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ARTICLE

Modeling Interstate Banking in the United States: the Spatial 3-Stage Least Squares Approach

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ABSTRACT

This study uses a spatial 3-stage least squares approach to model interstate banking of the United States in 1994 and 2014. The method simultaneously takes into account spatial dependence, outward and inward interstate banking and their interaction, and the temporal effects in interstate banking. The study shows that a healthy economic structure, an expanding market, and permissive banking legislation encourage inward interstate banking. A healthy economic structure is a basis for strong banking firms to rise and to expand in other states. Large banking institutions were dominate in outward interstate banking while smaller firm sizes tend to be associated with inward interstate banking. By 2014, large and well-capitalized banking firms from states with a healthy economic structure had expanded into states with lower income levels, and lower capital-to-labor ratios, higher labor resource use, and lower profitability in their banking industry. Evidence shows some banking geographical fragmentation remains.

1. Introduction

This study models interstate banking in the United States to ascertain significant contributing factors. Interstate banking in the U.S. refers to banking firms operating across state lines. It constitutes an important component of banking deregulation since the 1970s when major banking firms demanded more flexibility in choosing geographical locations for their businesses. Interstate banking is highly geographical since it involves banking networks spreading across space connecting various home states with host states. Modeling such networks allows an understanding of factors that contribute to and shape the spatial organization of banking. However, the accuracy in modeling interstate banking depends upon the approach adopted. In addition to data accuracy and model specification, other factors also contribute to the estimation accuracy. First, there is possible spatial dependence where certain geographical structures exist in interstate banking. There is also an issue of modeling "outward" vs. "inward" interstate banking. Outward interstate banking refers to banking firms going out of their own home states to operate in host states while inward interstate banking means host states receiving banking branches from out-of-state banking firms. These are different banking behaviors and both need to be accounted for. In addition, outward and inward interstate banking of the same states may interact with each other. For example, a strong out-

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ward interstate banking state with major banking firms may deter banking firms from other states to make acquisitions. Finally, there is the temporal factor where the earlier spatial pattern may affect the later pattern. An ideal modeling approach should take all these factors (spatial dependence, outward and inward, interaction between outward and inward, and temporal effects) into account. The purpose of this paper is to estimate interstate banking taking all four factors into consideration, using a spatial 3-stage least squares model (spatial 3SLS). In this approach, outward and inward interstate banking regression equations are included for different temporal points. All regression equations contain a spatial autoregressive term of the dependent variable as an endogenous explanatory variable (also known as the spatial lag) and a spatially autoregressive error term (also known as the spatial error) [2]. The regression equations in the system are estimated simultaneously to account for spatial dependence, and the contemporaneous correlation between outward and inward interstate banking, and between interstate banking of different temporal points.

2. Interstate Banking in the United States

During the 19th century, the U.S. banking industry developed geographical fragmentation due to divergent political and economic interests that existed between cities and rural areas, and between large money center banks headquartered in New York, Chicago, etc. and small community banks [9]. The geographical fragmentation was manifested in the limitations on branch banking, and later on in multi-bank holding companies which hold multiple banks in different locations. The multi-bank holding companies were developed as a way to get around branching limitations before they were prohibited [17]. Although industrialization and urbanization prompted some states to loosen such limitations to various extent (e.g. California and New York), the regulatory restrictions remained in many states until in the late 20th century, especially in agricultural states.

Geographical deregulation in banking came as a result of searching for solutions to the disintermediation in the 1970s and banking crisis during the 1980s [32]. Intra-state branching and interstate bank holding were the two main venues. Many states which previously prohibited or limited in-state branching now loosened or ended the limitation. Many states also passed laws allowing out-of-state banking firms to enter their states, some on the reciprocal basis. Banking geographical deregulation culminated in 1994 with the passage of the federal Interstate Banking and Branching Efficiency Act (IBBEA) which authorizes nationwide banking and branching opening a new era in the U.S. banking history.

Twenty years on, the IBBEA facilitated tremendous interstate banking consolidation. Figure 1 shows the number of interstate banking mergers and acquisitions based on the Federal Reserve Bank Merger data (bars in the figure). The numbers of interstate consolidations in Figure 1 exclude the mergers of institutions that were already operating under the same bank holding companies. During the 1980s, interstate banking mergers and acquisitions were numbered only 16 on average every year, including interstate rescues of failed institutions permitted by federal laws. During the 1990s, the annual average of interstate mergers and acquisitions rose to 96. In 1998, there was a record 183 deals of interstate banking consolidation. Although the number of interstate consolidations declined since then, there were still 100 deals per year on average between 1999 and 2005. These numbers are largely consistent with estimates from Jones and Critchfield [16] and DeYoung et al [10] whose research shows a peak in consolidation values around 1998. Adams [1] estimates that between 2000 and 2010, of the largest 30 bank merger and acquisition deals in the United States, 19 were interstate consolidations. The 2007/8 financial crisis triggered another wave of interstate banking mergers and consolidations as many weakened banking institutions entered the voluntary mergers [21].

Interstate banking consolidations have significantly altered the geography of banking in the United States. For example, in 1994, out of 10,328 independent domestic banking institutions (bank holding companies, independent commercial banks and saving institutions), 353 or 3.4% were engaged in interstate banking. Twenty percent of the total deposits and offices in the country was held across state lines (deposits and offices located in host states were owned by out-of-state banking firms). In 2014, banking consolidation had led to a reduction of the number of domestic banking institutions to 6147. There were 692 banking institutions or 11.2% of the total in 2014 which participated in interstate banking, holding 46% of deposits and 41% of bank offices across state lines. Using state centroids to measure interstate distance, the average distance between home and host states in interstate banking was 623 miles in 1994. When using deposits and offices as weights, the weighted interstate banking distance was 676 miles (deposits as weights) or 596 miles (offices as weights). In 2014, the average interstate banking distance rose to 773 miles with the weighted distance at 1100 miles (deposits as weights) or 895 miles (offices as weights). Figure 2 shows the percentage of deposits and offices held across state lines by distance range. In 1994, over half of the deposits and offices involved in interstate banking

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were held within 500 miles. In 2014, both percentages dropped below 50%. At the same time, percentages of deposits and offices held in longer distances consistently increased in 2014 than in 1994 with the exception of offices held at the 1500 to 2000 miles range.

Maps in Figure 3 confirm significant changes in the geography of interstate banking between 1994 and 2014. Figures 3a and 3b show deposits held in other states as a percent of total deposits of a state in 1994 and 2014, respectively, a measure of a state's outward interstate banking (i.e. owning banking facilities in other states). In contrast, Figures 3c and 3d display deposits held by other states as a percent of total deposits of a state in 1994 and 2014, respectively, a measure of a state's inward interstate banking (that is, deposits owned by other states). Clearly, during the 20 year span from 1994 to 2014, more states had become involved in outward and inward interstate banking, and in general at increasing magnitudes (rising percentages of deposits held in or by other states). A careful examination of the maps shows that inward interstate banking is much more common than outward interstate banking. While most states saw their shares of deposits held by other states increased, only a selective number of states emerged owning significantly higher shares of deposits in other states. These differential patterns motivate this study which aims to ascertain contributing factors of the outward interstate banking and inward interstate banking, respectively.

3. Method

The traditional banking modeling mostly uses the single equation method [4,15,24,27]. Using a single equation model, outward interstate banking and inward interstate banking would have to be estimated in separate regression models. The above maps suggest shortcomings of the single equation approach. For example, Figures 3b and 3d show that in 2014, major outward interstate banking states, such as California, North Caroline, New York, Ohio, Pennsylvania, Georgia, and Alabama had higher percentages of deposits held in other states but lower percentages of deposit held by other states. In contrast, many states with higher percentages deposits held by other states have lower percentages of deposits held in other states. This suggests that outward and inward interstate banking equations are not independent of each other and there may be possible inter-equation correlation. Taking the inter-equation correlation into account may help improve the efficiency of estimation.

In addition, some early patterns in interstate banking persisted to later time. For example, some Western states and states in the Southeast were major inward interstate banking states in 1994 (Figure 3c). In 2014, these states were still among those with higher percentages of inward interstate banking (Figure 3d). The persistence in outward interstate banking is less prominent than in inward interstate banking. Still, one can recognize states such as North Carolina, Ohio, and Minnesota which continued to be major outward interstate banking states from 1994 to 2014. Such temporal persistence suggests possible inter-equation correlation in models where different equations contain models of different years.

In addition to temporal persistence, the prominent position in inward interstate banking of Western states also suggests possible spatial dependence. Indeed, there are reasons to believe certain spatial structure in interstate banking. Historically, Western states tended to have more liberal banking laws compared with the Midwestern states, contributing to higher inward interstate banking in the West than in the Midwest. During the 1980s, there were regional interstate banking compacts where neighboring states agreed to allow each other's banks to enter respective markets [25,33]. In general space seems to act in a powerful way to shape interstate banking. Figures 2a and 2b show significant distance decay, though weakened somewhat from 1994 to 2014, suggesting spatially close states are more likely to enter interstate banking relationships. The distance decay may catch other various spatial factors which influence banking but are not easy to capture explicitly in regressions. These factors include costs, information, and preferences associated with distance in banking. The above discussion highlights the significance of a method which simultaneously account for spatial dependence, outward and inward interstate banking and their interaction, and the temporal effects. This motivates the adoption of the spatial 3SLS as a modeling approach.

Zellner [38] proposes the seemingly unrelated regression or SUR in a multi-equation system to account for contemporaneous covariance in the errors between different equations. Suppose a single cross-section regression in an M equation system as follows

$$y_i = X_i \beta_i + u_i \qquad i = 1, 2, \ldots M \tag{1}$$

where $y_i = (y_{i1}, y_{i2} \ldots y_{in})'$ is a n×1 vector containing observations of a dependent variable in equation i; X_i an n×k matrix containing n observations for k independent variables in equation *i*; $\beta_i=(\beta_{i1},\beta_{i2},\ldots\beta_{ik})'$ a k×1 vector of k regression coefficients in equation *i*; and $u_i=(u_{i1},u_{i2},\ldots u_{ik})'$ a vector of n errors in equation *i*. In Zellner's original work, the simultaneous system is estimated by using the (feasible) Generalized Least Square estimator

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$$\hat{\beta}_{GLS}=\left(X'\Omega^{-1}X\right)^{-1}\left(X'\Omega^{-1}y\right)=\left(X'\left(\sum^{-1}\otimes I\right)X\right)^{-1}\left(X'\left(\sum^{-1}\otimes I\right)y\right) \quad (2)$$

in which $\Omega=\Sigma \otimes I$ where Σ is an M×M matrix of variance-covariance of the M equations in the system. I is an N×N identity matrix. The Kronecker product operator $\otimes$ multiplies every element in Σ by I, leading to a (M·N)×(M·N) variance-covariance matrix Ω for the entire M equation system. The GLS estimator incorporates the inter-equation covariance and thus increases the estimation efficiency, with the efficiency gains rising with increasing inter-equation covariance [12].

In standard SUR, each equation by itself is a classical regression. Thus each equation's variance-covariance matrix is $\sigma_{ii}I$ with 0 in the off principal diagonal. When spatial effects exist, the following relationships replace equation (1) in an M equation system

$$y_i=\rho_i W y_i+X_i\beta_i+u_i$$

$$u_i=\lambda_i W u_i+\varepsilon_i \quad (3)$$

where W is a weight matrix that defines the spatial autocorrelation structure; □$_i$ the spatial autoregressive parameter for the spatial lag variable in equation I; λ_i the autoregressive parameter for spatial error; and ε_i a spherical error term. Other terms are defined as before. Lee [22] shows that the variance-covariance of any single equation *i* is $\sum_i=\sigma_{ii}(I-\lambda_i W)^{-1}(I-\lambda_i W')^{-1}$ The off principal diagonal elements are not necessarily zero and errors are spatially correlated. In addition, the endogenous explanatory variable Wy_i and error terms are correlated [20]. All these make Zellner's OLS-based estimator biased and inconsistent [2].

Kelejian et al. [20] and Anselin et al. [3] show a spatial Cochrane-Orcutt transformation, which uses filtered variables to remove the spatial dependence from the error term in (3). That is,

$$(I-\lambda_i W)y_i=(I-\lambda_i W)Z_i\delta_i+(I-\lambda_i W)u_i \quad (4)$$

where $Z_i=[X_i, Wy_i]$ and $\delta_i=[\beta_i',\rho_i]'$

Define filtered variables $y_{si}=(I-\lambda_i W)y_i$ and $Z_{si}=(I-\lambda_i W)Z_i\delta_i$ (5)

Thus (4) becomes $y_{si}=Z_{si}\delta_i+\varepsilon_i$ (6)

In both (4) and (6), the endogenous variable Wy_i is correlated with the error term [22]. As a result, 2-stage least squares (2SLS) is needed in estimation in which instrumental variables are used to generate residuals uncorrelated with the endogenous variable [36].

In the spatial regression system, parameters to be estimated include λ_i, ρ_i and β_i. Operationally, this can be done in three steps [3,20]. In the first step, a 2SLS is applied to estimate (3). Instrumental variables H=[X, WX] are used to instrument Wy_i (first stage) and then use the resultant $H(H'H)^{-1}H'Z$ to instrument y_i (second stage) to obtain initial estimates of ρ_i and β_i [22]. In the second step, residuals from the first step are used to estimate λ_i and the variance of the errors, by solving a three moment-equation system from the moment conditions, or the General Method of Moments (GMM) suggested by Kelejian and Prucha [19]. Anselin [3] gives a detailed description of implementation of the GMM. In the third step, λ_i from the second step is used to create filtered variables as in (5) and the Feasible Generalized Least Squares estimator is applied to (6) in a spatial SUR to obtain revised ρ_i and β_i. The Feasible Generalized Least Squares estimator is

$$\hat{\beta}_{FGLS}=(Z_s'\hat{\Omega}^{-1}Z_s)^{-1}(Z_s'\hat{\Omega}^{-1}y_s)=(Z_s'(\hat{\Sigma}^{-1}\otimes I)Z_s)^{-1}(Z_s'(\hat{\Sigma}^{-1}\otimes I)y_s) \quad (7)$$

where Z_s and y_s are filtered variables, $\hat{\Omega}=\hat{\Sigma}\otimes I$, and $\hat{\Sigma}$ is the estimate of Σ from the sample. The last step is essentially a 3-Stage Least Squares (3SLS) [2,14] in which a 2SLS is first performed on each single equation as in (6) of the equation system. The instrumental variables can still be those used in the first step as discussed above. However, Lee [22] suggests the use of the filtered instrumental variables, which is adopted in this study. Residuals from the 2SLS are then used to estimate between-equation correlations to obtain $\hat{\Sigma}$. Finally, estimator (7) is used to estimate the system of equations.

4. The Estimating Model, Variables and Data

In actual estimation, the method discussed above is applied to a panel data set. Equation (3) is adopted for all 50 states in the United States plus the District of Columbia. These are home and host states in the interstate banking networks. In addition, these are regulatory units regulating branch banking and multi-location bank holding historically, and to a certain degree, regulating interstate banking today (see below). For each state plus DC, outward and inward interstate banking equations are specified for both 1994 and 2014. Thus the following four estimating equations are included in the spatial 3SLS system.

$$y_{out1994}=\rho_{out\,1994}Wy_{out\,1994}+X_{out\,1994}\beta_{out\,1994}+(I-\lambda_{out\,1994}W)^{-1}\varepsilon_{out\,1994}$$

$$y_{out\,2014}=\rho_{out\,2014}Wy_{out\,2014}+X_{out\,2014}\beta_{out\,2014}+(I-\lambda_{out\,2014}W)^{-1}\varepsilon_{out\,2014}$$

$$y_{in\,1994}=\rho_{in\,1994}W_{yin\,1994}+X_{in\,1994}\beta_{in\,1994}+(I-\lambda_{in\,1994}W)^{-1}\varepsilon_{in\,1994}$$

$$y_{in\,2014}=\rho_{in\,2014}Wy_{in\,2014}+X_{in\,2014}\beta_{in\,2014}+(I-\lambda_{in\,2014}W)^{-1}\varepsilon_{in\,2014} \quad (8)$$

y_{out} is a 51×1 matrix of dependent variable, outward interstate banking, defined separately for 1994 and 2014.

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Similarly y_{in} is a 51×1 matrix of dependent variable, inward interstate banking, defined separately for 1994 and 2014. X is a 51×k matrix of independent variables. In operation, for each year, the same k independent variable are entered for both y_{out} and y_{in} regressions. However, each equation may end up having a different or overlapping combination of statistically significant variables from the k independent variables entered. I is a 51×51 identity matrix. W is the weights matrix that defines the pattern of spatial dependence. The Queen contiguity specification is adopted for the weights in this study. ε are errors of each equation. Parameters to be estimated are ρ, λ, and βs for each equations. It should be noted that due to the use of the Queen contiguity weights, Alaska and Hawaii are actually dropped out of the simultaneous system since these two states are not physically adjacent to any other states. They would be retained within the system with the use of alternative weights matrixes (such as distance-based or socioeconomic relationship-based matrices).

4.1 Dependent Variables

Table 1 contains brief definitions of dependent variables, democratic and socioeconomic intendent variables, banking intendent variables and banking legislative independent variables. Outbanking, or outward interstate banking, is defined as the deposits owned by a state (home state) but located in other states (host states) divided by the total deposits of the home state and measured as a percentage. Inbanking or inward interstate banking is the deposits located within a state (host state) but owned by other states (home states) divided by the total deposits of the host state, measured as a percentage. Outbanking and Inbanking measure the extent to which a state engages in outward and inward interstate banking, respectively.

4.2 Demographic/Socioeconomic Independent Variables

Demographic and socioeconomic variables are included to capture possible impacts from income, market size, and economic structure which essentially translate to demands for banking [6,13,28]. The percent of urban population (UrbanPop) and per capita income (PCI) measure states' general economic wellbeing and development. The total state employment or Employees is a proxy of the market size of a state, avoiding using the same aggregates (population, total deposits, total income, etc.) that are used in creating other variables. Location quotients are calculated using employment data to characterize states' economic structures. The location quotient is the ratio of a state's percent of employment in an industry to the percent of the U.S. employment in that industry. A high location quotient above 1 means a strong specialization in that industry, and a small value below 1 means a lack of specialization. The location quotients used in the study include primary (LQPrimay), service (LQService), manufacturing (LQMFG), FIRE (LQFIRE), and government (LQGov) sectors. Due to changes in industrial classification in 1997, location quotients for 1998 were calculated as a proxy of the economic structure of 1994. PopChange, or the average annual population change rate in a 10 year interval, is designed to reflect the changing market size (More in Subsection 4.3 on how the 10 year interval is determined).

4.3 Banking Independent Variables

FirmSize is the average size of a state's banking firms involved in interstate banking, calculated as the total deposits of these firms divided by the number of these firms. PCO or the average number of bank offices per 1000 people in a state measures the banking service availability, though online banking may have made such a measure less relevant. It turns out that PCO is not statistically significant in any of the four equations in the system. The Herfindahl-Hirschman Index or HHI measures the level of concentration of a state's banking industry. The HHI is the sum of the squared deposit market shares of banking firms in a state and ranges between close to 0 and 10000. Higher HHI values indicate higher levels of concentration which is associated with less competitive markets. ROEChange is used to capture the profitability of a state's banking industry. It is the average rate of return on equity for a state's banking industry in a 10 year interval. KalaChange is the average capital-to-labor ratio for a 10 year interval for a state's banking industry. The capital-to-labor ratio is the ratio of bank expenses on premises/physical capital to expenses on labor. LaborChange is the average percent of expenses on labor in the total non-interest expenses for a state's banking industry, calculated for a 10 year interval. Together, KalaChange and LaborChange may help capture the use of technology in banking as reflected in capital expenses. Since the two anchor years of the study are 1994 and 2014, the 10 year interval is taken as the 10 years prior to the two anchor years. That is, from 1984 to 1994, and 2004 to 2014 respectively.

4.4 Banking Legislative Independent Variables

Bklaw is a composite index adding up scores assigned to state banking laws concerning geographical restrictions on banking. Two sets of banking laws are used, intra-state branch banking and interstate banking. Within each law category, the 1985 statute and the 1992 statute are used to

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reflect the changing state banking laws from the 1980s up to the eve of the IBBEA in 1994. In terms of intra-state branching, various state laws permit statewide (3 points assigned), limited (2 points), or no branching (1 point). In terms of interstate banking, various state laws allow nationwide (4 points assigned), nationwide reciprocal (3 points), regionwide reciprocal (3 points), regionwide reciprocal when the state law takes effect (2 points), or no interstate banking (1 point). A few states had no interstate banking law in 1985 and/or 1992. They are assigned 1.5 points since they did not explicitly permit or prohibit it. The assigned value rises with increasing permissibility in the respective law. Each state's score in Bklaw is the sum of assigned values in both intra-state branch banking and interstate banking laws/regulations.

While Bklaw reflects the state banking laws prior to the nationwide interstate banking, Stbklaw is a composite measure designed by Johnson and Rice [15] to index limitations to interstate banking by states since the nationwide interstate banking in 1994. The IBBEA expressly allows states to restrict the manner by which the out-of-state banking firms enter a host state market in four ways. Host states can set the minimum age of the target institution in acquisition by out-of-state banking firms up to five years; host states can decide whether establishment of de novo branches is permitted by out-of-state banking firms; host states can decide whether out-of-state banking firms can acquire an existing office of a bank, instead of acquiring the entire bank; and host states can establish a deposit cap to restrict the size of an out-of-state banking firm under a certain percentage of the total deposits in a state, such as no more than 30% [15]. For each limitation, Johnson and Rice give one point if a certain limitation is applied or 0 otherwise. That is, one point is assigned for each of the following limitations: a minimum of 3 years or more is required for the interstate acquisition target institution; a de novo branching is not permitted; acquisition of a branch is not permitted; and a deposit cap less than 30% is imposed [15,31]. Stbklaw ranges from 0 to 4 with higher values indicating more restrictions on interstate banking.

Following Zhou and Kockelman [39], all explanatory variables are entered four equations individually. A stepwise regression procedure is applied to retain statistically significant variables. These variables are used in the three steps in the estimation process, as discussed in Section 3.

Income, population, and employment data are obtained from the U.S. Department of Commerce Bureau of Economic Analysis Internet sites. Urban population is from the Bureau of Census. All banking data are from the Federal Deposits Insurance Corporation Internet sites. The banking institutions include bank holding companies and independent banking institutions including commercial banks, state banks, saving banks, and saving and loans institutions which receive the depositary insurance from the FDIC. Thus it has the widest possible coverage of banking institutions in the United States.

5. Results

In estimating the four equation system, linear restrictions are applied to ρ and λ to restrict their values to be 0. The result is compared with the unrestricted model in order to test the statistical significance of spatial effects. The following F test is used following Greene [12] and Henningsen and Hamann [14].

$$F = \frac{\left(ESS^{*} - ESS\right)/j}{ESS/\left(M \times N - k\right)} \tag{9}$$

where ESS* and ESS are sums of squares of residuals for restricted and unrestricted models respectively; j is the number of linear restrictions, k the number of explanatory variables, N the number of observations in each equation, and M the number of equations. The F test has j and M×N-k degrees of freedom respectively. The resultant F value is 3.6 and the null hypothesis is rejected at the 0.01 level. Thus the spatial effects are present in the interstate banking system as a whole.

Table 2 provides between-question contemporaneous correlations. They show that in 2014, there was only slight contemporaneous correlation in residuals (-0.07) between Outbanking and Inbanking. However, this was not the case in 1994 when the contemporaneous correlation in residuals between Outbanking and Inbanking was much stronger at 0.22. In terms of temporal correlation, residuals in Outbanking during the earlier period informed later period (0.19) more than in Inbanking (-0.11). Incorporating these correlations in estimation has moderately significant impacts on the results. Of the 46 parameter estimates, twelve or 25% experience a change in the magnitude at or above 10% after incorporating the between-equation contemporaneous correlations.

Table 3 provides the final estimation result of the four-equation system. Since the expected signs for all parameters are either positive or negative for the alternative hypothesis, the table gives one-tailed p-values. The discussion below will focus on the roles of spatial variables, demographic/socioeconomic variables, banking variables, and banking legislative variables.

5.1 Spatial Lags and Spatial Errors

The spatial lag is statistically significant with a positive sign

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in the Inbanking equations of both years. This indicates a positive spatial autocorrelation in inward interstate banking where a state's position in inward interstate banking is positively associated with their neighboring states. In other words, states with similar levels of Inbanking tended to cluster, as seen in Figures 3c and 3d where the West in 1994 and the West and Southwest in 2014 had many higher inward interstate states, and the central portion of the country had many moderate inward interstate banking states in both years. The positive spatial autocorrelation is closely related to the distance decay as shown in Figures 2a and 2b. In banking, the need to obtain information, control costs, and understand markets still generally favor closer locations [8]. Another contributing factor may be the lingering effects of the regional patterns of geographical restrictions on banking (e.g. the restrictive Midwest vs. the permissive West) and the regional banking compacts. Indeed, analyzing the destinations of interstate banking acquisitions between 1988 and 1993, McLaughlin [23] finds that most expansions occurred in neighboring states, rather than non-contiguous states. On the other hand, the spatial lag is not statistically significant for the Outbanking equations of both years. In Figures 3a and 3b, states with higher Outbanking did not demonstrate clear concentration. This indicates that whether states rose as significant outward interstate banking players is not necessarily associated with their neighboring states' outward interstate banking status. It is likely that the actions and business strategies of banking firms (especially the large banking firms as discussed in Sub-section 5.3) within the states play significant roles. The spatial effects in the error term reflect factors which are not explicitly incorporated as explanatory variables in the model. Though magnitude varies, all equations show a negative impacts between neighboring states.

5.2 Demographic/Socioeconomic Variables

UrbanPop is significant for the 2014 Outbanking equation with a negative sign, indicating active outward interstate banking states are not confined to those with the highest percent of urban population. Indeed, in 2014, of the states with the highest Outbanking scores, only New York and California were among the top 10 states with the highest UrbanPop. Regional interstate banking center powerhouses such as Pennsylvania, Ohio, Alabama, Minnesota, Georgia, and Virginia ranked 14, 18, 26, 27, 28, and 30 in terms of UrbanPop. North Carolina, one of the three national outward interstate banking states, along with New York and California, ranked 29 in UrbanPop. While the last 20 years have seen significant banking consolidation, the U.S. banking industry as whole is still less concentrated than many other advanced economies. As stated early, by 2014 there were still over 6,000 independent banking institutions with nearly 700 of them engaged in interstate banking. Interstate banking activities from a vast number of banking institutions allowed strong outward interstate banking states to emerge in their respective regional contexts even though these states did not reach the highest level of urbanization at the national level. For example, as strong regional outward interstate banking states, Alabama and Minnesota ranked 26 and 27 respectively in UrbanPop nationwide but ranked 1 in their respective East South Central Region and North West Central Region. The correlation coefficient between Outbanking and the percentage of deposits held by top 20 outward interstate banking states as host states' deposit total is -0.24% (p-value = 0.04). At the same time, the correlation coefficient between Outbanking and the percentage of deposits held by home state banks as the state deposit total is 0.35% (p-value = 0.006). These relationships seem to suggest that while major outward interstate banking states tended to hold more of deposits in their own states, they tended to hold less deposits in other major interstate banking states. In other words, major interstate banking firms appear to be avoiding competition against each other on their own home turf. This finding is consistent with studies which suggest that due to the common ultimate ownership by fund managers and cross-ownerships (banks hold each other's stocks), there is little competition among some of the largest banks [5,34]. In the context of interstate banking, the net effect is that major regional outward banking states are shielded from an out-right onslaught by the largest banking centers in the country.

Employees, as a measure of market size, was significant in 1994 Outbanking with a negative sign suggesting that smaller states may actually be active centers of outward interstate banking. This may be due to the fact that in 1994, there had not been states with nationwide interstate banking connections (California banking firms operated in 25 other states, compared with 43 in 2014, the highest of all states in both years). Active outward interstate banking states include large states (e.g. California, Ohio, and North Carolina) as well as many smaller states (e.g. Rhode Island, North Dakota, Idaho, Connecticut, Oregon, Utah and Nebraska). The uneven state banking legislation by the early 1990s had allowed some small states to rise to prominence in outward regional interstate banking. However, by 2014, the prominence of the smaller states in Outbanking all but disappeared. Employees has a positive sign for the sample 2014 Outbanking equation, though it is not statistically significant at the 0.05 level.

While Employees measures the market size per se, PopChange, or the average population growth rate in a 10

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year interval, measures the change in the market size. The variable is significant for Inbanking equations with a positive sign in both 1994 and 2014, indicating that the rapidly growing markets were more likely to be the target of inward interstate activities. This result is in line with Gunther [13] who finds rising population leads to banking expansion.

Location quotients for manufacturing, FIRE, and government sectors are significant for Outbanking 2014 with a positive sign, indicating states with healthy economic structures tended to be actively engaged in outward interstate banking. In the 2014 Inbanking equation, location quotients for primary, manufacturing and FIRE sectors are significant with a positive sign, and location quotient for service is significant with a negative sign. The significant Primary sector may reflect the role of booming commodities sectors, especially in energy, in recent years. In addition, PCI is significant with a negative sign. Taken together, this seems to suggest that states with lower income but strong primary, manufacturing, and FIRE, and weak traditional service sector, tended to received much inward interstate banking. These results point to the role of broader economy in interstate banking: a strong state economy may bolster banking firms with an expansion ambition across state lines while states with healthy economic structures but lower income levels may attract inward interstate banking. Interestingly, location quotients for service and government sectors are significant for 1994 Inbanking with a positive sign. This still supports the notion that a strong economy may make a state an attractive interstate banking target. However, while the service sector may be part of what constituted a healthy economy in 1994, by 2014, its role is reversed.

The above findings are in general consistent with Morgan et al [26] regarding the state economy and the banking industry. While a healthy state economy supports a strong banking industry, a collapsing state economy tends to cause widespread bank failures [26]. Morgan et al find that under interstate banking, the collateral shocks are stronger than capital shocks. That is, while an interstate banking firm can supply bank capital for profitable lending from its home state to a host state, poor quality collaterals in the host state will cause the withdraw of bank capital [26]. This should necessarily impel the out-of-state banking firms to enter states with healthy economic structure since this help find quality lending customers with solid collateral assets.

5.3 Banking Variables

FirmSize is significant in all equations with a positive sign for Outbanking and negatives sign for Inbanking. Clearly, larger firm sizes contribute to dominant position in outward interstate banking while smaller firm sizes is a significant factor in states' role in inward interstate banking. This result is in line with Phillis and Pavel [28]. Here lies a paradox in the early days of interstate banking. As discussed in 5.2, many of the active outward interstate banking states in 1994 were small states. However, quite a few large and active interstate banking institution actually originated from these small states such as Riggs National Corporation in Washington D.C., First National of Nebraska Inc. in Nebraska, Shawmut National Corporation in Connecticut, U.S. Bancorp in Oregon, Zions Bancorporation in Utah, West One Bancorp in Idaho, Community First Bankshares Inc. in North Dakota, First Interstate BancSystem of Montana Inc. in Montana, Fleet Financial Group Inc. in Rhode Island, etc. Uneven banking legislation in early days allowed large banking firms to emerge and expand at the regional level, both from large and small states.

HHI is significant for 2014 Inbanking equation with a positive sign, suggesting a more concentrated banking industry as a factor in active inward interstate banking. This is generally consistent with the view that the active banking consolidation leads to higher concentration at the state level [29,37]. This evidence by itself does not suggest rising local market concentration. Early study of the local market concentration shows mixed results as a consequence of interstate banking [30,35]. However, more studies are sorely needed to assess the competitiveness effect using more recent data.

ROEChange or the average of rates of return on equity of the banking industry in a 10 year interval is significant with a negative sign in the 2014 Inbanking equation, suggesting that a lower profitability is a reason for a state becoming an interstate banking destination. This is consistent with Kowalik et al [21] who identify lower profitability as a characteristic of targets in banking merger and acquisition. Lower profitability normally leads to depressed asset values which necessarily attract out-of-state banking firms to enter a bank market [11].

Another telling sign is KalaChange or the average capital-to-labor ratio of the state's banking industry in a 10 year interval. KalaChange is significant in the 2014 banking equations but with a positive sign for Outbanking and negative sign in Inbanking. This suggests that the banking industry in outward interstate banking states tended to have a higher capital-to-labor ratio, while it was the opposite in inward interstate banking states. This may be the result of the larger banking firms in outward interstate banking and smaller firms in inward interstate banking. Since more capital use may embody better technologies, this means that outward interstate banking firms tended to use more new technologies while the inward interstate

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banking states use less. This is in line with Jones and Critchfield [16] and Berger et al [7] that banking consolidation is in part a response to the use of new technologies in banking and larger banking institutions tend to use new banking technologies. This pattern is in part confirmed by LaborChange, the average of the percent labor expenses in total non-interest expenses in a 10 year interval, which is significant in the 2014 Inbanking equation with a positive sign. For the 1994 Inbanking equation, LaborChange has a negative sign but is only marginally significant.

5.4 Banking Legislative Variables

Stbklaw, the composite index measuring the states' restrictions on interstate banking since 1994, is significant in the 2014 Outbanking equation with a negative sign, meaning that states with less restrictive interstate banking regulations/laws since 1994 tended to actively establish interstate banking connections in other states. This finding is consistent with Johnson and Rice [15]. Although Stbklaw also has a negative sign in the 2014 Inbanking equation, it is not statistically significant.

Interestingly, the effects of banking legislation during the 1980s seem to linger in the past 20 years. Bklaw is significant in three of the four equations. In the Inbanking equations, it is significant with a positive sign for both 1994 and 2014, indicating, unsurprisingly, the positive impacts of states' permissive banking legislation on inward interstate banking in 1994, and, surprisingly, their lingering positive impacts on inward interstate banking 20 years later. Both the regional banking compacts and the regional banking legislation, along with distance decay effect, aided the significant and positive spatial lag in the Inbanking equations.

For the Outbanking in 2014, Bklaw is significant with a negative sign, indicating many states with restrictive banking legislation during the 1980s emerged as the players in outward interstate banking in 2014. This result is also in line with Johnson and Rice [15] who find banking firms from states with restrictive intra-state banking laws tended to expand in other states. Indeed, of the 15 states with the highest Outbanking roles, only 2, California and New York, have a Bklaw score in the top 10. The major regional Outbanking states in 2014 such as Ohio, Virginia, Pennsylvania, Georgia, Alabama, and Minnesota, ranked 24, 29, 30, 36, 40, and 45 respectively in Bklaw scores. These states tended to have similar Bklaw scores as their neighboring states but managed to emerge as major Outbanking states. This provides support to an early argument in Subsection 5.1 that business strategies of banking firms within the states, rather than the banking legislation, played a significant role in states emerging as major outward interstate activity. However, this effect was not clear in 1994 since Bklaw is not statistically significant for 1994 Outbanking equation. This may happen due to the fact that there were not many states which had a strong positions in Outbanking in 1994.

5.5 Interstate Banking and Macroeconomic Conditions

While the discussion so far is focused on particular variables or factors, the role of some of these factors in interstate banking cannot be detached from general macroeconomic conditions. The 1990s witnessed the highest growth period in the U.S. economy since the 1970s. The decade saw an average annual real GDP growth rate 3.4%, compared with 3.2% in the 1980s and 1.8% in the first decade of 2000s (lines in Figure 1). The economy was basked in rising information and globalizing economy [16]. There was much optimism in the U.S. economy. The 1990s also saw the first wave of interstate banking (Figure 1). The desire for interstate banking had been building in many major banking firms and the pent-up demands were released as the IBBEA became law [23]. Under the circumstance, ambitious banking firms took interstate banking as a new venue to discover new markets and opportunities. Thus interstate banking acquisitions normally were accomplished by paying premiums to the acquisition targets [16] As a result, interstate banking targets are not solely guided by profitability, which may explain the statistical insignificance of profitability in the 1994 equation.

The economy around 2014 was much different. The GDP growth rates were down. The U.S. economy grew 4.4% in 1994 but only 3% in 2014. The average annual real GDP growth from 1984 to 1994 was 3.5% while that from 2004 to 2014 was 1.9%. Many state banking industries suffered losses during the 2007/2008 financial crisis, which contributed to lower banking profitability. Under such circumstances, it is understandable that in 2014 outward interstate banking states are those with higher profitability while inward interstate banking states are those with lower income levels and lower banking profitability. This assessment is in general agreement with Kowalik et al [21] who, while analyzing bank mergers between 2011 and 2014, characterize merger targets as those small firms with lower profitability and lower efficiency. In addition, banking technologies in the 1990s were likely to be more uniform between larger and smaller banks they are today. This may explain why profitability and capital-to-labor ratio were not out statistically significant in the 1994 equations, but significant in the 2014 equations.

6. Summary and Conclusions

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This study uses a spatial 3-stage least squares model to estimate the interstate banking in 1994 and 2014. The method takes into account simultaneously spatial dependence, outward and inward interstate banking and their interaction, and the temporal effects in interstate banking. The estimation system contains four equations with outward and inward interstate banking for 1994 and 2014 for the 50 states plus the District of Columbia. The results indicate a more efficient estimation than without taking these effects into account. These reflect in a statistically significant F test on the spatial effects, moderate inter-equation contemporaneous correlations, which results in a quarter of the parameters estimates to change values by more than 10%.

The study shows that interstate banking is driven by multiple factors. A healthy economic structure, an expanding market, and permissive banking legislation seem to encourage inward interstate banking. At the same time, a healthy economic structure is also a basis for strong banking firms to rise and to expand in other states. Large banking institutions were clearly dominate in outward interstate banking while smaller firm sizes tend to be associated with inward interstate banking. By 2014, states with active inward interstate banking had not only smaller interstate banking institutions, but also lower capital-to-labor ratios and higher labor resource use in the entire state banking industry. In addition, possibly for macroeconomic reasons, these states also tended to have lower income levels and possibly resultant lower banking profitability. At the same time, large and well-capitalized banking firms from states with a healthy economic structure had expanded into these states to operate bank branches and hold deposits. While these findings somewhat confirm the public impression of banking restructuring which favors the large and strong and disadvantages the small and weak, they do reveal making profits and improving efficiency through better technology as part of the underlying forces of spatial banking consolidation.

The study also shows evidence of continuous banking fragmentation. In 1994, interstate banking was clearly scattered in that a number of smaller states with large interstate banking firms began to emerge as important players in outward interstate banking. By 2014, while the nation had experienced significant banking consolidation, some active outward interstate banking states were from regions with lower levels of urbanization. Powerful banking firms from states with the highest urban development had not completely dominated over the nation's banking landscape. The study also demonstrates that the spatial effects of past banking legislation can linger for many years. This indicates the significant role of public policy on consumer welfare and points to the need for future banking regulation to carefully weigh conforming to the needs of business against the public interest. In this context, the research finds evidence of rising market concentration in inward interstate banking states and that major interstate banking firms are competing less against each other in their own home states. These findings necessarily raise the issue of competitiveness in banking markets as a result of interstate banking. Clearly, further study should be done at the local market level and necessary policy should be designed to insure that the bank service quality and prices do not come at the expense of consumers.

Appendixes

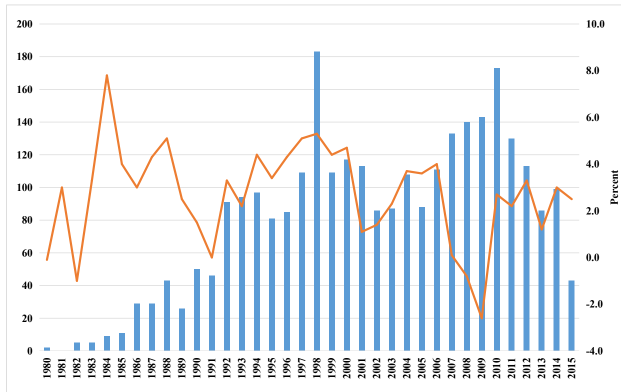

Figure 1. Annual numbers of interstate mergers and acquisitions (bars) and real GDP growth rates (curve)

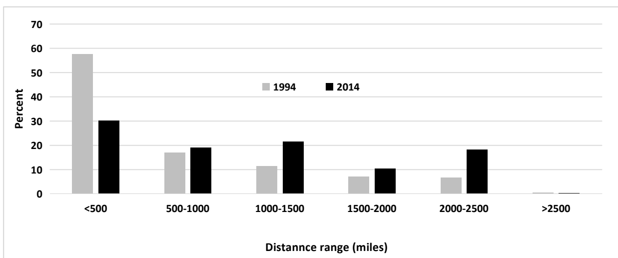

Figure 2a. Percentages of deposits held across state lines by distance range

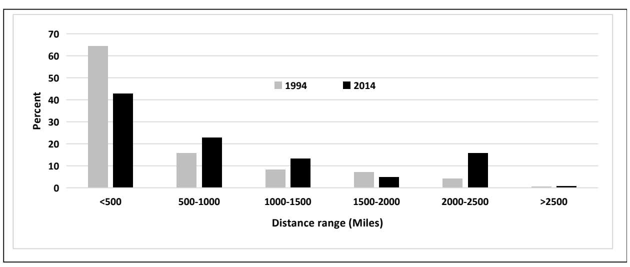

Figure 2b. Percentages of bank offices held across state lines by distance range

Figure 2. Percentages of deposits and offices held across state lines by distance range

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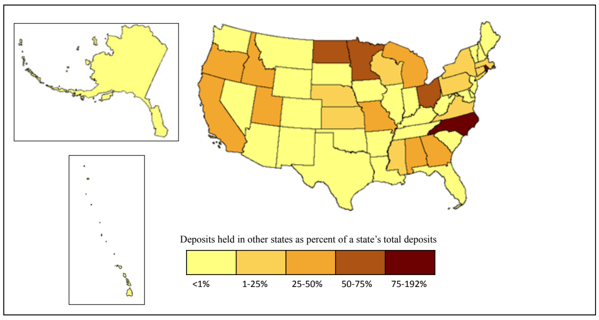

Figure 3a. Deposits held in other states as percent of a state's total deposits, 1994

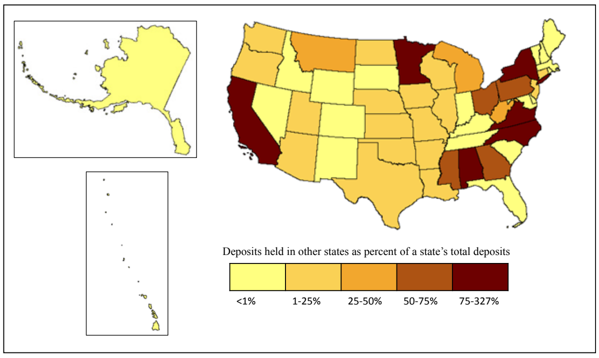

Figure 3b. Deposits held in other states as percent of a state's total deposits, 2014

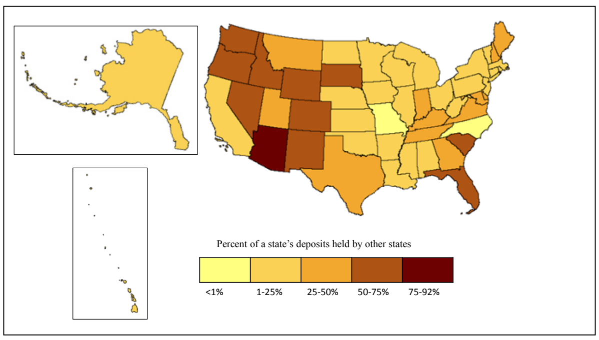

Figure 3c. Percent of a state's deposits held by other states, 1994

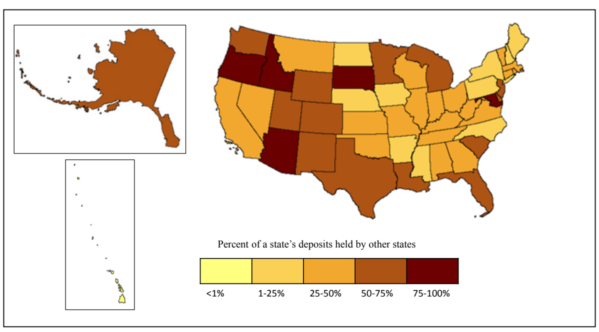

Figure 3d. Percent of a state's deposits held by other states, 2014

Figure 3. Percent of deposits in interstate banking

Table 1. Definitions and Descriptions of Variables used in Estimation

Variable	Definition and description
Dependent	
Outbanking	Outgoing interstate banking; deposits owned by a home state but located in host states as percent of the home state's total deposits
Inbanking	Incoming interstate banking; deposits owned by home states but located in a host state as percent of the host state's total deposits
Demographic and socioeconomic independent	
UrbanPop	Urban population as percent of a state's total population; both years
Employees	Total employments in a state; both years
PCI	Per capita income; both years
LQPrimary	Location quotient for primary sector; both years but use 1998 data for 1994
LQService	Location quotient for service sector; both years but use 1998 data for 1994
LQMFG	Location quotient for manufacturing; both years but use 1998 data for 1994
LQFIRE	Location quotient for FIRE sector; both years but use 1998 data for 1994
LQGov	Location quotient for government sector; both years but use 1998 data for 1994
PopChange	Average annual population change rate during a 10 year interval; 1984 to 1994 for 1994, 2004 to 2014 for 2014
Banking independent	
FirmSize	Average size of a state's banking firms with interstate activities; both years
PCO	Number of bank offices per 1000 population in a state; both years
HHI	The Herfindahl-Hirschman Index; sum of squared deposit shares from all banking firms in a state; both years
ROEChange	Average rate of return to equity of a state's banking industry during a 10 year interval; 1984 to 1994 for 1994, 2004 to 2014 for 2014
KalaChange	Average capital to labor rate of a state's banking industry during a 10 year interval; 1984 to 1994 for 1994, 2004 to 2014 for 2014
LaborChange	Average percent of labor expenses in total non-interest expenses of a state's banking industry during a 10 year interval; 1984 to 1994 for 1994, 2004 to 2014 for 2014
Banking legislative intendent	
Bklaw	A composite index for state banking laws incorporating both intra-state branching and interstate banking laws; same for both years
Stbklaw	A composite index for state interstate banking laws since 1994 reflecting specific restrictions on interstate banking

Table 2. Between-equation contemporaneous correlations

	Outbanking2014	**Inbanking2014**	**Outbanking1994**	**Inbanking1994**
Outbanking2014	1.0000	-0.0742	0.1901	0.0816
Inbanking2014			-0.0719	-0.1065
Outbanking1994				-0.2231

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Table 3. Estimates of parameters and one-tailed p-values (in parentheses)

	Models			
	Outbanking14	Inbanking14	Outbanking94	Inbanking94
Intercept	-11.0755 (0.3815)	44.0140 (0.2127)	73.5375 (0.0089)	-141.159 (0.0016)
UrbanPop	-0.63 (0.0028)		0.42 (0.055)	0.1709 (0.0817)
Employees	0.0002 (0.0577)		-0.001 (0.0001)	
PCI	-0.0003 (0.2518)	-0.0014 (0.0051)	-0.0024 (0.0534)	
LQPrimary		6.1440 (0.0026)		2.1586 (0.1024)
LQService		-96.1698 (0.006)		56.5662 (0.021)
LQMFG	14.0457 (0.0135)	12.0323 (0.0317		6.5600 (0.1267)
LQFIRE	51.8126 (0.0091)	92.1394 (0.0007)		
LQGov	31.4387 (0.0052)			33.9293 (0.0002)
PopChange	-6.8038 (0.0703)	8.0493 (0.035)		6.496 (0.0006)
FirmSize	0.0001 (0.0000)	-0.0001 (0.0001)	0.0001 (0.0000)	-0.0001 (0.0217)
PCO				
HHI		0.0109 (0.00015)		
ROEChange		-239.4 (0.0104)		
KalaChange	77.1646 (0.0005)	-91.3939 (0.0031)		
LaborChange		81.8808 (0.012)		-45.0713 (0.0458)
Bklaw	-4.1412 (0.0017)	3.221 (0.011)	-3.1541 (0.0569)	2.7596 (0.0083)
Stbklaw	-3.397 (0.0369)	-2.4369 (0.0932)		
ρ	0.1237 (0.0505)	0.3525 (0.0174)	-0.0352 (0.4442)	0.3520 (0.0121)
λ	-0.1847	-0.1553	-0.0583	-0.2991
Weighted R^2	0.82			

Note: Parameters used in estimation are selected through a stepwise process. Only selected variables are presented in the table.

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