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A geographically weighted approach to measuring efficiency in panel data: The case of US saving banks

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ABSTRACT

This paper discusses a new approach to controlling for the environment when estimating efficiency. In response to the literature on the international comparison of bank efficiency, we draw the attention to a local dimension of comparison. By introducing geographical weights and estimating local frontiers for each US savings bank in the 2001–09 period, we find that the bank technical performance is higher for most banks in comparison to a fixed-effects approach. This result highlights the importance of taking into account the local environment and constraints while analyzing banks' performance, so as not to consider the factors that are exogenous to these institutions as inefficiencies. Further analysis could improve the weighs calculation by employing other measures of interconnectedness besides geographical distance.

1. Introduction

The estimation of bank efficiency is a recurrent subject of analysis in the literature (Lensink et al., 2008; Berger et al., 2009; Lozano-Vivas and Pasiouras, 2010). Bank efficiency reflects the efficiency of financial intermediation and, thus, has direct implications on social welfare. The literature has been developing several methods to estimate bank efficiency in a particular banking industry.[1] This paper proposes a new method to estimate the technical efficiency and we apply this method for US Saving Banks over the 2001–2009 period. We basically employ geographical weights in the stochastic frontier estimation so as to give more importance to neighboring banks in the calculation of bank efficiency.

The stochastic frontier analysis (SFA), proposed and developed by Aigner et al. (1977) and Meeusen and van den Broeck (1977), is a parametric approach that estimates a frontier for a set of banking systems and compares each bank in the sample to the frontier. Inefficiency is how distant this bank is from this frontier. Further improvements to the model were made in Battese and Coelli (1992) that specified time varying inefficiency scores and in Battese and Coelli (1995) that permitted the model to account for other factors that influence both technology and inefficiency.

One interesting conclusion of the bank efficiency literature is that environmental conditions play a significant role in determining bank performance. According to both Lozano-Vivas et al. (2002) and Hasan et al. (2009), even in European financial systems, that have become more integrated with the establishment of the European Monetary Union (EMU), there are still relevant differences in the regulatory and economic conditions among them. In other words, to compare banks operating in different countries against a single reference could consider as inefficiencies specific characteristics that a particular banking system is subject to, rather than reflect whether its management of resources is effective. For instance, Dietsch and Lozano-Vivas (2000) state that the estimation of a single frontier for heteroge-

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[1] See Berger and Humphrey (1997) for a survey on bank efficiency estimation methods. The paper documents that the different estimation methods yield inconsistent bank-specific efficiency scores, even though the average efficiency for an industry remains similar.

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neous banking markets without controlling for environmental variables may result in biased efficiency scores.[2]

Notwithstanding these methods, we propose a new model that is suitable to explicitly modeling environmental factors in the estimation of technical efficiency. We assume that banks that are close geographically to one another are subject to similar constraints.[3] The geographically weighted stochastic frontier (GWSF) estimate local frontiers for each bank in the sample. In each estimation, we consider a different bank as the benchmark and a weight is given to the other banks depending on their distance to this reference. We therefore implicitly control for the geographical factors that influence the efficiency of banks that are close to one another. An additional advantage of the GWSF is that we are able to employ it even within a country, in this case, the US. Even though other papers apply this geographical method, such as Samaha and Kamakura (2008) for the real estate market, we are the first to employ it in panel data.

As in the case of cross-country studies, the influence of geographical factors on local banks' performance is an increasingly recurrent theme in the recent literature. For instance, Bos and Kool (2006) regress inefficiency scores on a set of variables that reflect, among other things, the local economic environment of the bank and find that these factors do explain part of the inefficiency scores, even though to a limited extent. Also, Pasiouras et al. (2011) concludes that factors that are external to managerial control influence Greek cooperative banks' efficiency measured by a Data-Envelopment Approach (DEA). In this fashion, we will show that there could be a significant bias in the efficiency scores if one does not take into account the geographical characteristics where each bank (or branch) operates. Some of these factors are observable, such as the size of the market, the different laws and regulations, and the accessibility of banking services to the population; other factors are unobservable. This method takes into account both types because it estimates the efficiency of a bank in comparison to its neighbors.[4]

There is extensive evidence that US banks' performance is geographically dependent. Akhigbe and McNulty (2003) find that US commercial banks operating in metropolitan areas (MSA) have different efficiency levels than those in non-metropolitan areas for the years 1990–1996. In fact, banks in a MSA are less profit efficient than those in a non-MSA. In addition, according to Tirtiroglu et al. (2011), bank productivity in the US appears to be geographically dependent among states, where the performance in one state is positively correlated with the performance of its neighbors. Finally, Berger and DeYoung (2001) note that the return on assets varies considerably with the region. These facts are a clear motivation for our exercise, where we apply this new method to US saving banks.

In addition, the US banking system presents other interesting features regarding the geographical field. First, not only are these banks subject to federal regulation, but they must also respond to state laws, which can exert different influences on the banking operation. Second, as DeYoung et al. (2004) state,[5] the removal of the geographical restrictions that were put in place with the McFadden Act of 1924 have allowed banks to operate across state lines and to acquire banks anywhere in the country, converting some subsidiaries and removing branching restrictions. The Riegle-Neal Act of 1994 led to a geographical expansion into new markets, where merger activities became more accepted by the banking industry. This merger process has increased and has improved the bank's ability to lend and monitor these loans from offices far away from headquarters. In fact, between 1980 and 1990, a period of consolidation and restructuring, many banks were taken over by other depository institutions to raise efficiency.

There is no denying that the study of US saving banks' efficiency fits our model because these banks have a stronger regional focus of operation than regular commercial banks. In other words, they tend to lend more to the institutions and enterprises that are close to where they are located. US saving banks tend to compete with others that operate in the same geographical location, as well. It is less likely that more distant banks can affect how a small bank performs. Also, savings banks lending are largely directed to small and medium enterprises (Strahan and Weston, 1998). It is clearly in the interest of bank's regulators to know exactly how these banks perform, thereby choosing the proper set of regulations for them.

The case of commercial banks is more complex. Since these banks tend to operate on a national-wide basis, local factors might not influence them over and above the national-wide factors. Having access to branch-level data, one could employ our method to estimate branch-specific efficiencies that controls for the region they are located. This way, it would be possible to compare the weighted stochastic frontier results from previous papers on branch efficiency (Berger et al., 1997; Paradi and Schaffnit, 2004; Portela and Thanassoulis, 2007; Paradi et al., 2011) Additionally, the weights calculation should also be generalized to different measures other than geographical distance. One suggestion may be the difference in the loan portfolio sectorial composition. Banks that lend to similar industries might be subject to common shocks originated from these sectors that are not necessarily related to managerial efficiency. We leave these questions for future research.

We structure the remainder of the paper as follows. Section 2 presents our methodology, where we define the GWSF model and all of the steps to estimate it. In Section 3, we present and summarize the data sources. In addition, in Section 4, we present the empirical results, where we apply the GWSF to the case of the US saving banks and compare it to a fixed-effects specification. Finally, we make our concluding remarks in Section 5.

2. Methodology

In this study, we employ two different specifications of the stochastic frontier model (SF). One is the standard method in which we estimate it using fixed-effects. In the other model, we use a geographically weighted estimation process (GWE), in which we

[2] Bos and Schmiedel, 2007 propose another modification to the SFA in order to make the efficiency scores comparable among countries. They use meta-frontiers, which allows for heterogeneous technology among banks from different countries. The authors affirm that part of the inefficiency of a single frontier estimation might be due to the technology gap among countries.

[3] The literature has interest in discussing whether recent technological developments, such as the more frequent use of internet and mobile banking, have reduced the importance of the physical location where a bank operates. Even though the internet plays an increasingly important role in reducing the cost of distance (Berger, 2003), Degryse and Ongena (2004) reaffirm the importance of the geographical distance in lending relationships.

[4] One downturn of our analysis is that we do know which factors influence bank efficiency. This is the "price" we have to pay in order to implement our method that controls for every local factor that may affect the efficiency estimation.

[5] DeYoung et al. (2004) considers these changes in economic conditions and explores whether the effects in geography changed with banks' headquarters locations, the bank branch office locations and the bank depositor locations. They found that (1) mergers and acquisitions have allowed banks to move their headquarters from smaller to larger cities, (2) bank branches have moved farther away from headquarters and (3) the spatial density of deposits in the 50 largest metropolitan areas has remained remarkably stable because the commercial banking industry became more spatially concentrated during the 1990s, which is evidence of gradual urbanization. The results suggest that the spatial distribution of deposits remained similar across time. The results also suggest that new technologies increase the ability of banks to manage credit relationships.