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Systemic Risk Contribution and Bank's Competitiveness

Buddi Wibowo[*]

Abstract

There are two competing views about bank's competitiveness and its systemic risk contribution: competition-stability and competition-fragility. Previous research shows mixed results. To test empirically the relationship, this research proposes a quadratic functional form that may reconciliate these two opposite views. Using marginal expected shortfall as individual bank's systemic risk contribution measurement and Lerner index as individual bank's competitiveness, this research find that the relationship resembles U-shape. In the first phase, competition creates prudent banking operation and low systemic risk contribution. But when competition become excessive, competition drive dominant bank to be a systematically important financial institution which may cause a serious systemic defaults and threat financial system stability.

Keywords: systemic risk, bank's competitiveness, marginal expected shortfall, market power, Lerner index.

I. INTRODUCTION

Recent crisis in US triggered by sub-mortgage bond and Asia economics turmoil in 1998 raise concern about a financial institution systemic risk contribution. A troubled bank may affect all existing banks because interconnected business transaction among them. Systemic risk become a challenging research topic in recent years (Brownlees & Engle, 2012). There are two views in academic literature which try to unveil impact of banking industry competition level to systemic risk. These two views have a sharp conflicting argument and contradiction: "competition-fragility" and "competition-stability". Competition-fragility view states higher bank competition level creates fragility in banking system. On the other hand, competition-stability view predicts competition builds more stable banking industry.

Controversy between two opposing views, "competition-fragility" and "competition-stability" may be solved referring to recent research like Martinez-Miera and Repullo (2010) which shows the relationship between competition and bank stability has a pattern that resembles inverse U-shape, which means that increased competition can initially improve banking system stability because competition will encourage banks to be more efficient and because there is no dominant bank in the credit market so that the selection of bank credit customers becomes more prudent. But, if the competition continues to increase at some level, excessive competition will cause what is predicted by the view of "competition-fragility" that banking system becomes more fragile. The relationship between competition and banking system stability is not linear and resembles quadratic function.

To test empirically two competing theoretical view ("competition-fragility" and "competition-stability"), we test the relationship of the bank's competitiveness and the bank contribution to systemic risk. I propose a hypothetical quadratic function to describe relationship between systemic risk and bank competition.

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The biggest challenge in systemic risk research is to determine the exact definition of systemic risk and how to measure it (Danielsson et al., 2016; Anginer et al., 2018). There are quite diversed systemic risk definitions and each definition produces a different measurement method

The most basic problem in systemic risk modeling is the availability of financial data of each bank and how we can measure the correlation of individual bank's financial condition with other banks is not always available to researchers who do not. Therefore, researchers build a systemic risk measurement model that fully uses market data which is can be obtained from stock market. Assuming financial markets are efficient, market data fully reflects the intrinsic condition of each bank. The systemic risk model in financial institutions that uses financial market data is the systemic expected shotfall proposed by Acharya (2009) where SES measures the contribution of each bank to systemic risk by observing the market price of each bank on the stock exchange and its correlation with the overall market.

II. LITERATURE REVIEW

How to measure systemic risk in the banking system and how the relationship between bank competition and banking system stability are the research topics which is still evolving until now. The lack of convergent and convincing empirical results has led to more research that tries to solve this research problem. The conventional view referred to as "competition-fragility view" states that increasingly tighter competition reduces bank market power in making profits and encourage banks to take greater risks in order to achieve higher profits. For example, Keeley (1990) shows that tighter competition driven by more restrictive regulation in the establishment of bank branches in several states in the United States has eroded bank profits and results in a wave of bankruptcy.

Finding of Keeley (1990) and some others, such as Anginer et al. (2018) and Goetz (2018) reinforce the view that when competition gets tighter and bank profit margins are depleted, banks will tend to take excessive risks to increase profits. Quality of loans given by banks deteriorate and increase its fragility. Hellmann et al. (2000) show that competition for deposits can also erode bank prudent operation. They observed the banking crisis in the United States and Japan and identified the banks that took excessive risks as the source of the crisis. According to them, the behavior of bank's risk taking become excessive driven by the liberalization of the banking sector, which is characterized by the elimination of barriers to entry, the elimination of the ceiling policy on deposit rates, and the ease of opening new bank branches. Increasing competition for deposits will erode bank profitability and encourage the emergence of large moral hazard to take large risks amid guaranteed deposits provided by the government.

The view of "competition-fragility" states that if a bank has considerable strength in the market, the bank's franchise value will increase because the price of bank shares in the stock market soars. Because franchise value reflects intangible capital which can only be maintained by the bank if the bank continues prudent operation and generates profits that meet investor expectations, the bank has large opportunity costs to be involved in high-risk business activities. Banks become more careful in lending, always maintain capital adequacy as existing banking regulation rules, or minimizing the high credit portfolio, and increase non-interest income and fee-based income. The bank is motivated to diversify its products so that bank is able to provide more complete and better products and services. The stability of the banking sector increase when competition between banks is limited by bank regulator.

More recent literature raises a different view from the traditional view. The new view relating to the relationship between competition and banking stability is referred to as "competition-stability view" which states that increasingly fiercer competition can actually increase the banking system stability. Jeon and Lim (2013) states that greater market power captured by a bank can create greater risk for banking system because dominant bank may set higher interest rates which more borrowers will not able to pay and increase borrower's moral hazard which may use the fund into riskier projects. High credit interest rates also create adverse selection in the bank lending process that bank customers who apply for credit are only those whose high risk because customers who have low risk tend to avoid high cost financing from banks and look for other funding sources. Banks that are too dominant in a banking system tend to take higher risks if the bank realizes that they will always be bailed out by the government because they have a serious systemic impact on the banking sector or even on the entire economy (too big too fail).

Marginal expected shortfall (MES), an extension of systemic expected shotfall, is the expected equity losses per dollar invested into the company if the overall market value falls by a certain size (often referred to as a "tail event" of the financial market). Brownlees and Engle (2012) offers a multi-step modeling approach based on GARCH time varying volatility models, dynamic conditional correlations (DCC) and non-parametric tail estimators.

The Lerner index measures the bank's competitiveness in the industry. The Lerner index measures the ability of a bank to sell its products always above its marginal cost. The marginal cost of each bank is obtained by estimating the cost function of each bank with three input factors which are labor costs, overhead costs, and cost of funds. According to Demirguc-Kunt and Peria (2010), Lerner index has advantages compared to Panzar-Rosse H-statistics, where the Lerner index is not a measure of competition in long-run equilibrium conditions such as Panzar Rosse H-statistics so that the Lerner index can be calculated in shorter observation periods.

III. RESEARCH METHODOLOGY

This research follow Acharya (2009) and Acharya et al. (2017) who set up a model with two periods that a bank has capital on the period 1 that comes from 3 sources: the risky debt of F_i, the guaranteed debt of G_i and initial capital W_i. The capital in period 1 invested in J-assets which has risks in sequence $X_{i1}, \ldots, X_{ij}$. Risky debt is valued at a discount rate of B_i and guaranteed debt is valued at par.

In the period 2, investment in J-assets yield returns of each $R_1, \ldots, R_j$ and debt is paid all its principal value. Because of bankruptcy fees and costs of capital shortage, additional costs will arise in the period 1. Therefore, the budget constraint appears in the period 1:

$$\mathbf{W_{i1} + F_{i1} + G_{i1} = \sum_{J=1}^{J} X_{iJ}} \quad (1)$$

A Bank in the period 1 must choose investment X and borrow F from the capital market. In the second period the net value of bank i is

$$\mathbf{W_{i2} = \sum_{J=1}^{J} X_{iJ} r_j - G_{i1} - F_{i1} - \emptyset_i} \quad (2)$$

Where:

$\emptyset_i$ is a cost of distress that will appear in the form of bankruptcy or failure to implement a business plan due to capital shortages.

If W_{i2} is negative, less than zero, bank is insolvent. If W_{i2} is positive, the company does not experience capital shortage and can function properly.

Capital shortages experienced by an individual bank may causes a severe impact on real economy if the troubled bank has close connection with other banks. The trouble is contagious and drifts all banks and other financial to same problem. Depositor will rush in all troubled banks and take all deposits out which rise huge cost in the form of government guarantees for deposits in the period 1 (G_{i1}).

The bankruptcy of an institution will spread to other institutions in the form of debt obligations that are not met. When most institutions in the system experience a lack of capital, the flow of funds into the business world and the economy in general will be disrupted or even stop altogether. Therefore, capital shortages not only endanger the companies concerned and their bondholders, but also threaten the financial system as a whole. How much capital shortage from each financial institution during the crisis period is a major concern in systemic risk modeling with MES.

Ratio between prudent asset value and equity is k, which refers to the commonly used capital adequacy ratio, that is CAR is 8% (Acharya, 2009). So, the capital buffer at the end of the period 1 is:

$$\mathbf{W_{i1} - k(B_iF_{i1} + G_{i1}W_{i1})} \quad \text{......} \quad (3)$$

If the capital buffer is negative so that the firm suffers capital shortage which causes an expected equity loss that occur in the next period.

The crisis period is when the stock market index falls below the threshold C, which we call "systemic event". The expected Capital Shortage of firm i (CS_{i1}) which occurs in the period 2 which is estimated in the period 1 is:

$$\begin{aligned} \mathbf{CS_{i1}} &= \mathbf{E_1(k(F_{i1} + G_{i1} + W_{i2}) - W_{i2} \mid Crisis)} \\ &= \mathbf{k(F_{i1} + G_{i1}) - (1 - k)(W_{i2} \mid Crisis)} \\ &= \mathbf{k(F_{i1} + G_{i1}) - (1 - k)W_{i1}E_1(R_{i2} \mid R_{m2} < C)} \\ &= \mathbf{k(F_{i1} + G_{i1}) - (1 - k)W_{i1}MES_{i1}} \quad \text{......} \quad (4) \end{aligned}$$

Where:

R_{i2} and R_{m2} are firm i's return and market return in the period 2.

MES is marginal expected shortfall, that is, a tail expectation of return obtained by the company if the market is on its left tail.

A large capital shortfall in the financial system causes a financial crisis. Bank that experiences the greatest decline in capital will be the biggest contributor to the probability of a crisis, so that capital shortages that occur during a crisis are also an indication or measure of systemic risk contribution.

To estimate the capital shortfall, we may use equation (4) with data of debt and bank equity which can be taken directly from the bank's financial statements. The size of MES requires a valid time series data estimation technique. Acharya et al. (2017) proposes a model to specify heteroskedastic bivariate conditionally models in order to model the dynamics of corporate returns and market returns. By estimating this bivariate model, we can extrapolate it to produce the MES of each company.

If R_{it} and R_{mt} are firm i and market daily returns, bivariate conditionally heteroskedastic models are as follows:

$$\mathbf{R_{mt}} = \sigma_{mt}\,\varepsilon_{mt}$$

$$\mathbf{R_{it}} = \sigma_{it}\rho_{it}\varepsilon_{mt} + \sigma_{it}\sqrt{1 - \rho_{it}^2}\,\xi_{it} \quad \text{......} \quad (5)$$

Where:

ε_{mt} and ε_{it} are independent shocks/residuals and identically distributed all the time and have zero average, one variance and zero covariance. The magnitude of the two shocks from these two equations can reach extreme values simultaneously for firm which have a high systemic risk impact. When market shock is at the tail end of its distribution, the shock of firm's return can be even lower if the firm has a serious risk of default.

The first step to model the MES of each bank is to model volatility by using GJR-GARCH, which is an asymmetric conditional volatility model so that the effect of bad news will increase volatility to a higher level (Braun et al. 1995). With this GJR-GARCH model we can get the amount of conditional volatility and standardized residuals. Based on this volatility estimation, we can use the DCC model to obtain the conditional correlation between bank's return and stock market returns and standardized idiosyncratic firm residuals.

$$\mathbf{MES^{1}_{it-1}(C) = E_{t-1}(R_{it} \mid R_{mt} < C)}$$
$$= \boldsymbol{\sigma_{it} E_{t-1}(\rho_t \varepsilon_{mt} + \sqrt{1-\rho_t^2}\xi_{it} \mid \varepsilon_{mt} < C/\sigma_{mt}} \quad \text{..............} \quad (6)$$

The institution observed in this study is a public bank which have shares listed and traded in the Indonesia stock exchange. Daily bank stock return data is taken from the daily stock price data of each bank, while the market daily return is the Jakarta composite index (JCI) return from 2009 to 2017. Equity value data and Bank loans are taken from the quarterly financial statements submitted by each bank to the stock exchange.

To measure bank' competitiveness, we use Lerner index (Brissimis & Delis, 2011). Lerner index captures individual bank's position in the industry and bank's power to compete within industry dynamics (Anginer et al., 2018). Lerner index is a difference between product price and production marginal cost. Higher Lerner index indicates higher individual bank's power to set price over its marginal cost.

The calculation for Lerner index is as follows:

$$\textbf{Lerner Index} = \frac{P_{TA_{i,j,t}} - MC_{TA_{i,j,t}}}{P_{TA_{i,j,t}}} \quad \text{..} \quad (7)$$

Where:

P_{TA} indicates the value of total assets, and MC_{TA} shows marginal cost of total assets which is derived from translog cost function as follows (Brissimis & Delis, 2011):

$$\begin{aligned}\mathbf{log(Cost)} = {} & \alpha + \beta_1 \log(TA) + \tfrac{1}{2}\beta_2(\log(TA)^2) + \beta_3 \log(W_1) + \beta_4 \log(W_2) \\ & + \beta_5 \log(W_3) + \beta_6 \log(W_1) \times \log(W_1) + \beta_7 \log(W_2) \times \log(W_2) \\ & + \beta_8 \log(W_3) \times \log(W_3) + \beta_9 \log(W_1) \times \log(W_2) + \beta_{10} \log(W_1) \\ & \times \log(W_3) + \beta_{11} \log(W_2) \times \log(W_3) + \beta_{12} \log(TA) \times \log(W_1) \\ & + \beta_{13} \log(TA) \times \log(W_2) + \beta_{14} \log(TA) \times \log(W_3) + \varepsilon \quad \text{.............} \quad (8)\end{aligned}$$

Where:

Cost is banks' total costs,

TA is a proxy for bank outputs or banks' total assets.

W shows three input prices: input price of labor (W_1) which is personnel expenses to total assets ratio, input price of funds (W_2) which is interest expense to total deposits ratio, and input price of fixed capital (W_3) which is other expenses to total assets ratio.

Bank's marginal cost (MC_{TA}) is a first derivation of total cost function (2) obtained from the calculation above:

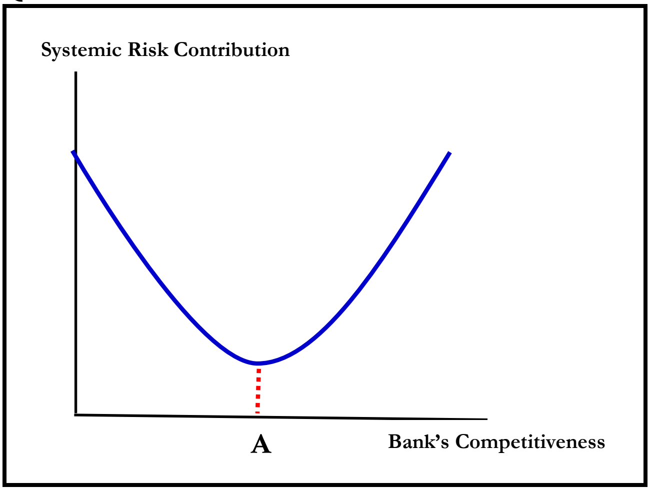
$$\mathbf{MC_{TA}} = \frac{Cost}{TA}(\beta_1 + \beta_2 \log(TA) + \beta_{12} \log(W_1) + \beta_{13} \log(W_2) + \beta_{14} \log(W_3)) \quad \text{..} \quad (9)$$

After estimating the MES of individual bank and bank's competitiveness, we can test two hypotheses: 1) whether relationship between this two variable is linear, or 2) the relationship is quadratic which resembles U-shape. If The regression model is as follows:

$$\mathbf{MES_{it}} = \alpha + \beta \mathbf{Compt_{it}} + \gamma \mathbf{Compt^2_{it}} + e_{it} \quad \text{..} \quad (10)$$

If $\gamma < 0$ and is statistically significant, we may conclude that functional form of relation between individual bank's systemic risk contribution and bank's competitiveness is quadratic (see Figure 1). It means higher bank's competitiveness drives individual bank's systemic risk contribution lower but until at one point, higher bank's competitiveness increases individual bank's systemic risk contribution.

Figure 1
Quadratic Functional Form



IV. RESULTS AND DISCUSSIONS

Following the modeling procedure proposed by Acharya et al. (2017), we can calculate the marginal expected shortfall average, which reflects the bank's contribution to systemic risk, from 27 public banks data in Indonesia. Table 1 shows that the average of MES is around 2.895% which indicates the individual bank's contribution to Indonesia's financial systemic risk is in the middle to low impact category (Brownlees & Engle, 2012). There are banks that have a significant systemic impact but there is no single bank that has a very serious and dominant systemic impact. Table 2 show all bank's contribution to systemic risk in more detail.

Table 1
Summary Statistics of Observed Variables

No.	Variable	Mean	Standard Deviation	Median
1	**Marginal Expected Shortfall**	2.895	1.893	2.448
2	**Bank Competitiveness**	1.976	2.957	1.897

Table 1 also show Indonesia bank's competitiveness average that is considerably moderate to high which imply a monopolistic competition type in Indonesia banking industry. Each bank serves its own specific market segment which gives them a significant market power to set up price above its marginal cost. The credit market with a monopolistic competition often causes ineffective monetary policy because interest rate pass-through takes a quite long time. The central bank's interest rate policy does not have an immediate and significant impact on bank interest rates. Wibowo and Lazuardi (2016) found that the time adjustment of Indonesia bank interest rates to policy rate changes was around 6 to 8 months. Similar findings were found by Hristov et al. (2014) in Euro countries and Wang and Lee (2009) in 9 Asian countries.

Table 2 show marginal expected shortfall of all Indonesia public banks. Bank Mandiri is the individual bank with highest systemic impact. Bank Mandiri, Bank BRI, and Bank BNI which are banks with biggest assets in the industry have highest marginal expected shortfall. It indicates that systemic risk contribution of bank is closely related to its asset size which also reflects its business relations with other bank in the system (Brownlees & Engle, 2012).

Table 2
Time Series Averages of Systemic Risk Contribution

No.	Bank	Average MES	Standard Deviation
1	**BMRI**	6.13%	2.55%
2	**BBRI**	5.96%	2.59%
3	**BBNI**	5.78%	3.15%
4	**BDMN**	5.17%	2.35%
5	**BACA**	4.92%	3.78%
6	**BBCA**	4.85%	2.59%
7	**BBKP**	4.87%	2.65%
8	**BNBA**	3.93%	2.59%
9	**BNLI**	3.78%	0.34%
10	**BNGA**	3.78%	2.25%
11	**PNBN**	3.69%	6.44%
12	**BTPN**	3.57%	6.95%
13	**MCOR**	2.53%	0.78%
14	**SDRA**	2.44%	0.67%
15	**AGRO**	2.32%	1.19%
16	**BVIC**	2.21%	7.47%
17	**BNII**	2.20%	1.38%
18	**BEKS**	1.84%	0.99%
19	**MEGA**	1.81%	0.78%
20	**INPC**	1.73%	1.45%
21	**MAYA**	1.52%	3.67%
22	**BSWD**	0.88%	7.47%
23	**BABP**	0.59%	0.59%
24	**BCIC**	0.49%	0.39%
25	**BKSW**	0.48%	0.79%
26	**BBNP**	0.38%	0.49%
27	**NISP**	0.25%	0.37%

Large banks have huge and interconnected transactions with the majority of banks in the financial system so financial problem faced by these banks create a systemic issue which all banks and all corporations also badly influenced. Credit allocations of large banks affect the business cycle in the real sector. Financial distress experienced by large and systemically important banks directly affect lending to the real sector that creates serious problem for all corporation and whole economy as well (Jeon & Lim, 2013).

Table 3
Empirical Test of MES Relation with Bank's Competitiveness

	Coefficient	Probability
Constant	0.9752	0.0002***
Bank's Competitiveness	0.5874	0.0137**
Squared of Bank's Competitiveness	-0.3856	0.0100***
R^2	0.8978	
Adjusted R^2	0.8650	

Notes: * significant at level of error 10%, ** significant at level of error 5% and *** significant at level of error 1%.

Table 3 shows the result of empirical test. Bank's competitiveness is positive and statistically significant, so higher market power tends to make higher contribution to systemic risk. Model's R^2 or goodness of fit is high that we can make a bold conclusion on this two variables relationship. Highly competitive bank tends to has a serious impact on financial system and economy as a whole (Anginer et al., 2018). Powerful bank tends to have a wide and various transactions with other bank and has an eminent impact on other banks (Martinez-Miera & Repullo, 2010). Powerful bank usually has an excessive risk-taking behavior because of overconfidence and awareness of its very important position in the financial that government always help and give a bail out in order to avoid collapse of whole financial system (Jeon & Lim, 2013). Powerful banks tend to have serious moral hazard because of deposit insurance guarantee all deposits in those banks (blanket guarantee). Combination of moral hazard and significant market power, large bank creates a serious potential impact to financial system stability.

The result support "competition-stability view" which high competition level make financial system more stable. As Jeon and Lim (2013) show a bank with strong market power can create significant systemic risk because a dominant bank may set higher interest rates which put most bank loan borrowers into an unfavorable position. High bank loan interest rate affects financial and economic system stability because all bank loan borrowers have high financial risk where business environment changes may create simultaneous corporate defaults. Because of thin profit margin, little revenue changes may put most corporations into serious financial distress and not able to pay loan interest.

Dominant bank which set high loan interest rates creates further banking system fragility because high loan interest rate creates an adverse selection in the bank lending process. Most bank loan borrowers are only those who high risky borrower because they who are aware of their low business risk tend to avoid borrowing high cost bank financing and be able raise fund from other funding sources, such as from capital market. Bad loan allocation portfolio threats bank performance and may create simultaneous and subsequential bank default. Dominant bank which has significant market power and high competitiveness tends to have high systemic risk contribution.

Regression result presented in Table 3 also show that squared bank's competitiveness is negative and statistically significant. We may conclude the relationship of marginal expected shortfall and bank's competitiveness resembles quadratic function as Figure 1. This result may reconciliate two competing views: "competition-stability" and "competition-fragility" (Martinez-Miera & Repullo, 2010).

In the first phase, increasing individual bank market power creates lower systemic risk contribution. In this phase, high banking industry competition creates more stable financial system. In the first phase, competition-fragility view conforms the data. Big and dominant bank has low systemic risk contribution. Because big bank usually is public company which its stock price fluctuates because of instantaneous investor adjustment to recent bank performance and risk-taking behavior (Anginer et al., 2018). Banks become more careful in executing its business plan, always maintain capital adequacy, follow all existing banking regulations, and perform a prudent and high loan portfolio quality. The stability of the banking sector increases when competition between banks is limited by regulators.

But increasing bank's competitiveness will have different impact on systemic risk contribution when it is higher than returning point at point A (see Figure 1). In this second phase, "competition-stability view" conforms the data which high competition level make financial system more stable. Big and dominant bank with strong market power is a threat to financial system stability (Goetz, 2018). An excessive bank's competitiveness may create significant systemic risk.

V. CONCLUSION

Bank's competitiveness significantly affects individual bank's contribution to systemic risk. More competitive banks may also contribute bigger portion of systemic risk. Low banking system competition level tends to create fragile financial system stability because few big banks may create a systemic problem which most of banks and other financial institution may simultaneously or subsequently in default position that they are not able pay their liability. The defaults are contagious drived mostly by big banks which have high systemic risk contribution.

This research also finds that the relationship between bank's competitiveness and bank's contribution to systemic risk may in two different modes. In the first phase where banking industry competition level are high and most of banks have weak market power, low bank's competitiveness creates low bank's contribution to systemic risk. Competition-stability prevails. But, when competition becomes excessive, higher bank's competitiveness create high contribution to systemic risk. Higher competition drive to more fragile financial system. Relationship of bank's competitiveness and bank's systemic risk contribution resembles a U-shape which is a quadratic functional form.

Further research may scrutinize individual bank characteristic that may influence the relationship between competition and systemic risk. We also should consider and investigate more seriously the impact of maroeconomic variables and type of monetary policy launched by central bank in each period which may affect competition-systemic risk relationship.

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