Analysis of Potential Correlates of Cooperative Banks' Technical Efficiency

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Abstract *–This paper analyzes the technical efficiency of 23 cooperative banks (CBs) in the Philippines applying stochastic frontier analysis (SFA), which takes into account inefficiency effects of potential correlates. The dataset was sourced from the CBs' published balance sheets provided by the Bangko Sentral ng Pilipinas for the period 2015-2018. Adopting the intermediation approach, input variables are total deposits and fixed assets while the outputs are total loans and other earning assets. Results reveal that total depositis the more significant predictor of the outputs. Conversely, CBs are more efficient in transforming total deposits and fixed assets into other earning assets rather than total loans. The inefficiency effects of consolidation, size and age are highly significant and are not due to random variation. This paper finds that large size CBs with more than 40 years of existence and have not consolidated with other CBs were operating efficiently than younger and medium size CBs that have experienced consolidation. Hence, on the average, CBs without consolidation are better off than CBs with consolidation and a steady flow of total deposits sustained their production of other earning assets.The mean technical efficiency of the cooperative banking sector is 72.2 percent. To attain the optimal efficiency level, the sector needs to increase their outputs by 27.8 percent. The findings suggest that total deposits should be transformed into more loans to conform with the basic mandate of CBs as producers of loans, bank-specific variables should also be given focus as they tend to be sources of inefficiency, and thorough study should be made before pursuing future consolidation as it may not be the best means to enhance efficiency.*

Keywords *–consolidation, inefficiency effects, stochastic frontier analysis, technical efficiency*

INTRODUCTION

Cooperative banks (CBs) are considered key component in the credit sector of the cooperative movement, which began in Europe in the mid-1800sto respond to the difficulties faced by small urban and rural businesses in accessing credit [1]. Just like any other cooperatives, CBs are members centered. They have a distinct business model because their customers are also their members [2]. They operate not for profit maximization but for the improvementof their members' economic wellbeing. The members in turn are to patronize the CBs' economic services and not to expect dividends [3]. Moreover, they are modelled basically as democratic member-controlled mutualorganizations, which progressed through the years and adopted worldwide based on the members' needs and their countries' legal framework [1]. CBs are typically focused on traditional banking activities such as deposit taking and loan granting, hence, they are more connected to the real economy than commercial banks [4]. These very traits enabled them to be resilient in the midst of financial crisis [5]. Aside from domestic pluses, they are also contributors to the country's economy because of their financial activities which helped in the improvement of its financial system [6]. Just like their foreign counterparts, CBs in the Philippines function both as cooperative and as bank. They are governed by Republic Act (R.A.) 7353 (Rural Bank Act of 1992), as amended by R.A.10574, and R.A. 8791 (General Banking Law of 2000), and at the same time by R.A. 9520 (Philippine Cooperative Code of 2008) and R.A. 6939 (Cooperative Development Authority Act). They are registered with the Cooperative Development Authority (CDA) but their operation is subject to the supervision and examination of the Bangko Sentral ng Pilipinas (BSP). They are primarily organized to provide financial and credit services to cooperatives and their members [7]. However, since they are categorized as rural banks, they may likewise perform all other services offered by rural banks. These CBs remain to be important financial actors particularly in the countryside and are recognized by the government as important component of the rural banking system.

Since almost all the CBs are operating in the rural areas, they primarily serve the financial needs ofthe cooperatives and their members who generally find it hard to access bank services [8]. As a matter of fact, despite limited share in the banking system's total loan portfolio, they were able to provide the financial needs of the agriculture sector as well as the micro, small and medium enterprises (MSME) that larger banksmay not have served or areunderserved [9]. However, with the expansion of universal/commercial banks to areas considered as home turf of cooperative banks, CBs are faced with stiffer competition from local universal/commercial banks and fellow rural banks. The result of BSP's 2018 first semester Banking Sector Outlook Survey (BSOS) disclosed that CBs considered competition as a major threat to them [10]. Accordingly, competition could be one of the compelling reasons why a number of CBs closed shop and others entered into consolidations. Records show that for the period 2000-2017, 17 CBs were closed by BSP and 14 CBs have heeded the call of BSP to consolidate. The 14 CBs consolidated under the Strengthening Program for Cooperative Banks (SPCB) of the BSP with the intent of rationalizing the sector in order to produce bigger and more robust CBs capable of extending improved services to their members, expand their scope deeper into the rural areas, promote savings, and stimulate credit operations in areas not served or sparsely served by larger banks[11]. The SPCB encouraged the mergers, consolidations, and acquisitions of CBs with strategic thirdparty investors by granting incentives such as capital augmentation from Philippine Deposit Insurance Corporation and Land Bank of the Philippines, and regulatory relief package from the BSP.

Out of the 25 currently operating CBs, four are results of consolidation. Their motives for consolidating include strengthening the CBs' financial position and operating efficiency, widen market, cost savings, capital sufficiency and competitive advantage [12]-[14]. In short, CBs expect that consolidation would improve their performance which would ultimately redound to the improvement of the Philippine cooperative banking sector. This expectation was echoed in several studies conducted in other countries which revealed that bank mergers or consolidation have resulted to the improvement of the banking sector performance [15],[16],[18]. However, there were also studies on bank consolidation that found no evidence of performance improvement after consolidation [1],[19]-[21]. These studies clearly showed that consolidation can be a determinant of bank efficiency. Aside from consolidation, earlier literature identified bank-specific factors size and age as potential correlates of bank efficiency. Size, proxied by total assets, may have an influence on efficiency through economies of scale. The influence of age, on the other hand, may be through wealth of experience. As to bank size, there were studies that showed it has significant positive effects on bank efficiency [22]-[24], while other studies showed otherwise [25],[26],[3]. In like manner, the influence of age on efficiency is multifaceted. Some studies reveal that age has significant positive impact on bank efficiency [27],[28], while others revealed it has negative impact [29],[30]. As far as the authors knew, no study has been conducted yet that focuses on the effects of consolidation, bank size and age to the technical efficiency of CBs in the Philippines.

OBJECTIVES OF THE STUDY

This study was conducted primarily to determine the stochastic effects of total deposits and fixed assets to total loans and other earning assets, and to analyze the inefficiency effects of consolidation, bank size and age to the technical efficiency of the CBs. The benefits of this study are threefold. First, it will guide the management of the CBs in evaluating their operational performance. Second, it will serve as a yardstick to CBs that are planning to consolidate. Third, it will aid the government in setting up policy directions appropriate for the cooperative banking sector.

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METHODS

Data Sample

A four-year panel data from the published balance sheets of the CBs was used in the study. Only the published balanced sheets provided by the BSP were used because of the provision under R.A. 7653 (The New Central Bank Act) as amended by R.A. 11211 (BSP Charter) prohibiting BSP personnel from disclosing information relating to the condition or business of any institution that are subject to BSP's supervision or examination. Out of the 25 operating CBs, 23 CBs have complete balance sheets but only for the years 2015 to 2018. With these limitations, only 23 CBs comprised the sample of this study and the test period was confined to four years (2015-2018). Further, one of the four consolidated CBs has no published balance sheets for the test period, hence, it was not included in the sample.

Input and Output Variables

Measuring bank efficiency depends largely on the selection of input variables and output variables. Threeapproaches are widely used in selecting the variables. The first is intermediation approach which recognizes that banks are primarily financial intermediaries between savers and borrowers in which deposits are accepted and transformed into loans and other earning assets [31]. The second is production approach which looks at banks as producer of goods and services with labor and other resources as inputs to provide deposits, loans and other services as outputs [32]. The third is profitability approach examines how a bank bestemploys its inputs, i.e., expenses in the production of its outputs, i.e., revenues[33].This study adopted the intermediation approach considering the basic operation of CBs as producers of loans mostly out of the deposits placed by the savers. Thus, the inputs used are total deposits and fixed assets [34]-[38]), and the outputs are total loans and other earning assets [34],[39],[40],[31]. Table 1 defines the input and output variables:

Table 1. Input and Output Variables

Variables	**Description**[1]
Inputs:	Deposit liabilities
Total Deposits	Bank premises, furniture, fixture
Fixed Assets	and equipment-Net
Outputs:	Gross total loan portfolio
Total loans	Due from BSP + Due from other
Other earning assets	banks + Financial Assets

[1]*Adopted & modified from BSP's Directory of Terms and Financial Statement Template*

Stochastic Frontier Analysis

Stochastic Frontier Analysis (SFA) is a parametric methodthat uses econometric conceptin the approximation of pre-determined functional form and treats inefficiency as anotherstochastic term[41]. It has the capability of measuring the efficiency of the producers in allocating their inputs and their outputs, and can include in the measurement the effect of external factors on the performance of the producers [42].

In this study, the stochastic frontier production function with technical inefficiency effects model of Battese and Coelli was used [43]. This approach measures the parametric construct of the production function and acknowledges the existence of random error terms in the data. The error terms have two elements, one which shows production inefficiency and the other shows the effects of outside factors not controlled by the producer [44]. The model allows the measurement of both technical change and time-varying technical inefficiency provided that the technical inefficiency effects are stochastic and distribution is identified.

Battese and Coelli (1995) express the stochastic frontier production function for panel data as follows:

$$Y_{it} = \exp (x_{it}\beta + V_{it} - U_{it})$$

"where Y_{it}denotes the production at the *t*-th observation ($t = 1,2, \ldots,T$) for the *i*-th firm ($i = 1,2, \ldots,N$); x_{it} is a ($1xk$) vector of values of known functions of inputs of production and other explanatory variables associated with the *i*-th firm at the *t*-th observation; β is a ($1xk$) vector of unknown parameters to be estimated; V_{it}s are assumed to be iid$N(0, \sigma^2_v)$ random errors, independently distributed of the U_{it}s; U_{it}s are non-negative random variables, associated with technical inefficiency of production, which assumed to be independently distributed, such that U_{it} is obtained by truncation (at zero) of the normal distribution with mean $z_{it}\delta$ and variance, σ^2 ; z_{it} is a ($1xm$) vector of explanatory variables associated with technical inefficiency of production of firms over time; and $\delta$is a ($mx1$) vector of unknown coefficients. Equation 1 specifies the stochastic frontier production function in terms of the original production values.

The technical inefficiency effect, U_{it}, in the stochastic frontier model could be specified in Equation 2:

$$U_{it} = z_{it}\delta + W_{it}$$

where the random variable, W_{it}, is defined by the truncation of the normal distribution with zero mean and variance, σ^2, such that the point of truncation is $-z_{it}\delta$, i.e., $W_{it} \geq -z_{it}\delta$ [pp. 326-327]."

To measure the parameters of the stochastic frontier and the technical inefficiency effects simultaneously, the method of maximum likelihood is recommended. It is statedas:

$$\sigma_s^2 \equiv \sigma_y^2 + \sigma^2 \text{ and } y \equiv \sigma^2/\sigma_s^2$$

The technical efficiency of production for *i*-th firm at the *t*-th observation is stated as:

$$TE_{it} = exp(-U_{it}) = exp(-z_{it}\delta - W_{it})$$

Aside from the input and output variables, uncontrollable variables consolidation, size and age which are potential correlates of the technical inefficiency of the CBs were included. Table 2 shows the description of the inefficiency effects variables.

Table 2. Variables for Inefficiency Effects

Variables	Description[1]
Consolidation	Represented by a dummy variable that has a value of 1 for with consolidation and 0 for without consolidation
Size	Coop bank size measured by total assets, signified by a dummy variable that has a value of 1 for large and 2 for medium
Age	Coop bank years of existence represented by a dummy variable that has a value of 1 for < 20 years of existence, 2 for 20-30 years, 3 for 30-40 years, and 4 for >40 yrs.

[1]Authors' own definitions

To come up with the empirical findings, the SFA Program FRONTIER Version 4.1 developed by Coelli was used in the study [45].

RESULTS AND DISCUSSION

Descriptive Statistics and Brief Profile of the CBs

Table 3 shows the descriptive statistics of the variables. Total loans, other earning assets, total deposits and fixed assets were calculated in PhP million to have a common measure. The standard deviation or dispersion showed that the data set were more spread out or further from the mean and required other statistical tool than ordinary least square regression.

Table 3. Descriptive Statistics of Variables

N = 92	Min.	Max.	Mean	SD
Total loans	21.33	3183.73	609.39	733.35
Other earning assets	3.03	1085.55	215.97	247.63
Total deposits	14.21	2530.97	520.97	564.04
Fixed assets	0.03	160.59	32.47	37.36

Table 4 shows the brief profile of the CBs. The brief profile served as the dummy variables in SFA that tested the inefficiency of the CBs. The size represents the total assets of the CBs and measured in nominal or binary scale (1 = large, 2 = medium) in the maximum likelihood estimate (MLE) of SFA. Majority of the CBs were large (N = 81, 88%) and few were medium (N = 11, 12%). Consolidated CBs were few (N = 14, 15%) and majority (N = 78, 85%) were not consolidated. Age of the CBs were almost equally dispersed in four (4) classes, namely: 1 = < 20 years (N = 27, 29%), 2 = 20 – 30 years (N = 33, 36%), 3 = 31 – 40 years (N = 11, 12%) and 4 = > 40 years old (N = 21, 23%).

Table 4. Brief Profile of the CBs

Size (Total Assets)	Frequency	Percent
1 = large	81	88
2 = medium	11	12
Total	92	100
Consolidation	Frequency	Percent
0 = without	78	85
1 = with	14	15
Total	92	100
Age (Years)	Frequency	Percent
1 = < 20	27	29
2 = 20 - 30	33	36
3 = 31 - 40	11	12
4 = > 40	21	23
Total	92	100

The Effects of Inputs to Outputs

1. The effects of total deposits and fixed assets to total loans.

Table 5 shows the stochastic effect of total deposits and fixed assets to total loans of the CBs. In the beginning of 2015, the contribution of technology in generating total loans of the CBs was 116.7% or the equivalent of PhP 3.213 million without the influence of total deposits and fixed assets. A 100% increase in total deposits generated 89.1% increase in total loans. Although statistically not significant, the result suggested that fixed assets have zero effect to total loans. The sum of the b-parameters (output elasticity) showed a decreasing return to scale (DRS, 0.877 < 1.00). At DRS, CBs were operating at higher scale to achieve better economies of scale as they aspire to generate more of total loans using total deposits and fixed assets resulting to decline in productivity. Between the two variables, total deposit is the more significant predictor of total loans, with an estimated elasticity of 0.891. This implies that the CBs' efficiency increases as more total deposits are utilized. Overall, constant (b_0) is statistically significant (1.167). This finding connotes that generally, the combined effects of the two variables on technical efficiency are positive and significant although the effect of the other variable is not statistically significant. Fixed assets showed a negative effect (-0.015) but is statistically

insignificant, suggesting that efficiency declines when more fixed assets are used.

Table 5. Factors Affecting Total Loans

Stochastic Frontier Estimates		MLE			
Parameter	Variable	Coeff.	t-ratio	t-critical	Sig.
b_0	Constant	1.167	4.618	3.499	0.005
b_1	Total Deposits	0.891	19.722	4.785	0.001
b_2	Fixed Assets	-0.015	-0.523	n.s.	
Inefficiency Effects					
d_0	Constant	-2.006	-0.616	n.s.	
d_1	Size:1=large, 2 = medium	-1.290	-2.690	2.365	0.025
d_2	Consolidation: 1=with, 0= without	-0.098	-0.030	n.s.	
d_3	Age: 1= <20, 0 = >40	2.728	0.920	n.s.	
d_4	Age:2=20-30, 0 = >40	3.657	1.133	n.s	
d_5	Age:3=31-40, 0 = >40	1.723	0.716	n.s.	
σ^2	sigma-squared	0.384	2.072	1.895	0.05
γ	gamma	0.899	16.338	4.785	0.001
Dependent variable = Total loans (PhP Million)					
LR test of the one-sided error = 63.485 > 23.551					
With number of restrictions = 7					
(note that this statistic has a mixed chi-square distribution)					
Kodde& Palm (df = 7, 0.001) = 23.551					

The inefficiency effects showed thatthe estimated coefficient associated with size is negative (-1.290) which implies that large size CBs tend to belessinefficient in their operation than medium size CBs. This result supports the findings that larger asset size banks were more efficient in their operation than smaller asset size banks [24] and cost inefficiency tend to decrease with bank size [46]. It likewise showed that the statistically insignificant value of consolidation (-0.098) suggests that CBs were efficient in their operation during the pre-consolidation (without) than during the consolidation (with) period. This finding supports the conclusion that profit and asset utilization efficiencies of Nigerian commercial banks deteriorated after consolidation [19] and that right after merger, there was a deterioration of the merged banks' technical efficiency in the case of Indian banks [20]. Further, the statistically insignificant results shown by age classes (2.728, 3.657 and 1.723) imply that younger CBs (< 20 years, 20 – 30 years, and 31 – 40 years) were more inefficient in their operations than those CBs with more than 40 years of operation. This result reflects the findings that the oldest Islamic banks are more efficient than their newer counterparts [28].

Hypotheses test for b-parameters of total loans and the full model (Model 2 of Battese & Coelli 1995 specification).

The significance of the above parameters ($b_0$and b_1) at 5% level indicates that the study rejected the null hypothesis (H_o: $b_i = 0$) *"total deposits and fixed asset did not affect total loans"* and accepted the alternative hypothesis (H_a: $bi \neq 0$),"there was at least a factor *affecting total loan".* Thus, total deposits greatly affected total loans (by at least 89.1%).

The values of sigma-squared ($\sigma^2 = 0.384, \rho = 0.05$) and gamma ($\gamma = 0.899, \rho = 0.001$) indicate that the 23 CBs were not efficient in their annual production of total loans and the distance between the best years of generating total loans (frontier or potentials of achieving total loans) and their actual data are due to inefficiency and not due to random variation. The value (=63.485) of likelihood ratio test of the one-sided error is greater than the value of 23.551 at 0.001 level of significance per Kodde and Palm table [47] and 7 degrees of freedom (number of restrictions = 7) implying that the assumption on a general truncated (reduced) normal distribution ($\mu \neq 0$) where mean (mu) is not zero and the time-varying (2015 – 2018) efficiencies passed all expectations. So, the two distributions in this paper are normal for the stochastic portion (*Vi* = error term) and half – normal for the efficiency portion (*Ui*). Also, the likelihood ratio test implied that the SFR - MLE appropriately estimated total loans than the ordinary least squares (OLS) of the classical statistics.

2. **The effects of total deposits and fixed assets to other earning assets.**

Table 6 shows the inputs affecting other earning assets of the CBs from 2015 to 2018. A 100% use of total deposits improved other earning assets by 93.8% implying that an average CB experienced growth in other earning assets through a steady inflow of total deposits. Although not statistically significant, a 100% increase in fixed asset contributed 4.2% in other earning assets. As suggested by the sum of the elasticity of output (0.938 + 0.042 = 0.980 < 1.00), an average CB was operating at decreasing return to scale (DRS). This means that at higher scale of sizes a CB received a decreasing income (other earning assets) through

time. The results showed that CBs were highly dependent on total deposits as it is the more significant predictor of the other earning assets output, with an estimated elasticity of 0.938.

Table 6. Factors Affecting Other Earning Assets

Stochastic Frontier Estimates		MLE			
Parameter	Variable	Coeff.	t-ratio	t-critical	Sig.
b_0	Constant	-0.526	-2.130	2.029	0.041
b_1	Total Deposits	0.938	20.51	4.784	0.001
b_2	Fixed Assets	0.042	1.089	1.663	n.s. (0.05)
Inefficiency Effects					
d_0	Constant	-2.211	-2.235	2.136	0.035
d_1	Size: 1=large, 2 = medium	-3.746	-6.092	4.784	0.001
d_2	Consolidation: 1 = with, 0 = without	5.828	3.600	3.499	0.005
d_3	Age:1= <20, 0 = >40	4.761	3.957	3.667	0.004
d_4	Age:2=20-30, 0 = >40	2.042	2.995	2.365	0.025
d_5	Age:3=31-40, 0 = >40	5.731	3.792	3.667	0.004
σ^2	sigma-squared	0.318	2.892	2.365	0.025
γ	gamma	0.727	8.736	4.784	0.001
Dependent variable = Other earning assets (PhP Million)					
LR test of the one-sided error = 62.020> 23.551					
With number of restrictions = 7					
(note that this statistic has a mixed chi-square distribution)					
Kodde& Palm (df = 7, 0.001) = 23.551					

The findings in the technical inefficiency effects portion is similar to the findings in the total loans model. Itshows that the size coefficient is negative (-3.746) which indicates that large size CBs are less inefficient than medium size CBs.This supports the findings that bank size has positive effect on efficiency [23].The consolidation coefficient is positive (5.828) which implies that CBs with consolidation were more inefficient in their operation than the CBs without consolidation. This corroborates the findings that the CBs involved in the mergers of Italian cooperative banks will experiencedifficulty in levelling up with the cost efficiency of banks that did not merge[1].Per age class, cooperative banks under the age classes of less than 20 years, 20 – 30 years, and 31 – 40 years were more inefficient in operation than those cooperative banks with more than 40 years in operation. This supports the findings that the age of firms which signifies experience affects efficiency positively[27].The results suggest that large size CBs with more than 40 years of experience and did not experience consolidation were more efficient in operation than medium size CBs with less than 40 years of experience and in consolidation with other CBs. The findings imply that in general, consolidation appears not to be the best option for CBs to attain efficiency.

Hypotheses test for b-parameters of other earning assets and acceptance of the full model (model 2 of Battese & Coelli 1995 specification) as the appropriate tool for the study.

The parameters ($b_0$and b_1) were all significant at 5% level indicating that the study rejected the null hypothesis (H_o: $b_i = 0$) *"total deposits and fixed asset didn't affect other earning assets"* and accepted the alternative hypothesis (H_a: $bi \neq 0$), *"there was at least a factor affecting other earning assets".* Thus, the study concluded that total deposits greatly affected other earning assets (by at least 93.8%). Also, the delta parameters *(d_0, d_1, d_2, d_3, d_4 and d_5)* were all significant at 5% level suggesting a rejection of the null hypothesis (H_0: $d_i = 0$) *"Size, consolidation and age didn't affect the cooperative banks' efficiency"* and accepted the alternative hypothesis (H_0: $d_i \neq 0$) *"Size, consolidation and age affected the efficiency of cooperative banks".* The results implied that size, consolidation and age greatly affected the efficiency of CBs at 5% level of significance.

The values of sigma-squared ($\sigma^2 = 0.318$, $\rho = 0.025$) and gamma ($\gamma = 0.727$, $\rho = 0.001$) indicated that the 23 CBs were not efficient in their annual production of other earning assets and the distance between the best years of generating other earning assets (frontier or potentials of achieving other earning assets) and their actual data are due to inefficiency and not due to random variation. The value (= 62.02) of likelihood ratio test of the one-sided error is greater than the value of 23.551 at 0.001 level of significance per Kodde and Palm table [47] and 7 degrees of freedom (number of restrictions = 7) implying that the assumption on a general truncated (reduced) normal distribution ($\mu \neq 0$) where mean (mu) is not zero and the time-varying (2015 – 2018) efficiencies passed all expectations. So, the two distributions in this paper are normal for the stochastic portion (*Vi* = random variation) and half –

normal for the efficiency portion (*Ui*). Also, the likelihood ratio test implied that the SFR - MLE estimated appropriately other earning assets than the ordinary least squares (OLS) of the classical statistics.

Comparing the results of the total loans and other earning assets model, the latter appears to be the best model for the CBs. The results of the latter model indicated that a large size CB with more than 40 years in existence and did not consolidate with other CBs were operating efficiently than younger and medium size CBs that experienced consolidation. Hence, on the average, a CB was better off without consolidation and a steady flow of total deposit sustained their production of other earning assets.

Finally, the mean technical efficiency for the cooperative banking sectoris 72.2 percent. This implies that on the average, the CBs are producing 72.2% percent of the outputs that might be ideally produced using the same combination of inputs by a totally efficient CB. In order torealize the optimal level of efficiency, the cooperative banking sector needs to increase their outputs by 27.8 percent.

CONCLUSION AND RECOMMENDATION

Through stochastic frontier analysis, this study determined the effects of total deposits and fixed assets to total loans and other earning assets, and investigated the inefficiency effects of consolidation, bank size and age to the technical efficiency of the CBs. The results yielded relevant managerial and regulatory implications. The stochastic frontier model employed in this study may be used by the CBs and regulatory bodies as an alternative tool to the customary ratio analysis in assessing bank performance. Though the results revealed that the best model for the CBs is the other earning assets model, it must be remembered that the CBs' basic mandate is to be producers of loans for cooperatives and their members who have little access to credit. Hence, total deposits which was found to be the more significant predictor of the outputs should be transformed into more loans. Policy makers and managers of CBs should also focus on bank-specific factors as these tend to be sources of bank inefficiency. Corollary, thorough study should be made before pursuing future CBs consolidation as it may not be the bestmeans to enhance efficiency. Future studies may consider using income statement variables like interest income/expense, non-interest income/expense fora longer study period. These are some of the limitations the study encountered because of the absence of some needed data. For the measurement of data, the non-parametric data envelopment analysis (DEA)-Malmquist Productivity Index may be considered to also determine the productivity improvements of the CBs.

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