_r} \equiv D_1$
Test 2	$C_{R_m \neq R_r \cup T_m \neq T_r} - C_{R_m = R_r \cup T_m \neq T_r} \equiv D_3$
Test 3	$C_{R_m \neq R_r \cup T_m \neq T_r} - C_{R_m \neq R_r \cup T_m = T_r} \equiv D_2$

are denoted for two regions by the subscripts m and r. Differences in the cost functions are denoted as D_i.

In the first test, the most general model, in which both regulation and technology are allowed to vary across regions (i.e., $C_{R_m \neq R_r \cup T_m \neq T_r}$), is compared to the most restrictive model in which each region is restricted to have the same coefficients, i.e., the national model ($C_{R_m = R_r \cup T_m = T_r}$). If the difference between these two models is insignificant then both technology and regulatory effects do not have regional variations and use of the standard national model can not be considered inappropriate.

In the second test the most general model is compared to one with identical regional regulatory effects, but with variations in technology as implied by the most general model. If the difference between these two models is insignificant then regional variations in technological characteristics can not be considered significant.

Test 3 compares the most general model to one with identical regional technologies but different regulatory effects as implied by the more general model. An insignificant difference between these two models would imply insignificant regional variations in regulatory distortions.

3. Bank Cost Models and Empirical Specification

In this section we introduce the models to be compared. We utilize a methodology developed by Lau and Yotopoulos (1971), and Atkinson and Halvorsen (hereafter AH, 1980). The methodology has been employed in previous studies to account for regulatory induced market distortions, e.g., AH (1984), Israilevich and Kowalewski (1987), and Evanoff, Israilevich, and Merris (1989). The reader is referred to these studies for a detailed discussion of the methodology.

From the first-order conditions for cost minimization in the neoclassical model, the marginal rate of technical substitution between inputs is equal to the ratio of the prices of the inputs. Given input prices, and the predetermined level of output as the only constraint, the optimal combination of inputs can be derived to minimize costs.

However, if additional (regulatory) constraints exist they need to be accounted for in the optimization process. From the first-order conditions for cost minimization, the marginal rate of technical substitution between the inputs should be equal to the ratio of the *effective* prices of the inputs. It is these effective or *shadow* prices of the inputs which are influenced by the additional constraints. In the absence of binding regulatory constraints, shadow and actual prices are equal and the first order condition reduces to the standard neoclassical condition. This special case is nested within the more general Shadow-Price (SP) Model.

Since the shadow prices of the inputs are not directly observable, following Lau and Yotopoulos, and AH they are approximated by

$$P_i^* = k_i P_i \text{ for } i = 1, \dots, m \quad (1)$$

where P_i and P_i^* are market and shadow input prices, respectively, and k_i is an input-specific factor of proportionality; again, when regulation is nonbinding, all shadow prices equal the respective market prices, $k_i = 1$ for all i, and the shadow cost function reduces to the more restricted function.

Applying Shephard's Lemma (1970) to the more general Shadow Cost function the input demand functions can be obtained, from which the actual or observed cost and factor share equations can be derived.[4]

$$\ln C^A = \ln C^S + \ln \sum_{i=1}^{k} \frac{M_i^S}{k_i} \quad (2)$$

and

$$M_i^A = \frac{P_i X_i}{C^A} = \frac{M_i^S k_i^{-1}}{\sum_{i=1}^{m} M_i^S k_i^{-1}}. \text{ for } i = 1, \dots, m \quad (3)$$

where C^A and C^S are actual and shadow cost, respectively; and M_i^A and M_i^S are actual and shadow factor-cost shares, respectively. Equations 2 and 3 comprise our most restrictive model where both technology and regulatory impacts are constant across regions.

The shadow cost function is a more comprehensive representation of costs to be minimized and is the appropriate dual to the production process. It allows one to calculate the optimal (unobserved) input combination given observed prices. This combination is relevant for measuring the cost differences resulting from production under competitive conditions and those under binding regulatory constraints.

Correspondingly, differences in C^A computed with P and P^* measure the cost of the binding constraints, or, stated differently, the extent of production inefficiency produced by regulation. We employ this procedure in our comparison of distortions induced by regulation on our cost models.

In applying the Shadow-Price Model to large U.S. banks, the following empirical specifications are adopted: (1) Z is specified to account for exogenous variables pertinent to banking including the number of bank offices, B; holding company structure, H; and technological change, T. (2) Banks produce a single output, Q, by utilizing two inputs: labor and capital. (3) The shadow cost function is specified in translog form. Total shadow cost is specified as linearly homogenous in shadow prices. (4) The shadow price factors, k_i for $(i = L, K)$, are specifed as input specific but as identical across banking firms.[5] The shadow price factor for labor, k_L, is set equal to unity and the shadow price factor for capital, k_K, is estimated. The absolute values of k_L and k_K cannot be estimated, given that the equations for total actual cost and factor cost shares are homogeneous of degree zero in k_L and k_K. Therefore, we test for relative price efficiency only $(k_L = k_K)$, not absolute efficiency.

The total shadow cost function in translog form is

$$
\begin{aligned}
\ln C^S = {} & \alpha_0 + \beta_Q \ln Q + 0.5\beta_{QQ}(\ln Q)^2 + \sum_i \gamma_{iQ} \ln Q \ln(k_iP_i) + \sum_i \beta_i \ln(k_iP_i) \\
& + 0.5 \sum_i \sum_j \gamma_{ij} \ln(k_iP_i) \ln(k_jP_j) + \phi_T \ln T + 0.5\phi_{TT}(\ln T)^2 \\
& + \theta_{QT} \ln Q \ln T + \sum_i \gamma_{iT} \ln(k_iP_i) \ln T + \beta_B \ln B + 0.5\beta_{BB}(\ln B)^2 \\
& + \gamma_{QB} \ln Q \ln B + \gamma_{TB} \ln T \ln B + \sum_i \gamma_{iB} \ln(k_iP_i) \ln B + \beta_H H \\
& + \gamma_{HQ} H \ln Q + \gamma_{HT} H \ln T + \gamma_{HB} H \ln B + \sum_i \gamma_{iH} \ln(k_iP_i) H \\
& \text{for } i, j = L, K
\end{aligned}
\tag{4}
$$

where $\gamma_{LK} = \gamma_{KL}$. Linear homogeneity in shadow prices implies the following adding-up restrictions on parameters:

$$
\begin{aligned}
& \sum_i \beta_i = 1 \text{ and } \sum_i \gamma_{iQ} = \sum_i \gamma_{iB} = \sum_i \gamma_{iT} = \sum_i \gamma_{iH} = 0 \sum_i \gamma_{ij} \\
& \quad = 0 \text{ for } i, j = L, K
\end{aligned}
\tag{5}
$$

Shadow cost shares for the translog specification are derived by logarithmic differentiation of C^S in equation 4:

$$M_i^S = \frac{\partial \ln C^S}{\partial \ln(k_i P_i)}$$

$$(6) \qquad = \beta_i + \gamma_{iQ} \ln Q + \sum_j \gamma_{ij} ln(k_j P_j) + \gamma_{iT} \ln T + \gamma_{iB} \ln B + \gamma_{ih} H$$

$$\text{for } i,j = L,K$$

From equations 1, 4, and 6, total actual costs are

$$\ln C^A = \ln C^S + \ln \Bigg(\sum_i [\beta_i + \sum_j \gamma_{ij} \ln(k_j P_j) + \gamma_{iQ} \ln Q$$

$$(7) \qquad \sum_i \gamma_{iT} \ln T + \sum_i \gamma_{iB} \ln B + \sum_i \gamma_{iH} H] k_i^{-1} \Bigg)$$

$$\text{for } i,j = L,K$$

where $\ln C^S$ is given in equation 4.

The derived actual cost shares are given by

$$M_i^A = \left[\beta_i + \sum_j \gamma_{ij} \ln(k_j Pj) + \gamma_{iQ} \ln Q + \gamma_{iT} \ln T + \gamma_{iB} \ln B + \gamma_{iH} H \right] k_i^{-1} +$$

$$(8) \qquad \sum_i \left[\beta_i + \sum_j \gamma_{ij} \ln(k_j P_j) + \gamma_{iQ} \ln Q + \gamma_{iT} \ln T + \gamma_{iB} \ln B + \gamma_{iH} H \right] k_i^{-1}$$

$$\text{for } i,j = L,K.$$

Equation 7 and one of the share equations 8, appended with classical additive disturbance terms, is the set of equations to be jointly estimated as our restricted national model. Because of the singularity of the variance-covariance matrix of the error terms resulting from the adding-up conditions on the share equations, we arbitrarily drop the capital-share equation. The empirical results are invariant to the choice of the factor share deleted and to the normalization, $k_L = 1$, for the labor shadow-price factor.

We adjust the national model to generate the other three models discussed in Section 2. Regional regulatory differences can be accounted for by including an additive binary variable on k_K. Negative values for this additive term would indicate additional regulatory induced price distortions in the specified region. Differences in technology across regions can be accounted for by including binaries on all the exogeneous variables except k_K. Our most general model accounts for differences in both dimensions.

Data

The model was estimated for a panel data set for the years 1972–87 for the largest banks in the U.S. which were members of a holding company over the entire period. The final data set consisted of 164 banks and 2,624 observations.

Two regions were considered: the Midwest, MW, and the rest of the U.S., RN.[6] The Midwest was chosen because of a priori information suggesting that the banking environment may be unique in this region. First, a large portion of the banks in this area operate under very restrictive state-imposed limitations to geographic expansion. Second, there is a preponderance of small, state-chartered banks in this region providing the potential for a strong lobbying group and restrictive regulatory environment. Third, the region is somewhat unique in its regional economic base, i.e., concentrated in heavy industry such as the steel and automotive industries. Thus, the banking environment in the Midwest may differ from that in other areas. For banks located in this region the binary variable was set equal to one; zero otherwise.

The Federal Reserve *Call Report* was the major data source. Costs were defined as the sum of expenditures on labor and physical capital. Bank output was defined as the dollar value of loans and investment securities.[7] The number of banking offices was also taken from the Call Report as was the type of bank holding company organization. Technical progress was accounted for with a time trend. The input price for labor was obtained from the Bureau of Labor Statistics. State level wage trends were collected for each year and assigned to each bank according to the location of its home office. The price of physical capital was approximated from *Call Report* data as the ratio of physical capital expenditures measured as additions to plant and equipment, furniture, and physical premises, to the book value of net bank premises, furniture, and physical equipment.

4. Empirical Results

Estimates were derived using the iterated seemingly unrelated regression technique. Results for the most general model are presented in Table 2. A cursory review of the results suggest that the banks in the two regions have different production technologies. They also suggest that regulation distorts the effective price of physical capital downward; moreso in the MW than in the RN.[8]

Table 2
Estimation Results For the Most General Model: $C_{R_m \neq R, \cup T_m \neq T}$

Coefficients	Two Regions: k_K for RN and $(k_K + g_K)$ for MW			
	RN		MW	
α_0	2.623	(2.51)	−15.194	(6.47)
β_L	0.683	(21.49)	0.809	(10.57)
β_Q	0.045	(0.28)	2.627	(7.69)
β_{QQ}	0.056	(4.48)	−0.130	(5.24)
β_B	0.143	(1.97)	−0.307	(1.39)
β_{BB}	0.003	(0.39)	0.038	(1.45)
β_H	−0.219	(1.10)	1.788	(3.92)
γ_{LL}	0.033	(9.25)	0.020	(2.27)
γ_{LQ}	0.005	(5.63)	0.002	(1.66)
γ_{LB}	0.0004	(0.99)	−0.002	(1.77)
γ_{LH}	−0.001	(0.98)	−0.002	(0.82)
θ_{QB}	−0.001	(0.24)	0.016	(0.87)
θ_{QH}	0.047	(2.82)	−0.107	(3.03)
θ_{BH}	−0.079	(5.93)	−0.101	(4.13)
θ_{QT}	0.006	(0.53)	0.128	(4.41)
θ_{TB}	0.004	(0.53)	−0.004	(0.28)
θ_{TH}	−0.082	(4.19)	0.009	(0.21)
ϕ_T	0.136	(0.96)	−1.548	(4.28)
ϕ_{TT}	−0.234	(9.92)	−0.289	(5.73)
γ_{LT}	−0.014	(8.16)	−0.002	(1.18)
k_K	0.555	(5.68)	0.555	(5.68)
g_K	N.A.		−0.278	(1.70)

Absolute t-values are in parenthesis.
The t value for the k_K coefficient was calculated under the hypothesis of $k_K = 1$.

Likelihood ratio tests were used to perform the tests introduced in Section 2, i.e., Table 1. Test results suggests a very significant difference between the most restrictive and general models, i.e., Test 1. The likelihood ratio test statistic was 328 and the critical chi-square value at the two-percent siginificance level is 36.3. Therefore the appropriateness of a national model for the sample of banks considered is rejected.

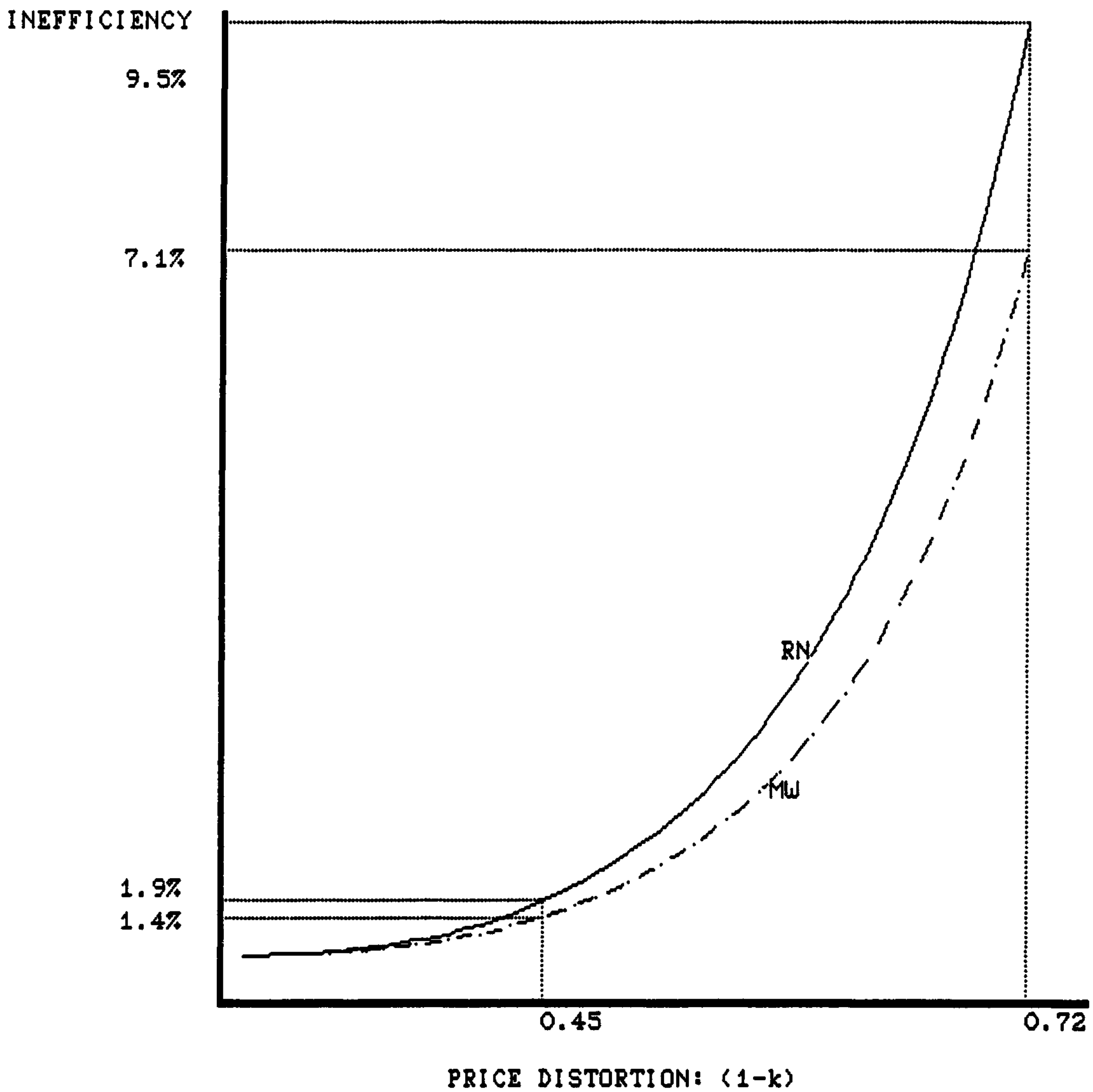
However, the source of the difference cannot be determined from Test 1. It can result from different technologies, different regulatory-induced price distortions, or both. Results for Test 2 and Test 3 indicate that both forces are operative and important. For each test the more restrictive cost model was rejected at the two-percent significance level.[9]

Therefore the results suggest significant technological differences and significant and unique regulatory distortions across the two regions. We calculate the level of inefficiency for each region at the mean using the most general model. We compare the predicted costs based on the estimated level of distortion (i.e., the predicted k and g parameters) with that found when the distortion is assumed not to exist (i.e., $g = 0$ and $k = 1$). The mean level of inefficiency in RN was calculated to be 1.9 percent, while in the MW it was 7.1 percent. The difference in efficiency is consistent with the estimated differences in regulatory-induced price distortions, i.e., $g < 0$. Thus, regulation specific to the MW apparently causes greater input price distortions which, in turn, leads to greater inefficiency for MW banks. Again, this is in agreement with our expectations and indicates that regulation more adversely effects production in the MW.

There is an additional dimension of the regional production process which our results allow us to analyze. Our findings indicate that banks located in the MW are more adversely affected by regulation — realizing that levels of regulation can differ across regions. Using these estimates we can simulate how production efficiency would be affected if regional regulatory distortions were varied. That is, how does the production technology of banks in a particular region allow them to respond to changes in regulation. To determine this we generated predicted values for inefficiency in each region by altering the regulatory-induced price distortions and comparing them to the costs found when price efficiency was assumed (i.e., $k_K = 1, g_K = 0$).

Our results suggest that banks located in the MW region are in a better position to bear the burden of regulation. Simulations imposing $g_K = 0$ on MW observations produced a 1.4% mean level of inefficiency for these banks; less than the 1.9% level for banks in the RN. Similarly, imposing the estimated k_K and g_K parameters on the RN banks produced cost inefficiencies of 9.5%; compared to 7.1% for the MW banks. Results for alternative price distortions were simulated and are summarized in Figure 1. They suggests that the MW banks, burdened by more stringent regulation, may have adjusted their production technique to minimize the regulatory effect. Thus, ceteris paribus, relaxation of certain restrictions may have a greater beneficial impact on banks located in this region.

Figure 1
Simulated Levels of Bank Production Inefficiency.



5. Conclusion

Although it is generally recognized that potential differences exist in regional production technologies and the extent of regulatory stringency, studies of bank costs have ignored these differences. This omission is somewhat perplexing given the important role assigned to banking in regional development. Using data definitions and measures utilized in previous bank cost studies we compare the Midwestern states of the U.S. to the rest of the nation and find significant differences in bank technologies and allocative inefficiency. Banks located in the Midwest, a region where regulatory stringency appears to be somewhat greater, were found to be more adversely affected by regulation. However, apparent adjustments in their production technology have enabled them to be more resilient to regulatory-induced distortions. Simulations imposing similar regulatory-induced factor price distortions on banks in the Midwest and in the rest of the nation suggested that the Midwest banks would be able to produce more efficiently under comparable regulatory conditions.

The finding that bank production processes differ across regions has important policy implications. Ideally, given the perceived role of banking in regional development, local legislators and regulators would realize the peculiarities of the local production process and respond by providing incentives to improve productivity — e.g., if the need is for the use of more advanced techniques, legislators could encourage advances in technological development, communication systems, capital flows, etc. Similarly, the finding that region specific regulations have adversely affected efficiency should encourage policy-setters to reevaluate regulations and, perhaps, to incorporate alternatives which have been found to be more conducive to productivity. Growth in the MW states has lagged behind the national growth rate during the observed period, thus, there may be some credence to the argument that banks influence regional grow. Stringent regulation could impair regional economic development.[10]

However, the findings may serve to reignite arguments over the proper extent of local control over bank regulation. Ever since a dual bank-chartering system developed in the U.S., both economists and bankers have been split over the proper role of federal and state legislatures. It has long been argued that bank regulation has not been guided by efficiency concerns, but, rather, service accessibility and market protection from "unfair" competitive forces. In many cases this has served to preserve market power for incumbent banks. In most industries, a finding of differences in regional technologies would lead to recommendations for local regulatory control. This way the local governments could account for the local peculiarities and legislate accordingly. In banking, local regulations may actually be the root cause of the inefficiency problem.

Footnotes

1. For a review of these studies see Gilbert (1984) or Hunter and Timme [hereafter HT (1986)]. There has been a differentiation in the literature between unit and branch banks, however none of the studies have attempted to account for regional differences resulting from regional specific technology or regulation.

2. Although some deregulation has occurred in banking, numerous restrictions remain and the industry is still recognized as being heavily regulated.

3. Actually, this "restrictive" model is more general than that used in nearly all previous bank cost studies which implicitly assume that regulation does not influence firm behavior, i.e., relative price efficiency exists (see Section 3).

4. Again, the reader is referred to AH (1984) or Evanoff, Israilevich, and Merris (1989).

5. To the extent that the firms evaluated are homogenous within the regions considered with respect to their technology and the burden of regulation, the restriction of identical k_i values is appropriate.

6. Midwestern banks were considered those located in the states of Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin. The results were robust with respect to minor adjustments to this definition — e.g., only banks within these states located in the Seventh or Ninth Federal Reserve Districts, etc.

7. Alternative balance sheet output measures were considered and produced similar results. The lack of a consensus on the theory of banking renders the appropriate bank output measure an unsettled issue. We are interested in the cost structure of large banks with special emphasis on regulatory distortions. For comparison purposes we use an output measure (as well as other variable measures) similar to that used by others evaluating these aspects of bank costs — e.g., HT, Shaffer (1985). Also, like HT, we assume that the production process of raising funds is separable.

8. Second order conditions are met globally for banks in the MW, and for factor shares less than 97% for RN banks. All of our observations have shares within this range. Estimates for the remaining three models, and more detailed statistical results, are available from the authors on request.

9. Derived likelihood-ratios for Test 2 and 3 were 1117.and 8.7, respectively, allowing us to reject the null that the models compared were equivalent for the number of restrictions imposed at the two percent level of significance.

10. This is an important research topic for future analysis. While banks are obviously not limited to making loans in their local markets, regulatory induced bank structure could influence loan-to-deposit ratios, the mix of specific types of loans, etc. While structure may not influence the flow of financial capital for the largest or second tier of borrowers, smaller businesses could be affected.

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