

## COMPETITION AND INNOVATION RELATIONSHIP: EMPIRICAL TEST ON INDONESIA BANKING INDUSTRY

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### Abstract

This study examined inverted-U relationship between competition and innovation on Indonesian banking industry. The pattern was an output of Schumpeterian and escape competition effect. Innovation level was not measured only specific to reflect a product innovation but rather to measure the overall enterprise's innovation level by using the concept of technology gap ratio. This method measured the utilized technical efficiency of the technology compared to the utilization of all the potential of existing technology. Banks with low technology gap ratio showed a trend of mergers, bankruptcy, or be acquired by others. It showed an increase of the technology gap ratio after implementation of Indonesian Banking Architecture. It also showed a significant relationship between competitions level, because of the increasing competitiveness of individual banks, with innovation level. The relationship was an inverted-U. So increasing competition initially stimulated more innovation, but at one point, increasing competition tends to limit innovating initiatives.

**Keywords:** Bank, innovation, technology, competition, inverted-U relationship.

### Introduction

Innovation is needed to make a company to keep pace of competition on an ongoing basis. According Michalopoulos, Laeven, and Levine (2009) continuous innovation will encourage endogenous growth which are derived from internal factors and not only follow fluctuation of external conditions. Endogenous growth theory believes that investments in innovation, human capital, and knowledge will have a significant effect on economic growth (Romer, 1994).

Innovation is an important factor for financial institutions, including banks. Innovation in the banking activities reduce both costs and risks in the banking system. Innovation in the banking sector ensures bank can meet consumer needs and always improve service quality delivered to consumers and have a positive impact on the economy of the country (Levine, 1997). Innovation in banking, according to Frame and White (2004) consist of three forms. Firstly, new products (e.g. automated teller machines, or ATMs, credit cards, debit cards, adjustable-rate mortgage). Secondly the new production process (e.g. electronic payments, record keeping, automated credit scoring models, loan securitization) and, thirdly a new organizational forms (diversified bank structure, business mix of traditional financial services and non-traditional services). Many believe that an innovative banks will be able to increase the amount of credit to customer and to optimize the existing bank input and to offer better services. (Bos, Kolari, and Van Lamoen, 2013).

Previous research of banking innovation were focused on only one form of banking innovations, rather examine overall innovation level. For the example, Hannan and McDowell (1984) focused on the adaptation of ATMs, Courchane, Nickerson, and Sullivan (2002) studied the internet banking, Mantel and McHugh (2001) studied electronic payment, and Akhavein, Frame, and White (2005) examined small business credit scoring practices. Innovation on one product alone cannot reflect the level of innovation for overall bank. Bos *et al.* (2013) formulated the use of technology gap ratio to measure how much the company has used the potential of existing technology. The greater the level of bank technology utilization then lower bank efficiency gap. If the bank technology utilization is low, banks will have high efficiency gap. Technology utilization can be boost by increasing bank internal resources quality through innovation and education. With the innovation, technical efficiency will increase, reduce efficiency gap and improve technology utilization rates.

One example in Indonesia bank that supports this statement is automated credit scoring innovation. This innovation helps bank to shorten the time of the consumer credit selection and be able to set the optimal credit limit, down payment, and interest rate. It can also help banks in providing more specific debt restructuring for specific customer. This concept has been applied by some banks like BCA so that it succeed to increase the credit growth.

Several studies on banking innovations show competition has a significant influence on bank inno-

vation level. Many believe that competition and innovation relationship are an output from schumpeterian effect and escaped competition effect. Based on Schumpeter (1942), too high market competition reduce incentive to make innovations because competition reduces monopoly rents that is a direct incentive for bank to launched innovation program. Schumpeter (1942) introduced theory of a negative relationship between competition and innovation which is usually called as "Schumpeterian Effect". Stand at opposite position, Aghion, Harris, Howitt, and Vickers (2001) argue that competition has a positive relationship with innovation called as "Escape Competition Effect" which said that the company will try to create more innovation to win the competition. The opposing opinions regarding the relationship between competition and banking innovations come further that many believe the relationship is an inverted-U type which increasing competition initially drives more innovation but, at one point, higher competition level lead innovation to lower pace and finally hamper innovative initiatives. In the United States, Bos *et al.* (2013) find inverted-U relationship between bank competitiveness and innovation based on 1993-2004 data which is similar to Aghion and Griffith (2005) who studied UK banking industry.

Bos *et al.* (2013) also examined the effect of Riegle Neal Act to the US Banking Industry. Riegle Neal Act eliminate merger restrictions, lift entry barrier and encourages creation of new bank. In Indonesia, regulator launched the Indonesian Banking Architecture policy in 2004 which has different spirit from Riegle Neal Act. The Indonesian Banking Architecture policy has clear objectives: downsize number of banks through minimum bank capital regulation that hopefully would induce merger and acquisition among existing banks.

Our study on the relationship of competition and innovation based on Indonesia banking industry data has a significant contribution. Firstly, this study examines bank's ability and willingness to compete with innovation in an emerging market which has a unique type of competition and industry structure that drive to non-price competition. Secondly, this study also provides a new reference in the measurement methodology of bank overall innovation parameter based on technology gap ratio concept. Thirdly, this research reveals the empirical findings related to the theory of inverted-U relationship between competition and innovation. This findings will be very useful as the basis for the Indonesian banking policy and managerial strategy. Furthermore, this study examines the results after implementation of the Indonesian Banking Architecture policy both at the level of

competition and bank technology gap ratio. Policy analysis can be carried out further to provide input for policy makers considering the future direction of the policy.

The structure of the paper is as follows: section 2 discusses literature review of the basic theory and previous research on technology gap ratio, the level of competition, inverted-U relationship and the Indonesian Banking Architecture policy. Section 3 discusses the data, methodology, and empirical model, section 4 discusses the findings and analyze the behavior pattern of innovation and competition relationship whether there are inverted-U relationship, and the changes that occur after the Indonesian Banking Architecture policy implementation. Then, section 5 discusses conclusions and suggestions for further research.

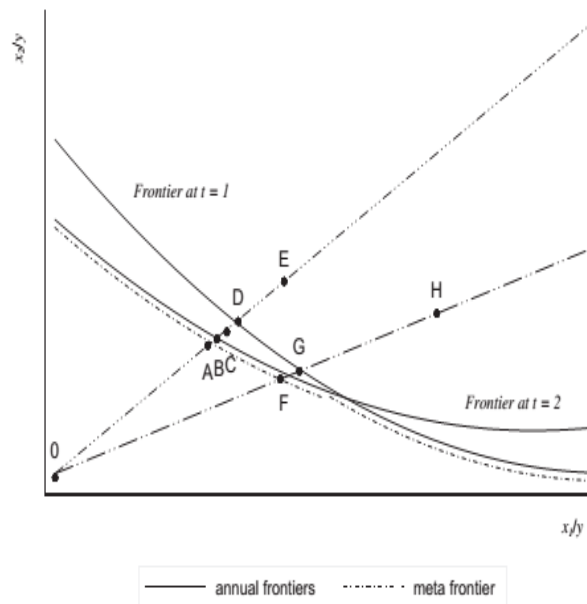
### *Technology Gap Ratio and Degree of Competitiveness*

We use technological gap ratio as an innovation level measurement that accurately reflects bank's overall innovation capacity. Previous studies measured bank innovation level by using traditional measurements such as the number of patents, research and development costs. Some experts criticized application of these traditional innovation level in banking research because this traditional measurement do not correspond to the financial sector, especially banking sector (Frame & White, 2004).

This relatively new innovation measurement come up because not all patented innovations in banking and research and development costs can be interpreted as bank innovative initiatives. Traditional innovation measures potentially produce a bias indication of bank innovation level. Bos *et al.* (2013) argue that the technology gap ratio is better measurement for bank's overall innovation level. Based on studies of Hayami and Ruttan (1970), Mundlak and Hellinghausen (1982), Lau and Yotopoulos (1989) proposed a method to calculate a minimum annual global cost frontier. This frontier represents the maximum potential capability of existing technology. The distance between a bank's real positions with global technology frontier is a gap which should decrease if the bank are able to fully use its innovative capacity.

Figure 1 illustrates the basic concept of the technology gap ratio with a simple example, the cost minimization of two production inputs ( $X_1$ ,  $X_2$ ) to create an output ( $Y$ ). In this illustration, there are two annual frontier at time  $t = 1$  and  $t = 2$ . Each frontier represents the minimum cost curve at a particular

output level for each year. The dashed line represents the minimum frontier in the whole period or may be called meta-frontier.



**Figure 1. Technology gap ratio**

Source: Bos *et al.*, 2013

Bank technology gap ratio in the given period reflects level of technology that has been used by a bank relative to the available potential technology which has value between 0 to 1 (Battase & Rao, 2002). At period  $t = 1$ , bank 1 has the technology gap  $OA / OD$  and  $OA / OB$  at  $t = 2$ . This means that the bank were able to increase its technology usage level. Similarly, for bank 2, at period  $t = 1$ , bank 2 has a technology gap  $OA / OG$  and  $OA / OF$  at  $t = 2$ . According to Farrell (1957), an efficiency ratio like bank 1 and bank 2 achieve is basically a technical efficiency. The ratio is simply a comparison between existing positions of a bank with its isoquant. Isoquant is an optimum combination of inputs to produce a given level of output.

The use of technical efficiency as innovation level is based on stylized facts that banking innovations such as the effective selection of loan customer and efficient of loan monitoring would be able to increase quantity and quality of banking services. Banks that can optimize the use of technology and invest appropriately in the internal resources and human capital through innovation will be able to optimize the input combinations.

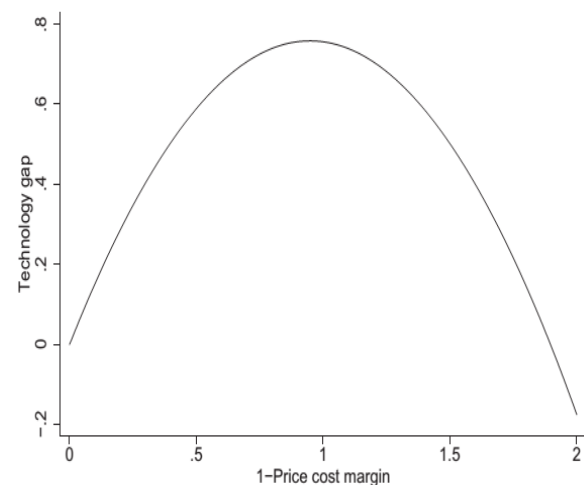
Viverita and Ariff (2011) show that the average technical efficiency of 18 Indonesia banks are 0.979. The study also states that the gap of 2.1 percent indicates a weakness of bank top management to opti-

mize existing resources or to invest in new technologies.

Research on Indonesia banking competition has been widely studied. But research on Indonesian banking competition is more focused at industry level rather than on firm-level. Calculation of banking industry competition level usually used Panzar-Rosse H-statistics. Widyastuti and Armanto (2013) shows for a period of six years, from 2001 to 2006, most banks are in a monopoly or collusive oligopoly type of competition. Our study will examine whether the Indonesian banking architecture policy changes Indonesia banking competition level based on comparative H statistics.

In calculating the degree of competitiveness for firm-specific level, Bos *et al.* (2013) used firm market power. According to Lerner (1938) market power is a company's ability to set prices above its marginal cost. Aghion, Bloom, Blundell, Griffith, and Howitt (2005) states the level of banking competition are inversely related to average value of individual bank market power. If a bank can set price above its marginal cost, it indicates low banking competition level that because it has a monopoly power to implement that action.

The inverted-U relationship between competition and innovation was found by Aghion *et al.* (2005) in the UK banking industry. Bos *et al.* (2013) also proved the existence of an inverted-U relationship banking in the United States.



**Figure 2. An inverted-U relationship between banking competition and innovation**

Source: Bos *et al.*, 2013.

### Indonesia Banking Policy

Bank Indonesia as monetary authority has undergone an evolution of policies. Since 1980s, the

Indonesian banking policy began with policy deregulation that drive to banking liberalization, re-regulation, and consolidation. Banking deregulation gave the ease in terms of the amount of capital to boost domestic economy. But the Asian crisis in 1998 caused so severe damage to Indonesia banks that drive the authority launched more tight policy further, strengthening the bank capital structure, and urged more strong banking industry structure through implementing Indonesian Banking architecture policy.

Indonesian Banking Architecture (IBA) policy is a framework of the Indonesian banking system road map that provide a comprehensive direction to all banking industry stakeholders about the shape, conduct, and structure of the Indonesia banking industry. IBA implementation period is about for 5–10 years after launched in 2004. The aim of IBA policy is to build a healthy, efficient, strong banking system in order to create a stable financial system that is crucial to boost economic growth. To achieve these objectives, there are six pillars of programs were planned, e.g. strengthening the national banking structure, improving the quality of banking regulation, increase monitoring functions, improving the quality of management and banking operations, develop of banking infrastructure, and increase customer protection.

## Research Method

### Data

This study uses all Indonesia banks data which its financial report can be obtained and operated in the period of 2001–2011. We includes all banks that were closed, merged or acquired by other bank during the observation period. Bank's monthly financial reports were obtained from the Bank Indonesia website.

### Technology Gap Ratio Estimation Method

Innovation generates increasing quality of banking techniques and technology. Changes in technical quality is measured by how much technology set has been used by bank compared to the available potential of existing technology. Innovation improve bank capability to decrease the technology gap.

$$TGR_{it} = \frac{f_{metafrontier}(y_{it}, w_{it}, z_{it})}{f(y_{it}, w_{it}, z_{it})} \quad (1)$$

Increasing quality of technology makes bank become more efficient in using combination of inputs and are able to utilize and produce the most optimal output. The technology gap ratio is measured by opti-

mizing the production frontier models. The equation of this model are as follows:

$$y_{it} = f * (w_{it}, z_{it}; \beta) TE_{it} \quad (2)$$

$$Y_{it} = X_{it}\beta + m_{it} + (V_{it} - U_{it}) \quad (3)$$

$$m_{it} = z_{it}\delta$$

Where  $y$  is bank output in the form of bank loan and services,  $w$  is bank input in the form of fixed assets, labor, and  $z$  is bank equity ratio which reflects bank risk profile. This specifications follows the input output-based approach

Technology gap is estimated using the technical efficiency gap with Stochastic Frontier Approach. This estimates is calculated using Frontier 4.1 software to get the value of technical efficiency. How bank has optimally utilized available technology is reflected in technical efficiency estimates. Technology gap ratio according to Bos and Schmiedel (2007) will be in a range from 0 to 1.

We choose stochastic frontier approach as a parametric approach because the weakness of non-parametric approaches such as the DEA that does not take into account random error on the frontier. Non-parametric approaches such as DEA cannot take into account differences in data such as price differences between regions, differences in regulations, quality of data, and extreme value. Non-parametric approach can only be used to measure general inefficiency (Hadad, Santoso, Ilyas, & Mardanugraha, 2003).

### Competition Level Estimation Method

To calculate banking competition level, first we measure each bank's degree of competitiveness. Aghion and Griffith (2005) states that bank's ability to compete can be measured by bank price-cost margin, adapted from Lerner index concept. Following Aghion and Griffith (2005) and Bos *et al.* (2013) argue banking competition level as follows:

$$C_{it} = 1 - \text{price cost margin} \quad (4)$$

$$C_{it} = 1 - \left( \frac{\pi_{it} + F_{it}}{R_{it}} \right) \quad (5)$$

Where  $\pi$  is net income (after tax and extraordinary item),  $F$  is fixed cost which reflected by depreciation expense and leasing expense (expense of fixed asset) and cost of fund, and  $R$  is total revenue (total interest income and non-interest income). Banking industry competition level is a weighted average of all individual bank's  $C_{it}$ . The weight is each bank's total asset to total asset of banking industry.

### Empirical Model

This study uses empirical model which refers to a model of the competition and innovation relationship proposed by Bos *et al.* (2013). After estimating value of technology gap ratio and banking competition level, we test the hypothesis and try to find whether competition on innovation relationship are better described by the inverted-U curve or the linear model. Empirical model is as follows:

$$TGR_{it} = \beta_1 C_{it} + \beta_2 C_{it}^2 + \alpha_{it} + \varepsilon_{it} \quad (6)$$

Where  $TGR$  is estimated technology gap ratio and  $C_{it}$  is banking competition level at given period. We use quadratic value of competition level ( $C_{it}^2$ ) to test whether there are an inverted-U relationship between competition and innovation (Aghion *et al.*, 2005). We hypothesize that  $\beta_2$  is negative and statistically significant.

We also analyzed the differences of technology gap ratio before and after implementation of the Indonesian Banking Architecture. Model (7) and (8) test Indonesian Banking Architecture effect on technology gap ratio using a dummy variable ( $D$ ). For 2001–2003 period, the value of the dummy is 0 because the Indonesian Banking Architecture policy had not been implemented yet. In 2004–2011 period, dummy variable value is 1 because it is a period of the Indonesian Banking Architecture implementation. Model (7) explains the difference in the value of technology gap ratio and models (8) explain the difference variable value of competition.

$$TGR_{it} = \alpha D_t + \varepsilon_{it} \quad (7)$$

$$C_{it} = \alpha D_t + \varepsilon_{it} \quad (8)$$

## Results and Discussions

### Technology Gap Ratio and Degree of Competitiveness

The average value of Indonesia bank technology gap ratio approached 1 (0.903759) means that Indonesia bank, on average, were capable enough to capitalize the potential of existing technologies. Even though there were still inefficiency gap amounted to 0.096241 that show potential gap that can be bettered through financial innovation. Indonesia banking industry technology gap ratio dispersion is so high, that there were still a lot of banks have score far below industry average. If a bank has a lower technology gap ratio than the industry average, it is a strong indication that the bank fails to exploit the available potential technology. There were 20 banks that have the lowest value ratio lower technology gap (see Table 2). All banks that were classified as having a low

ratio technology gap were proved as unable to compete, whether they stopped their operations, acquired by other bank, or merged with other banks.

All closed banks in the period 2001–2011 were also in the 25 banks that have the lowest technology gap ratio. This stylized fact shows the important influence of innovation in the banking business. This fact also supports Frame and White (2004) that states financial innovation led to a cost and risk reduction in the banking system. These findings suggest that a low level of financial innovation does causes a lot of bank liquidation and merger which indicates those banks' level of costs and risks were high enough to become acquisition targets or forced merger with another bank to survive the competition.

Indonesia banking industry competition level, which is reflected by bank price-cost margins are presented in Table 2. Bank price cost margin shows bank's ability to compete (*monopoly power*). Aghion and Griffith (2005) states the level of banking competition are inversely related to average value of individual bank market power. If a bank can set price above its marginal cost, it indicates low banking competition level that because it has a monopoly power to implement that action.

Table 2 shows the average level of Indonesia banking competition, since 2001 to 2011 period, is 0.826897. The result indicates the average level of competition to be faced by individual bank in Indonesia is relatively low. Indonesia banking industry competition tend to be a monopolistic competition type which each bank have their own market segment so they have a relatively high market power in their specific market segment. Indonesia banks competition is not a price-competition but resemble a non-price competition where banks applied a focus strategy to serve their focused market segment optimally the results are affected by high Indonesia banking industry performance fluctuation. Indonesia banking performance in 2008 was very bad due to a large loss.

Previous studies show the existence of inverted-U relationship between banking competition level and technology gap ratio. Table 3 presents empirical test on Indonesia banking industry that are similar with previous one in other countries. Because square of the banking competition level is statistically significant and has a negative sign, it can be concluded that the banking competition level and bank innovation level relationship is an inverted-U relationship. Bos *et al.* (2013) also proves the existence of an inverted-U relationship between technology gap ratio and the US banking competition level. It is also consistent with the results of research Aghion *et al.* (2005) who also found inverted-U relationship is in the UK banking industry.

### *Differences between Pre and Post-Implementation of Indonesian Banking Architecture Policy*

Table 4 show that the value of dummy variables are statistically significant in both model (7) and (8), so it indicates the Indonesian Banking Architecture had a significant influence to competition level and innovation level. The findings are interesting because dummy variables has different sign. After the Indonesian Banking Architecture policy implementation, the technology gap ratio increased while the level of competition declines. It is also supported by the description of statistics before and after the period of the IBA policy implementation shown in Table 2.

Increasing technology gap ratio basically is one of Indonesia Banking Architecture objectives. Indonesian Banking Architecture policy has some objectives, such as providing guideline for future ideal banking structure, improving the quality of management and banking operations, improving banking infrastructure that would yield a better technical efficiency and would be achieved through creating financial innovation.

These results are in line with Mantel and McHugh (2001) study which shows the private sector will strive to meet the customer satisfaction and safety following government regulatory intervention.

**Table 1**  
**List of 20 Bank with Low Technology Gap Ratio**

Bank	Technology gap ratio	Latest Bank Condition
Bank Societe Generale Indonesia.	0.6782	Closed, 25 April 2003
PT Bank Patriot	0.7400	Merged with Bank Permata, 30 September 2002
PT Bank Alfindo Sejahtera	0.792912	Change Company Name, as PT National Nobu Bank, 2007
PT Bank Merincorp	0.794346	Closed, 7 Agustus 2003
PT Bank Maybank Indocorp	0.804703	Acquired by Bank Internasional Indonesia
PT Bank Asiatic	0.818215	Closed, pada 8 April 2004
Prima Express Bank	0.819708	Merged with Bank Permata 30 September 2002
PT Bank Swaguna	0.821453	Acquired by Bank Victoria
PT Bank Purba Danarta	0.828243	Merger, 2004
PT ING Indonesia Bank	0.832694	Closed, 6 Oktober 2004
Keppel Tat Lee Buana B	0.836019	Merged with OCBC Bank 28 Februari 2003
PT Liman International Bank	0.840855	Acquired by Nio Yantony (individual Investor) in 2012 and became Bank Dinar Indonesia
PT Bank Artamedia	0.843409	Merged with Bank Permata 30 September 2002
PT Bank Syariah Mandiri, Tbk	0.850419	Still operate
PT Bank Bisnis Internasional	0.854037	Merged
PT Bank Metro Ekspres	0.854626	Merged
PT Bank Universal	0.855411	Merged with Bank Permata 30 September 2002
PT Bank Persyarikatan Indonesia	0.861129	Became Bank Syariah Bukopin 2008
PT Global Intl Bank	0.863788	Closed 13 Januari 2005
PT Bank Pikko	0.863895	Merged with Bank Century 6 Desember 2004

Source: Bank Indonesia, 2004.

**Table 2**  
**Descriptive Statistics**

	Observation	Average	Std. Deviation	Maximum	Minimum
2001–2011					
Technology gap ratio	1313	0.903759	0.084521	0.997814	0.396693
Competition	1313	0.826897	0.184986	1.675944	-0.108576
2001–2003					
Technology gap ratio	415	0.845840	0.070188	0.951082	0.421907
Competition	415	0.862143	0.197668	1.628283	-0.108576
2004–2011					
Technology gap ratio	898	0.930525	0.076851	0.997814	0.396693
Competition	898	0.810608	0.197668	1.675944	-0.080117

**Table 3**  
**Hypothesis Test on Competition and Technology Gap Ratio Relationship Result**

	OLS 2001–2011
constant	0.8864 (0.000)*
$C$	0.0572 (0.000)*
$C^2$	-0.0051 (0.0001)*
$F$ test	39.5244 (0.000)*
$R$ -squared	0.0569
Adjusted $R$ -Squared	0.0554
Sum squared residual	8.0287
Numb Observations	1313

Mantel and McHugh (2001) examined some issues related to consumer protection, whether banking competition has significant influences to innovations which give wider and more complete banking services to customer such as electronic payment including credit cards, debit cards, e-cash, and smart cards. Chava, Oetl, Subramanian, and Subramanian (2013) also examined how banking policy has important influences on banking competition level and how its impact play crucial role through micro channel innovation.

Declining Indonesia banking industry competition level was caused by increasing average banks market power which reflected in increasing price cost margins. The results of this study contradicts with Bos *et al.* (2013) that shows Riegle-Neal Act stimulated lower degree of bank competitiveness in United States banking industry. But implementation of Riegle-Neal Act reduced the number of US banks, same impact of the Indonesian Banking Architecture policy which tightening the amount of bank capital and reducing number of banks. Stiroh and Strahan (2003) said such a policy would make banks change its strategy focus from low unit profit-high volume

into a high profit-limited volume and raising the price cost margins to increase profitability

Our results that show declining Indonesia banking competition level is also consistent with the World Bank data which reported that average Indonesia banks interest spread after IBA implementation were higher than previous period. Interest spread which is the difference of the lending rate and deposit rate, in 2001–2003 period is 4.267% on average and rose to become a 5.775% in 2004–2011 period. Bank tendency to increase the price cost margins indicates an increase of individual bank market power and a decrease of banking industry competition level.

Our findings about declining Indonesia banking competition level is also in line with Widyastuti and Armanto (2013) who shows three years after the Indonesian Banking Architecture implement, the Indonesian banking market structure tend to mimic a collusive oligopoly market. Our results is more robust than Widyastuti and Armanto (2013) because our observation period is longer and we empirically test the differences between pre and post IBA period. Our result is also supported by a statement of Bos *et al.* (2013) that reduction in banking industry competition and the number of banks will lead to multimarket contact, each bank search its own market segment and play as if a monopoly in that specific market segment

### Conclusions and Implications

The study show the Indonesia banking competition level and bank innovation are better described in the form of an inverted-U shape curve. This study is consistent with the findings of Bos *et al.* (2013) and Aghion *et al.* (2001) who proves the existence of an inverted-U relationship between banking competition and the technology gap ratio in the United States and UK banking industry. This finding should be considered further as a reference for banking regulatory framework which should consider its impact on bank innovating capability and eagerness.

**Table 4**  
**Comparison of Pre and Post Indonesia Banking Architecture Policy Period**

	Technology Gap Ratio		Competition Level	
	OLS	GLS	OLS	GLS
Constant	0.845840 (0.000)*	0.852655 (0.000)*	0.880583 (0.000)*	0.870908 (0.000)*
Indonesia Banking Architecture (dummy variable)	0.084685 (0.000)*	0.088085 (0.0020)*	-0.061908 (0.0013)*	-0.046235 (0.0000)
$R$ -squared	0.217173	0.358480	0.007914	0.070243
Adjusted $R$ -squared	0.216576	0.357991	0.007158	0.069534
$F$ -test	363.6993 (0.000)*	7325847. (0.000)*	10.45850 (0.001251)*	99.0465 (0.000)*

Our study, using the parameters of a bank's overall innovation based on technology gap ratio concept, shows that increasing competition led to increasing levels of innovation, but until at a inflection point, more intense competition cause banks to reduce the activity of innovation and focus on finding specific market segments which can be served optimally. Estimated technology gap ratio in the Indonesian banking 2001–2011 period is 90.37% on average. This level is relatively high, which means Indonesian banks have sufficiently utilize the available technology. Even so the efficiency gap amounted to 0.096241 shows there were still the gap that can be explored through financial innovation.

This study also found evidence that the lowest technology gap ratio banks during observation period (25 banks) had stopped its operation (liquidated, merged, or acquired). This evidence gives a strong highlight to innovation capability as an important tool to survive in banking industry.

On average in observation period, the individual banks' degree of competitiveness in Indonesia banking industry is 0.8268 which indicates level of competition faced by Indonesia banks is relatively low because many banks has a significant market power to set price above their marginal cost. Indonesia banking industry competition tend to be a monopolistic competition type which each bank have their own market segment so they have a relatively high market power in their specific market segment. Indonesia banks competition is not a price competition but resemble a non-price competition

Indonesia Banking Architecture policy has an opposite effect to innovation and banking industry competition. IBA policy which has objectives to improve quality of banking supervision, managerial and banking operational risk management, infrastructure development, and strengthening banking capital structure. Bank capital adequacy policy has driven a wave of merger and acquisition in Indonesia banking industry in recent decades. Strong capital has an imminent result that bank technology utilization increased. Technology gap ratio became narrower.

Indonesia banking restructurization driven by Indonesia Banking Architecture policy has a significant effect to Indonesia banking industry structure. Number of bank decreased and industry concentration increased where some banks held bigger percentage of market size and have huge market power. Small and medium banks has launched a smart focused strategy, they choose a captive market and serve it so optimally that they found themselves has a significant market power in those specific market segment. Overall Indonesia banks have a high market power on

average. Decreasing banking competition reflected in increasing Indonesia banks' price cost margins. Banks have an ability to set up high price above their marginal cost. This monopolistic competition indication is also supported by the increase in interest spread from 4.267% in previous IBA implementation period, while in 2004–2011 reached 5.775% (World Bank, 2013). The downward trend of the competition allegedly was caused by a multimarket contact (Widyastuti & Armanto, 2013; Bos *et al.*, 2013) rather than market collusion or oligopoly. However, the findings provide an important evidence and caution for policy makers to also keep forward the issue of consumer protection and improve supervision function.

Further research could explore the influence of specific financial innovation in banking industry such as certain new products, new banking processes in particular, or the type of business model and bank diversification strategy which expectedly influence the technology gap ratio. In addition, further research may examine the comparison results in the short-term dynamics observation e.g. by examining monthly data or to classify the effect of short-term issues to innovation decision and bank competition initiatives and strategy.

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