KOÇ UNIVERSITY-TÜSİAD ECONOMIC RESEARCH FORUM
WORKING PAPER SERIES

BANKING GEOGRAPHY AND CROSS-FERTILIZATION IN THE PRODUCTIVITY GROWTH OF US COMMERCIAL BANKS

Dogan Tirtiroglu
A. Basak Tanyeri
Ercan Tirtiroglu
Kenneth N. Daniels

Working Paper 1108
April 2011

KOÇ UNIVERSITY-TÜSİAD ECONOMIC RESEARCH FORUM
Rumeli Feneri Yolu 34450 Sarıyer/Istanbul

Banking Geography and Cross-Fertilization in the Productivity Growth of US Commercial Banks

Dogan Tirtiroglu(*)
Professor and Chair of Banking
The University of Adelaide, Business School
10 Pulteney Street
Adelaide, SA 5005 Australia
e-mail: dogan.tirtiroglu@adelaide.edu.au Tel: +61-(8) 8303-8007

A. Basak Tanyeri
Assistant Professor of Finance
Bilkent University, Faculty of Business Administration
Ankara, Turkey
e-mail: basak@bilkent.edu.tr Tel: +90-312-290-1871

Ercan Tirtiroglu
Professor of Operations & Decision Sciences
The University of Adelaide, Business School
10 Pulteney Street
Adelaide, SA 5005 Australia
e-mail: ercan.tirtiroglu@adelaide.edu.au Tel: +61-(8) 8303-4513

Kenneth N. Daniels
Professor of Finance
Virginia Commonwealth University, School of Business
Richmond, VA 23284-4000
e-mail: kndaniel@vcu.edu Tel: (804) 828-7127

Last Updated: March 18, 2011

JEL Codes: D24, C23, G21, G28, K23

Keywords: Spatial, Commercial Banks, Total Factor Productivity Growth, Kalman Filter.

We owe Evren Örs and John V. Duca many thanks for their valuable comments. Mourad Jeddi provided excellent research assistance.

(*) **Corresponding Author**

Banking Geography and Cross-Fertilization in the Productivity Growth of US Commercial Banks

Abstract

The US banking industry offers a unique, natural and fertile environment to study geography's effects on banks' behavior and performance. The literature on banks' operating performance, while extensive, says little about the influence of spatial interactions on banks' performance. We compute and examine, using a physical distance-based spatio-temporal empirical model, the state-wide total factor productivity growth (TFPG) indices of US commercial banks for each state for the 1971-1995 period. We observe that the productivity growth of commercial banks in state i depends strongly, positively, and contemporaneously on the productivity growth of commercial banks located in state i's contiguous states. Further, "regulatory space" appears to induce frictions and lessen the documented spatial interactions. These findings support our plea that research on commercial banking sector's behavior need to pay a particular attention to the effects of banking geography.

Banking Geography and Cross-Fertilization in the Productivity Growth of US Commercial Banks

1. Introduction

The US banking industry offers a unique, natural and fertile environment to study geography's effects on banks' behavior and performance. Yet, a few research papers have recognized empirically, and only recently, geography's economic effects on banks' behavior and performance, leaving an open field for further investigation. This rather delayed recognition is surprising, given the presence of a huge volume of empirical literature on the measurement and policy implications of the productive efficiency of commercial banks, geography's effects on the market structure of the banking industry and some observed geographically-concentrated patterns in the banking sector.[1] Meantime, regional scientists, urban and real estate economists, and economic geographers have long recognized the importance of geography, formulating distance- (or space-)based models in their economic analyses. For example, Haynes and Fotheringham[2] (1984, pp. 10 and 11) note:

> "Social scientists are interested in discovering fundamental and generalizable concepts that are basic to social relationships. One of the distinguishing aspects of human behavior is the ability to travel or move across the face of earth and to exchange information and goods over distance. Such exchange processes are referred to generically as interaction, and that which occurs over a distance occurs over space. Hence, the general term 'spatial interaction' (emphasis added) has been developed to characterize this common type of geographic behavior. Shopping, migrating, commuting, distributing, collecting, vacationing, and communicating usually occur over some distance, and therefore are considered special forms of this common social behavior – spatial interaction. ... the farther places, people, or activities are apart, the less they interact (emphasis added)."

Research results show that spatial interactions over short-distances cause diffusion (or contagion) of diseases (Cliff and Ord 1981), of innovations (Griliches 1957; Mandeville 1985), of asset prices (Garbade and Silber, 1978, 1979; Dubin, 1988; Clapp et al., 1990, 1995; Tirtiroglu and Clapp, 1996; Grinblatt and Keloharju, 2001; Dolde and Tirtiroglu, 2002; Loughran and Schultz, 2005; Christoffersen and Sarkissian, 2009; Uysal et al. 2008), of income (Haining, 1987), and of other similar processes. Close physical proximity among individuals or decision units in spatial models serves often as a proxy for more locally-relevant information with less noise. We endorse and subscribe to this viewpoint,[3]

---

[1] A great majority of federal and especially state banking regulations in US was historically (until the passage of the Riegle-Neal Bank and Branch Efficiency Improvement Act of 1994, which was implemented in phases, beginning in 1995 and ending in 1997) formulated in relation to commercial banks' location, gradually shaping a geographically concentrated industry structure (Amel, 1993; Kane, 1996). Restricting banks to operate only in a state, where they were chartered, might have deprived them of the benefits of diversifying their risks across the country, exposing the entire banking system, regulators and the federal deposit insurance administrators to face and deal with the ensuing bankruptcies (Kane, 1996; Berger and DeYoung, 2001).

[2] Helsley and Zenou (2011) formalize mathematically these and similar arguments for social networks with an explicit analysis of geographic location.

[3] Communicating may occur via personal (i.e., face-to-face) or impersonal (i.e., telecommunications-based) processes. Impersonal ones can cover a much larger territory. For example, Garbade and Silver (1978) study how faster availability of

which has a number of interesting implications for the market structure of local banking markets and the banking sector at large.[4] For example, the acquisition and processing of more information with less noise has the potential to contribute to the efficiency in financial intermediation and to the social welfare of the market participants. Indeed, the *intrastate* regulations were much more geographically-concentrated (such as at the county level) than the interstate ones.[5] Their removal, during the wave of banking deregulations between 1970s and mid-1990s, led to a substantially better, faster and more direct effect on banks' performance and consumers' welfare than removal of the *interstate* banking regulations that occurred pretty much during the same time period (Jayaratne and Strahan (JS), 1998; Tirtiroglu et al., 2005). A second example follows from Berger and DeYoung's (BD) (2001) conjecture that short distances between clients and bank branches might give local (and mostly community) banks a comparative advantage in producing locally-relevant and important information for the so-called 'relationship banking.' Last but not the least, Geltner and Miller (2001) point out that extensive default risk inherent in commercially-originated *construction* (mortgage) loans requires the lenders to have access to the locally-relevant information about the surrounding real estate space market, local developers, and construction firms. The presence of extensive systems of local branches gives commercial banks and thrifts comparative advantage over the large national and international lenders in developing local expertise. This, in turn, allows them to produce the majority of the construction loans, and equips them with a useful tool in asset-liability management.[6]

Furthermore, the conjecture that increased distance between/among states is a barrier to spatial interactions – and to the ensuing diffusion (i.e., cross-fertilization) processes – implies that there should be regionally (or locally) and distinctly observable patterns in banks' performance. Evidence on this

---

information, after the wider usage of telegram, would affect US Treasury bond prices. They note (p.820), "English investors had a substantial volume of US Treasury debt, and that debt traded in London as well as in New York. Prior to the opening of the cable participants in one market location received price information from the other center with a time delay equal to the duration of an ocean crossing, or about three weeks." Certainly, the Internet has been playing a key role in storing and diffusing vast amounts of information in a cheap, fast and round-the-clock manner all over the world.

[4]See Clapp et al. (1990), and Haining (1984) and Ning and Haining (2003) for geography's effects on the market structure of insurance agencies and gasoline stations, respectively.

[5]The Illinois Banking Commission's "home office protection" prohibited a bank from opening a branch within a certain number of feet of another bank's main office until the early 1990's (Kroszner and Strahan, 1999). This is an example of legislatures' strict intrastate restrictions. Meanwhile, Tirtiroglu et al., (2005) find that the corporate control market under the regional reciprocity category was more effective in the short-run than that under both the national reciprocity and national non-reciprocity categories. This evidence from interstate deregulations also supports the importance of close proximity for banking markets.

[6]A construction loan has a short-term maturity, is dispensed over time, and is not backed by an existing collateral commercial property, while a permanent financing loan has a long-term maturity, is dispensed typically all at once, and backed by a commercial property. The short-term nature of construction loans matches with the short-term nature of banks' deposit liabilities, and offers banks an asset-liability management tool. The long-term nature of permanent financing loans matches the long-term liabilities of life insurance companies and pension funds, and offers them, once again, an asset-liability management tool.

implication is reported, *albeit indirectly*, in a number of papers.[7] For example, return on assets for US commercial banks exhibit a regionally-distinct pattern[8] (BD, 2001). Also, the US commercial banks under the jurisdiction of the Third Federal Reserve District have noticeably less X-***in***efficiency than those under the jurisdiction of the remaining eleven Federal Reserve Districts (Mester, 1997). Further, DeLong (2001) shows that bank mergers based on geographic similarity enhance stockholder value considerably more than other types of mergers do (see also Cornett et al. 2006; Delong and DeYoung, 2007 for further evidence). Also, spatial patterns appear to be present in the production factors and commercial banks' output. For example, agriculture seems to be a dominant economic activity for many heartland states, potentially leading to a concentration and expertise in agriculture-based loans in the local commercial banks' loan production. Kane (1996) highlights the dangers of risks inherent in the underdiversified loan and deposit portfolios of such local commercial banks. Similarly, educational attainment of people, which might affect commercial banks' labor input and output level, seems to be varying in relation to geography. Perhaps the most obvious evidence for the regionally distinct patterns in bank behavior is the geographic concentration of the massive bank failures of late 1980s, early 1990s, and late 2000s.

Hence, we call for (further) spatially-driven empirical approaches to the questions of interest in banking. Given the crucial role that commercial banks play in credit allocation, liquidity provision, and the implementation and transmission of monetary policy, understanding and documenting the nature and the reasons for geographical patterns in banks' behavior and performance is important not only for banks, their clients, and policy-makers, but also for the capital markets. Our paper makes one of the early attempts in pursuing a spatially-driven approach. We first estimate total productivity factor growth (TFPG) indices at the state-level for each US state, plus the District of Columbia (DC), and then develop a spatially-driven novel empirical model to test for the hypothesis that adjacency of states is a determinant of the productivity growth of the banking sector in a given state. The basic underlying idea of our model is also consistent with the contagion (or spillover) arguments in finance. In particular, we examine the following interrelated questions, which – to our knowledge – have not been studied in the banking literature so far:

(1) Is there a positive association between the state-wide TFPG estimates of banks in a state and the state-wide TFPG estimates of banks in this state's contiguous states?

(2) What is the "die-out duration" of the spatial diffusion process of TFPG?

---

[7]These findings are a by-product of research on non-geographic questions. Berger and Humphrey (1997) suggest, without empirical evidence, that regional and seasonal influences along with differences in market location or operating environments, office size or even management style and organization, may be influential on commercial banks' operating performance. The first paper with an explicit focus on the geography's effects on banks' operating performance was BD's (2001) contribution. They use cost and profit efficiency estimates, at the bank level for 7,000 US banks from 1993 to 1998, to examine geographic expansion in the banking sector. Other relevant banking studies include Tirtiroglu et al. (2005) and Zhou (1997).

[8]The correlation matrix for regional ROEs in BD (2001) supports the idea that distance between regions is a determinant of the correlation coefficients, and might be a source of diversification opportunities.

(3) If there is evidence of spatial interactions in banks' state-wide TFPG performance, is it an outcome of the *regulatory space (i.e., similarity in the state-wide banking legislation)* or physical distance?

In addition, a comparison of the TFPG measurements by state, though not the main focus, also follows.

In regards to the first question, we first note that TFPG, which measures improvements in productivity growth, is an amalgam of technical change and changes in efficiency (i.e., scale economies), and has been a commonly used indicator of the role of technology on input productivity. The literature attributes any positive TFPG findings *mainly* to the growth in technical change. This is because the growth in the US banking industry was in the large regional and money center banks that, as identified in empirical studies, did not have much scale economies left to be realized in the 20th century – see Daniels and Tirtiroglu (1998), who also use similar data, and the literature cited in this paper. A finding of positive association in banks' TFPG estimates between a subject state and its adjacent neighboring states provides evidence of spatial interactions over short(er)-distances, as does no or little association in banks' TFPG estimates between the subject state and its non-neighboring (and farther and farther away) states. Some of the likely agents that can generate this "cross-fertilization" of TFPG within banking markets include the social interactions during the mergers and acquisitions (M&A) activities, banks' recruitment of managerial talent with a strong enough reputation known within local labor markets, and /or urban sprawl and client movements. In general, these are factors that arise from face-to-face communication.

The second question examines how long the spatial diffusion of TFPG lasts. Given that our data frequency is annual, if the spatial diffusion process of TFPG does not die off during its voyage across distances, it would be around for quite some time, reaching and affecting noticeably the non-neighboring states even after extended time periods. Our empirical models include up to three lags to examine the temporal life span of the spatial diffusion process.

The third question recognizes that similarities and differences in the regulatory space of the states may be a confounding factor, with respect to the first research question, in the spatial diffusion of TFPG over a distance. Our main concern here is on the state-wide interstate multibank holding company (IMBHC) banking (de)regulations. They took place in varying intensities and at different times across states during our sample period. We remove potentially confounding effects of the state-wide interstate (de)regulations by constructing a sub-sample of states that declared the *national non-reciprocity* (NN) regime. These states offered an unconditional (i.e., no reciprocity) entry by any bank irrespective of where it was chartered and headquartered within the USA. Frictions,[9] imposed by the protections of the regulations, might potentially reduce the intensity of the spatial diffusion of TFPG. This sub-sample is free from such frictions. So, spatial diffusion of productivity growth across contiguous states should be

---

[9]For example, Kane (1996) describes a *frog-leaping* behavior, such that some states allowed their banks to move their headquarters only within a 30-35 miles radius, gradually leading to relocations in an adjacent state, over a defined period of time.

noticeably stronger for this sub-sample than that for the entire sample. Further empirical tests on the control sample of the remaining states – with conditionally eased regulatory space – offer comparative results.

Our sample focuses on the 1971-1995 period and offers a *natural experiment* setting to study our questions. The Douglas Amendment to the Bank Holding Company Act of 1956 had prevented holding companies from acquiring out-of-state banks unless a state explicitly permitted such acquisitions by statute. The Riegle-Neal Act of 1994 has brought an end to these geographic restrictions. This period includes all state-wide interstate (de)regulatory evolutions from full restriction to partial, and then, to full removal of them. The FDIC makes state-wide data available starting with 1966. The data initialization requirements under the Kalman filter estimations move the sample-beginning year to 1971. Our sample period overlaps sufficiently with that of Berger and DeYoung (2006), who study empirically agency costs associated with geographic expansion of US banks between 1985 and 1998. BD (2006, p.1487) also note that the banks significantly increased their use of new information processing, telecommunications, and financial technologies over their sample period.

The spirit of our investigation carries that of BD's (2001, 2006).[10] We differ, however, from their work in at least three main ways. First, we borrow more from the rich empirical literature on the spatio-temporal models than BD (2001, 2006) do. Our approach allows for empirical tests based on regulatory space, as opposed to only distance-based space.[11] Space, wherein relevant data are generated, may be defined in a number of ways, depending on the research purposes; physical distance being only one of many possibilities in defining space. The sample period witnessed the state-level interstate deregulations in the form of *regional reciprocity* (RR) or *national reciprocity* (NR), or *national non-reciprocity* (NN).[12] Hence, regulatory space among the states was not homogenous during this period. We elaborate on the possible confounding effects and empirical implications of the regulatory space, and examine empirically whether interstate (de)regulations in the neighboring and non-neighboring states exerted any confounding effects on the empirical results. Second, the process of "learning-by-observing," studied by DeLong and DeYoung (2007) for bank M&As, also has relevance for our paper. Learning-by-observing refers to, in their context, a *temporal* learning process from earlier M&A transactions. Meanwhile, spatial interactions (or cross-fertilization) are more general, and benefit from both temporal and spatial learning processes.

[10] Deng and Elyasiani (2008) and DeYoung et al. (2008) also recognize distance in their works.

[11] This distinction is likely to be important. Haynes and Fotheringham (1984) state, "Distances can be specified in these absolute terms. It is then possible to talk about one location being 'five miles from New York City' and another being 'five miles from Bloomington, Indiana.' In absolute terms these two locations are equal in that they are both five miles from an urban area. In relative terms, however, these locations are significantly different in a multitude of ways (for example in terms of access to shopping, access to job opportunities, access to museums, and theaters, access to rural life-styles, or access to wilderness opportunities.) Each of these significantly differentiates absolute location from relative location." Furthermore, scale effects are important to recognize. For example, cities with large populations tend to generate and attract more activities than cities with small populations. See Christoffersen and Sarkissian (2009) for how the size of a city affects the mutual fund industry.

[12] We are not concerned about the confounding effects of the intrastate deregulations since we use state-level aggregated data.

Third, the state of technology is latent and dynamic. The Kalman filter captures the latent and dynamic nature of the technology in our productivity growth estimates, and offers us the flexibility to exclude variations of time-related indicator variables in our empirical approach (Slade 1989; Daniels and Tirtiroglu, 1998).

We find strong, positive and contemporaneous spatial diffusion of banks' productivity growth between a state and its contiguous states. This diffusion or cross-fertilization does not travel in time, dying off within a year. The empirical evidence also shows that removal of frictions, arising from the interstate multi-holding bank company regulations, nurtures considerably stronger spatial interactions among banks with close(r) proximity, and that regulatory space also matters for banks' productivity growth. Overall, these findings support our plea that new research on commercial banking sector's behavior need to pay a particular attention to the banking geography, and that policymakers recognize the implications of spatial interactions in formulating their policies for banks.

Section 2 spells out the details of our empirical approach and data. Section 3 reports the empirical results. Section 4 concludes the paper, and provides some thoughts for future research.

2. Empirical Approach

We identify "state" as the geographic unit to examine the relation between banking geography and commercial banks' TFPG (Neely and Wheelock, 1997; JS, 1998; Kroszner and Strahan (KS), 1999; Tirtiroglu et al., 2005; and Jeon and Miller (JM), 2007), and use the Federal Deposit Insurance Corporation's (FDIC) state-wide annual aggregated data, as explained in section 2.1, for 1966-1995 on commercial banks. In the present paper, our empirical approach is comprised of four steps:

(1) Computing *state-wide* annual unfiltered total factor productivity growth (UTFPG) indices of US commercial banks for 1967-1995 is the first step. This state-wide approach is consistent with Harrigan's (1997) criticism of the international trade economists for their assumption that TFPG for each industry is the same in every country (see also Corsetti et al, 2007). We study TFPG because: (a) currently, there is not any empirical evidence on the *state-wide* TFPG in banking, and the evidence on the banking sector's TFPG in US also is rather limited,[13] and (b) recent investment in technology in the commercial banking industry has been vast (in billions of dollars) and increasing. Thus, understanding the nature of technology and the role it plays in commercial banking is important in a time period when technology is a sizeable and growing part of business.[14] Appendix 1 reports the details of UTFPG index estimation.

---

[13]Humphrey (1992) stresses the need for more empirical evidence on TFPG in banking. Existing evidence suggests low productivity growth for the US commercial banks during the 20th century (See Humphrey, 1992, 1994; Bauer et al., 1993; Daniels and Tirtiroglu, 1998).

[14]*The Economist* (Oct. 3, 1992, pp.21-24) reported that the investment in technology by US commercial banks went up from about $5.5 billion in 1982 to somewhere around $13 billion in 1991. Saunders (1994, p.79) points out that, prior to 1975, almost all transactions in the financial services sector were paper based.

(2) Slade (1989) warns that, a) when some input factors are not freely variable, shadow costs and market prices for these factors can differ, b) this kind of measurement error, in turn, leads to biases in UTFPG indices, and c) the bias will manifest itself in a pro-cyclical fashion (see also Sbordone, 1997). The shadow costs and market prices can further differ if the factor markets are not competitive. Absence of competitive factor markets, combined with quasi-fixed inputs, will lead to an exaggerated pro-cyclical bias. Evidence indicates that conditions such as the ones described here exist in US commercial banking, providing the grounds for pro-cyclical bias.[15]

Recent methodological advances, which employ the Kalman-filtering techniques (Kalman, 1960; Kalman and Bucy, 1961) to purge the pro-cyclical bias component from the stochastic trend component of the TFPG indices, enable us to portray a fairly reliable picture of the TFPG (Slade, 1989; Sbordone, 1997; Daniels and Tirtiroglu, 1998). We remove the pro-cyclical bias in the state-wide UTFPG indices and obtain the state-wide filtered total factor productivity growth (FTFPG) indices for 1971-1995.[16] Appendix 2 reports the details of the Kalman filter application.

(3) Next, we develop a *spatio-temporal* empirical model of commercial banks' productivity growth, following similar models implemented in the regional science and urban economics literature.[17] The basic underlying idea of our model is also consistent with the contagion/spillover arguments in finance. Constructing a panel data set on the state-wide FTFPG yields a balanced *fixed-effects* model, which can test for whether the productivity growth of commercial banks in a given state exhibits any *distance*-based spatio-temporal dependencies with the productivity growth of commercial banks in (a) the adjacent neighboring states, and (b) randomly chosen non-neighboring states. Our thinking here is that the existence of spatial interactions should manifest itself as a "cross-fertilization of productivity growth," and particularly so, if and when the states are contiguous. Section 2.1 offers the details of this empirical model.

(4) Kane (1996) indicates that most states within a given region have chosen similar IMBHC market entry restrictions. Thus, there is the possibility that any significant "cross-fertilization of productivity growth" from adjacent neighboring states to a given subject state (and vice versa) may be reflecting the effects of regulatory, rather than distance-based, spatio-temporal dependencies. To control for this possibility, we construct a sub-sample consisting of the 11 (out of the total of 13) states, whose legislatures chose the NN regime. Since states, which declare this regime, open their banking markets to all banks across the country both irrespective of their origin and without any reciprocity requirements, regulatory space, for this sub-sample, can be ruled out as an explanation for any spatio-temporal

---

[15]For example, Noulas et al. (1990) treat non-interest bearing deposits as a quasi-fixed input, while Hannan and Liang (1993) report evidence of lack of perfectly competitive bank deposit markets. Similarly, Humphrey (1992, 1994) recognizes that input prices may not reflect their shadow prices due to the extensive (de)regulations of the banking industry in the 20th century.
[16]Data for the first few years are used up to initialize filtering.
[17]See Clapp et al. (1995).

interaction. We repeat our empirical *contemporaneous* test on this sub-sample and consider, further, the potential effects of the real US GNP growth, the real growth in the state-wide per capita income, the growth in the state-wide population, the state-wide population density, and the state-wide total number of branches. This extension seeks possible reasons for spatio-temporal interactions in banks' productivity growth. Section 2.3 lays out the arguments for this empirical step.

2.1 Data

Our data set consists of the annual state-by-state data on insured US commercial banks for 1966-1995, obtained from the FDIC *Historical Statistics on Banking, 1934-1995* database (see www.fdic.gov).[18] FDIC aggregates annually commercial banks' data, from their call reports, at the national level as well the state level. The state level data show the annual aggregates for the variables in commercial banks' call reports of all banks located in a given state and the number of bank branches. We use the state level data in this paper. This data set offers us a spatial distribution over 50 states (and also for DC) for every year between 1966 and1995, which facilitates the identification of "state" as the geographic unit.

Using commercial banking data defined at the state level is attractive for at least three reasons. First, JS (1998) document empirically that deregulations in the 1980s and 1990s enhance the natural tendency of markets to weed out inefficient firms, increasing the likelihood of the selection and survivorship problems that would bias tests based on data from individual banks. Second, using state-level aggregates allows us to produce homogeneous estimates of the TFPG indices for the time period under consideration with data pertaining only to a given state. This means that the confounding effects of the performance of commercial banks of other states on the performance of a given state's commercial banks are controlled for. Third, the state-wide data allow us to highlight the state-by-state spatial differences in the operating performance of commercial banks. This is consistent with Mester's (1997) aforementioned finding of significant differences in US commercial banks' X-efficiency scores.

Data on state-wide population, personal income and per capita income data are available at http://govinfo.library.orst.edu/reis-stateis.html. The Bureau of Economic Analysis (www.bea.doc.gov) also offers similar and useful data. Data on US real GNP are from the Federal Reserve Bank of St. Louis (http://www.stls.frb.org/fred/).

2.2 Testing for Spatio-Temporal Productivity Growth Interactions[19]

The key argument of this paper is that, close(r) proximity among market participants (1) makes

[18] JS (1998), Tirtiroglu et al. (2005) and JM (2003, 2007) use commercial banking data aggregated at the state level. Others using state-wide data to study TFPG include Denny et al. (1981), Beeson (1987) and Domazlicky and Weber (1997).

[19] See Clapp et al (1995) for a similar empirical model.

information transmission and sharing easier, faster, cheaper and more reliable (or less noisy) than distant proximity does, (2) allows for cross-fertilization among market participants, and, (3) leads to clustered bank performance within geographic space. DeLong and DeYoung (2007) and Uysal et al. (2008) show that locally-driven bank mergers enhance relevant information diffusion (see also Evanoff and Ors, 2008). Close proximity is also likely to endow regulators with pertinent information and precedence for regulatory measures from nearby jurisdictions, fostering the argument for geographically clustered bank performance. Another factor for performance clustering is the easier and faster transfer of managerial and technological know-how among nearby banks. Short(er) distances are likely to increase the mobility of human capital. Further, face-to-face interactions (for example, in the same country club or in churches or local civic organizations), especially among bank managers and other relevant parties, should also facilitate and foster such social network processes. Last factor, though not the least, are the client choices and actions. Clients open and close bank accounts and seek bank services in geographic space, as described in the opening quote from Haynes and Fotheringham (1984). Closing a bank account is abandonment option, and may be exercised for several reasons, including poor service of the current bank, better bank account deals offered by other banks, increased banking services through the Internet usage, or just sheer urban sprawl. Also, bank referrals from one customer to another, which is a common form of information transmission and experience sharing among individuals, also occur over a geographic space.[20]

This paper tests the hypothesis that bank performance clusters across space by regressing the productivity growth of commercial banks in state i at time t on the contemporaneous average productivity growth of commercial banks located in state i's (1) adjacent neighboring states and (2) *randomly chosen* non-neighboring states in the following fixed-effects model with a balanced panel data set:

$$FTFPG_{i,t} = a_o + \sum_{i=2}^{48}\delta_i * SD_i + \sum_{t=2+j}^{25}\theta_t * TD_t + \sum_{j=0}^{3}\gamma_{(j+1)} * AFTFPG_{ng,(t-j)} + \sum_{j=0}^{3}\varphi_{(j+1)} * ATFPG_{nn,(t-j)} + \sum_{k=1}^{4}\beta_k * X_{k,i,t} + u_{i,t} \qquad \textbf{[1]}$$

where i, j, k and t refer to sample states, the number of (time) lags, the number of other explanatory variables, and each year of the sample period of 1971-1995; $FTFPG_{i,t}$ is the Kalman-filtered TFPG for state i at time t; SD_i refers to cross sectional indicator variables for each state (excluding Alaska, Hawaii, and DC, since the first two are outside the realm of contiguous US states, while the last is not a state); TD_t refers to time related indicator variables for each year for 1971-1995; $AFTFPG_{ng,t}$ ($AFTFPG_{nn,t}$) refers to the average Kalman-filtered TFPG for commercial banks in adjacent neighboring (randomly chosen non-neighboring) states at time t, respectively; $u_{i,t}$ refers to the regression error term; $X_{k,i,t}$ is a ((48xt)x5)

[20] We use state-level aggregated data. Under the conjecture of spatial interactions, bank managers are more likely to find and accept a new out-of-state job in a neighboring rather than non-neighboring state and, consequently, are more likely to transfer their banking expertise earned in their present state to the banking market of a neighboring state. Also, clients who may live in one state and work in another can foster the cross-fertilization process for local banking markets. .

matrix with control variables of *Popu Growth* (annual state-wide population growth), *Popu Density* (annual state-wide population density), *Income Growth* (annual growth in state-wide real per capita income), and *Branch No* (annual state-wide total number of branches) for state i at time t. The number of randomly chosen non-neighboring states is the same as that of adjacent states for state i.

Geographic clustering should yield a positive and statistically significant coefficient estimate on the contemporaneous average productivity growth of commercial banks located in state i's adjacent neighboring states. Further, inclusion in the empirical models of time lags for the average productivity growth of commercial banks located in state i's adjacent neighboring states should capture the temporal spatial effects of geographic clustering. On the other hand, for the *control sample* of commercial banks in a set of non-neighboring states to be chosen at random for each subject state, the signs and significance of the coefficient estimates in the regression are not predictable. Random selection will dictate what states will make up the composition of the random sample of non-neighboring states. Overall, we expect the contemporaneous and temporal interactions for the control sample to be not significant.

We run regressions for several alternative model specifications.[21] Model 1 tests for only the contemporaneous neighboring and non-neighboring effects with j=0. Models 2 through 4 test, respectively, for whether contemporaneous, lagged neighboring and lagged non-neighboring influences are present concurrently on a given state's productivity growth of commercial banks. Specifically, j=3 (=2, =1) in the fourth (third, second) model(s). Models 5 through 8 replicate Models 1 through 4, while including other control variables. The dependent variable is a vector of either [48x25] or [48x24] or [48x23] or [48x22] observations. To avoid perfect collinearity, we drop the cross-sectional indicator variable for Alabama and also the earliest time-related indicator variable (either 1971 or 1972 or 1973 or 1974). Table 1 provides a list of neighboring and randomly chosen non-neighboring states for each state.

- insert Table 1 about here -

2.3 Controlling for the Effects of the State-wide IMBHC Regulations

2.3.1 Background for the State-wide IMBHC Banking Regulations

The Douglas Amendment to the Bank Holding Company Act of 1956 prevented holding companies from acquiring out-of-state banks unless a state explicitly permitted such acquisitions by statute. Until 1978, no state allowed such provisions (Kane, 1996; JS, 1998; KS, 1999). The Riegle-Neal Act of 1994, as indicated in footnote 1, has brought an end for these geographic restrictions. Restrictions placed on geographic expansion make entry into or exit from a state's market and/or expansion within a state difficult, and hence, protect (especially the smaller and inefficient local) banks in this market from

[21] Hausman's (1978) test results indicate that data do not fit the random effects model. We consider other fixed-effects specifications with no indicator variables or with indicator variables only for either states or time. These results are available from the authors upon request.

stiffer outside competition. As JS (1998, p.241) indicate, the banking "industry's efficiency may have been impaired by geographic restrictions because they vitiated corporate control markets by reducing the number of potential acquirers, thereby worsening agency problems between bank owners and managers."[22]

The first state to relax the IMBHC restrictions was Maine (in 1978). While all states (with the exception of Hawaii) and DC followed suit, each state nevertheless expressed its legislative choice for the degree (or intensity) of how much out-of-state competition to be permitted under its jurisdiction. A majority of states chose the RR regime, which represents the most restricted entry permission for the IMBHC expansion. Under this regime, state i determines the other states within its region whose banks it will grant conditional expansion opportunities in state i. The chosen states' banks can expand in state i only if their own states grant reciprocity to the banks of state i to expand in the chosen states' markets. Many other states, however, chose the NR regime. Under this regime, a state determined to grant conditional expansion opportunities to all remaining US states and DC. The NR choice is more liberal than the RR choice, but reciprocity by other states is still an entry condition. Finally, the NN regime allowed for the most intense (or the least restricted) form of out-of-state competition. A state granting this regime opened its market totally for the out-of-state competition to all banks in US without requiring any reciprocity.

Amel (1993) classifies the states according to their regulatory regime. A review of his work reveals that, between January 1978 and September 1993, a total of 37 states declared *initially* RR (with seven and five other states declaring, NR or NN, respectively). Also, 17 of 37 RR states eventually moved to NR and six to NN later on, while two NR states moved eventually to NN during the same time period. As of 1993, there were 14 RR states, 22 NR states, and 14 NN states. Table 2 reveals some interesting patterns for these regulatory movements.

- insert Table 2 about here -

2.3.2 Empirical Implications of the National Non-Reciprocity IMBHC Regime

Prior to state i removing its market entry barriers in one form or another, the states invited by state i for reciprocity, in all likelihood, maintain similar protections and experience their consequences. For the most part, Amel's (1993) work shows that the states invited for reciprocity by state i are neighboring states. Thus, what might appear in empirical results, as per eq. **[1]**, as a distance-based cross-fertilization relation may, in fact, be arising *only* as a result of the close(r) geographical proximity in the regulatory space of the sample states. We feel, therefore, it is useful to delineate the effect of

[22] These regulations protected inefficient local commercial banks, and allowed them to avoid stiff competition from out-of-state banks or, alternatively, allowed them to face competition only from other local and like-minded inefficient banks (see Kane, 1996; KS, 1999; JS, 1996, 1998). Such protections increased these inefficient commercial banks' probability of survival, and kept them profitable. Meanwhile, bank performance improved significantly after restrictions were lifted, and operating costs and loan losses decreased sharply after states permitted statewide branching and interstate banking (JS, 1998). Other consistent evidence, for the entry of the de novo banks, is in DeYoung et al. (1998) and DeYoung and Hasan (1998).

regulatory space from the effect of physical proximity.

A sub-sample of NN states is valuable from an experimental design viewpoint.[23] The NN regime removes effectively all major restrictions imposed by the Douglas Amendment while the other two provide only partial and conditional removal of the entry restrictions. So, the market for corporate control under the NN regime should have been more effective than that under the RR or NR regimes. All NN states give any bank anywhere in the US the option to move *freely* into any one or more of these states. In this context, if physical proximity and cross-fertilization between a sample state and its adjacent neighboring states were not a factor, then the coefficient estimates for $AFTFPG_{ng}$ and $AFTFPG_{nn}$ in eq. **[2]** below should exhibit similar signs and statistical (in)significance levels. Thus, the differences in the signs and statistical significance levels of the coefficient estimates for $AFTFPG_{ng}$ and $AFTFPG_{nn}$ will be crucial and reveal evidence for or against the contemporaneous physical-distance based spatial dependencies in commercial banks' productivity growth and behavior:

$$FTFPG_{i,t} = a_o + \sum_{i=2}^{11} \delta_i * SD_i + \sum_{t=\mu}^{T} \theta_t * TD_t + \gamma * AFTFPG_{ng,t} + \lambda * AFTFPG_{nn,t} + \sum_{k=1}^{4} \beta_k * X_{k,i,t} + u_{i,t} \quad \text{.......[2]}$$

where μ and T refer to the beginning – which, as explained below, is different for each sample state – and ending (i.e., 1995) years for the time indicator variables. We run several specifications of eq. **[2]** by introducing progressively various combinations of cross-sectional and temporal indicator variables in a fixed-effects setting. To avoid perfect collinearity, we drop the indicator variable for Arizona.

DC and 13 states adopt this regulatory regime. We exclude Alaska, Oklahoma and DC from this sub-sample since Alaska is not in the continental US; DC is not a state; and Oklahoma assumes this regime under time-dependent conditions. This leaves a total of 11 states in this sub-sample. We use the data for a NN state only after this regime takes effect. Most of these 11 states have a different declaration date for their NN regime and are coded with an "***NN***" in Table 1. The resulting data set is unbalanced and restricts us to study *only* the contemporaneous spatial interactions:

The remaining 37 states, either with the RR or the NR regime, constitute another sub-sample with an unbalanced panel data set. Empirical tests, similar to those for the sub-sample of 11 NN states, on this sub-sample allow us to obtain comparative results, potentially with the influence of both spatial interactions as well as the regulatory restrictions.

3. Empirical Results

3.1 Results for the Productivity Growth Indices and Patterns

To the best of our knowledge, this is the first time that the *state-wide* TFPG estimates for US commercial banks are being reported in the literature. In Table 3, the means and standard deviations of

[23] Alternatively, one can construct a sub-sample of *only* either RR or NR states such that all the states in each sub-sample meet the reciprocity requirement. But neither deregulatory regime exerts as much competition as the NN regime does.

UTFPG and FTFPG indices are categorized by state and according to their geographical region. They illustrate that the state-wide FTFPG time paths have a stochastic trend that are centered about their means. Furthermore, each of the state-wide UTFPG and FTFPG indices share a common mean, but the volatilities of the state-wide UTFPG indices are much higher. Therefore, we use the state-wide FTFPG indices[24] in our further empirical tests as they are free from bias and/or pro-cyclical measurements.

- insert Table 3 here -

Table 3 results clearly 1) depict varied performance by region and states, 2) support our view that commercial banks' operating performance is related to where they are located, 3) are consistent with Harrigan's (1997), Mester's (1997), Neely and Wheelock's (1997) and Zhou's (1997) empirical findings,[25] and 4) indicate low productivity growth for a good majority of the states during our sample period. The low productivity growth patterns are quite consistent with results reported in Humphrey (1992), Bauer et al. (1993), Boyd and Gertler (1993), Daniels and Tirtiroglu (1998).

3.2 Full Sample Results for the Spatio-Temporal Model of Productivity Growth

Table 4 reports all empirical results from estimating eq. **[1]** on the full sample. The R-squared values indicate a good fit.

- insert Table 4 here -

Estimation results demonstrate a strong, positive and substantial amount of contemporaneous spatial dependency of the productivity growth of commercial banks located in state i on the average productivity growth of commercial banks located in state i's adjacent neighboring states (i.e., $AFTFPG_{ng}$). There is no evidence in the results for the lagged spatial neighboring, contemporaneous spatial non-neighboring or lagged spatial non-neighboring interactions. We interpret these results as strong and clear evidence in support of the hypothesis that banks' performance exhibits clustering over geographic space. These results also indicate that spatial interactions do not travel over time, and die off within a year.

The estimates for $AFTFPG_{ng}$ are significant at least at the 1% level in six models (Models 1 through 6), and at the 5% level in two models. None of the estimates for variables for temporal spatial interactions attain statistical significance in all model specifications. Their progressive inclusions in Models 2 through 4 boost the magnitude of the estimates for $AFTFPG_{ng}$ from 0.46 in Model 1 to 0.71 in Model 4, but also change the associated t-statistics, without altering the significance level of 1%, from 9.84 in Model 1 to 2.9 in Model 4. Introduction of other control variables exerts similar effects on the $AFTFPG_{ng}$ estimates and their associated t-statistics in Models 5 through 8. All coefficient estimates of other control variables attain strong statistical significance – with the exception of that, at 10%, for Popu

[24] The Dickey-Fuller test does not reject the stationarity of the state-wide FTFPG indices.

[25] Zhou (1997) documents that TFPG varied by geographic region with negative and positive performance, ranging from as high as 9.00% to as low as -8.00%.

Dens in Model 5), and do not exhibit any sign reversals. Model 8 reports empirical results from the full model specification. The estimate of $AFTFPG_{ng}$ is 0.58; significant at 5%.

3.3 Results for the National Non-Reciprocity Sub-Sample

Estimation results, as per eq. **[2]**, in Table 5 for the NN IMBHC sub-sample confirm, again, a strong, positive and substantial amount of contemporaneous spatial interaction/cross-fertilization between the productivity growth of commercial banks in state i and $AFTFPG_{ng}$. These results are considerably stronger than their counterparts in Table 4. Meanwhile, the coefficient estimates $AFTFPG_{nn}$ are also relatively strong, large but negative.

- insert Table 5 about here -

The states in this sub-sample eradicate their banking market entry restrictions. So, any bank anywhere in the US has the option to move freely to a given subject state's banking market. As indicated before, if spatial interactions due to close(r) proximity are not an important factor for banks' behavior, then the coefficient estimates for both $AFTFPG_{ng}$ and $AFTFPG_{nn}$ should not be significantly different from zero. However, the coefficient estimates for both variables are statistically significantly different from zero in Table 5 and exhibit differences in signs, magnitudes and significance levels. We take these obvious sign differences of the coefficient estimates for both variables across Table 5 as strong evidence for the presence of contemporaneous spatial interactions in commercial banks' productivity growth and behavior. Further, we also view these results as strong evidence that regulatory space induces frictions, and also matters for banks' performance and behavior. Removal of these frictions enhances and fosters considerably the intensity of the spatial interactions over the US banking geography.

Model 1 through Model 4 exclude other control variables, and consider the differential effects of introducing state or time indicator variables. A comparison of the empirical results in Models 1 and 4 indicates clearly that controlling for these fixed-effects variables boost (dampen) the magnitude and statistical significance of estimates for $AFTFPG_{ng}$ ($AFTFPG_{nn}$), respectively. In Model 4, the estimate for $AFTFPG_{nn}$ attains statistical significance only at the 10% level. Results in Model 5 through Model 8, with other control variables, are overall consistent with those in Model 1 through Model 4.

Table 6 reports the empirical results for the sub-sample of states with the RR and NR IMBHC regimes. Results demonstrate, once again, the presence of strong, positive and substantial amount of contemporaneous spatial interactions between the productivity growth of commercial banks in state i and $AFTFPG_{ng}$. These results are considerably *statistically* stronger than their counterparts in Tables 4 and 5. Meanwhile, the coefficient estimates $AFTFPG_{nn}$ are also strong, large and – interestingly – positive, differing completely from their counterparts, especially in Table 5 and confirming that regulatory space, too, matters and exerts its effects on the coefficient estimates in Tables 4 and 6.

- insert Table 6 about here -

The RR and NR states do not eradicate entirely their banking market entry restrictions. Reciprocity by the other pertinent states remains a condition for the entry of non-state banks into a particular state's banking markets. Hence, empirical results from this sub-sample are likely to be injected with both the spatial diffusion of productivity growth and the regulatory protections. Once again, if spatial interactions are not an important factor for banks' behavior, then the coefficient estimates for $AFTFPG_{ng}$ could –and should– be insignificant from estimations on this sub-sample. Further, the presence of confounding regulatory effects should induce positive coefficient estimates for $AFTFPG_{nn}$.

The positive and significant coefficient estimates for $AFTFPG_{ng}$ and $AFTFPG_{nn}$ offer further clear and strong evidence that banks engage in spatial interactions, and that regulatory space also matters in banks' productivity growth. The coefficient estimate for $AFTFPG_{ng}$ ($AFTFPG_{nn}$) ranges from 0.66 (0.28) with a t-statistics of 20.23 (8.07) in Model 1, having no controls for the time and state indicator variables, to 0.36 (0.17) with a t-statistic of 8.10 (2.62) in Model 4, having full controls for the time and state indicator variables, respectively. These results suggest that the force of spatial interactions among banks is stronger than that of regulatory space. Results in Model 5 through Model 8 are, overall, consistent with those in Model 1 through Model 4.

4. Summary, Conclusions and Further Thoughts

This paper first provides estimates of annual state-wide total factor productivity growth indices of US commercial banks. An examination of these indices reveals, (1) non-homogeneity (i.e., visible differences in the magnitudes and/or dynamics) of commercial banks' productivity growth over space, which is consistent with Harrigan (1997) (see also Zhou, 1997),[26] and (2) low productivity growth across time and space. These findings, in our view, reflect the influence of banking geography on the performance of US commercial banks.

Next, we develop a spatio-temporal empirical model to test for whether proximity plays a role in the cross-fertilization of productivity growth to a given state from its contiguous states (and vice versa). The empirical results from this model are consistent with both physical proximity's effects on productivity growth as well as regulatory space's effects on productivity growth. To control for whether the empirical results are driven by regulatory space rather than physical-distances among the states, we construct a sub-sample of states which had opened up their banking markets to competition from all out-of-state banks anywhere in US by declaring the national non-reciprocity regime. All estimation results indicate that

[26]Zhou (1997) finds that TFPG is generally negative in most large metropolitan areas, but that the performance changes as the firm characteristics change. For example, most metropolitan unit banks tend to have higher TFPG than the metropolitan branch banks. Zhou's (1997) findings also suggest that, after controlling for the (1) the same branching regime, the northern commercial banks have lower TFPG than the southern commercial banks, and (2) metropolitan location, western commercial banks have higher TFPG than the northern commercial banks. Zhou (1997) attributes the differences in TFPG to regional commercial banking characteristics such as the branching regime, bank holding company affiliation, and regional location.

the physical proximity of states to one another has a strong contemporaneous influence on US commercial banks' productivity growth for 1971-1995. Further empirical tests on the control sample of the remaining states – with conditionally eased regulatory space – demonstrate that interstate regulations, in addition to the physical proximity, were also feeding the process of cross-fertilization of banks' productivity growth.

These results clearly highlight the importance and significance of banking geography on US commercial banks' operating performance. An understanding of the nature of, the reasons for, and the consequences of the spatially-driven similarities and differences in commercial banks' operating performance should be an important public policy objective. Furthermore, our findings suggest that neglecting banking geography in empirical modeling may result, inadvertently and implicitly, in the omitted variable problem in modeling bank behavior, and that empirical findings may miss the true nature of the relations between commercial banks' behavior and some other relevant (and perhaps crucial) factors. We feel that future research, which will capture geographic variations, can provide new and important insights into the commercial banks' behavior and the intensity of competition in this sector. This, in turn, should lead to better and more informed public policies and decisions, and also improvements in the quality of empirical measurements.

There are indeed quite interesting empirical applications of the spatio-temporal modeling. For example, Haining (1984) shows that the intensity of competition and the dynamics of gasoline prices are a function of how closely the gas stations in a local market area are located to one another. The firm behavior observed in road intersections with many gas stations differs considerably from the firm behavior observed for gas stations, which are separated by a few miles with no other gas station in between. In another interesting paper, Dubin (1988) considers the impact of physical distance between residential properties on their prices, and reports a rather significant relation between distance and pricing.[27] The finance literature, cited in our introduction, has demonstrated recently the strength and importance of the geography for investment patterns and performance, mutual fund flows, and M&As.

These and other studies in the urban economics and the economic geography literature, and increasingly in financial economics, can easily, richly and fruitfully be adapted to many aspects of the commercial banking issues, as exemplified in BD (2001, 2006) and Deng and Elyasiani (2008), and data. We are convinced that spatially-designed approaches will provide new and important insights for the commercial banks' behavior, and the intensity of competition in this sector, leading to more informed public policy. We are currently tackling some of these important issues in our ongoing work.

[27] For recent spatial modeling applications in real estate prices and further relevant literature, see Bogdon and Can (1997), and Pavlov (2000, 2001).

Table 1: Adjacent Neighboring and Randomly Assigned Non-Neighboring States for Each State

This table shows for each state its adjacent neighboring and randomly assigned non-neighboring states. The averages of the Kalman-filtered productivity growths in the neighboring and the randomly assigned non-neighboring states are used in the spatio-temporal model for empirical tests in Tables 4, 5 and 6. Alaska and Hawaii do not have neighboring states, and DC is not a state. They are excluded. The states, which had declared their choice for the national non-reciprocity IMBHC regime (Amel, 1993), are coded with an (**NN**) next to them. This regime removes the interstate barriers for entry into a state's banking markets without imposing any reciprocity from other states. The data for these states are used in producing the results in Table 5. While Alaska and DC had declared the NN regime, they are excluded in producing the results in Table 5.

States	Neighboring States	Non-neighboring States
Alabama	Florida, Georgia, Mississippi, Tennessee	Oregon, Washington, Kansas, Missouri
Arizona(**NN**)	California, Colorado, Nevada, New Mexico,Utah	Alabama, Iowa, Louisiana, Massachusetts, West Virginia
Arkansas	Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, Texas	Connecticut, Wisconsin, Arizona, Wyoming, Minnesota, Iowa
California	Arizona, Nevada, Oregon	Michigan, Delaware, Kentucky
Colorado(**NN**)	Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, Wyoming	Nevada, Maryland, Virginia, Delaware, South Carolina, Georgia, Illinois
Connecticut	New York, Massachusetts, Rhode Island	California, Ohio, South Carolina
Delaware	Maryland, New Jersey, Pennsylvania	Georgia, Utah, Illinois
Florida	Alabama, Georgia	Pennsylvania, Tennessee
Georgia	Alabama, Florida, South Carolina, Tennessee	Mississippi, Delaware, California, New York
Idaho(**NN**)	Montana, Nevada, Oregon, Utah, Washington, Wyoming	Maryland, Indiana, Rhoda Island, New Mexico, California, North Dakota
Illinois	Indiana, Iowa, Kentucky, Missouri, Wisconsin	Texas, Maine, Alabama, Tennessee, Michigan
Indiana	Illinois, Kentucky, Michigan, Ohio	Wisconsin, Florida, Iowa, Mississippi
Iowa	Illinois, Minnesota, Nebraska, South Dakota, Missouri, Wisconsin	Maine, Kansas, Oregon, West Virginia, Idaho, Vermont
Kansas	Colorado, Missouri, Nebraska, Oklahoma	Maryland, Kentucky, Iowa, Alabama
Kentucky	Illinois, Indiana, Missouri, Ohio, Tennessee, Virginia, West Virginia	Oklahoma, Minnesota, Delaware, Texas, North Carolina, Florida, Arkansas
Louisiana	Arkansas, Mississippi, Texas	Missouri, North Carolina, Utah
Maine(**NN**)	New Hampshire, Massachusetts	Wyoming, Montana
Maryland	Delaware, Pennsylvania, Virginia, West Virginia	Iowa, Connecticut, Tennessee, Minnesota
Massachusetts	Connecticut, Maine, New Hampshire, New York, Rhode Island, Vermont	Arkansas, Florida, California, Iowa, New Jersey, Utah
Michigan	Indiana, Ohio, Wisconsin	Minnesota, Arizona, California
Minnesota	Iowa, North Dakota, South Dakota, Wisconsin	Colorado, Utah, Massachusetts, Delaware
Mississippi	Alabama, Arkansas, Louisiana, Tennessee,	Rhoda Island, Kentucky, Vermont, New Mexico
Missouri	Arkansas, Illinois, Iowa, Kansas, Kentucy, Nebraska, Oklahoma, Tennessee	Georgia, Wisconsin, Maine, New Jersey, New York, Delaware, North Carolina, Vermont
Montana	Idaho, North Dakota, South Dakota, Wyoming	Illinois, Maryland, New Hampshire, Arizona
Nebraska	Colorado, Iowa, Kansas, Missouri, South Dakota, Wyoming	Florida, Rhode Island, Tennessee, New Jersey, Idaho, Maine
Nevada(**NN**)	Arizona, California, Idaho, Oregon, Utah	Colorado, Pennsylvania, New Hampshire, Maryland, Vermont
New Hampshire(**NN**)	Maine, Vermont, Massachusetts	Wisconsin, Louisiana, Arizona

New Jersey	New York, Pennsylvania, Delaware	Mississippi, Indiana, Nebraska
New Mexico(**NN**)	Arizona, Utah, Colorado, Oklahoma, Texas	Florida, South Dakota, Oregon, Michigan, Idaho
New York	Vermont, Massachusetts, Connecticut, Pennsylvania, New Jersey	New Mexico, Rhode Island, Illinois, Kentucky, Maryland
North Carolina	Virginia, Tennessee, South Carolina	Iowa, Maryland, West Virginia
North Dakota	South Dakota, Minnesota, Montana	Kansas, Michigan, Iowa
Ohio	Michigan, Pennsylvania, West Virginia, Kentucky, Indiana	Arizona, Virginia, Alabama, New Jersey, Oregon
Oklahoma	Arkansas, Colorado, Kansas, Missouri, New Mexico, Texas	Virginia, Delaware, Kentucky, Nebraska, Wisconsin, North Carolina
Oregon(**NN**)	Washington, Idaho, California, Nevada	Kansas, Illinois, Missouri, Rhode Island
Pennsylvania	New York, New Jersey, Delaware, Maryland, West Virginia, Ohio	Indiana, Kansas, Colorado, Massachusetts, Arkansas, Montana
Rhode Island	Massachusetts, Connecticut	Iowa, California
South Carolina	North Carolina, Georgia	Alabama, Nebraska
South Dakota	North Dakota, Minnesota, Iowa, Nebraska, Wyoming, Montana	New Mexico, Illinois, Utah, North Carolina, Oregon, New Jersey
Tennessee	Kentucky, Virginia, North Carolina, Georgia, Alabama, Mississippi, Arkansas, Missouri	Minnesota, Wyoming, Indiana, Pennsylvania, South Dakota, New York, Delaware, Maine
Texas(**NN**)	Oklahoma, Arkansas, Louisiana, New Mexico	Illinois, Nebraska, New Hampshire, Florida
Utah(**NN**)	Idaho, Wyoming, Colorado, New Mexico, Arizona, Nevada	Connecticut, Iowa, Oklahoma, South Carolina, Kansas, Montana
Vermont	New Hampshire, Massachusetts, New York	Wisconsin, Idaho, Virginia
Virginia	West Virginia, Maryland, North carolina, Tennessee, Kentucky	South Carolina, Delaware, Pennsylvania, New Hampshire, Michigan
Washington	Idaho, Oregon	New Hampshire, California
West Virginia	Pennsylvania, Virginia, Maryland, Kentucky, Ohio	New Mexico, Connecticut, Florida, Utah, South Carolina
Wisconsin	Michigan, Illinois, Iowa, Minnesota	Nevada, Delaware, Arizona, Rhode Island
Wyoming(**NN**)	Colorado, Idaho, Montana, Nebraska, South Dakota, Utah	North Carolina, Iowa, Alabama, North Dakota, Kentucky, Nevada

Table 2: Evolution of the state-wide IMBHC regulatory movements.

This table shows the transitions and evolution of the IMBHC regulatory regimes between 1978 and 1993. Oklahoma declared NN on July 1, 1987, conditional on a four-year delay, imposing this regime to take effect on and after July 1, 1991. Oregon was the only state with the regional non-reciprocity regime.

a) The distribution of the state level IMBHC regulations as of September 1993:

Regulatory Regime	No. of States
Regional Reciprocity	14
National Reciprocity	22
National Non-reciprocity	14
No Transitions Yet	1
Total	51 (including the District of Columbia)

b) The distribution of the transitions of state level IMBHC regulatory regime until September 1993.

Transition	Initial No. of States	No. of States Remaining (Sep. 1993)
Initial Transition to Regional Reciprocity	37	14
Initial Transition to Regional Non-reciprocity	1	0
Initial Transition to National Reciprocity	7	5
Initial Transition to National Non-reciprocity	5	5
No Transitions Yet	1	1
From Regional Reciprocity to National Reciprocity		17
From Regional Reciprocity to National Non-reciprocity		6
From Regional Non-reciprocity to National Non-reciprocity		1
From National Reciprocity to National Non-reciprocity		2

Table 3: Summary Statistics for the Total Factor Productivity Growth Rates by State, 1971-1995

This table provides the means and standard deviations of the state-wide unfiltered and filtered total factor productivity growth (UTFPG and FTFPG) indices. The UTFPG indices are estimated using the Tornqvist index for 1967-1995. The FTFPG indices are obtained via Kalman filtering on the UTFPG indices. The FTFPG indices are for the 1971-1995 (1967-1971 are initial values for the Kalman filter). We deflate all nominal variables by the GNP deflator with 1987 set at 100.

Region/State	Mean UTFPG	Std UTFPG	Mean FTFPG	Std FTFPG
North East				
Connecticut	0.22	6.43	0.22	1.7
Maine	1.57	6.33	1.57	2.63
Massachusetts	2.61	8.57	2.62	2.28
N. Hampshire	2	5.23	2	1.94
Rhode Island	1.14	7.35	1.14	1.2
Vermont	1.81	4.49	1.81	1.11
Mid-Atlantic				
New York	1.45	10	1.45	0.47
New Jersey	2.13	5.62	2.15	1.5
Pennsylvania	1.57	5.05	1.58	1.32
East North Central				
Indiana	1.63	4.93	1.63	2.18
Illinois	0.72	6.15	0.72	1.55
Michigan	1.34	5.69	1.34	2.95
Ohio	1.67	4.5	1.67	1.45
Wisconsin	1.25	4.83	1.25	2.15
East South Central				
Alabama	1.05	4.6	1.05	1.69
Kentucky	1.36	4.49	1.36	1.4
Mississippi	1.93	4.68	1.94	1.31
Tennessee	1.38	5.38	1.38	2

Region/State	Mean UTFPG	Std UTFPG	Mean FTFPG	Std FTFPG
West North Central				
Iowa	0.87	4.13	0.87	1.69
Kansas	0.93	4.39	0.91	1.55
Minnesota	1.16	5.05	1.16	1.24
Missouri	1.38	5.21	1.38	2.01
Nebraska	1.12	4.26	1.11	2.04
South Atlantic-1				
Delaware	2.04	7.05	2.04	2.28
Maryland	2.07	6.44	2.08	1.1
Virginia	1.78	4.77	1.78	1.53
W. Virginia	1.7	5.2	1.68	2.88
South Atlantic-2				
Florida	2.35	5.63	2.35	2.01
Georgia	2.13	5.26	2.13	4.41
N. Carolina	3.22	6.19	3.23	2.46
S. Carolina	1.99	5.34	2.01	0.88
West South Central				
Arkansas	1.43	4.32	1.43	2.09
Louisiana	1.12	3.98	0.99	1.4
Oklahoma	0.73	3.72	0.73	1.33
Texas	0.94	4.4	0.94	1.4

Region/State	Mean UTFPG	Std UTFPG	Mean FTFPG	Std FTFPG
Mountain				
New Mexico	1.14	4.64	1.16	1.49
Arizona	-0.14	7.24	-0.14	2.06
Utah	0.96	5.04	0.97	1.4
Nevada	-0.96	8.06	-0.89	1.29
Colorado	0.99	5.74	0.99	3.24
Pacific States				
Washington	1.29	4.44	1.29	1.2
Oregon	0.91	7.24	0.9	3.32
California	-1.02	7.19	-1.02	1.2
Mountain-West North Central				
N. Dakota	1.04	4.06	1.05	1.75
S. Dakota	1.25	5.07	1.17	0.64
Montana	0.9	5.26	0.91	2.5
Idaho	1.72	5.79	1.72	2.19
Wyoming	2	6.14	2	4.23
Other States and regions				
Alaska	1.86	6.12	1.86	0.71
Hawaii	-2.16	5.14	-2.15	2.11
D.C.	-0.82	7.81	-0.83	0.28

Table 4: Results from the spatio-temporal model for the full sample

The results reported below come from the following spatio-temporal empirical model:

$$FTFPG_{i,t} = a_o + \sum_{i=2}^{48}\delta_i * SD_i + \sum_{t=2+j}^{25}\theta_t * TD_t + \sum_{j=0}^{3}\gamma_{(j+1)} * AFTFPG_{ng,(t-j)} + \sum_{j=0}^{3}\varphi_{(j+1)} * ATFPG_{nn,(t-j)} + \sum_{k=1}^{4}\beta_k * X_{k,i,t} + u_{i,t}$$

where i, j, k and t refer to sample states, the number of (time) lags, the number of other explanatory variables, and each year of the sample period of 1971-1995; $FTFPG_{i,t}$ is the Kalman-filtered total factor productivity growth for state i at time t; SD_i refers to cross sectional indicator variables for each state (excluding Alaska, Hawaii, and DC); TD_t refers to time related indicator variables for each sample year; $AFTFPG_{ng,t}$ ($AFTFPG_{nn,t}$) refers to the average Kalman-filtered total factor productivity growth for commercial banks in adjacent neighboring (randomly chosen non-neighboring) states at time t, respectively; $X_{k,i,t}$ is a [(48xt)x5] matrix with variables of *Popu Growth* (annual state-wide population growth), *Popu Density* (annual state-wide population density), *Income Growth* (annual growth in state-wide real per capita income), and *Branch No* (annual state-wide total number of branches) and $u_{i,t}$ refers to the regression error term. We stack the data, run several fixed-effects models and do not report the coefficient estimates for cross-sectional and time indicator variables. Model 1 tests for only the contemporaneous neighboring and non-neighboring effects (j=0). Models 2 through 4 test, respectively, for whether contemporaneous, lagged neighboring and lagged non-neighboring influences are present concurrently on a given state's commercial banks' productivity growth. Specifically, j=3 (=2, =1) in the fourth (third, second) model(s). After including control variables, Models 5 through 8 replicate Models 1 through 4. The dependent variable is comprised of a vector of either [48x25] or [48x24] or [48x23] or [48x22] observations. See Table 1 for a list of neighboring and randomly chosen non-neighboring states. ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

Variable	Model 1	Model 1	Model 2	Model 2	Model 3	Model 3	Model 4	Model 4
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	0.15	0.45	0.01	0.03	-0.34	-0.91	-0.62	-1.61
$AFTFPG_{ng}$	0.46	9.84***	0.42	3.16***	0.69	3.02***	0.71	2.90***
$AFTFPG_{nn}$	-0.06	-1.01	0.21	1.04	-0.21	-0.60	-0.35	-0.94
$AFTFPGL1_{ng}$	n/a	n/a	0.03	0.28	-0.54	-1.30	-0.46	-0.90
$AFTFPGL2_{ng}$	n/a	n/a	n/a	n/a	0.33	1.45	0.14	0.28
$AFTFPGL3_{ng}$	n/a	n/a	n/a	n/a	n/a	n/a	0.09	0.37
$AFTFPGL1_{nn}$	n/a	n/a	-0.33	-1.49	0.58	0.88	0.73	0.92
$AFTFPGL2_{nn}$	n/a	n/a	n/a	n/a	-0.55	-1.49	-0.46	-0.58
$AFTFPGL3_{nn}$	n/a	n/a	n/a	n/a	n/a	n/a	-0.17	-0.45
Pop Grw	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pop Dens	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Branch No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inco Grw	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Time Indic	Yes	n/a	Yes	n/a	Yes	n/a	Yes	n/a
State Indic	Yes	n/a	Yes	n/a	Yes	n/a	Yes	n/a
N	1200		1152		1104		1056	
R-squ	0.64		0.66		0.67		0.68	

Table 4 Cont'd

Variable	Model 5	Model 5	Model 6	Model 6	Model 7	Model 7	Model 8	Model 8
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	0.75	1.69*	0.70	1.48	0.32	0.63	0.35	0.70
$AFTFPG_{ng}$	0.39	8.09***	0.37	2.82***	0.57	2.51**	0.58	2.42**
$AFTFPG_{nn}$	-0.043	-0.70	0.23	1.13	-0.16	-0.45	-0.30	-082
$AFTFPGL1_{ng}$	n/a	n/a	-0.0006	-0.00	-0.43	-1.05	-0.37	-0.75
$AFTFPGL2_{ng}$	n/a	n/a	n/a	n/a	0.24	1.10	0.11	0.22
$AFTFPGL3_{ng}$	n/a	n/a	n/a	n/a	n/a	n/a	0.06	0.28
$AFTFPGL1_{nn}$	n/a	n/a	-0.32	-1.49	0.48	0.74	0.68	0.88
$AFTFPGL2_{nn}$	n/a	n/a	n/a	n/a	-0.48	-1.32	-0.51	-0.66
$AFTFPGL3_{nn}$	n/a	n/a	n/a	n/a	n/a	n/a	-0.08	-0.22
Pop Grw	0.39	2.79***	0.47	3.38***	0.53	3.79***	0.58	4.05***
Pop Dens	-4.71	-1.87*	-6.90	-2.74***	-8.47	-3.33***	-9.69	-3.73***
Branch No	-0.003	-3.70***	-0.003	-3.89***	-0.003	-3.89***	-0.003	-3.84***
Inco Grw	6.57	4.28***	6.35	4.15***	6.80	3.73***	5.48	3.11***
Time Indic	Yes	n/a	Yes	n/a	Yes	n/a	Yes	n/a
State Indic	Yes	n/a	Yes	n/a	Yes	n/a	Yes	n/a
N	1200		1152		1104		1056	
R-squ	0.65		0.671		0.684		0.691	

Table 5: Results from the spatio-temporal model for the sub-sample of national non-reciprocity states.
The results below come from a spatio-temporal model, which uses data for 11 states with the national non-reciprocity (NN) IMBHC regime:

$$FTFPG_{i,t} = a_o + \sum_{i=2}^{11}\delta_i * SD_i + \sum_{t=\mu}^{T}\theta_t * TD_t + \gamma * AFTFPG_{ng,t} + \lambda * AFTFPG_{nn,t} + \sum_{k=1}^{4}\beta_k * X_{k,i,t} + u_{i,t}$$

where i, k, and t refer to 11 sample states with the national reciprocity regime, the number of other explanatory variables, and the number of (time) lags, and each year of the sample period 1971-1995; $FTFPG_{i,t}$ is to the Kalman-filtered total factor productivity growth for state i at time t; SD_i refers to cross sectional indicator variables for each state in this sub-sample; TD_t refers to time related indicator variables for each sample year; $AFTFPG_{ng,t}$ ($AFTFPG_{nn,t}$) refers to the average Kalman-filtered total factor productivity growth for commercial banks in adjacent neighboring (randomly chosen non-neighboring) states at time t, respectively; $X_{k,i,t}$ is a [(11xt)x5] matrix with variables of *Popu Growth* (annual state-wide population growth), *Popu Density* (annual state-wide population density), *Income Growth* (annual growth in state-wide real per capita income), and *Branch No* (annual state-wide total number of branches) and $u_{i,t}$ refers to the regression error term. We stack the data beyond the declaration date of the NN regime by a given state and generate an unbalanced panel data set. The dependent variable represents 11 states and is comprised of a vector of 83 observations. We run several regressions and do not report the coefficient estimates for cross-sectional and time indicator variables. Table 1 provides a list of neighboring and randomly chosen non-neighboring states for the sub-sample of states with the NN regime, coded **NN**. ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

Variable	Model 1	Model 1	Model 2	Model 2	Model 3	Model 3	Model 4	Model 4
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	2.04	2.12**	1.72	1.35	1.71	3.89***	0.94	1.83*
$AFTFPG_{ng}$	1.05	4.81***	1.05	4.08***	1.34	11.56***	1.59	10.20***
$AFTFPG_{nn}$	-0.66	-3.39***	-0.56	-1.99**	-0.47	-6.03***	-0.20	-1.67*
Pop Grw	N/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pop Dens	N/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Branch No	N/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inco Grw	N/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Time Indic	No	n/a	Yes	Insig	No	n/a	Yes	Some sig
State Indic	No	n/a	No	n/a	Yes	All sig	Yes	9/10 sig
N	83		83		83		83	
R-squ	0.339		0.349		0.934		0.944	

Variable	Model 5	Model 5	Model 6	Model 6	Model 7	Model 7	Model 8	Model 8
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	5.58	3.82***	5.99	3.38***	6.82	3.23***	5.54	1.22
$AFTFPG_{ng}$	0.97	4.78***	0.86	3.65***	1.41	9.65***	1.42	7.91***
$AFTFPG_{nn}$	-0.85	-4.33***	-1.00	-3.31***	-0.42	-4.54***	-0.35	-2.08**
Pop Grw	-58.02	-4.51***	-64.04	-4.58***	11.25	1.30	11.88	1.26
Pop Dens	-16.61	-1.85*	-18.61	-1.97*	-172.28	-2.52**	-140.56	-1.02
Branch No	0.0001	0.16	0.0001	0.18	0.0005	0.44	0.001	0.44
Inco Grw	-20.39	-1.49	-24.39	-1.55	-2.28	-0.44	-3.07	-0.51
Time Indic	No	n/a	Yes	Insig	No	n/a	Yes	None
State Indic	No	n/a	No	n/a	Yes	7/10 sig	Yes	4/10 sig
N	83		83		83		83	
R-squ	0.488		0.517		0.944		0.948	

Table 6: Results from the spatio-temporal model for the sub-sample of regional and national reciprocity states.

The results reported below come from the following spatio-temporal empirical model:

$$FTFPG_{i,t} = a_o + \sum_{i=2}^{37} \delta_i * SD_i + \sum_{t=\mu}^{T} \theta_t * TD_t + \gamma * AFTFPG_{ng,t} + \lambda * AFTFPG_{nn,t} + \sum_{k=1}^{4} \beta_k * X_{k,i,t} + u_{i,t}$$

where i, j, k and t refer to 37 sample states with the regional or national reciprocity regime, the number of (time) lags, the number of other explanatory variables, and each year of the sample period of 1971-1995; $FTFPG_{i,t}$ is the Kalman-filtered total factor productivity growth for state i at time t; SD_i refers to cross sectional indicator variables for each sample state (excluding Alaska, Hawaii, and DC); TD_t refers to time related indicator variables for each sample year; $AFTFPG_{ng,t}$ ($AFTFPG_{nn,t}$) refers to the average Kalman-filtered total factor productivity growth for commercial banks in adjacent neighboring (randomly chosen non-neighboring) states at time t, respectively; $X_{k,i,t}$ is a [(37xt)x5] matrix with variables of *Popu Growth* (annual state-wide population growth), *Popu Density* (annual state-wide population density), *Income Growth* (annual growth in state-wide real per capita income), and *Branch No* (annual state-wide total number of branches) and $u_{i,t}$ refers to the regression error term. We stack the data to build an unbalanced dataset with 1,117 observations, run several fixed-effects models and do not report the coefficient estimates for cross-sectional and time indicator variables. See Table 1 for a list of neighboring and randomly chosen non-neighboring states. ***, **, and * indicate statistical significance at 1%, 5% and 10% levels, respectively.

Variable	Model 1	Model 1	Model 2	Model 2	Model 3	Model 3	Model 4	Model 4
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	0.10	2.01**	0.457	2.14**	-0.403	-1.68*	0.168	0.54
$AFTFPG_{ng}$	0.66	20.23***	0.544	12.65***	0.492	14.11***	0.359	8.10***
$AFTFPG_{nn}$	0.28	8.07***	0.098	1.72*	0.433	11.71***	0.171	2.62***
Pop Grw	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pop Dens	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Branch No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Incogrw	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Time Indic	No	n/a	Yes	13/24 sig	No	n/a	Yes	19/24 sig
State Indic	No	n/a	No	n/a	Yes	26/47 sig	Yes	25/47 sig
N	1117		1117		1117		1117	
R-squ	0.571		0.577		0.677		0.684	

Variable	Model 5	Model 5	Model 6	Model 6	Model 7	Model 7	Model 8	Model 8
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
Intercept	-0.88	-0.68	0.01	0.05	0.56	1.54	1.12	2.73***
$AFTFPG_{ng}$	0.62	18.63***	0.49	11.28***	0.43	11.79***	0.26	5.82***
$AFTFPG_{nn}$	0.34	9.32***	0.14	2.42**	0.49	12.42***	0.19	2.95***
Pop Grw	0.17	1.67*	0.18	1.77*	0.32	2.62***	0.40	3.22***
Pop Dens	0.48	2.55**	0.44	2.36**	-2.31	-1.07	-3.96	-1.77*
Branch No	-0.001	-3.63	-0.0005	-3.19***	-0.003	-5.27***	-0.004	-5.41***
Inco Grw	3.00	2.51**	7.34	4.69***	2.37	2.11**	6.31	4.57***
Time Indic	No	n/a	Yes	17/24 sig	No	n/a	Yes	21/24 sig
State Indic	No	n/a	No	n/a	Yes	25/47 sig	Yes	30/47 sig
N	1117		1117		1117		1117	
R-squ	0.583		0.594		0.689		0.703	

Appendix 1: Measurement and Computation of the TFPG

We follow a two-step procedure, identical to that used in Daniels and Tirtiroglu (1998). The first step employs the Tornqvist (1936) index to compute UTFPG indices for each sample year and for each state and DC, while the second step separates UTFPG into its stochastic trend and pro-cyclical components. The Tornqvist (1936) index computation for UTFPG indices is as follows:

$$UTFPG_{i,t} = (\ln O_{i,t} - \ln O_{i,t-1}) - \sum_{n=1}^{N} 0.5\left[cs_{n,i,t} + cs_{n,i,t-1}\right] * \left[\ln I_{n,i,t} - \ln I_{n,i,t-1}\right] \quad \textbf{(A1)}$$

where i = Alabama, ..., Wyoming, including DC; ln $O_{i,t}$ is the natural log of output for state i at time t; $cs_{n,i,t}$ is the respective input cost share for state i, at time t, defined as the cost of the respective input divided by total cost; ln $I_{n,i,t}$ is the natural log of each input quantity for state i, at time t; and N is the number of inputs, respectively (to simplify notation, we suppress i, unless explicitly needed).

Following Humphrey (1992), and Daniels and Tirtiroglu (1998), we construct a model with a single output and three factors of production in defining the variables to estimate UTFPG. Our variable definitions follow from Humphrey's (1992) real balance measure (in Humphrey's notation, it is QD). The single output, denoted by O, is the real dollar value of deposit and loan balances. Labor (W), capital (K), and loanable funds (F) are the inputs. We use a single output to keep our work simple. Existing literature shows that US commercial banks' productivity growth has been low and that the measurement of productivity growth does not differ under a multiple output or a single output specification. All these variables are stock measurements since our data do not allow us to implement flow measurements. Humphrey (1992, 1994) establishes that there is not much difference in the predictive accuracy of aggregate productivity based on stock or flow measurements. Table A1.1 lists the definition of each variable.

- insert Table A1.1 about here -

Eq. **(A1)** computes UTFPG with data from two consecutive years. So, 1967 is the earliest year for a UTFPG estimate. We deflate the data by the GNP deflator using 1987 as the base year. Table A1.2 provides the summary statistics for the variables in eq. **(A1)**. All variables are measured at year end.

- insert Table A1.2 about here -

Our production model omits a growing aspect of bank production, namely, the off-balance sheet activities, which now generate a substantial portion of bank income. We note, however, that our productivity growth indices are for the period of 1971-1995, during which the off-balance sheet activities were not as much prominent as they are *now*. In fact, Humphrey's (1992) work support that our production model describes well the productivity growth of US commercial banks between 1970s and mid-1990s.

Appendix 2: A State-Space Model of TFPG

Following Slade (1989), Daniels and Tirtiroglu (1998) use a latent variable approach to purge the pro-cyclical bias from the true or filtered TFPG. This is achieved by modeling the FTFPG as a stochastic trend, and the measurement error as the residual bias. State-space techniques are a natural method of handling latent variables. The latent variable is the stochastic trend component of the UTFPG index:

UTFPG(t) = FTFPG(t) + e(t) **(A2.a)**

FTFPG(t) = FTFPG(t-1) + w(t) **(A2.b)**

where UTFPG(t) is the unfiltered index of TFPG; FTFPG(t) is the filtered TFPG modeled as a stochastic trend; e(t) is the measurement error of the UTFPG index; w(t) is the white-noise error term for FTFPG(t) with mean and variance $(0,\Phi^2_w)$. Equations **(A2a,b)** are estimated by maximum-likelihood techniques, using the Kalman filter. Eq. **(A2.a)** is the observation equation, and eq. **(A2.b)** is the transition equation. In our analysis, the conditional distribution of UTFPG(t) is normal with the following mean and likelihood functions:[28]

E[UTFPG(t)|(t-1)] = FTFPG(t) **(A3)**

$$LogL = -(T/2)\log 2B - (1/2)\sum_{t=1}^{T}\log \Phi_e^2 - (1/2)\sum_{t=1}^{T}\left[e_t^2/\Phi_e^2\right] \quad \textbf{(A4)}$$

where Log L is maximized with respect to the parameters μ (the FTFPG(t)), Σ (a (NxN) covariance matrix), Φ, and B (the covariance of the residuals from the observation equation) . Initializing the Kalman filter estimations require data for 1967-1970 for each state, reducing the time period for the FTFPG estimates from 1967-1995 to 1971-1995.

[28] See Daniels and Tirtiroglu (1998) for more details of the estimation procedure. The results of the maximum likelihood estimations are available from the authors upon request.

Table A1: Definition of Variables

This table provides the variable definitions used in computing the state-wide TFPG indices. We follow Humphrey (1992, 1994) and Daniels and Tirtiroglu (1998) in defining these variables. The state-wide data are from the Federal Deposit Insurance Corporation (http://www.fdic.gov). We deflate all nominal variables by the GNP deflator with 1987 set at 100.

1. output (Y) – the real value of deposit and loan balances
2. cost (C) -- the real value of sum of expenses on physical capital, labor and total interest on loanable funds
3. price of labor (W) – the real value of total wages and salaries divided by the number of employees
4. price of physical capital (K) – the real value of physical capital expenses such as expenses on furniture, equipment, and bank premises (including depreciation) divided by the book value of net bank premises, furniture, equipment and fixture
5. price of funds (F) – {the real value of interest paid on domestic checking and savings deposits} plus {the real value of interest paid on time deposits, subordinated notes and debentures, and other borrowed money} plus {the expense of acquiring federal funds and funds under repurchase agreements} divided by {the sum of loanable funds from each of these sources}.

Table A2: Descriptive Statistics for Tornqvist Index by State, 1971-1995

This table provides the summary statistics for the FDIC's state-wide data. These data are used in the Tornqvist index to estimate the state-wide unfiltered total factor productivity growth indices between 1967 and 1995. Total Cost, Deposits and Loans are a percentage of the total assets; *Labor Shr* is the labor share of total cost; *Funds Shr* is the funds share of total cost; Capital's share in total costs can be found by subtracting the sum of labor's share and fund's share from one; and W is the real wage, K is the real capital cost and F is the price of funds.

	Total Cost		Labor Shr.		Funds Shr.		Deposits		Loans		W		K		F	
	Mean	Std.	Mean	Std.	Mean	Std	Mean	Std	Mean	Std	Mean	Std.	Mean	Std.	Mean	Std.
North East																
Connecticut	7.46%	1.55%	24%	6%	51%	10%	82%	5%	59%	4%	$26,569	$4,803	$121	$33	4.20%	1.54%
Maine	7.87%	1.47%	22%	4%	52%	8%	84%	4%	63%	4%	$21,619	$3,016	$120	$24	4.55%	1.43%
Massachusetts	8.96%	2.25%	21%	6%	58%	10%	76%	3%	56%	5%	$27,701	$5,076	$133	$23	5.74%	2.18%
New Hampshire	8.30%	1.79%	18%	6%	53%	9%	85%	4%	66%	6%	$22,263	$3,480	$152	$62	4.84%	1.53%
Rhode Island	8.39%	1.78%	20%	5%	59%	9%	78%	5%	64%	4%	$27,250	$5,404	$136	$46	4.93%	1.64%
Vermont	7.82%	1.48%	21%	3%	57%	7%	89%	2%	70%	5%	$21,877	$3,192	$109	$34	4.86%	1.41%
Mid-Atlantic																
New York	8.23%	2.20%	18%	6%	65%	10%	72%	5%	56%	4%	$37,232	$8,691	$133	$49	5.88%	2.19%
New Jersey	6.91%	1.42%	21%	4%	55%	8%	85%	2%	57%	6%	$24,307	$4,001	$111	$26	4.15%	1.34%
Pennsylvania	7.24%	1.57%	19%	4%	62%	9%	78%	3%	58%	4%	$24,948	$2,129	$124	$27	4.90%	1.63%
East North Central																
Indiana	7.14%	1.61%	19%	4%	61%	8%	83%	2%	55%	6%	$21,872	$1,419	$110	$34	4.81%	1.63%
Illinois	7.42%	1.87%	18%	5%	65%	10%	79%	3%	55%	2%	$28,274	$3,643	$99	$24	5.32%	1.97%
Michigan	7.35%	1.63%	19%	3%	61%	7%	83%	4%	58%	4%	$24,323	$2,647	$110	$17	4.88%	1.58%
Ohio	7.27%	1.60%	19%	3%	58%	8%	79%	4%	58%	7%	$22,841	$2,136	$127	$25	4.68%	1.54%
Wisconsin	7.27%	1.52%	19%	3%	60%	7%	84%	2%	59%	4%	$23,614	$2,186	$90	$15	4.81%	1.47%
West North Central																
Iowa	7.03%	1.64%	19%	4%	62%	8%	86%	2%	51%	2%	$24,003	$1,887	$118	$37	4.87%	1.68%
Missouri	6.80%	1.64%	20%	4%	59%	8%	82%	2%	52%	5%	$22,049	$1,601	$114	$52	4.48%	1.60%
Nebraska	7.38%	1.73%	21%	4%	56%	8%	86%	2%	54%	4%	$24,036	$1,220	$131	$39	4.58%	1.61%
Minnesota	7.24%	1.65%	18%	4%	61%	10%	79%	4%	57%	4%	$26,581	$3,615	$136	$29	4.85%	1.73%
Kansas	7.00%	1.68%	21%	4%	59%	8%	86%	1%	50%	3%	$23,394	$1,740	$87	$24	4.66%	1.68%
South Atlantic-1																
Delaware	8.21%	1.92%	18%	9%	54%	12%	61%	17%	64%	16%	$25,481	$3,273	$285	$181	4.93%	1.63%
Maryland	7.21%	1.62%	24%	5%	53%	8%	81%	4%	60%	5%	$22,310	$3,886	$118	$31	4.28%	1.51%
Virginia	7.67%	1.50%	21%	3%	57%	8%	82%	4%	61%	4%	$22,511	$3,474	$95	$29	4.64%	1.47%
West Virginia	6.85%	1.64%	18%	3%	61%	7%	85%	2%	51%	5%	$20,309	$1,007	$76	$19	4.72%	1.59%
South Atlantic-2																
South Carolina	7.29%	1.52%	26%	7%	48%	10%	80%	5%	56%	7%	$21,126	$2,271	104	$30	3.92%	1.44%
Georgia	7.54%	1.38%	23%	4%	52%	7%	77%	4%	58%	5%	$23,834	$2,449	$97	$12	4.34%	1.33%
Florida	7.13%	1.60%	20%	3%	53%	7%	85%	2%	53%	8%	$21,641	$2,902	$98	$31	4.16%	1.40%
North Carolina	7.32%	1.47%	22%	4%	58%	8%	76%	7%	56%	5%	$23,323	$3,879	$101	$34	4.63%	1.54%

East South Central																
Alabama	7.19%	1.62%	22%	4%	57%	7%	82%	3%	55%	6%	$21,303	$1,787	$95	$26	4.60%	1.58%
Mississippi	7.18%	1.72%	22%	5%	57%	9%	86%	2%	52%	2%	$21,597	$1,795	$87	$31	4.58%	1.73%
Kentucky	6.84%	1.66%	20%	4%	59%	8%	82%	3%	55%	5%	$21,490	$2,089	$106	$33	4.53%	1.66%
Tennessee	7.42%	1.68%	21%	3%	57%	7%	84%	2%	56%	4%	$22,882	$2,973	$93	$16	4.71%	1.58%
West South Central																
Arkansas	6.96%	1.66%	21%	4%	58%	8%	87%	1%	52%	3%	$21,078	$1,691	$93	$31	4.48%	1.65%
Louisiana	7.26%	1.77%	21%	4%	56%	9%	86%	2%	51%	2%	$22,543	$2,128	$91	$43	4.48%	1.62%
Oklahoma	7.19%	2.08%	21%	4%	58%	8%	86%	1%	50%	3%	$23,573	$2,093	$95	$33	4.59%	1.65%
Texas	7.04%	1.67%	18%	5%	59%	11%	82%	2%	51%	4%	$24,243	$2,497	$84	$24	4.59%	1.71%
Mountain																
Colorado	7.77%	1.60%	23%	4%	48%	8%	84%	3%	55%	4%	$24,140	$2,477	$121	$34	4.11%	1.43%
New Mexico	7.51%	1.68%	22%	4%	55%	8%	86%	3%	54%	2%	$20,557	$1,733	$88	$35	4.58%	1.62%
Arizona	7.67%	1.59%	24%	4%	52%	8%	83%	5%	64%	4%	$24,525	$3,376	$87	$17	4.37%	1.46%
Utah	7.68%	1.64%	20%	4%	55%	8%	81%	5%	60%	4%	$21,016	$2,719	$115	$32	4.59%	1.51%
Nevada	7.90%	1.83%	21%	6%	48%	10%	73%	16%	62%	9%	$23,427	$2,846	$145	$87	4.09%	1.41%
Mountain-West North Central																
North Dakota	7.05%	1.64%	20%	4%	62%	7%	88%	1%	52%	4%	$24,527	$2,135	$107	$37	4.82%	1.62%
South Dakota	9.49%	3.22%	14%	6%	54%	14%	70%	19%	68%	10%	$23,447	$2,535	$317	$216	5.28%	1.77%
Montana	7.27%	1.61%	20%	4%	57%	8%	87%	2%	54%	5%	$23,318	$1,947	$108	$28	4.60%	1.58%
Idaho	7.50%	1.78%	21%	5%	57%	7%	83%	5%	62%	5%	$21,266	$1,508	$111	$25	4.68%	1.65%
Wyoming	6.96%	1.75%	20%	2%	57%	6%	87%	3%	50%	5%	$23,424	$1,712	$96	$23	4.43%	1.51%
Pacific States																
Washington	7.89%	1.77%	24%	4%	52%	9%	81%	2%	66%	7%	$26,253	$2,807	$88	$20	4.51%	1.66%
Oregon	7.36%	1.57%	25%	5%	53%	10%	80%	3%	61%	6%	$23,536	$2,793	$92	$13	4.28%	1.56%
California	7.94%	1.83%	22%	5%	57%	11%	82%	1%	64%	6%	$28,688	$4,829	$101	$23	4.92%	1.85%
Other States and regions																
Alaska	7.37%	1.48%	29%	6%	46%	8%	81%	5%	52%	6%	$29,269	$2,342	$73	$24	4.11%	1.39%
Hawaii	7.36%	1.45%	24%	5%	56%	7%	84%	7%	60%	3%	$25,593	$3,847	$84	$19	4.49%	1.42%
D.C.	7.02%	1.88%	22%	7%	55%	13%	82%	3%	52%	6%	$29,942	$5,036	$127	$65	4.34%	1.90%

BIBLIOGRAPHY

Amel, D.F., 1993, State Laws Affecting the Geographic Expansion of Commercial Banks, *Unpublished Paper*, Board of Governors of the Federal Reserve System, Washington, D.C.

Bauer, P.W., A.N. Berger, and D. Humphrey, 1993, Efficiency and Productivity Growth in US Banking, in *The Measurement of Productive Efficiency: Techniques and Applications*, eds., H.O. Fried, C.A.K. Lovell and S.S. Schmidt, Oxford University Press, pp. 386-413.

Beeson, P., 1987, Total Factor Productivity Growth and Agglomeration Economies in Manufacturing, 1959-1973, *Journal of Regional Science*, vol. 27, no.2, pp. 183-199.

Berger, A.N. and R. DeYoung, 2001, The Effects of Geographic Expansion on Bank Efficiency, *Journal of Financial Services Research*, vol. 19, pp. 163-184.

Berger, A.N., and R. DeYoung, 2006. Technological progress and the geographic expansion of commercial banks, *Journal of Money, Credit, and Banking*, vol. 38, no. 6, pp. 1483-1513.

Berger, A.N., and D.B. Humphrey, 1997, Efficiency of Financial Institutions: International Survey and Directions for Future Research, European Journal of Operational Research, vol. 98, no. 2, pp. 175-212.

Bogdon, A. and A. Can, 1997, Indicators of Local Housing Affordability: Comparative and Spatial Approaches, *Real Estate Economics*, vol. 25, no. 1, pp. 43-80.

Boyd, J.H. and M. Gertler, 1993, US Commercial Banking: Trends, Cycles, and Policy, *NBER Macroeconomics Annual,* vol. 8, pp. 319-368.

Cornett, M.M., J.J. Mc Nutt, and H. Tehranian, 2006, Performance Changes around Bank Mergers: Revenue Enhancements versus Cost Reductions, *Journal of Money Credit and Banking*, vol. 38, no. 4, pp. 1013-1050.

Corsetti, G., P. Martin and P. Pesenti, 2007, Productivity, Terms of Trade and the 'Home Market Effect', *Journal of International Economics,* vol. 73, no. 1, pp 99-127.

Christoffersen, S.E.K. and S. Sarkissian, 2009, City Size and Fund Performance, *Journal of Financial Economics*, vol. 92, no. 2, pp. 252-275.

Clapp, J.M., W. Dolde and D. Tirtiroglu, 1995, Imperfect Information and Investor Inferences from Housing Price Dynamics, *Real Estate Economics*, vol. 23, no. 3, pp. 239-269.

Clapp, J.M., J. Fields, and C. Ghosh, 1990, An Examination of Profitability in Spatial Markets: The Case of Life Insurance Agency Locations, *Journal of Risk and Insurance*, vol. 57, no. 3, pp. 431-454.

Cliff, A.D. and J.K. Ord, 1981, *Spatial Processes: Models and Applications*, London:Pion.

Daniels, K. and D.Tirtiroglu, 1998, Total Factor Productivity Growth in US Commercial Banking for 1935-1991: A Latent Variable Approach Using the Kalman-Filter, *Journal of Financial Services Research*, vol. 13, no. 2, pp. 119-135.

Deng, S.E. and E. Elyasiani, 2008, Geographic diversification and BHC return and risk performance, *Journal of Money, Credit and Banking, vol.* 40, pp. 1217–1238.

DeLong, G.L., 2001, Stockholder Gains from Focusing versus Diversifying Bank Mergers, *Journal of Financial Economics*, vol. 59, no.2, pp. 221-252.

DeLong, G.L. and R. DeYoung, 2007. Learning by observing: information spillovers in the execution and valuation of commercial bank M&As, *Journal of Finance*, vol. 62, no. 1, pp. 181-217.

Denny, M., M. Fuss, and J.D. May, 1981, Inter-temporal Changes in Regional Productivity in Canadian Manufacturing, *Canadian Journal of Economics*, vol. 14, no. 3, pp. 390-408.

DeYoung, R., D. Glennon and P. Nigro, 2008, Borrower-lender distance, credit scoring, and loan performance: evidence from informationally opaque small business borrowers, *Journal of Financial Intermediation*, vol. 17, pp. 113-143.

DeYoung, R. and I. Hasan, 1998, The Performance of De Novo Commercial Banks: A Profit Efficiency Approach, *Journal of Banking and Finance*, vol. 22, no. 5, pp. 565-587.

DeYoung, R., I. Hasan, and B. Kirchhoff, 1998, The Impact of Out-of-State Entry on the Cost Efficiency of Local Commercial Banks, *Journal of Economics and Business*, vol. 50, no. 2, pp. 191-203.

Dolde, W. and D. Tirtiroglu, 2002, “Housing Price Volatility Changes and Their Effects,” *Real Estate Economics*, vol. 30, no. 1, pp. 41-66.

Domazlicky, B.R. and W.L. Weber, 1997, Total Factor Productivity in the Contiguous United States, 1977-1986, *Journal of Regional Science*, vol. 37, no. 2, pp. 213-233.

Dubin, R., 1988, Estimation of Regression Coefficients in the Presences of Spatially Autocorrelated Error Terms, *The Review of Economics and Statistics*, vol. 70, no. 3, pp. 466-474.

Evanoff, D. and E. Ors, 2008, The Competitive Dynamics of Geographic Deregulation in Banking: Implications for Productive Efficiency, *Journal of Money, Credit and Banking*, vol. 40, no. 5, pp. 897-928.

Garbade, K.D. and W.L. Silber, 1978, Technology, Communication and the Performance of Financial Markets: 1840-1975, *Journal of Finance*, vol. 33, no. 3, pp. 819-832.

Garbade, K.D. and W.L. Silber, 1979, Dominant and Satellite Markets: A Study of Dually-Traded Securities, *Review of Economics and Statistics*, vol. 61, no. 3, pp. 455-460.

Geltner, D. and N. Miller, 2001, *Commercial Real Estate Analysis and Investments*, Prenctice-Hall.

Griliches, Z., 1957, Hybrid Corn: An Exploration in the Economics of Technological Change, *Econometrica*, vol. 27, no. 4, pp. 501-522.

Grinblatt, M. and M. Keloharju, 2001, How Distance, Language, and Culture Influence Stockholdings and Trades, *Journal of Finance*, vol. 56, no. 3, pp. 1053-1073.

Haining, R., 1984, Testing a Spatial Interacting-Markets Hypothesis, *The Review of Economics and Statistics*, vol. 66, no. 4, pp. 576-583.

Haining, R., 1987, Income Diffusion and Spatial Econometric Models, *Geographical Analysis*, vol. 19, no. 1, pp. 57-68.

Harrigan, J., 1997, Cross-Country Comparisons of Industry Total Factor Productivity: Theory and Evidence, *Federal Reserve Bank of New York Research Paper No. 9734*, International Research Department, New York, NY, 10045.

Hausman, J., 1978, Specification Tests in Econometrics, *Econometrica*, vol. 46, no. 6, pp. 1251-1271.

Haynes, K.E. and A.S. Fotheringham, 1984, *Gravity and Spatial Interaction Models*, Sage Publications.

Helsley, R. and Y. Zenou, 2011, Social Networks and Interactions in Cities, University of Berkeley Working Paper, Haas Business School, Berkeley, California, USA.

Humphrey, D.B., 1992, Flow versus Stock Indicators of Banking Output: Effects on Productivity and Scale Economy Measurement, *Journal of Financial Services Research*, vol. 6, no. 2, pp. 115-135.

Humphrey, D.B., 1994. Delivering Deposit Services: ATMs Versus Branches, *Federal Reserve Bank of Richmond Quarterly Review*, vol. 80, pp. 59-81.

Jayaratne, J. and P. Strahan, 1996, The Finance-Growth Nexus: Evidence from Bank Branch Deregulation, *Quarterly Journal of Economics*, vol. 111, no. 3, pp. 639-670.

Jayaratne, J. and P. Strahan, 1998, Entry Restrictions, Industry Evolution, and Dynamic Efficiency: Evidence from Commercial Banking, *Journal of Law and Economics*, vol. 41, no. 1, pp. 239-274.

Jeon, Y. and S.M. Miller, 2003, Deregulation and Structural Change in the US Commercial Banking Industry, *Eastern Economic Journal*, vol. 29, no. 3, pp: 391-414.

Jeon, Y. and S.M. Miller, 2007, A Bennet Decomposition of Industry Dynamics: An Application to the Nationwide and State Level U.S. Banking Industry, Available at SSRN: http://ssrn.com/abstract=1006307.

Kalman, R. E., 1960, A New Approach to Linear Filtering and Prediction Problem. Transactions of ASME, Series D: *Journal of Basic Engineering*. Vol. 82, pp. 35-45.

Kalman, R.E. and Bucy, R.S., 1961, New Results in Linear Filtering and Prediction Theory, *Journal of Basic Engineering*, vol. 83, pp. 95-108.

Kane, E., 1996, De Jure Interstate Banking: Why Only Now?, *Journal of Money, Credit and Banking*, vol. 28, pp. 141-146.

Kroszner, R.S. and P.E. Strahan, 1999, What Drives Deregulation? The Economics and Politics of the Relaxation of Bank Branching Restrictions, *Quarterly Journal of Economics*, vol. 114, no. 4, pp. 1437-1467.

Loughran, T. and P. Schultz, 2005, Liquidity: Urban versus Rural Firms, *Journal of Financial Economics*, vol. 78, no. 2, pp. 341-374.

Mandeville, T., 1985, Information Flows Between Australia and Japan, *Papers in Regional Science*, vol. 56, no. 1, pp. 189-200.

Mester, L.J., 1997, Measuring Efficiency at US Banks: Accounting for Heterogeneity is Important, *European Journal of Operational Research*, vol. 98, no. 2, pp. 230-242.

Neely, M.C. and D.C. Wheelock, 1997, Why Does Bank Performance Vary Across States?, *Federal Reserve Bank of St. Louis Review*, vol. 79, no. 2, pp. 27-49.

Ning, X. and R. Haining, 2003, Spatial pricing in interdependent markets: a case study of petrol retailing in Sheffield, *Environment and Planning A,* vol. 35, no. 12, pp. 2131–2159

Noulas, A.G., S.C. Ray and S.M. Miller, 1990, Returns to Scale and Input Substitution for Large U. S. Banks, *Journal of Money, Credit and Banking, vol. 22, no. 1, pp.* 94-108

Pavlov, A., 2000, Space Varying Regression Coefficients: A Semi-Parametric Approach Applied to Real Estate Markets, *Real Estate Economics*, vol. 28, no. 2, pp. 249-283.

Pavlov, A., 2001, Competing Risks of Mortgage Terminations: Who Refinances, Who Moves, and Who Defaults?, *Journal of Real Estate Finance and Economics*, vol. 23, no. 2, pp. 185-211.

Saunders, A., 1994, *Financial Institutions Management: A Modern Perspective*, Irwin.

Sbordone, A.M., 1997, Interpreting the Procyclical Productivity of Manufacturing Sectors: External Effects or Labor Hoarding?, *Journal of Money, Credit, and Banking*, vol. 29, no. 1, pp. 26 - 50.

Slade, M.E., 1989, Modeling Stochastic and Cyclical Components of Technical Change: An Application of the Kalman Filter, *Journal of Econometrics*, vol. 41, no. 3, pp. 363-383.

The Economist, October 03, 1992, Banks and Technology: Cure-all or snake-oil?, pp.21-25.

The Federal Deposit Insurance Corporation, 1995, *A Statistical History of the United States Banking Industry*. (Website Address: http://www.fdic.gov/).

Tirtiroglu, D. and J.M. Clapp, 1996, Spatial Barriers and Information Processing in Housing Markets: An Empirical Investigation of the Effects of the Connecticut River on Housing Returns, Journal of Regional Science, vol. 36, no. 3, pp. 365-392.

Tirtiroglu, D., K. Daniels and E. Tirtiroglu, 2005, Deregulation, Intensity of Competition, Industry Evolution and the Productivity Growth of US Commercial Banks," *Journal of Money, Credit and Banking*, vol. 37, no.2, pp. 339-360.

Tornqvist, L., 1936, The Bank of Finland's Consumption Price Index, *Bank of Finland Monthly Review*, vol. 10, pp. 1-8.

Uysal, V., S. Kedia and V. Panchapagesan, 2008, Geography and Acquirer Returns, *Journal of Financial Intermediation*, vol. 17, no.2, pp 256-275

Zhou, B., 1997, *Banking Geography of the United States: Structure, Conduct, and Performance of Commercial Banks in the US Metropolitan System*, Garland Publishing, Inc.