# The Effect of Spatial Competition on Rural Banks Performance: Profitability and Efficiency

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**Abstract**

This study explores the effect of spatial competition as well as other factors (i.e. bank-specific characteristics, industry-specific characteristics, and macroeconomics variables) on rural banks performance (profitability and efficiency) in Indonesia. A distance proxy (physical distance from a bank to nearest bank) and market boundary (area of Thiessen Polygon) as the main spatial variables. The Panzar-Rosse test, Lerner Index, and Boone Indicator are used to assess the degree of competition in the market. Cost efficiency is measured using Stochastic Frontier Analysis (SFA). Preliminary results reveal that the distance of banks' to the nearest bank negatively affects profitability, but positively affects bank efficiency. However, the area of market boundary has positive impact to bank profitability and efficiency. The Lerner index shows that rural banks engage in mark-up pricing in all models since the index positively affects performance. Consistent with industrial organisation theory, the Boone indicator, a measure of competition based on profit efficiency, shows negative value indicative of competitive market conditions. Overall, the findings show that spatial competition exists in rural banking in Indonesia.

*Keywords: rural banks, profitability, efficiency, spatial competition*

## 1. Introduction

Banks play a vital role both in the financial system and economy. Small and large corporations, as well as individuals (households), engage in activities and transactions with banks for credits, deposits and other financial services. Rural banks are crucial for many small businesses and have been one of the important sources of credit for local people since those people hard to get options for other external funding (Berger and Udell, 1998; Carbo-Valverde et al., 2009). Another reasons are because small firms are often informationally opaque and bound

to their local economies (Agarwal and Hauswald, 2010) so they prefer to get loan from rural banks as they match the rural bank's internal credit assessment.

Indonesia small and medium sized enterprises (SMEs) accounted for about 60% of Indonesia's gross domestic product (GDP) in 2017 and create employment for nearly 108 million people needing funding from banks, especially rural banks, to run their business (Tambunan and Xiangfeng, 2006). Initially, the rural banks were formed to address the credit needs of SMEs and the needs of rural communities, which had not been reached by commercial banks. As stated in Banking Supervision Report (Bank Indonesia, 2011), rural banks aim to create equal opportunities and avoid the loan shark. In 2017, the total assets of rural banks in Indonesia reached Rp125.9 billion. These rural banks held only about 1.7 percent of total commercial bank assets and 1.6 percent of total commercial bank deposits. However, Indonesia has the largest number of small credit banks (1.619 Rural Banks as per 2017) in the world after China, India and United States.

Although the advancement of information and technologies has influenced the banking transaction process in the age of globalisation, rural banks in Indonesia still face a lack of technologies. The rural banks do not offer internet banking, automated teller machines (ATMs) and automated credit scoring models[1]. The reason behind this is the technology is too expensive for rural banks. However, the Financial Services Authority of Indonesia (OJK) has implemented a regulation that rural banks should provide information technology to support the implementation of their business activities such as the core banking system and the data center[2]. In fact, the scale of rural banks is too small in terms of capital to invest in technology (86% of rural banks only have capital less than IDR 15 billion or approxiametely equivalent USD 1 billion)[3] compare to rural banking in the USA which small rural banks have capital USD 50-100 billion in average. As a result, it makes local people go directly to rural banks. Rural people are also not too familiar with advanced technology, so they may not use technology to get services from rural banks. Because of this fact, the location between banks does matter in competition, thus it seems spatial competition among banks are necessary to be explored.

Large number of players in the banking industry have resulted the banks to improve their competitive level as more banks results higher competition. Competition in the banking sector

[1] Bank Indonesia has only released license for 11 Rural Banks to issue ATM
[2] FSA (OJK) Law No. 75/POJK.03/2016 concerning the Standard of Information Technology for Rural Banks
[3] 1 USD = 14,387.80 IDR (as per July 2018)

has been one the most debated issues of all time. Competition can be seen as one of the most essential ideas in economics, since firms aim to get profits (Stiroh & Strahan, 2003). Cetorelli and Strahan (2006) suggested that competition promotes growth. On the other hand, too much rivalry among banks has a negative influence on market power and margins of profit (Keeley, 1990). In case of Indonesia, the rural banking industry continues to grow and face tight competition as the industry has high number of banks.

The measurement of market competition or competitive structure has been widely discussed in the empirical banking literature (Berger et al., 2004; Claessens & Laeven, 2004; Goddard et al., 2007). A review of previous literature shows the measures that are extensively used to measure bank competition in empirical studies are the Herfindahl-Hirschman Index (HHI), the Lerner Index, the Panzar and Rosse H-statistic and the Boone Indicator.

One of competition in banking can be classified as spatial banking competition. The physical location of banks is relevant when studying spatial competition. Since there are so many rural banks and commercial banks in each district in Indonesia[4], the competition among them may be tight especially if the location is close from one bank to others. Each rural bank may face increased competitive pressure from other rural bank as rival bank. This competition will likely decrease profit margins because of effects such as lower loan rates and higher deposit rates. Some of previous studies such as Alessandrini et al. (2009) argue that the distance between banks' lending branches and local borrowers, as well as internal distance between a local branch and the bank headquarters in the local credit market is a major factor for lending transaction. In the same view, Petersen and Rajan (2002) state that cost of information about potential borrowers increases with distance, thus closer bank to the borrowers will be more informed about local credit market conditions. In rural banking case, the closer the distance between banks might create high competition. Thus, each bank must compete well by operating their business efficiently. If they are inefficient and not profitable, they likely experience losses and increase the probability of default that will result in liquidation and bank closures. As per 2017, Indonesia Deposit Insurance Corporation (IDIC) has liquidated one commercial bank and 82 rural banks.

Efficiency may have a great impact on the future viability of rural banks. This study also identifies the factors influencing rural bank profitability and efficiency, including the bank-

[4] Indonesia is divided into 34 provinces and 416 districts or cities. Indonesia is a country with the largest number of commercial banks and rural banks in ASEAN. There are currently 115 Commercial Banks and 1609 Rural Banks (as per April 2017)

specific characteristics, industry-specific characteristics and macroeconomic conditions. This paper examines the unexplored issue of how the rivalry bank distance affects the bank performance (profitability and efficiency) focusing on Indonesian data on individual rural banks. This study aims to get best possible results of the effects of spatial competition on bank performance in rural banking.

Furthermore, this study contributes to the literature of spatial competition by measuring the effect of spatial competition on bank performance using physical distance from bank to another banks in one region using haversine formula and thiessen polygon as main variables using panel data in large sample of data of more than 1,000 rural banks. Moreover, unlike the previous literature, I use all competition models (Panzar and Rosse, Lerner Index, and Boone indicator) and parametric or stochastic frontier analysis to measure efficiency.

## 2. Literature review

The literature review is divided into three big views. First, studies exploring bank competition and spatial competition are reviewed. Second is a review of bank profitability and bank efficiency. Lastly, literature on empirical studies of rural banks and an overview of rural banking in Indonesia will follow.

### 2.1 Bank competition

Competition is an interesting phenomenon and its impact to banks' performance has evolved over time. In general, competition in banking sector is an activity involving two or more banks with aim to get consumer to buy the bank's services (i.e. deposit money, taking loan) in preference to the other bank's. Society can reap the benefits from effective competition between banks in terms of lower loan interest and higher deposit interest. However, there is a trade off in competition: some banks went bankrupt because they could not compete with other banks in highly competitive market, which lead to a reduced degree of competition between banks. In a monopoly situation, cost of credit for borrower is higher which resulting bad loan for the banks.

Earlier literature on bank competition classified competition into two paradigms, structural and non-structural approaches. The structural approaches are mainly based on the traditional industrial organisation under the structure conduct performance (SCP) paradigm and on the efficient structure hypothesis (ESH). The structural approaches suggest a positive relationship between market concentration and performance. The SCP paradigm was originally developed by

Mason (1939) and Bain (1951) and it assumes that a higher concentration in the banking market will result in collusive opportunities between banks, thus leading to higher bank profitability and market power. It assesses bank competition by concentration ratios or indices and creates a causal relationship between the structure of the market to the bank's profits and degree of market power (Lloyd-Williams et al., 1994; Berger & Hannan, 1998). Other hypothesis, the ESH, as proposed by Demsetz (1973) and Peltzman (1977), suggests reversal causality between market concentration and performance. The higher profits are created not because of collusive behaviour but because of efficiency. Being more efficient, the banks (with advantages, such as technology, size, good corporate governance or management) may have higher profits by maximising returns. As a result, the banks earn a greater market share that leads to a higher concentration in the market. However, analysing competitiveness using the SCP paradigm creates a number of problems, such as the implicit assumptions of appropriate market structure measure since there is no information about the absolute number of firms to achieve market power (Evanoff & Fortier, 1988). A good concentration index should also meet a number of criteria, such as that the concentration should be a one-dimensional measure; concentration in an industry should be independent of the size; and concentration should increase if the market share of any firm is increased at the expense of a smaller firm (Hall & Tideman, 1967).

In response to deficiencies found in the structural approach, non-structural approaches have been developed in the context of the new empirical industrial organisation that observes the behaviour of firms in the market to assess the degree of competition or estimates parameters reflecting the level of competition using various models and assumptions about the banks' behaviour (Shaffer, 1983). These approaches see banks behave differently depending on their market and assume that competitive behaviour is not affected by market structure or concentration. In addition, these models measure competition without using explicit information about the structure of the market. However, the nonstructural models also have their problems, for instance these methodologies measure pricing of market power rather than a proxy of competition (Leon, 2015).

**2.2 Spatial competition in banking**

Competition in rural banking market is mostly spatial as borrowers typically travel to the bank to access banking services because the banks do not have improvement in online banking technologies. In a literature of small banking in rural area, banks in non-metropolitan areas

compete in a spatially differentiated environment (Richards et al., 2008). Banks derive cost advantages from being geographically closer to the borrowers and this creates spatial competition between banks.

The physical distance in banking is believed to be important in competition as concluded by previous studies. A study by Brevoort and Hannan (2006) showed that distance matters. They stated that the probability of a bank lending in a given area decreases with physical distance from the nearest office of that bank. Mach and Wolken (2008) used data from the 2003 Survey of Small Business Finances and examined how distances between small firms and their financial service suppliers changed. They suggested that distance remains an important factor in banking. Similarly, Agarwal and Hauswald (2010) found that loans are more likely to be approved by banks closer to a firm. Degryse and Ongena (2005) studied loan rates and found that they declined with the distance between the firm and lending bank but rose between the firm and rival banks. A study of geographic proximity in banking by Dell'Ariccia (2001) concluded that geographic proximity to clients represents an important competitive advantage especially when transaction costs (such as transportation and information costs) exist. In a recent study, Degl'Innocenti et al. (2017) examined the relationship between bank performance and geographical location by measuring the distance of banks to the two major global financial centres: New York and London. Their results showed that the distance of bank headquarters to these financial centres matters.

Some literature has been done in the small business lending context. In their seminal paper, Petersen and Rajan (2002), with US data, showed a significant increase in the average distance between borrower and lender. They found that the median distance between firms and bank branches was approximately six miles in the beginning of the 1990s. However, Belluci et al. (2013) found that the average distance between the borrower and bank is almost three miles. There are various different measurements of distance because they depend on the objective of the spatial study and data characteristics.

The spatial competition literature has analysed distance from different perspectives. Physical distance is calculated as distance in km between the location of the headquarters of the bank and the capital of the firm's province (e.g. Jimenez et al., 2009). Another view is organisational distance, which is the distance between the headquarters of the bank and the operating branches (e.g. Coval & Moskowitz, 1999; Malloy, 2005; Brighi & Venturelli, 2016). Degryse and Ongena

(2005) describe a borrower's distance to competing banks is the 25th percentile. Another type of measurement was carried out by Ho and Ishii (2011), they calculated the distance from each consumer's home to the closest and second-closest branches of each bank with a cross-section of banking institutions for the year 2000 with the dataset of the 2001 Survey of Consumer Finance. In another study, Hauswald and Marquez (2002) presented a model that focused on "informational distance" and its relationship to investments in information acquisition technology by lenders. They suggested that banks may respond by shifting their resources to loans involving greater informational proximity (translates to physical proximity) as competition increases.

Several studies have used geographic diversification or diversity. Meslier et al. (2016) used an inverse concentration measure of deposits across each banks' branches as geographic diversification. In the same vein, Goetz et al. (2016) measured geographic diversity as 1 – Herfindahl index of deposits across markets. Alessandrini et al. (2008) studied Italian firms over the period 1996-2003 and they define the distance as operational and functional. Operational distance is measured as the number of bank branches in the province in proportion to the local population or the provincial area, and functional distance is measured as the ratio of local branches weighted by physical, economic and socio-cultural distance to the total number of local branches. In a recent study, Brei and Goetz von Peter (2018) used quarterly data to measure distance as a population-weighted distance in kilometers from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), which consistently measures cross-border and internal distances.

In spatial competition with Salop's modeling (Salop, 1979), a free entry is assumed. The equilibrium with free entry determines the distance among branches and the degree of access consumers have to financial services. The higher the distance for a consumer has to travel, the higher the transportation cost and the lower the accessibility. Measuring distances of two or more entities is often used in spatial literature. The most typical and well-known distances of two entities is the Euclidean distance (e.g. Cinca, 1998; Christoffer Kok & Maria, 2006; Rebeca de Juan, 2003). It is computed from the vectors of values of their characteristics. In the Euclidean distance case, consumers are assumed distributed over the market area and the distance between banks represent an appropriate proxy for the average distance from a given consumer (Richards et al., 2008). In a similar way, to measure distances between two points on the surface of a

sphere, the Haversine Formula is very accurate for computing those distances. It also uses the latitude and longitude of the two points. This formula is more useful for small angles and distances.

For the retail market, Kalnins (2003) used Thiessen polygons to define a set of common boundaries shared by firms in the same market. Thiessen polygons were presented by A. H. Thiessen (1911) based on the assumption that measured amounts at any point can be applied halfway to the next. They are built from the intersection of the perpendicular bisectors of points that are closer together. The theory assumes that borrowers will choose the closest bank in a region and transportation costs are homogeneous. In this case, the region is on a polygon form. Large polygons may imply less competition while small polygons indicate a region of high competition.

### 2.3 The effect of competition on bank performance

#### 2.3.1 Bank competition on bank profitability

Assessing bank profitability has been established as a significant topic in research on the banking industry and has been explored comprehensively both theoretically and empirically. The identification of determinants of bank profitability is important due to banks' role in the economy. Starting with the works of Short (1979) and Bourke (1989), many scholars are still interested in identifying the determinants of the bank profitability.

Bank profitability is usually determined from internal and external factors. Internal factors are bank-specific characteristics such as size, capital, equity, non-performing loans and expenses. Smirlock (1985) found a positive and significant relationship between size and bank profitability. On the other hand, Goddard et al. (2004) found a weak relationship between size and profitability in European banks during 1990s, yet the relationship between the capital adequacy and profitability was positive. Equity is also one of bank-specific characteristics that may affect profitability. Berger and Di Patti (2006) concluded that a lower equity ratio was associated with higher profit efficiency in US commercial banks over the period 1990-1995. In addition, management efficiency and capital adequacy growth influenced bank profitability in five selected CEE countries in 2004-2011 as shown in a study from Căpraru and Ihnatov (2014). Albulescu (2015) found that non-performing loans and non-interest expenses negatively affected bank profitability (either in ROA or ROE) in emerging countries for the period 2005-2013. Study also concluded that non-interest expenses negatively impacted profitability.

The external variables reflect the economic environment that affect the operation of bank, such as inflation, gross domestic product and market conditions. One of the first investigations of the effect of inflation on bank profitability was conducted by Revell (1979). The results showed that the effect of inflation on bank profitability depended on whether operating expenses increased at a higher rate than inflation. Other studies (e.g. Bourke, 1989; Molyneux & Thornton, 1992; Athanasoglou et al., 2006; Pasiouras & Kosmidou, 2007) have also shown a positive and significant relationship between inflation or long-term interest rates and profitability. Other studies have found the inflation rate to negatively affect interest margins (e.g. Afanasieff et al., 2002; Naceur & Kandil, 2009). Bank performance studies also usually include GDP growth (Molyneux & Thornton, 1992) or variation in per capita income or wage levels (Berger & Hannan, 1989) as macroeconomic variables. Previous studies have found a positive relationship between GDP growth and the net interest margin (e.g. Claessens et al., 2001; Schwaiger & Liebig, 2008). Using ROA and ROE, Goddard et al. (2004), DemirgucKunt and Huizinga (1999), Bikker and Hu (2001), and Flamini et al. (2009) found a positive relationship with real GDP growth.

The impacts of competition on bank profitability are found in mixed results. Bank performance is usually measured using return on assets, return on equity and net interest margin. A number of empirical studies have examined how market structure and competition impact on interest margins. Greater market power indicates that banks would set higher interest margins. A study by Maudos and de Guevara (2004) found a positive effect of bank market power on interest margins in the banking sector of the European Union using the Lerner Index. Later, Maudos and Solís (2009) found that banks with greater market power, measured by the Lerner Index, had higher interest margins. Another study also found that a higher interest margin was associated with a higher concentration of the banking industry (Claeys & Vennet, 2008). Mirzaei et al. (2013) concluded that a greater market share leads to higher bank profitability and profitability increases with an interest margin revenue in a less competitive environment for emerging markets. Scott and Dunkelberg (2010) showed that an increase in bank competition has a positive effect on banking outcomes. In contrast, Tan (2016) found no impact of competition on profitability in the Chinese banking industry over the period 2003-2011 using a one-step Generalized Method of Moments (GMM). Chinese bank profitability is affected by taxation, overhead costs, labour productivity and inflation.

### 2.3.2 Bank competition on bank efficiency

The concept of efficiency is related to transformation of inputs into outputs according to the company's strategy (e.g. cost efficiency, revenue efficiency, and profit efficiency) and the objective of the study (Tzeremes, 2014). In the banking sector, for instance, profit efficiency uses inputs (e.g. cost of borrowed funds, physical capital, wages) and prices of outputs (e.g. total loans, securities and fee-based financial services). Efficiency can be defined as how quickly deposits are transformed into loans, how well it liquidates non-performing loans (loss given default) and how accurately it screens borrowers (Blass & Russ, 2013).

The relationship between market structure and efficiency (higher concentration = less efficiency) was first stated by Hicks (1935). The study is followed by several findings argue that higher profits in concentrated markets could be the result of greater productive efficiency (Smirlock, 1985; Evanoff & Fortier, 1988). The positive impact of competition on efficiency is also supported by Chen (2007) and Dick and Lehnert (2010).

The hypothesis is that increasing competition leads to an increase in profit efficiency. This hypothesis is adapted from the efficient structure hypothesis proposed by Demsetz (1974). According to the efficient structure hypothesis, more efficient firms have lower costs, which lead to higher profits, thus increasing their market share and resulting in a higher concentration. Another view of the effect of competition on efficiency is the competition-inefficiency hypothesis. It suggests that competition leads to a decline in bank efficiency (Evanoff & Örs, 2002; DeYoung et al., 1998; Kumbhakar et al., 2001). The reason behind this argument is that higher competition makes the relationships between customers and banks less stable, as customers' propensity to switch to other providers increases (Boot & Schmeits, 2005). This situation will amplify asymmetric information and additional resources for screening and monitoring borrowers are required. Another reason is a shorter duration of bank relationships in a competitive environment can be expected by banks as they are likely to reduce relationship-building activities, which inhibits the reusability and value of information (Chan et al., 1986).

There are two main ways to measure the bank efficiency: parametric techniques such as stochastic frontier analysis (SFA) and non-parametric technique such as data envelopment analysis (DEA). DEA was first proposed by Charnes et al. (1978) based on the earlier work of Farrell (1957). In this technique, suitable combinations of inputs and outputs are used to measure the efficiency using a frontier by least one efficient bank in the sample. A problem arises when

DEA does not allow for random errors in the optimisation problem, so that all deviations are considered as inefficiencies. Another measure is the stochastic cost frontier analysis, which overcomes the critical disadvantage of DEA, under which no random error is included. Stochastic frontier analysis was first conducted by Aigner, Lovell and Schmidt (1977) and Meeusen and van der Broeck (1977). SFA measures the relative performance of banks by providing numerical efficiency values and ranking these accordingly. A bank is considered inefficient if its costs are higher than predicted for a bank producing the same output under the same existing conditions with the difference unexplainable by statistical noise. The stochastic frontier approach assumes that the residual contains two components: the statistical noise capturing the effects of random noise and a non-negative inefficiency score capturing inefficiency relative to the frontier.

Choosing the appropriate definition of bank input and output is an important issue for research in bank efficiency, as there is no agreement of the definition and measurement of banks' inputs and outputs. Berger and Humphrey (1992) highlighted several approaches used to model the bank production process: the intermediation and production approaches. Under the intermediation approach, banks use purchased funds together with physical inputs to produce various assets. In other way, the production approach assumes that banks use only physical inputs, such as labour and capital, to produce deposits and various assets. Later, Berger and Humphrey (1997) argued that the intermediation approach is the best approach to evaluate bank efficiency, whereas the production approach is appropriate for evaluating the efficiency of bank branches.

Several studies of spatial competition on bank efficiency have also been conducted. For instance, Berger and DeYoung (2001) state that as banks expand geographically by opening branches in remote markets, the operating efficiency is inversely related to the average distance from banks' headquarters to their operating units. Another example is a study by Degl'Innocenti et al. (2017), which measured the distance from the headquarters of commercial banks to New York and London and found that increasing transaction costs results a decline in level of efficiency. Weill (2004) investigated the relationship between competition and efficiency using a stochastic parametric method then regressed the competition measure and a set of independent variables including GDP per capita and density of demand to the geographical location. The results showed a negative relationship between competition and efficiency in EU banking.

## 2.4 Previous studies on competition in rural banking

The concept of rural banking is different to commercial banking as they have different characteristics (e.g. size, capital, liquidity). Rural banks operate in rural communities mostly to serve the interest of local people and SMEs. Cole et al. (2004) argue that firms in rural areas are more likely to use small banks than large banks to get funding. Devaney and Weber (1995) used rural US individual bank data and the changes in concentration and deposit growth. They argued there is no systematic relationship between market structure (concentration) and deposit growth if markets are perfectly contestable. They concluded that rural banking markets in the US are imperfectly contestable.

Several studies of spatial competition in rural banking also considered. Hannan and Prager (2009) found the relationship between the profitability of community banks that operate in a single geographic banking market and the geographic scope of their rivals. Pilloff (1999) and Hannan and Prager (2009) argue that big banks create lower competition in rural markets as they may operate at lower efficiency levels. Smirlock (1985) used a sample of 2,700 banks operating between 1973 and 1978 and found a positive correlation between market share and profitability, but no relationship between market structure and profitability

### 2.4.1 Rural banks in Indonesia

Indonesian banking institutions can be divided into two categories: commercial banks and rural banks. Indonesia's local banks are called Bank Perkreditan Rakyat "BPR", literally "People's Credit Bank". The main difference between the two categories is that (1) rural banks have limited scope of services in terms of deposits, investments (limited amount of capital invested in banks' operation) and payments; (2) rural banks cannot open branches outside their region (restricted to one province) or limited area of operation; and (3) rural banks are not allowed to carry out foreign exchange transactions. It can be said that rural banks operate under more restrictions compared to commercial banks. In term of assets, rural banks tend to be smaller than commercial banks (even though the largest rural bank has more total assets than the smallest commercial bank).

Rural banks operate in rural areas and in cities, including the capital city. There were 1,796 rural banks in Indonesia as of May 2017. There are two types of rural banks: 1,629 conventional banks and 164 sharia banks. However, the assets held by rural banks were less than 2% of the assets held by commercial banks. Despite their relatively small size in the Indonesian banking

sector, the central bank considers rural banks to be particularly important in supporting the programme of financial inclusion. This role of rural banks was stressed by the Governor of Bank Indonesia that rural banks should be enhanced and directed to provide services to SMEs and local economies. This type of institution was introduced by the Indonesian government in order to protect consumers from predatory lenders. However, rural banks charge higher interest rates than commercial banks to compensate for risk. The Indonesian Deposit Insurance Corporation (IDIC) guarantees deposits at maximum 8.25% for rural banks and 5.75% for commercial banks. The third-party funds in rural banks are mostly in the form of time deposits, accounting for 68.9% of total deposits in rural banks. In 2017, the rural banks charged an average lending rate above 20% p.a., while commercial banks' average lending rate was about 11% p.a.

In regards to opening a new bank, it is relatively not needed large amount of capital. The regulation on rural banks formulated by Indonesia's FSA No.20/OJK/2014 states that the capital required to open a new bank is different based on the 'zone' where the new rural bank is to be established. There are four zones based on economic potential and level of banking competition in a region. Zone 1 to 4 is a region with higher economic potential and tighter bank competition while Zone 4 has lower potential and more relaxed competition[5].

**2.5 Competition measures**

This section reviews methodologies in the way that competition between banks is measured. Originally, studies in banking competition were done in the model of SCP. It refers to Mason (1939) and Bain (1951) who relied on market share measures to proxy competition. Mostly the market shares in the relevant market are calculated based on total assets, outstanding loans, or the amount of deposits located at the bank. Eventhough this measure is easy to obtain, there are several important critiques (Demsetz, 1973). First, the definition of the relevant market and product should be clear. Second, a higher level of efficiency might results high market share (the efficient structure hypothesis). This hypothesis emphasizes the importance of controlling for bank efficiency when testing whether higher concentration leads to higher bank profits. The empirical studies also supported that concentration index (i.e. CR*k*, HHI) alone does not fully proxy for competition (Berger, 1995; Rhoades, 1995) but it should include bank efficiency.

[5] Zone 1 requires IDR 14 billion for capital. Zone 2, zone 3, and zone 4 is IDR 8 billion, IDR 6 billion, and IDR 4 billion, respectively (Indonesia FSA, 2014). In comparison, to open a new commercial bank, the required capital is IDR 3 trillion.

Alternative competition measures, the New Empirical Industrial Organization (NEIO) have added additional theories opposite to the traditional approaches. These measures are not dependent on the specific market structure, but are based on the behavior of bank. The NEIO measures mainly based on monopoly power which developed by Lerner (1934). The Lerner Index suggests the mark-up of price over marginal cost. The higher the mark-up price results the greater market power. Another NEIO measured based on competitive behaviour in contestable markets, such as Panzar and Rosse (1987) which measures the extention of changes in bank cost reflected in its revenue. In addition, the recent indicator is the Boone Indicator (Boone, 2008), which assumes that more efficient firms will have higher performance and attract greater market shares.

### 2.5.1 Concentration measures

There are two measures of concentration that are widely used in the literature: the *k* bank concentration ratios (CRk) and the Herfindahl-Hirschman Iindex (HHI). By using the concentration measure, the market should be define, for instance the size of total banking sector is based on assets or deposits in a market or country.

The CR*k* measures the market share of the top *k* banks in the industry (summing including only the market shares of the *k* largest banks in the market). The computation is as follows:

$$CR_k = \sum_{i=1}^{k} MS_i \qquad (1)$$

where $S_i$ is the market share of the $i$'th bank, when bank are ranked in descending order or market share. This index assumes that the behavior of a market is dominated by a small number of large banks. Concentration ratios usually use the ratio of a country's three, five and ten largest banks as a proxy to measure competitiveness. Fritzer (2004) defined concentration of banks as the ratio of a country's three largest bank's' assets to the country's total banking sector assets.

The Herfindahl-Hirschman index (Hirschman, 1945; Herfindahl, 1950) is a measure of concentration based on structural measure that accounts the number of firms in a market by incorporating the relative size or market share of all firms in a market. This measure is the one most commonly used in literature (Cetorelli and Strahan, 2006). Bikker and Haaf (2002) argue that increased market concentration is expected to reduce competition in banking. The HHI is calculated as the sum of squared market shares of all banks in a market. The market share may be based on either deposits or assets. The calculation of HHI is as follows:

$$HHI = \sum_{i=1}^{n} (MS_i)^2 \quad (2)$$

where $MS_i$ is the market share of bank *i* and *n* is the total number of banks in the industry. The sum of market share is 100%. In this calculation, larger banks receive a heavier weighting eavier than smaller banks, thus reflecting their importance. The larger the HHI, the more concentrated the market.

### 2.5.2 Lerner Index

The Lerner Index proposed by Lerner (1934) indicates firms' ability to set prices over marginal costs divided by price. This index has become popular in empirical studies on banking (e.g., Beck et al., 2013; Anginer et al.,2014). The Lerner index is defined as the mark-up of price over marginal cost, that is, prices that exceed marginal costs provide a useful indicator or measure of market power and are considered to have a higher degree of monopoly power. That means, higher index values imply greater market power. In perfect competition, price equals marginal cost. The calculation is as follows:

$$Lerner_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \quad (3)$$

where $P_{i,t}$ is the price of output and $MC_{i,t}$ is the marginal costs (MC). The price of output can be calculated in different ways depending on the study's objectives. Referring to Koetter et al. (2012), price is average revenues. In banking applications, the Lerner Index is typically estimated by approximating the price with the ratio of total revenue and total assets (Carbó et al. 2009). In other studies, price is proxied by total income (interest and non-interest income) to total assets (Fernandez de Guevara et al., 2005; Jimenez, Lopez, & and Saurina, 2007; Berger et al., 2009). Under perfect competition, this index would be exactly zero and increasing with the degree of competition. However, the marginal costs cannot be directly observed, so the estimation of a total cost function is used to derive marginal cost, which is then used together with input prices (price of labor, price of physical capital, and price of borrowed funds) for the computation of the Lerner Index (Maudos and Fernández de Guevara, 2004; Turk-Ariss, 2010).
The cost function for one output and three inputs is specified as follows:

$$\ln TC = \alpha_0 + \alpha_1 \ln y + \frac{1}{2}\alpha_2 (\ln y)^2 + \sum_{j=1}^{3} \beta_j \ln w_j + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{jk} \ln w_j \ln w_k$$

$$+\sum_{j=1}^{3}\gamma_j \ln y \ln w_j + \varepsilon \quad (4)$$

where *TC* denotes total costs, *y* is total assets, and $w_j$ is the input prices. The estimated coefficients of the cost function are then used to compute the marginal cost (MC), as follows:

$$MC = \frac{TC}{y}\left(\alpha_1 + \alpha_2 \ln y + \sum_{j=1}^{3}\gamma_j \ln w_j\right) \quad (5)$$

The advantage from of using the Lerner Index is that it can be measured both at the bank level and time, so it can identify different patterns of behaviour across banks, market and years. However, because costs may differ across the different product markets on which the bank is active, the limitation of this model occurs.

**2.5.3 Panzar and Rosse H-statistic**

Rosse and Panzar (1977) and Panzar and Rosse (1981, 1987) developed a test that examines competitive behaviour of banks without explicitly using information on market structure. They estimated marginal-cost pricing and examined whether firm-level conduct is a perfect competition, monopolistic competition, or monopoly. The Panzar and Rosse H-statistic (PRH) test is also known as the revenue test. It is the sum of the elasticities of the reduced-form revenue equation with respect to all input prices. A higher H-statistic represents a higher level of competition. A negative value or 0 indicates a monopoly and 1 indicates perfect competition.

The standard procedure for estimation of the H-statistic involves the application of fixed effects (FE) regression using firm-level panel data, as follows:

$$logTR_{i,t} = \alpha + \sum_{j=1}^{J}\beta_i log\, w_{j,i,t} + \theta' X_{i,t} + \varepsilon_{i,t} \quad (6)$$

where $TR_{i,t}$ is the total revenue of bank *i* in year *t*; $w_{j,i,t}$ is the price of factor input; $X_{i,t}$ is other firm-specific control factors; and $\varepsilon_{i,t}$ is a random error. The PRH is then defined as the sum of input price elasticities:

$$H = \sum_{j=1}^{J}\beta_j \quad (7)$$

The assumption based on PRH is homogeneous cost structure and no vertical product differentiation. It is also argued as a continuous and long-run measure of competition (Shaffer,

1983; Bikker, 2004) and as alternative method to infer the degree of market power in the banking industry (Claessens & Laeven, 2004). Problems associated with this model has explored by Bikker et al. (2012) who argue that the Panzar–Rosse approach is not very informative of the degree of competition in the long run equilibrium and being likely to provide ambiguous conclusions on the level of market competition. Several papers have estimated degree of competition using the Panzar and Rosse H-statistics (Molyneux et al. 1994; de Bandt and Davis, 2000; Bikker and Groenveld, 1998; Goddard and Wilson, 2009; Bikker et al. 2012).

### 2.5.4 Boone Indicator

The Boone Indicator assumes that more efficient banks (banks with lower marginal costs) have higher profits or performance and attract greater market shares (Berger & De Young, 1997). The use of the indicator is consistent with the industrial organisation literature demonstrating that competition reallocates profits from inefficient to efficient firms (Stiroh, 2000).

Boone (2008) developed a broad set of theoretical models, a new measure called the Boone indicator based on the efficiency hypothesis proposed by Demsetz (1973). The Boone Indicator can be estimated by the following equation:

$$\ln\pi_{i,t} = \alpha + \beta \ln MC_{i,t} + \varepsilon_{i,t} \quad (8)$$

where $\pi_i$ is the profit of bank *i*, $MC_i$ is the marginal cost of bank *I*, $\beta$ is the Boone indicator and $\varepsilon_{i,t}$ is noise or error. The estimate of $\beta$ is expected to be negative but can be positive in empirical implementation (as more efficient, less marginal cost). The marginal costs cannot be directly observed, so the translog cost function is used to derive marginal cost. The Boone indicator is calculated on bank-level data as the percentage change in profits or market shares due to a one percent change in marginal costs (Boone and van Leuvensteijn, 2010; van Leuvensteijn et al., 2011). This indicator can capture market dynamics and be easily implemented for a limited number of observations.

## 2.6 Hypothesis Development

According to the literature review, the hypothesis of this study as follows:

HYPOTHESIS 1: All else equal, longer physical distance from bank to the nearest rival bank and wider area of market boundary mean lower competition and impact more positive to bank performance.

HYPOTHESIS 2: All else equal, higher concentration index means more concentrated the market and impacts impact more positive to bank performance.

HYPOTHESIS 3: All else equal, higher number of Lerner Index indicating greater market power, thus affect positively to bank performance.

HYPOTHESIS 4: All else equal, Boone index affects negatively to bank performance. As lower marginal costs have higher profits or performance and attract greater market shares.

HYPOTHESIS 5: All else equal, bank-specific characteristics affect bank performance. Size impacts positively to bank performance. Capital impacts positively to bank performance as higher capital levels may denote banks with riskier assets. Lending impacts positively to bank performance, however it is pro-cyclical and that banks with higher profits will lend more generously. Diversification as non-interest income is associated with weaker bank profitability and negatively impacts performance. Liquidity usually associated with lower rates of return, thus create negative effect to bank performance.

HYPOTHESIS 6: All else equal, macroeconomics variables affect bank performance. Inflation is expected to negatively affect bank efficiency. Gross Domestic Product (GDP) is expected to positively affects bank performance as it is stimulates investment.

## 3. Data and Methodology

### 3.1 Data and Sample

I tested the effect of spatial competition and other factors on bank performance using bank-level data from Indonesian rural banking industry. I collected financial statement of rural banks in Indonesia originating from the Indonesia Financial Services Authority (OJK)[6], which collects quarterly financial statements of all Indonesian rural banks. The sample was unbalanced panel data from 2014Q1-2017Q2[7]. The period beginning in 2014 was chosen because this is when rural banks began reporting the current form of financial statements to the OJK. The total number of rural banks (in February 2017Q2) was 1,682 across 32 provinces[8]. I excluded the banks that did not report financial statement in each period from 2014 to 2017, and banks with unusual data (outliers) were first investigated individually. For example, I removed observations that had a negative estimated price, negative, zero and missing gross-total assets and loan

[6] Commonly abbreviated as OJK (Otoritas Jasa Keuangan), an independent institution which has authority to regulate, supervise, examine, and investigate against the activities in the financial services sector established in 2011

[7] These data are available online via the Indonesian Financial Service Authority (Otoritas Jasa keuangan)'s website http://www.ojk.go.id

[8] North Kalimantan province does not have any rural banks, all banks in West Papua province did not report the financial statement.

composition. This filtering leaves 15,773 bank-quarter observations in the final sample. In regard to macroeconomic variables, I used quarterly data from the Indonesian Central Bureau of Statistics (BPS).

To assess spatial competition, the addresses of each rural bank were downloaded from the Central Bank of Indonesia (Bank Indonesia). After geocoding the rural bank (assigning a latitude and longitude to each bank), I calculated the distance between banks (bank to the closest rival bank). Measuring distance could be done in different ways as distance is a relative concept (Richards et al., 2008). I measured distance using the Haversine Formula from bank *i* to closest bank *j* and shares a common market boundary and use the physical distance in metres. In this case, I used Thiessen Polygon to draw the area of each region. Kalnins (2003) used Thiessen polygons to define a set of common boundaries shared by firms in the same market.

**3.2 Variables**

The dependent variable is bank performance, which devided into profitability and efficiency. Profitability is measured by Return on Assets (ROA). ROA is chosen as the profitability indicator due to the fact that it has emerged as the key ratio for the evaluation of bank profitability (Athanasoglou et al., 2008). I also use Return on Equity (ROE) and Net Interest Margin (NIM) as robustness.

$$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}} \tag{11}$$

$$\text{ROE} = \frac{\text{Net Income}}{\text{Total Equity}} \tag{12}$$

$$\text{NIM} = \frac{\text{Net Interest Income}}{\text{Total Productive Assets}} \tag{13}$$

In regards to the efficiency measurement, I use inputs and outputs. This study adapted the intermediation approach for the selection of inputs and outputs, as banks are viewed as financial intermediaries which accumulate deposits and purchase funds and then intermediate these funds. The output price can be proxied by observable variables; however the marginal cost should be estimated because it is not observable. In the financial service industry, competition among firms is usually mostly cost-driven because of high regulatory standards and low appropriability of innovation (Berger & Humphrey, 1997). The inputs used in present study are personal expenses, deposits, and capital. The outputs are loans, other earning assets and non-interest income. The

translog formulation originally proposed in Christensen et al. (1973) is the most widely adopted functional form in banking competition studies.

In price estimation, the variables chosen to proxy the respective prices are often affected by some limitations. Many previous studies used the ratio of personnel expenses to total assets which the number of employee is often not available. However, the value of assets is considerably more volatile than the number of employees. Thus, in this study the price of labour is calculated as the ratio of personal & administration expenses relative to total assets because labour is likely to be a much more important component for banks engaging in non-traditional lines of business (Titotto, D., & Ongena, S., 2017). The ratio of total depreciation expenses to fixed assets as the price of physical capital. In some cases, banks can decide to lease rather than buy the buildings and other physical assets. In regard to the price of funds, the cost of borrowed funds is taken to be equal the ratio of interest expenses to total deposits including the deposits from other banks.

For independent variables, I use the following variables:

1. Spatial competition is measured by physical distance from bank to the nearest rival bank and the area of market boundary each bank in a province.
   a. Distance is calculated as the physical distance using Haversine formula in metres between the location of the bank and its closest rival bank in a province by assigning longitude and latitude coordinates. The Haversine Formula is used to calculate distances on a sphere. To calculate the distance, I assume a spherical Earth with radius (R=6,371 km), and the locations of the two points in spherical coordinates (longitude and latitude) are *long1*, *lat1* and *long2*, *lat2*. The Haversine formula is as follows:

$$\Delta lat = lat2 - lat1 \tag{14}$$

$$\Delta long = long2 - long1 \tag{15}$$

$$a = sin^2\left(\frac{\Delta lat}{2}\right) + \cos(lat1)\,.\,cos(lat2).\,sin^2\left(\frac{\Delta long}{2}\right) \tag{16}$$

$$c = 2.\,atan2\left(\sqrt{a}, \sqrt{(1-a)}\right) \tag{17}$$

$$d = R.\,c \tag{18}$$

   To normalise the data, I use the natural logarithm of distance.

   b. The market boundary is constructed using Thiessen polygons. It defines individual areas of influence around each of a set of points. Thiessen polygons are polygons whose

boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points. This study calculated the square kilometer region in which rural banks operate per province.

2. Industry characteristics:
    a. Concentration measure = I measure market concentration using the Herfindahl Hirschman Index (HHI). The concentration indices are estimated based on the share of assets of the banks using bank-level data.
    b. Lerner index = The Lerner index is defined as the difference between a bank's price and the marginal cost, divided by the price. The index value ranges from a maximum of 1 to a minimum of zero (or in some cases of empirical studies the Lerner index could be negative), with higher numbers indicating greater market power and hence lower competition.
3. Bank-specific characteristics:
    a. Size = the natural logarithm of total assets. Banks with larger size are able to reduce costs from economies of scale and scope. It is expected that size will impact positively to profit and efficiency.
    b. Capital = the ratio of equity to assets. Higher capital levels may denote banks with riskier assets. Generally, empirical evidence suggests a positive relationship between capital and profitability.
    c. Lending = the ratio of total loans to total assets. It represents a bank's relative lending size. Lending is pro-cyclical and that banks with higher profits will lend more generously.
    d. Diversification = the ratio of non-interest income to total income. Non-interest income is generated via fee and commission income or trading activities. Greater reliance on non-interest income is associated with weaker bank profitability. It will negatively impact profit.
    e. Liquidity = the ratio of loan to deposit ratio (LDR). A higher value of this ratio makes a bank more liquid and less vulnerable to failure. However, liquid assets are usually associated with lower rates of return, and so generally a negative relationship is expected between this variable and profitability.

4. Macroeconomic variables[9]:
   a. Inflation is expected to negatively affect bank efficiency due to the fact that under inflationary conditions, banks might feel less pressure to control their inputs, and therefore they become less efficient.
   b. Gross Domestic Product (GDP). Higher GDP growth stimulates investment. Thus, it is expected that GDP growth rate affects profitability and efficiency positively.

**3.3 Model and Methodology**

The empirical study was conducted as follows:

1. **First, I estimated the effect of bank competition on bank profitability.** I used spatial competition as the main variable. I estimate bank competition in three models: Panzar and Rosse model, Lerner index model, and Boone index model.
   a. Panzar and Rosse H-statistic (PRH)

I calculated the PRH statistic, which is defined as the elasticity of revenue with respect to the marginal cost of the inputs used in the production of banking services (Bikker and Haaf, 2002; Goddard and Wilson, 2009). The Panzar and Rosse model is as follows:

$$\ln(R_{i,t}) = \alpha_i + \beta_1 \ln(W_{1,i,t}) + \beta_2 \ln(W_{2,i,t}) + \beta_3 \ln(W_{3,i,t}) + x_{i,t,j}\gamma + e_{i,t} \qquad (19)$$

where $i$ refers to the bank, $j$ refers to province or region, and $t$ indexes time. $R_{i,t}$ is ROA (ROE and NIM as robustness) as a measure of the revenue or profit for bank $i$ in year $t$; $W_{k,i,t}$ is the price of factor input $k$, all measured as the ratio of each type of cost ($k$ = 1 for personnel expenses to total assets as the cost of labor, $k$ = 2 for total depreciation expenses to fixed assets as the cost of physical capital, and $k$ = 3 for interest expenses to total deposits as the cost of funds); $x_{i,t,j}$ is a vector of exogenous control variables at the bank level, which includes : distance proxy, market boundary (Thiessen polygon to province area), market concentration (industry-specific variable), bank-specific characteristics, and macroeconomic indicators. $\alpha_i$ is an individual bank effect, and $e_{i,t}$ is a random disturbance term. The PRH statistic is given by the sum of the elasticities of revenue with respect to input prices, ($\beta_1 + \beta_2 + \beta_3$). Under a monopoly, PRH < 0; under perfect competition, PRH = 1; and under monopolistic competition, 0 < PRH < 1. The larger value of PRH means stronger competition.

   b. Lerner Index

[9] These data are available online via The Indonesian Central Bureau of Statistics (BPS)'s website http://www.bps.go.id

The Lerner Index was used to measure the degree of competition. The Lerner Index is the difference between the price of total assets (the ratio of total revenue to total assets) and marginal cost of total assets divided by the price of total assets (Maudos & Fernandez de Guevara, 2007; Delis & Tsionas, 2009; Koetter et al., 2012). Banks with a higher spread between price and marginal cost could be considered to have a higher degree of monopoly power.

$$Lerner_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \tag{20}$$

where:

$$P_{i,t} = \text{ratio of revenues to total assets}$$

$$MC_{i,t} = \text{ratio of marginal cost to total assets}$$

To calculate the marginal costs, I estimated the translog cost function. The inputs are personal expenses, deposits, and capital. The output is total assets. To obtain marginal cost, I differentiated the translog cost function.

To obtain the marginal costs of a bank, it starts by assuming a translog production function.

$$\ln q = \sum_{n=1}^{N} \beta_n ln k_n + \frac{1}{2} \sum_{n=1}^{N} \sum_{m=1}^{M} \beta_{n,m} \ln k_n \ln k_m \tag{21}$$

where $q$ is the total cost of the bank, and there are $N = M$ input quantities $k$.

Or, in panel data model, with one output (total assets) and three input prices (price of labor, price of physical capital, and price of funds), the translog function is written as follows:

$$lnTC_{it} = \beta_0 + \beta_1 lnQ_{it} + \frac{\beta_2}{2} lnQ_{it}^2 + \sum_{k=1}^{3} \gamma_{kt} lnW_{k,it}$$

$$+ \sum_{k=1}^{3} \phi_{kt} lnQ_{it} lnW_{k,it} + \frac{1}{2} \sum_{k=1}^{3} \sum_{j=1}^{3} \rho_{kt} lnW_{k,it} lnW_{j,it} + \varepsilon_{it} \tag{22}$$

As outlined in Weill (2013), the prices were normalised by dividing TC, $W_1$, and $W_2$ by $W_3$. This is a simple way to impose the symmetry and homogeneity constraints without complicating the estimation procedure. The cost function is:

$$\ln\left(\frac{TC}{W_3}\right) = \alpha_0 + \alpha_1 \ln Y + \frac{1}{2}\alpha_2 (\ln Y)^2 + \alpha_3 \ln\left(\frac{W_1}{W_3}\right) + \alpha_4 \ln\left(\frac{W_2}{W_3}\right) + \alpha_5 \ln\left(\frac{W_1}{W_3}\right)\ln\left(\frac{W_2}{W_3}\right) + \frac{1}{2}\alpha_6 \left(\ln\left(\frac{W_1}{W_3}\right)\right)^2 + \frac{1}{2}\alpha_7 \left(\ln\left(\frac{W_2}{W_3}\right)\right)^2 + \alpha_8 \ln Y \ln\left(\frac{W_1}{W_3}\right) + \alpha_9 \ln Y \ln\left(\frac{W_2}{W_3}\right) + \varepsilon \quad (23)$$

where TC is total cost, Y is total assets, $W_i$ indicates the price of input *i*. $P_{it}$ is the ratio of total revenues (interest and non-interest income) to total assets for bank *i* at time *t* following the example in Carbó et al. (2009). After the results of estimation were obtained, MC was calculated by differentiating the Total Cost. The marginal cost was then computed as:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Y_{it}} = \frac{TC_{it}}{Y_{it}}\left[\alpha_1 + \alpha_2 lnY_{it} + \sum_{k=1}^{3} \phi_k lnW_{k,it}\right] \quad (24)$$

After all the variables were collected, I estimated them with panel data regression model.

c. Boone Indicator

The Boone (2008) Indicator is a measure of competition developed in the industrial organization literature. This indicator is based on the efficiency hypothesis developed by Demsetz (1973) and shows the strength of the relationship between efficient banks (measured in terms of their marginal costs) and performance. In a competitive market, more efficient firms obtain higher profits. The Boone (2008) Indicator aims to capture the impact of competition on the performance of banks.

The market power of banks can be estimated from the following profitability equation:

$$\pi_{it} = \alpha + \beta_t mc_{it} + \varepsilon_{it} \quad (25)$$

where π is the profits of each bank (ROA, ROE, and NIM), *mc* is marginal cost, $\beta$ is the Boone Indicator of market power, $\varepsilon$ is error. Intuitively, the profitability of banks with lower marginal costs (higher efficiency) is expected to increase, i.e., $\beta$ should be negative. A lower market power (higher competition) implies that the value of $\beta$ is larger in absolute terms (more negative) and, therefore, $\beta$ serves as a continuous indicator of market power. To estimate the equation, I added a vector of control variables, $X_i'\gamma$, and an error term, $e_{i,t}$. The marginal cost is unobservable, so the translog cost function was obtained to estimate the marginal cost.

The translog function is written as follow:

$$lnTC_{it} = \beta_0 + \beta_1 lnQ_{it} + \frac{\beta_2}{2} lnQ_{it}^2 + \sum_{k=1}^{3} \gamma_{kt} lnW_{k,it}$$

$$+ \sum_{k=1}^{3} \phi_k lnQ_{it} lnW_{k,it} + \sum_{k=1}^{3} \sum_{j=1}^{3} lnW_{k,it} lnW_{j,it} + \varepsilon_{it} \quad (26)$$

The marginal cost is then computed as:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}} = \frac{TC_{it}}{Q_{it}} \left[ \beta_1 + \beta_2 lnQ_{it} + \sum_{k=1}^{3} \phi_k lnW_{k,it} \right] \quad (27)$$

After all the variables were collected, I estimated them with panel data regression model.

**2. Second, I investigate how banking competition affects bank efficiency.**

For analysis of the efficiency of the rural banks, this study has been obtained using the stochastic frontier approach (SFA). It estimates a parametric frontier of the best possible practices given a standard cost function. The using of parametric model is because according to Daraio and Simar (2007) the application of full nonparametric models can suffer from different problems, such as extreme values or outliers. It allows for a random error, which accounts for measurement errors. For the assessment of banks' efficiency, I estimated the cost frontier using a translog function.

Cost efficiency is the ratio between the minimum cost at which it is possible to attain a given volume of production and the realised cost. Cost efficiency considers a bank as inefficient if its costs are higher than those predicted for an efficient bank producing the same output under the same existing conditions with the difference unexplainable by statistical noise. Specifically, a stochastic cost function model implies that the bank's observed total cost will deviate from the efficient frontier. Efficiency ranges over the (0,1) interval, and equals 1 for the best-practice bank in the sample.

According to the SFA, the general form of cost efficiency takes the following specification:

$$TC_{it} = f(q_{it}, p_{it}, \beta) + (V_{it} + U_{it}) \quad (28)$$

where:

$TC_{it}$ = total costs (expenses) of the bank

$q_{it}$ is vector of outputs

$p_{it}$ is vector of input prices

β is a vector of other variables

$V_{it}$ is random variables which are assumed independent and identically distributed, with mean zero

$U_{it}$ is inefficiency.

It is independently distributed as truncations at zero of the $N(m_{it}, \sigma_U^2)$ distribution.

The general form of translog frontier analysis is shown as equation:

$$ln(C) = \beta_0 + \sum \frac{1}{2}\beta_i\left(ln(Y_i)\right)^2 + \sum \frac{1}{2}\beta_j\left(ln(W_j)\right)^2 + \sum\sum \beta_{ij}\, ln(Y_i) ln(W_j) + V_i + U_i \quad (29)$$

Where $Y_i$ is output variables; $W_j$ is input price; $V_i$ is random error; $U_i$ is cost inefficiency.

This paper selected the translog cost function, which reflects the interaction between explanatory variables and explained variables. Following Liadaki and Gaganis (2009), the specific form of cost function used in this study is written as follows:

$$\begin{aligned} ln\frac{TC}{P_3} = {} & \beta_0 + \beta_1 ln(Q_1) + \beta_2 ln(Q_2) + \beta_3 ln(Q_3) + \beta_4 ln\left(\frac{P_1}{P_3}\right) + \beta_5 ln\left(\frac{P_2}{P_3}\right) + \beta_6 \frac{1}{2}[ln(Q_1)]^2 \\ & + \beta_7 ln(Q_1) ln(Q_2) + \beta_8 ln(Q_1) ln(Q_3) + \beta_9 \frac{1}{2}[ln(Q_2)]^2 + \beta_{10} ln(Q_2) ln(Q_3) \\ & + \beta_{11} \frac{1}{2}[ln(Q_3)]^2 + \beta_{12} \frac{1}{2}\left[ln\left(\frac{P_1}{P_3}\right)\right]^2 + \beta_{13} ln\left(\frac{P_1}{P_3}\right) ln\left(\frac{P_2}{P_3}\right) + \beta_{14} \frac{1}{2}\left[ln\left(\frac{P_2}{P_3}\right)\right]^2 \\ & + \beta_{15} ln(Q_1) ln\left(\frac{P_1}{P_3}\right) + \beta_{16} ln(Q_1) ln\left(\frac{P_2}{P_3}\right) + \beta_{17} ln(Q_2) ln\left(\frac{P_1}{P_3}\right) \\ & + \beta_{18} ln(Q_2) ln\left(\frac{P_2}{P_3}\right) + \beta_{19} ln(Q_3) ln\left(\frac{P_1}{P_3}\right) + \beta_{20} ln(Q_3) ln\left(\frac{P_2}{P_3}\right) \\ & + (V_{it} + U_{it}) \end{aligned} \quad (30)$$

Where TC is defined as the total costs; $P_i$ is the vector of input prices; $Q_i$ is a vector of variable outputs. This model is estimated using maximum likelihood estimation. In order to calculate the level of cost efficiency, based on Battese and Coelli (1992), I used the ratio of the observed cost relative to the potential cost, defined by:

$$Cost\ Inefficiency_{it} = \frac{C_{it}^*}{C_{it}} = \frac{exp(x_{it}\beta)}{exp(x_{it}\beta + u_{it})} = exp(-u_{it}) \quad (31)$$

$$Efficiency_{it} = 1 - exp(-u_{it}) \quad (32)$$

After the cost efficiency for each bank is obtained, I estimated the effect of spatial competition and other factors (bank-specific characteristics, industry-specific characteristics, and macroeconomic variables) on bank efficiency using panel data regression model.

The cost efficiency model for SFA could be expanded with netput variables and other characteristics variables, such as dummy variables, as follows:

$$TC_{it} = f(Q_{it}, P_{it}, N_{it}) + v_{it} + u_{it} \quad (33)$$

where $TC_{it}$ stands for the total cost of bank *i* at time *t*, $Q_{it}$ is a vector of inputs and $P_{it}$ is a vector of outputs, $N_{it}$ is a vector of quasi-fixed netputs, $v_{it}$ stands for the random variables which are assumed independent and identically distributed, with mean zero and constant variance and independent of the $u_{it}$ which are inefficiency as non-negative random variables. Following Batesse and Coelli (1995), the error is distributed as truncations at zero of the $N(m_{it}, \sigma_u^2)$ distribution, where the mean $m_{it}$, is assigned as $m_{it} = z_{it}\delta$, where $z_{it}$ is a vector of variances that affect the efficiency and $\delta$ is the vector with the parameters to be estimated. This study includes quasi-fixed netput the fixed assets of each bank (N1) which stands for a proxy of physical capital. Furthermore, the equity (N2) is as a second quasi-fixed netput. Equity represents an alternative source of funding for banks and therefore, it might affect their cost structure (Fiordelisi et al. 2011).

The translog cost function is constructed as follows:

$$\begin{aligned} lnTC_{it} = \alpha_0 &+ \sum_i \alpha_i lnQ_{it} + \sum_i \beta_i lnP_{it} + \sum_i \zeta lnN_{it} + \frac{1}{2}\sum_i \sum_j \alpha_i \, lnQ_{it} lnQ_{jt} \\ &+ \frac{1}{2}\sum_i \sum_j \beta_i \, lnP_{it} lnP_{jt} + \frac{1}{2}\sum_i \sum_j \zeta_i \, lnN_{it} lnN_{jt} + \sum_i \sum_j \delta_{ij} \, lnQ_{it} lnP_{jt} \\ &+ \frac{1}{2}\sum_i \sum_j \theta_i \, lnQ_{it} lnN_{jt} + \sum_i \sum_j k_{ij} \, lnP_{it} lnN_{jt} + \, v_{it} + u_{it} \end{aligned} \quad (34)$$

$$ln\frac{TC}{P_3} = \beta_0 + \beta_1 ln(Q_1) + \beta_2 ln(Q_2) + \beta_3 ln(Q_3) + \beta_4 ln(N_1) + \beta_5 ln(N_2) + \beta_6 ln\left(\frac{P_1}{P_3}\right)$$
$$+ \beta_7 ln\left(\frac{P_2}{P_3}\right) + \beta_8 \frac{1}{2}[ln(Q_1)]^2 + \beta_9 ln(Q_1)ln(Q_2) + \beta_{10} ln(Q_1)ln(Q_3)$$
$$+ \beta_{11} \frac{1}{2}[ln(Q_2)]^2 + \beta_{12} ln(Q_2)ln(Q_3) + \beta_{13} \frac{1}{2}[ln(Q_3)]^2 + \beta_{14} \frac{1}{2}[ln(N_1)]^2$$
$$+ \beta_{15} ln(N_1)ln(N_2) + \beta_{16} \frac{1}{2}[ln(N_2)]^2 + \beta_{17} \frac{1}{2}\left[ln\left(\frac{P_1}{P_3}\right)\right]^2 + \beta_{18} ln\left(\frac{P_1}{P_3}\right) ln\left(\frac{P_2}{P_3}\right)$$
$$+ \beta_{19} \frac{1}{2}\left[ln\left(\frac{P_2}{P_3}\right)\right]^2 + \beta_{20} ln(Q_1) ln\left(\frac{P_1}{P_3}\right) + \beta_{21} ln(Q_1) ln\left(\frac{P_2}{P_3}\right) + \beta_{22} ln(Q_2) ln\left(\frac{P_1}{P_3}\right)$$
$$+ \beta_{23} ln(Q_2) ln\left(\frac{P_2}{P_3}\right) + \beta_{24} ln(Q_3) ln\left(\frac{P_1}{P_3}\right) + \beta_{25} ln(Q_3) ln\left(\frac{P_2}{P_3}\right)$$
$$+ +\beta_{26} ln(N_1) ln\left(\frac{P_1}{P_3}\right) + \beta_{27} ln(N_1) ln\left(\frac{P_2}{P_3}\right) + \beta_{28} ln(N_2) ln\left(\frac{P_1}{P_3}\right)$$
$$+ \beta_{29} ln(N_2) ln\left(\frac{P_2}{P_3}\right) + \beta_{30} ln(N_1) ln(Q_1) + \beta_{31} ln(N_1) ln(Q_2) + \beta_{32} ln(N_1) ln(Q_3)$$
$$+ \beta_{33} ln(N_2) ln(Q_1) + \beta_{34} ln(N_2) ln(Q_2) + \beta_{35} ln(N_2) ln(Q_3)$$
$$+ (V_{it} + U_{it}) \qquad (35)$$

Hence, the inefficiency, $U_{it}$ , is obtained by truncation (at zero) of the normal distribution with mean, $m_{it} = z_{it}\delta$. It takes the following form:

$$U_{it} = \delta_0 + \delta_1 Distance_{it} + \delta_2 Boundary_{it} + \delta_3 HHI_{it} + \delta_4 GDP_{jt} + \delta_5 Inflation_{jt}$$
$$+ \varepsilon_{it} \qquad (36)$$

## 4. Results

### 4.1 Variables and selected descriptive statistics

### a. Descriptive Statistics

**Table 1.1** Variables definition and Summary Statistics

| Variable | Symbol | Definition | Obs | Mean | St. Dev | Min | Max |
|---|---|---|---|---|---|---|---|
| Panel A: Variables used in the analysis of bank profitability | | | | | | | |
| A. Dependent variable | | | | | | | |
| Return on Assets | ROA | The ratio of net income to total assets | 15,773 | 0.0269 | 0.0754 | -2.4673 | 0.6077 |
| Return on Equity | ROE | The ratio of net income to total | 15,773 | 0.1248 | 0.7103 | -16.7060 | 15.37589 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | equity | | | | | |
| Net Interest Margin | NIM | The ratio of net interest income to total productive assets | 15,773 | 0.1532 | 0.0684 | -0.1465 | 0.5912 |
| B. Independent variable | | | | | | | |
| Price of labor | $W_1$ | The ratio of administration expenses to total assets | 15,773 | 0.1113 | 0.0565 | 0.0063 | 0.3497 |
| Price of physical capital | $W_2$ | The ratio of depreciation expenses to fixed assets | 15,773 | 0.6129 | 0.1873 | 0.0195 | 0.9948 |
| Price of funds | $W_3$ | The ratio of interest expenses to total deposits | 15,773 | 0.1008 | 0.0514 | 0.00005 | 0.5752 |
| Distance | | Distance from bank to nearest rival bank (in meter) | 15,773 | 88,118.33 | 35,698.63 | 1.05 | 550,918.8 |
| Boundary | | Area of Thiessen polygon for each bank (in suared meter) | 15,773 | 1.53e+09 | 8.94e+09 | 10,356.4 | 1.57e+11 |
| HHI | | Market concentration of assets | 15,773 | 85.8733 | 650.6333 | 0.00006 | 9,892.22 |
| Size | | Ln Total Assets | 15,773 | 16.9906 | 1.2265 | 13.6900 | 22.7198 |
| Capital | | The ratio of equity capital divided to total assets | 15,773 | 0.2254 | 0.1588 | -2.0432 | 0.9925 |
| Lending | | The ratio of loans to assets | 15,773 | 0.7551 | 0.1238 | 0.1377 | 3.3010 |
| Diversification | | The ratio of non-interest income to total income | 15,773 | 0.1122 | 0.1118 | 0.00001 | 3.6434 |
| Liquidity | | The ratio of loan to deposits | 15,773 | 2.2928 | 43.4096 | 0.2159 | 2705.99 |
| GDP | | Growth provincial GDP by Expenditures in Constant Prices | 15,773 | 5.4811 | 1.7993 | -9.57 | 34.08 |
| Inflation | | Provincial Inflation | 15,773 | 4.7940 | 4.4995 | -16.16 | 29.12 |
| Total Assets | Y | Total Assets | 15,773 | 6.57e+07 | 2.61e+08 | 882,061 | 7.36e+09 |
| Price | P | Total revenues to total assets | 15,773 | 0.1659 | 0.0738 | 0.0039 | 0.9072 |
| Marginal Cost | MC | First derivative | 15,773 | 0.4789 | 0.3250 | 0.0462 | 11.6707 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | of translog cost function | | | | | |
| Lerner Index | | $Lerner = \frac{P - MC}{P}$ | 15,773 | -2.294775 | 6.3953 | -706.83 | 0.6541 |
| Panel B: Variables used in the analysis of bank efficiency | | | | | | | |
| Total Cost | TC | Total Interest Expenses + Total Operational Expenses | 15,773 | 2.36e+07 | 9.49e+07 | 114,984 | 3.64e+09 |
| Outputs: | | | | | | | |
| Loans | $Q_1$ | Loans to other rural banks + Loans to commercial banks + Loans to non bank - related parties + Loans to non bank - unrelated parties | 15,773 | 4.97e+07 | 2.00e+08 | 230,131 | 5.87e+09 |
| Other earning assets | $Q_2$ | Interbank placement | 15,773 | 1.37e+07 | 6.59e+07 | 393 | 2.00e+09 |
| Non-interest income | $Q_3$ | Non-interest income | 15,773 | 818,817.5 | 3,998,068 | 5 | 1.87e+08 |
| Inputs: | | | | | | | |
| Price of labour | $P_1$ | The ratio of administration expenses to total assets | 15,773 | 0.1113 | 0.0565 | 0.0063 | 0.3497 |
| Price of physical capital | $P_2$ | The ratio of depreciation expenses to fixed assets | 15,773 | 0.6129 | 0.1873 | 0.0195 | 0.9948 |
| Price of borrowed funds | $P_3$ | The ratio of interest expenses to total deposits | 15,773 | 0.1008 | 0.0514 | 0.00005 | 0.5752 |
| Netput 1 | $N_1$ | Fixed assets | 15,773 | 1,084,095 | 5,178,465 | 281 | 2.00e+08 |
| Netput 2 | $N_2$ | Equity | 15,773 | 9,742,654 | 2.91e+07 | -2.31e+07 | 7.37e+08 |

A list of variables with symbols and definitions is provided in Table 1.1. This table contains summary statistics for the variables employed in analysis of the effect of spatial competition on bank profitability and bank efficiency. As can be seen from the table, the average ROA of sample is 2.69%. This number is slightly higher with average ROA for all rural banks in Indonesia in year 2017 which is 2.45%. The ROE and NIM of rural banks in Indonesia are high because of their characteristics of high interest rate.

**b. Thiessen Polygon Map**

The Thiessen polygons are created using ArcGIS application. First, I assigned the latitude and longitude coordinates to the map of each province in *shp*.file. Then I computed the area of Thiessen Polygon as proxy of market boundary in meter squared. The maps of Thiessen Polygons are in Appendix D.

### 4.2 The Effect of Spatial Competition on Bank Profitability

I calculate the marginal cost for each bank-year observation and then compute the Lerner indices as in Eq. (23) and (24). The first derivatives of the cost function with respect to the outputs (i.e., the marginal costs) need to be non-negative in order for the cost function to be monotonically non-decreasing in the output quantities. In Table 1.2, I provide estimation of the effect of spatial competition and other factors on bank profitability using three models: Panzar and Rosse model, Lerner Index model, and Boone Indicator model.

The overall results show that the main variables, spatial competitions proxied by distance and boundary significantly affect profitability. The distance is negatively affect ROA, ROE, and NIM, on the other hand, the boundary positively affect profitability. These results arise interesting fact that closer a bank to its rival bank creates higher profitability in an area of wider market boundary. The results support previous study which concluded that distance matters in estimating bank profitability (Brevoort and Hannan, 2006; Mach and Wolken, 2008; Degl'Innocenti et al. 2017). However, the negative coefficient of distance in this study rejects the hypothesis that closer bank with rival bank will decrease profit because of higher competition.

Looking at the coefficient of Lerner index, in all proxies of profitability, the Lerner index is positive, which support the theory that the banks have mark-up price. The Lerner index is defined as the relative markup of an output price over the associated marginal cost. The results support some previous studies (Maudos and de Guevara, 2004; Claeys & Vennet, 2008; Mirzaei et al. 2013) that found a positive effect of bank market power on bank profitability using the Lerner Index. The result of Boone Indicator also supports the hypothesis. The results are similar with previous studies (Boone and van Leuvensteijn, 2010; van Leuvensteijn et al., 2011). The Boone indicator shows significantly negative value which consistent with the industrial organisation literature that this value is expected to be negative (as more efficient, less marginal cost). The concentration index, HHI, is significant when estimated with ROA as profitability proxy. However, the value is negative that means increased market concentration is not expected to reduce competition in banking. In case of rural banking in Indonesia, the larger the HHI, the

less profitable is the bank. The results contrast with Cetorelli and Strahan (2006) and Bikker and Haaf (2002).

The effect of bank-specific characteristics on bank profitability in these three model mostly support the hypothesis. Size positively affects profitability (ROA and ROE) and significant in all models. This result is same with a study by Smirlock (1985) which found a positive and significant relationship between size and bank profitability. Capital also affects the profitability positively and significantly in all models. In case of rural banks in Indonesia, a lower equity ratio was not associated with higher profit. The lending, proxied by ratio of loan to assets, shows positive in ROE and NIM. This implies a larger share of loans to total assets should imply more interest revenue. Bank diversification is also significantly influence bank profitability in all models. The negative signs mean it negatively impacts bank profitability because the more diversified banks trigger banks to set lower margins. The liquidity, proxied by loan to deposits is not significant in all models.

The macroeconomic variables, GDP and Inflation affect bank profitability positively and significantly in all models. This is no doubt since many previous studies (e.g. Bourke, 1989; Molyneux & Thornton, 1992; Athanasoglou et al., 2006; Pasiouras & Kosmidou, 2007; Claessens et al., 2001; Schwaiger & Liebig, 2008) have also shown a positive and significant relationship between inflation and/or GDP and profitability.

**Table 1.2 The Effect of Spatial Competition on Bank Profitability**

This table presents the regression estimates of the effect of spatial competition on bank profitability (ROA, ROE, and NIM). Column (1) employs Panzar and Rosse models, (2) Lerner Index model, and (3) Boone Indicator ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Numbers in parentheses are t-statistics.

| | Dependent Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ROA | ROE | NIM | ROA | ROE | NIM | ROA | ROE | NIM |
| Independent Variable | | (1) | | | (2) | | | (3) | |
| Cons | -0.107*** | -0.934*** | 0.183*** | -0.511*** | -1.261*** | 0.390*** | -0.384*** | -1.069*** | 0.379*** |
| | (-3.84) | (4.63) | (11.21) | (-21.93) | (-7.3) | (22.53) | (-17.49) | (-6.09) | (22.75) |
| W1 | -0.787*** | -9.21*** | 0.299*** | | | | | | |
| | (-36.87) | (-4.94) | (29.55) | | | | | | |
| W2 | 0.004 | 0.007 | -0.019*** | | | | | | |
| | (0.92) | (0.17) | (-10.01) | | | | | | |
| W3 | 0.055*** | 0.147 | 0.030*** | | | | | | |
| | (3.55) | (0.97) | (4.38) | | | | | | |
| Distance | -0.002** | -0.011* | -0.002*** | -0.002** | -0.011* | -0.001** | -0.002*** | -0.011* | -0.001** |
| | (-1.96) | (-1.89) | (-3.72) | (-2.16) | (-1.78) | (-2.25) | (-2.58) | (-1.87) | (-2.50) |
| Boundary | 0.003*** | 0.009* | 0.003*** | 0.002** | 0.006 | 0.003*** | 0.002*** | 0.006 | 0.003*** |
| | (4.37) | (1.93) | (6.05) | (2.34) | (1.33) | (4.59) | (2.57) | (1.43) | (5.11) |
| Lerner | | | | 0.002*** | 0.012*** | 0.0004*** | | | |
| | | | | (27.91) | (13.98) | (14.21) | | | |
| Boone | | | | | | | -0.081*** | -0.189*** | -0.0013** |
| | | | | | | | (54.77) | (-9.58) | (-2.02) |
| HHI | -3.5e-06* | 1.6e-06 | 1.9e-06 | -6.5e-06*** | 1.2e-06 | 3.9e-06*** | -5.6e-06*** | 2.7e-06 | -3.8e-06*** |
| | (-1.68) | (0.12) | (1.46) | (3.26) | (0.09) | (2.59) | (-3.04) | (0.20) | (2.59) |
| Size | 0.006*** | 0.044*** | -0.010*** | 0.029*** | 0.066*** | -0.021*** | 0.022*** | 0.052*** | -0.021*** |
| | (4.53) | (4.56) | (-13.05) | (26.70) | (8.23) | (28.39) | (21.14) | (6.39) | (28.34) |
| Capital | 0.349*** | 0.109** | 0.106*** | 0.309*** | -0.002 | 0.106*** | 0.272*** | -0.004 | 0.109*** |
| | (57.52) | (1.97) | (37.76) | (50.86) | (-0.04) | (36.84) | (47.28) | (-0.08) | (37.23) |
| Lending | -0.017*** | 0.455*** | 0.083*** | -0.055*** | 0.395*** | 0.093*** | -0.015*** | 0.501*** | 0.095*** |
| | (-3.28) | (7.86) | (36.18) | (-10.49) | (7.06) | (41.06) | (-3.08) | (8.82) | (41.34) |

**Table 1.2 The Effect of Spatial Competition on Bank Profitability (*continued*)**

| | Dependent Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ROA | ROE | NIM | ROA | ROE | NIM | ROA | ROE | NIM |
| Independent Variable | | (1) | | | (2) | | | (3) | |
| Diversification | -0.022*** | -0.551*** | -0.098*** | -0.042*** | -0.529*** | -0.088*** | -0.022*** | -0.515*** | -0.089*** |
| | (-4.34) | (-9.33) | (-45.79) | (8.29) | (-9.10) | (41.74) | (-4.47) | (-8.77) | (-41.46) |
| Liquidity | -0.00002 | -0.0001 | 3.68e-06 | -0.00002 | -0.00003 | 5.6e-06 | -0.00002 | -0.00003 | 5.2e-06 |
| | (-1.59) | (-0.39) | (0.70) | (-1.58) | (-0.20) | (1.09) | (-1.34) | (-0.24) | (0.98) |
| GDP | 0.0006** | 0.004 | 0.0002** | 0.0008*** | 0.004 | 0.0002* | 0.0012*** | 0.005 | 0.0002* |
| | (2.25) | (1.11) | (2.02) | (3.0) | (1.34) | (1.76) | (4.85) | (1.49) | (1.70) |
| Inflation | 0.0002*** | -0.0006 | 0.0001*** | 0.0006*** | 0.001 | 0.0001*** | 0.002*** | 0.003*** | 0.0001*** |
| | (2.73) | (-0.48) | (3.90) | (6.84) | (0.90) | (3.42) | (22.39) | (2.75) | (2.67) |
| R-sq | | | | | | | | | |
| Within | 0.285 | 0.009 | 0.306 | 0.224 | 0.018 | 0.298 | 0.313 | 0.013 | 0.289 |
| Between | 0.212 | 0.116 | 0.576 | 0.303 | 0.084 | 0.380 | 0.354 | 0.117 | 0.374 |
| Overall | 0.173 | 0.035 | 0.544 | 0.211 | 0.050 | 0.367 | 0.286 | 0.040 | 0.361 |
| Number of obs | 15,773 | 15,773 | 15,773 | 15,773 | 15,773 | 15,773 | 15,773 | 15,773 | 15,773 |

### 4.3 The Effect of Spatial Competition on Bank Efficiency

The cost efficiency is measured by SFA using parametric approach. For the assessment of banks' efficiency, I estimated the cost frontier using a translog function. The average of cost efficiency in sample is 82.52%, with minimum of 77.23% and maximum 85.99%. This study uses Battese and Coelli (1995) model. The result of estimation of the effect of spatial competition on bank efficiency is shown in Table 1.3.

**Table 1.3. Stochastic Frontier Model**

This table presents SFA regression estimates of the effect of spatial competition on bank efficiency using cost efficiency estimation. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Numbers in parentheses are t-statistics.

| Dependent Variable | Coef. |
|---|---|
| $ln\frac{TC}{P_3}$ | |
| Independent Variable | |
| $cons$ | -1.9691*** |
| | (-3.09) |
| $ln(Q_1)$ | 0.8018*** |
| | (6.48) |
| $ln(Q_2)$ | 0.5467*** |
| | (6.90) |
| $ln(Q_3)$ | 0.0261 |
| | (0.47) |
| $ln(N_1)$ | 0.6212* |
| | (1.82) |
| $ln(N_2)$ | -2.7707*** |
| | (-6.74) |
| $ln\left(\frac{P_1}{P_3}\right)$ | 1.3019*** |
| | (8.54) |
| $ln\left(\frac{P_2}{P_3}\right)$ | -0.0937 |
| | (-0.66) |
| $\frac{1}{2}[ln(Q_1)]^2$ | 0.1100*** |
| | (5.72) |
| $ln(Q_1)ln(Q_2)$ | -0.1365*** |
| | (-13.91) |
| $ln(Q_1)ln(Q_3)$ | -0.0099 |
| | (-1.46) |
| $\frac{1}{2}[ln(Q_2)]^2$ | 0.0698*** |
| | (17.46) |
| $ln(Q_2)ln(Q_3)$ | 0.0089** |
| | (2.07) |
| $\frac{1}{2}[ln(Q_3)]^2$ | -0.0007 |
| | (-0.20) |
| $\frac{1}{2}[ln(N_1)]^2$ | -5.4167*** |
| | (-2.75) |
| $ln(N_1)ln(N_2)$ | 2.8838*** |
| | (3.08) |

| | |
|---|---|
| $\frac{1}{2}[ln(N_2)]^2$ | 6.5837*** |
| | (3.74) |
| $\frac{1}{2}\left[ln\left(\frac{P_1}{P_3}\right)\right]^2$ | 0.1803*** |
| | (5.74) |
| $ln\left(\frac{P_1}{P_3}\right) ln\left(\frac{P_2}{P_3}\right)$ | -0.1231*** |
| | (-4.48) |
| $\frac{1}{2}\left[ln\left(\frac{P_2}{P_3}\right)\right]^2$ | 0.0391 |
| | (1.28) |
| $ln(Q_1)ln\left(\frac{P_1}{P_3}\right)$ | -0.0098 |
| | (-0.53) |
| $ln(Q_1)ln\left(\frac{P_2}{P_3}\right)$ | 0.0474** |
| | (2.51) |
| $ln(Q_2)ln\left(\frac{P_1}{P_3}\right)$ | -0.0630*** |
| | (-5.70) |
| $ln(Q_2)ln\left(\frac{P_2}{P_3}\right)$ | 0.0146 |
| | (1.21) |
| $ln(Q_3)ln\left(\frac{P_1}{P_3}\right)$ | -0.0089 |
| | (-1.01) |
| $ln(Q_3)ln\left(\frac{P_2}{P_3}\right)$ | 0.0184** |
| | (1.96) |
| $ln(N_1)ln\left(\frac{P_1}{P_3}\right)$ | 0.0049 |
| | (0.40) |
| $ln(N_1)ln\left(\frac{P_2}{P_3}\right)$ | -0.0607*** |
| | (-4.71) |
| $ln(N_2)ln\left(\frac{P_1}{P_3}\right)$ | 0.0436*** |
| | (3.03) |
| $ln(N_2)ln\left(\frac{P_2}{P_3}\right)$ | -0.0165 |
| | (-1.13) |
| $ln(N_1)ln(Q_1)$ | -0.0155 |
| | (-1.61) |
| $ln(N_1)ln(Q_2)$ | 0.0157*** |
| | (3.40) |
| $ln(N_1)ln(Q_3)$ | 0.0035 |
| | (0.81) |
| $ln(N_2)ln(Q_1)$ | 0.0313*** |
| | (2.69) |
| $ln(N_2)ln(Q_2)$ | 0.0363*** |
| | (5.38) |
| $ln(N_2)ln(Q_3)$ | -0.0028 |
| | (-0.55) |
| mu | |
| cons | 0.6542*** |
| | (14.91) |
| Distance | -0.0007 |
| | (-0.20) |
| Boundary | -0.0053* |
| | (-1.91) |
| HHI | -0.00002** |
| | (-2.33) |

| | |
|---|---|
| GDP | 0.0104*** |
| | (3.63) |
| Inflation | 0.0533*** |
| | (45.07) |

The coefficient of distance and boundary are negative. The negative coefficient of the exogenous variable in the regression indicates that banks with larger values of the variables tend to have a lower level of inefficiency (they are more efficient). It means that distance and boundary have positive effect to bank efficiency. The positive impact of competition on efficiency is also supported by Chen (2007) and Dick and Lehnert (2010).

## 5. Conclusion

In this paper, I analyse the importance of physical distance between banks to their nearest rival bank and the area or market boundary as proxy of spatial competition. I estimate the effect of spatial competition, together with bank-specific characteristics, industry-specific characteristics, and macroeconomic variables on bank performance measured by profitability and efficiency. The competition models used in this study are Panzar and Rosse model, Lerner Index model, and Boone Indicator model. To measure the cost efficiency of banks, I use Stochastic Frontier Analysis (SFA).

This study first examines relevance of spatial competition for the bank profitability using ROA, ROE, and NIM. Second, this study examines relevance of spatial competition for the bank efficiency. The results reveal that overall the distance of banks' to the nearest bank negatively impact profitability, but positively impact the efficiency. The area of market boundary, proxied by Thiessen Polygon of each bank has positive impact to bank profitability and efficiency. The Lerner index also shows that the rural banks have mark-up pricing in all models since the index positively affect the performance. The Boone indicator shows negative value, consistent with the industrial organisation literature that this value is expected to be negative. Overall, the findings show that spatial competition exists in rural banking in Indonesia.

**Glossary**

| | |
|---|---|
| ASEAN | Association of Southeast Asian Nations |
| BI | Bank Indonesia (Central bank of Indonesia) |
| BCBS | Basel Committee on Banking Supervision |
| BPR | Bank Perkreditan Rakyat – Rural Banks in Indonesian language, "People's Credit Bank" |
| BPS | Badan Pusat Statistik (The Indonesian Central Bureau of Statistics) |
| CEPII | Centre d'Etudes Prospectives et d'Informations Internationales |
| DEA | Data Envelopment Analysis |
| ESH | Efficient Structure Hypothesis |
| FSA | Financial Services Authority |
| GMM | Generalized Method of Moments |
| HHI | Herfindahl-Hirschman Index |
| IADI | International Association of Deposit Insurers |
| IDIC | Indonesia Deposit Insurance Corporation |
| LPS | Lembaga Penjamin Simpanan (Indonesia Deposit Insurance Corporation - IDIC) |
| MMR | Martinez-Miera and Repullo model |
| NEIO | New Empirical Industrial Organization |
| OJK | Otoritas Jasa Keuangan (Indonesia Financial Services Authority) |
| PRH | The Panzar and Rosse H-statistic |
| SCP | Structure Conduct Performance |
| SDEM | Spatial Durbin Error Model |
| SFA | Stochastic Frontier Approach |
| SME | Small Medium Enterprises |
| TBTF | Too Big To Fail Banks |

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