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An Analysis on the Efficiency and Productivity for Major Mutual Financing Cooperatives in Korea

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우리나라 상호금융조합의 효율성 및 생산성 분석

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Abstract The Mutual Financial Cooperatives(MFCs) in Korea need to make efforts to increase efficiency and productivity in order to secure stable and sustainable growth and competitiveness. Therefore, this study analyzes the efficiency and productivity of MFCs from 2012 to 2018 and suggests some implications. The methodology employed is a Dynamic-Network Slacks-Based Measure(DNSBM) Model. The findings from an empirical study include that first, on average efficiency scores of the institutions, NH(0.225) showed the highest overall efficiency, and followed by SH(0.128) and MG(0.126). After 2015, most of the MFCs' efficiency scores had risen until to 2018. Second, in divisional analysis, the inefficiency in creating the high profitability-stage had been greater than establishing-funds-stage. Third, in projection analysis of Division 2, the inefficiency of the output factors such as interest income and operating income was severe. Fourth, the results from the Malmquist Productivity Index analysis of Division 1 of the fist-stage illustrate that all three MFCs showed minus catch-up effects. Also, a soundness from reducing bad loans and expansion of loans in combination with generating various ways of creating profits besides the interest income is urgently needed for Korean MFCs.

Key Words : mutual financing cooperatives, dynamic-network SBM, efficiency, productivity, Malmquist Index

요 약 우리나라 상호금융조합은 안정적이고 지속가능한 성장과 경쟁력 확보를 위해 효율성 및 생산성을 높이기 위한 노력이 필요하다. 따라서 본 연구에서는 2012-2018 기간 중 상호금융조합의 효율성과 생산성을 분석하고, 효율성 및 생산성 제고를 위한 시사점을 제시한다. 분석을 위해 기존의 연구에서 사용된 전통적 블랙박스 DEA(Data Envelopment Analysis) 모형에서 벗어나, 단계 및 동태 분석이 보다 세부적으로 가능한 Dynamic-Network Slacks-Based Measure(DNSBM) 모형을 사용하였다. 분석결과, 첫째, 상호금융기관의 평균 효율성은 매우 낮게 나타났으나, 2015년 이후 개선되고 있는 것으로 분석되었다. 둘째, 우리나라 상호금융기관은 예수금과 대출금 확보 등 영업활동에서의 비효율 보다는 안정적인 이자수익의 확보 등 수익성 측면에서의 비효율이 더 높은 것으로 나타났다. 셋째, 대부분의 상호금융기관의 비효율은 투입요소에서 보다는 산출요소에서 비효율이 높은 것으로 나타났으며, 넷째, Malmquist 생산성 분석결과, 생산성은 효율성 변화(catch-up)에서 후퇴, 기술변화(frontier-shift)에서 성장한 것으로 분석되었다. 이상의 분석결과를 통해 우리나라 상호금융조합은 무수익여신의 관리, 이자수익을 위한 대출확보, 이자수익 외 다양한 수익기반 확보 등의 개선 노력이 필요하다.

주제어 : 상호금융, dynamic-network SBM, 효율성, 생산성, 맴퀴스트 생산성지수

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1. Introduction

The three largest Mutual Financial Cooperatives (MFCs hereafter) in Korea consist of NongHyup, Saemael Gumgo, and ShinHyup(NH, MG, and SH hereafter) according to the level of their total assets in 2018. The purpose of the MFCs includes an operation of providing mutual savings through loans to their members, and many of them are small merchants. Thus, MFCs play an important role as ordinary and regional financial institutions in Korea.

The recent growth in deposits and loans to the members by the MFCs was impressive in 2015-2018: SH's average rates of increase in deposits and loans in those years were 8.7% and 14.5%, while NH and MG's figures are 6.5% and 10.0% and 8.3% and 13.4%, respectively. Notably, the skyrocketing level of loans for SH in 4 years is astounding, approximately 58%. However, despite the high growth of MFCs, many argue how these MFCs could survive amid the risk of not only a prolonged economic recession, which creates the high status of the non-performing loans(NPLs) but also low-interest rates that contribute to low profitability. Therefore, this study aims to analyze the efficiency and productivity of MFCs operating in Daejeon city and Chungjeong provinces in 2012-2018 and suggest policy implications for the stable and sound growth of MFCs for regional development.

A methodology employed in this paper is a Dynamic & Network Slacks-Based Measure(DNSBM) Model initiated by Tone & Tsutsui(2014). DNSBM Model differs from the previous black-box DEA models in that a more comprehensive analysis is enabled where between sub-DMU and between periods interactions are reflected in efficiency estimates. Then, a Malmquist productivity analysis is performed to see longer perspectives for the institutions.

The rest of this paper unfolds as follows. In the second section of this paper, the literature on the efficiency analysis of cooperatives in Korea and other countries, literature on dynamic and network DEA models used for financial institutions, and literature on the Malmquist productivity Index analysis of the cooperatives are discussed. The third section explains the models used: the DNSBM Model and the Malmquist Productivity Index(MPI) analysis. In the fourth section, an empirical analysis is performed. In this section, data sources and basic statistics used are presented first, and next, an empirical analysis of efficiency is performed. Subsequently, the results from the Malmquist productivity Index analysis are discussed. Finally, some concluding remarks including policy suggestions are presented in section 5.

2. Review of the Literature on Management Efficiency for Cooperatives and Credit Unions

Since 2000, there has been a voluminous literature related to management efficiency of the NHs, MGs, and SHs in Korea, analyzed by DEA's basic CCR and BCC models[[1,2]. Hwang(2003) analyzed the management efficiency of the 70 agricultural cooperatives(NHs) in Jeonbuk Province with CCR and BCC models of DEA using the 2002 data. The average efficiency was 0.822, which was inefficient compared to other regions, and only 12 NHs were found to be efficient[3].

Kang and Park(2016) recently analyzed and compared the management efficiency of the credit business of 62 NHs and Fisheries Cooperatives(FCs) in Korea. The system-DEA and bilateral-DEA models were employed[4].

Jung and Lim(2014) utilized the Malmquist Productivity Index to examine 270 MGs in Daegu City and Kyungbuk Province in 2003-2008[5].

B. C. Kim(2003) also examined 50 MGs in the Busan City area[6]. Furthermore, Roh and

Hahn(2002) examined 14 MGs in the Kunsan City area, and concluded that the excessive inputs decreased with more effective human resources after the financial crisis of 2007-8[7].

Lee and Beon(2003) also analyzed 40 MGs in Chungbuk Province in 1999-2002. Their findings include that the average efficiency rate increased from 82.13% in 1999 to 87.67% in 2002 mainly because of the rising the loan-deposit margin[8].

Hong and Gu(2000), Kho(2003), and Kang(2015) investigated SHs in Seoul, Jeonbuk Province, and Gyeonggi Province, respectively[9-11].

Unlike others, Kho(2003) used Tone's(2001) SBM model with an analysis of grouping 8 CRS(Constant Returns to Scale), 31 DRS(Decreasing Returns to Scale), and 36 IRS(Increasing Returns to Scale) SHs among 75[10].

B. C. Kim(2013) also tried to measure the CCR efficiency using non-radial SBM model and Window technique for the regional SHs from 2005 to 2012. Wilcoxon's sign rank test was used[6].

Furthermore, Kim, Cho, and Park(2014) analyzed the management efficiency of the SHs of Gwangju-Jeonnam province from 2006 to 2011, using the bootstrap DEA method. His findings suggest that the results from the general CCR and BCC models of DEA were somewhat overestimated than the bootstrap model[12].

There are also studies of mixing the MFCs: Based on the financial data for 2006 to 2009, Baek(2011) measured the efficiency of management with CCR-DEA for NHs, MGs, SHs, and savings banks in Jeonnam Province. The results of the analysis were surprising since savings banks, which became the main trouble issue in 2011, showed the highest efficiency, and the NHs showed the lowest efficiency scores among the four different institutions[13].

Hahn and Kim(2016) recently studied the efficiency of MGs by CCR and BCC methods from 2010 to 2014. Regression analysis was employed to measure the determinant variables on efficiency: They concluded that the Loans/total assets and securities/total assets had strong positive effects on the efficiency, while equity investment, log assets and BIS capital adequacy ratio had no relationships with the efficiency[14].

In the literature on other countries' cooperatives banks, Amoah and Ohene-Asare(2018) investigated the factors that tend to influence credit union efficiency by specifically examining cost efficiency(CE) and technical efficiency(TE) in Ghana from 2008 to 2014. They used a two-stage DEA method and Tones' SBM-DEA approach with variable returns to scale(VRS)[15]. Perhaps, the most interesting research has been done by Fukuyama and Weber(2012) applied the directional distance function within a two-stage framework model to analyze the efficiency of Japanese credit cooperative Shinkin Banks(similar to MGs of Korea) using labor, physical capital, and equity capital in the first stage to produce deposits. Then the deposits are used as another input to produce loans, securities investments, and other interest-bearing assets in the second stage. Their findings show that there was a more significant inefficiency in the first stage than in the second stage of production. They also added that using a black-box DEA model such as the basic CCR and BCC models with a simple input/output concept could miss about 50% of total bank inefficiency[16].

Several similar studies have been performed by Fukuyama and Weber(2015) and Wanke(2014)[17,18]. Akther, Fukuyama, and Weber(2013) also analyzed 19 private commercial banks and two government-owned banks in Bangladesh in 2005-2008 using a slacks-based inefficiency measure and the directional technology distance function[19].

One may notice that there are many different methods used for measuring the productivity changes in the financial literature: Fisher Index, Tornqvist Index, and the Malmquist Index. The

Malmquist Index method, which was initiated by Malmquist(1953), and developed by Fare, Grosskopf, and Lovell(1994), has been mostly used as an analytical tool to evaluate the productivity change due to the various advantages[20,21]. One of the advantages is that an assumption of profit maximization or cost minimization is not necessary in the model. The Malmquist Productivity Index can be decomposed into the catch-up effect, which relates to the degree to which a DMU improves or worsens its efficiency, and the frontier-effect, which explains the change in the efficient frontiers between the two time periods.

Jung and Lim(2014) employed the Malmquist Index analysis to measure the efficiency and productivity of Saemaul Credit Cooperatives(MGs)[5].

An(2001) also used the Malmquist Index method to analyze the efficiency and productivity of Korean domestic banks in the process of restructuring. Compared to a 1% increase in productivity in 1998, he found that there was a downward shift of the frontier in 1999 by 2.6%[[22].

There are various studies on foreign countries: Pasiouras and Sifodaskalakis(2007) employed the Malmquist Productivity Index to examine the Total Factor Productivity(TFP) change in 13 Greek cooperative banks in the period of 2000-2005. Using both models of the intermediation approach and production approach, they found a discrepancy(mixed results) in the measurement[23]. Many researchers decomposed the Malmquist Index into the catch-up effect and frontier-shift effect such as Bonfiglio(2006) and Bassem(2014) with MENA(Middle East and North Africa)'s microfinance institutions(MFIs) throughout 2006-2011[24,25]. The productivity change of MFIs has been further investigated by Gebremichael and Rani(2012), and Krishnasamy et al.(2004), and Sufian(2007)[26,27,28].

The studies of NHs, MGs, and SHs mentioned above mainly used the CCR and BCC models, which are general and basic models of DEA with somewhat exaggerated results as discussed earlier.

A methodology employed in this paper is a Dynamic & Network Slacks-Based Measure(DNSBM) Model initiated by Tone & Tsutsui(2014). The DNSBM Model differs from the previous black-box DEA models in that a more comprehensive analysis is enabled where between sub-DMU and between-period interactions are reflected in efficiency estimates. Some studies used the dynamic & network SBM models of DEA. H. Kim(2017) used a DNSBM model to measure the efficiency of credit unions in Daejeon and Chungnam/Chungbuk Provinces[29]. Fukuyama and Weber(2017) also measured Japanese bank performance with a dynamic-network Luenberger indicator in 2006-2012, and stated that the dynamic aspect of the model recognizes that non-performing loans, as a final outcome, generated in one period will typically constrain production in a subsequent period[30]. The dynamic behavior of managers when they face high risk lending environment or saving deposits as an excess reserve to use in a subsequent period could be built into the system of DEA. Serrano et al.(2014) presented an analysis of efficiency on Mexican commercial banks after the global financial crisis using a DNSBM DEA model[31].

3. Explaining Methodologies Used - DNSBM Model and Malmquist Productivity Index

The DEA model of the traditional method is most frequently used by the CCR model of Charnes, Cooper and Rhodes (1978) and the BCC model of Banker, Charnes and Cooper (1984). After the traditional CCR and BCC models,

advanced models such as SBM, Network SBM, and Dynamic SBM were proposed. In this study, we used a dynamic & network SBM model that combines three models. With a dynamic & Network DEA model, this section deals with the overall, period, and divisional efficiencies in the case of the non-oriented(i.e., both input- and output-oriented) model. The overall-efficiency is evaluated by the following program. The objective function would be[32]. Period efficiency is defined by

$$r_o^{t*}=\frac{\sum_{k=1}^{k} W^{k}[1-\frac{1}{m_k+linkin_k+nbad_k}(\sum_{i=1}^{m_k}\frac{s_{ik}^{t-}}{x_{ik}^{t}}+\sum_{(kh)_l=1}^{linkin_k}\frac{s_{o(kh)_l\in}^{t}}{z_{o(kh)_l\in}^{t}}+\sum_{k_i=1}^{nbad_k}\frac{s_{ok;bad}^{(t,t+1)}}{z_{ok;bad}^{(t+1)}})]}{\sum_{k=1}^{k} W^{k}[1-\frac{1}{r_k+linkin_k+ngood_k}(\sum_{r=1}^{r_k}\frac{s_{rok}^{t+}}{y_{iok}^{t}}+\sum_{(kh)_l=1}^{linout_k}\frac{s_{o(kh)_lout}^{t}}{z_{o(kh)_lout}^{t}}+\sum_{k_i=1}^{ngood_k}\frac{s_{ok;good}^{(t+1)}}{z_{ok;good}^{(t+1)}})]} \quad (\forall t) \tag{1}$$

Where variables on the right hand side indicate optimal values for the overall efficiency θ_o^*. Divisional efficiency is defined by

$$\delta_{ok}^{*}=\frac{\sum_{t=1}^{T} W^{t}[1-\frac{1}{mk+linkin_k+nbad_k}(\sum_{i=1}^{m_k}\frac{s_{ik}^{t-}}{x_{ik}^{t}}+\sum_{(kh)_l=1}^{linkin_k}\frac{s_{o(kh)\in}^{t}}{z_{o(kh)l\in}^{t}}+\sum_{k_i=1}^{nbad_k}\frac{s_{ok;bad}^{(t,t+1)}}{z_{ok;bad}^{(t+1)}})]}{\sum_{t=1}^{T} W^{t}[1+\frac{1}{rk+linkout_k+ngood_k}(\sum_{r=1}^{r_k}\frac{s_{rok}^{t+}}{y_{rok}^{t}}+\sum_{(kh)_l=1}^{linkout_k}\frac{s_{o(kh)out}^{t}}{z_{o(kh)_lout}^{t}}+\sum_{k_i=1}^{ngood_k}\frac{s_{ok;good}^{(t+1)}}{z_{ok;good}^{(t+1)}})]} \quad (\forall k) \tag{2}$$

Finally, period-divisional efficiency is defined by

$$p_{ok}^{t*}=\frac{1-\frac{1}{m_k+linkin_k+nbad_k}(\sum_{i=1}^{m_k}\frac{s_{ik}^{t-}}{x_{ik}^{t}}+\sum_{(kh)_l=1}^{linkin_k}\frac{s_{o(kh)_l\in}^{t}}{z_{o(kh)_l\in}^{t}}+\sum_{k_i=1}^{nbad_k}\frac{s_{ok;bad}^{(t,t+1)}}{z_{ok;bad}^{(t+1)}})}{1-\frac{1}{r_k+linkin_k+ngood_k}(\sum_{r=1}^{r_k}\frac{s_{rok}^{t+}}{y_{rok}^{t}}+\sum_{(kh)_l=1}^{linout_k}\frac{s_{o(kh)_lout}^{t}}{z_{o(kh)_lout}^{t}}+\sum_{k_i=1}^{ngood_k}\frac{s_{ok;good}^{(t+1)}}{z_{ok;good}^{(t+1)}})} \quad (\forall k, \forall t) \tag{3}$$

where, there are n DMUs (Decision Making Units) (j=1…n) with K divisions (k=1…K) over T time periods (t=1…T). Let mk and be the numbers of inputs and outputs to division k, respectively. Let us denote link leading from division k to division h by $(k,h)_l$, and the set of links by L_{kh}

As we have explained in the previous section, the Malmquist Productivity Index may be divided into the catch-up and frontier-shift effects. The catch-up effect from period 1 to 2 is measured by the following formula[33].

$$catch-up=\frac{Effciency\ of\ (x_o,y_o)^2\ frontier_2}{Effciency\ of\ (x_o,y_o)^1\ frontier_1} \tag{4}$$

Thus, the catch-up effect from the following Fig. 3-1 can be computed as:

$$catch-up=\frac{BD/BQ}{AC/AP} \tag{5}$$

When the catch-up effect is greater than 1, there is a relative efficiency progress from period 1 to 2, and when the catch-up effect is greater than 1, there is a relative efficiency regress or no change in efficiency.

The frontier-effect, on the other hand, can be computed as:

$$Frontier-Shift=\sqrt{\theta_1\theta_2} \tag{6}$$

Where,

$$\theta_1=\frac{Effciency\ of\ (x_o,y_o)^1\ frontier_1}{Effciency\ of\ (x_o,y_o)^1\ frontier_2}=\frac{AC/AP}{AE/AP} \tag{7}$$

And, $$\theta_2=\frac{Effciency\ of\ (x_o,y_o)^2\ frontier_1}{Effciency\ of\ (x_o,y_o)^2\ frontier_2}=\frac{BF/BQ}{BD/BQ} \tag{8}$$

The Malmquist Productivity Index is a product of the catch-up effect and frontier- shift effect:

$$MPI=(Catch-up)\times(Frontier-shift) \tag{9}$$

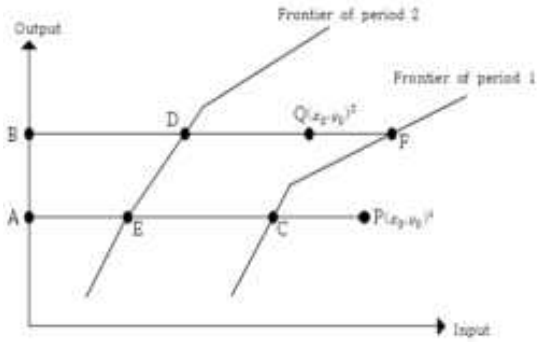

Fig. 1. Catch-up and Frontier-shift Effects

4. Empirical Analysis

4.1 Data Sources and Selection of the Variables Used

This study aims to derive implications for enhancing the competitiveness of Korea's MFCs

in the era of low economic growth and low interest rates by analyzing the efficixency and productivity of NH, MG, and SH in the regions of Daejeon City as well as Chungnam /Chungbuk Provinces. As a methodology used, DNSBM (Dynamic-Network Slacks-Based Measure) Model has been chosen. The period of coverage to be analyzed is from 2012 to 2018, and there are 213 NH branches, 148 MG branches, and 179 SH branches operating in the regions of Daejeon and Chungnam/Chungbuk Provinces. The data has been collected from the Financial Statements, the Financial Statistics System, and Management Disclosure from each institution. The methods of selecting input-output variables for the efficiency analysis of MFCs are the production function approach, the intermediation approach, and the value- added function approach: The production function approach produces outputs of deposits and loans with inputs of the labor and capital; and the intermediation function approach replaces deposits as an input rather than an output, then produces the output of loans; and the value-added function puts the labor, capital, and various expenses as inputs and produces outputs of Loans and profits[34].

In this study, each division illustrates the production function (establishing-funds-stage) and value-added function (profitability-stage); then, input-output variables and link variables are selected based on the above-mentioned methods. First, Division 1 represents the production function of the financial institution, and the number of employees and tangible fixed assets as are selected as inputs, and the deposit has been used as an output variable. The loans used as output variables in this study are selected as a link variable since it is an intermediate output that links to the outputs. In Division 2, which functions as a value-added property, securities and sales management expenses are used as input variables with loan receivables, a link variable. The interest income and operating income are selected as outputs. The carry-over variables are selected to influence between t and t + 1 in each division. Table 1 illustrates the variables of the inputs and outputs, link, and carry-over variables used by H. C. Kim (2017)[29], Fukuyama and Weber (2012, 2015), and Akther, Fukuyama, and Weber (2013), which are quite different from the previous black-box DEA models[16,17,19]. Fig. 2 shows the variables used in this study, similar to the ones H. C. Kim(2017) used in Table 1.

4.2 Empirical Study on Measuring the Efficiency Scores

Table 2 represents the basic statistics of the inputs and outputs used for MFCs in Daejeon and Chungnam/Chungbuk Provinces. Table 3 shows the results of the average efficiencies by MFCs. According to Table 3, the results show that the

Table 1. Inputs, Intermediate Product, Outputs, Carryovers Used in Two-stage DEA Models

Authors	Inputs			Outputs			Link Variables (intermediate product)
	Carryover Inputs	Desirable Inputs	Undesirable Inputs	Desirable Outputs	Undesirable Outputs	Carryover Outputs	
H. C. Kim (2017)	total assets	no. of employees, fixed assets, labor costs	NPLs	deposits, no. of union members	NPLs	total assets, NPLs	loans
Fukuyama & Weber (2015)	loans securities	labor, capital, equity	NPLs	loans securities	NPLs	loans, securities	deposits other raised funds
Akther, Fukuyama & Weber (2013)	-	labor, capital equity	NPLs	loans securities	NPLs	-	deposits

Notes: NPLs denotes non-performing loans.

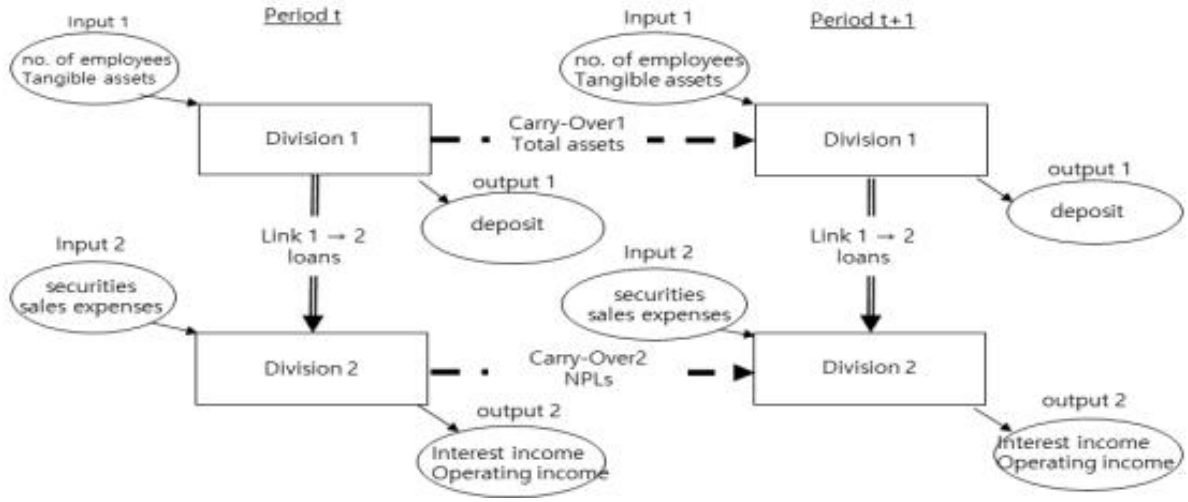

Fig. 2. Two-stage Dynamic Network DEA Model

Table 2. Basic Statistics of the Inputs and Output

	no of employees	tabgible assets	deposits	loans	total assets	GAE	securities	interest income	operating income	RSBLTL (%)
Average	41	1600	116677	85502	138452	1480	3697	5285	6035	2
Max	301	37162	1703722	1325890	1886853	17135	79299	73790	81796	41
Min	2	0	0	5	614	6	0	34	34	0
St Dev	40	2571	158872	121557	180525	1824	7701	6812	8014	2

Notes: GAE and RSBLTL denote the general and administrative expenses and ratio of sub-stand and below loans to total loans, respectively.

Table 3. Efficiency Scores of the MFCs in 2012~2018

efficiency	overall	2012	2013	2014	2015	2016	2017	2018
Total	0.166	0.172	0.197	0.197	0.151	0.159	0.173	0.185
St Dev	0.104	0.106	0.109	0.116	0.113	0.115	0.131	0.140
NH	0.225	0.222	0.247	0.250	0.203	0.219	0.251	0.270
MG	0.126	0.139	0.164	0.162	0.117	0.114	0.116	0.133
SH	0.128	0.140	0.165	0.163	0.116	0.124	0.127	0.127

Table 4. Efficiency Scores by Types in 2012~2018

types	overall	2012	2013	2014	2015	2016	2017	2018
organizations	0.141	0.142	0.170	0.179	0.135	0.151	0.143	0.144
regions	0.168	0.175	0.200	0.200	0.151	0.160	0.175	0.189
workplaces	0.137	0.147	0.160	0.163	0.148	0.151	0.144	0.127

total average efficiency score is 0.166, which illustrates that the average inefficiency was 83.4%, which is strikingly high for MFCs in Deajeon and Chungnam/Chungbuk Provinces in 2012~2018. The efficiency score declined very sharply in 2015 due to many factors including low economic growth, sustaining the global financial crisis, prolonged low interest rates, and increased competition by the lending regulations of the banks. On individual efficiency scores, NH(0.225) showed the highest overall efficiency, followed by SH(0.128) and MG(0.126). After an economic turmoil in 2015, most of the MFCs' efficiency scores had risen to 2018. Up to the year of 2014, MG and SH grew faster(16.5% each) than NH, but NH(33%) grew faster than

Table 5. Average Efficiency Scores by Regions in 2012~2018

Regions	overall	2012	2013	2014	2015	2016	2017	2018
Daejeon	0.156	0.169	0.197	0.198	0.145	0.145	0.152	0.169
Chungnam	0.180	0.186	0.209	0.210	0.163	0.175	0.190	0.204
Chungbuk	0.152	0.156	0.182	0.180	0.136	0.145	0.161	0.168

Table 6. Divisional Efficiency Scores by MFCs

	Overall Score	Division 1	Division 2
Total (540)	0.166	0.285	0.111
MG (148)	0.126	0.228	0.087
NH (213)	0.225	0.350	0.160
SH (179)	0.128	0.253	0.072

others(13.7% for MG and 9.5% for SH) in 2015-2018. The standard deviation of the average efficiency in 2015-2018 rose from 0.113 to 0.140, indicating that the efficiency gap between mutual financial institutions has been widening. The lower efficiency scores measured compared to other studies are due to the dynamic and network system of the methodology used.

Table 4 illustrates the average efficiency scores by various types in each cooperative: By organizations, regions, and workplaces. The overall efficiency scores show that the type of region is the most efficient type (0.168), followed by organizations(0.141) and workplaces (0.137). Furthermore, the efficiency scores for the regions have been steadily increasing since 2012, although there was a big slump in 2015 as we have discussed before, while organizations and workplaces have constantly decreased. According to the results of the regional efficiency measurement in Table 5, it seems that the overall efficiency rate was the highest in Chungnam Province(0.180) than Daejeon(0.156) and Chungbuk Province(0.152). One may notice that during the period, the efficiency scores for Chungnam and Chungbuk rose slightly to 0.204 and 0.168, but that of Daejeon did not improve.

On divisional efficiency analysis, Table 6 summarizes the efficiency scores by Division 1 and Division 2: In Division 1, NH showed a stronger performance in efficiency(0.350) than other competitors, SH(0.253) and MG(0.228). In Division 2, NH also showed the highest score of 0.160 than others, MG(0.087) and SH(0.072). It also seems that the inefficiencies attributed to Division 2 rather than Division 1 for all three institutions. In other words, the inefficiency in creating high profit-stage which measures the sales activities of the financial institutions has been greater than the production-stage. This founding is identical to the results of Fukuyama and Weber(2012)[16].

In summary, the efficiency level of three MFCs in Daejeon City and Chungnam/Chungbuk P rovinces had risen slightly after a severe decline in 2015. However, this rise is the result of a great contribution from NH, especially the type of regions in cooperatives of NH. Also, our results show that the inefficiency has mainly come from Division 2 so that the MFCs need to improve the profitability. Except for NH, the improvement of the efficiency in MG and SH was very insignificant.

4.3 Empirical Analysis of Inefficiency

According to the analysis of divisional inefficiency performed, the causes of the inefficiency in Korea's MFCs seem to lie on the fact of the shortfall of outputs created rather than excessive input factors. According to Table 7, on Division 1, the inefficiency of the input factors, such as the number of employees and

Table 7. Projection of Input−Output, Carryover, and Link Variables

<NH>	Division 1					Division 2				
	Shortage officer	Shortage tasset	Excess deposit	Excess loan	Excess asset	Shortage sga	Shortage security	Excess inter	Excess rev	Shortage nplratio
2012	−28.46	−82.54	40.24	64.28	28.14	−26.85	−76.66	199.07	168.01	−83.09
2013	−27.31	−70.94	35.84	72.67	27.75	−44.10	−75.11	146.87	118.72	−86.45
2014	−20.75	−65.56	70.01	75.67	49.38	−48.34	−69.93	142.03	113.99	−86.04
2015	−26.13	−50.73	138.66	146.42	103.41	−39.17	−61.53	306.41	251.89	−85.01
2016	−23.72	−52.43	160.63	178.64	118.09	−46.00	−59.43	236.03	183.69	−82.98
2017	−21.45	−45.17	155.24	168.23	119.87	−50.92	−56.05	216.99	166.58	−75.87
2018	−21.09	−44.82	165.24	172.90	127.01	−53.92	−52.44	145.82	110.29	−83.74

<MG>	Division 1					Division 2				
	Shortage officer	Shortage tasset	Excess deposit	Excess loan	Excess asset	Shortage sga	Shortage security	Excess inter	Excess rev	Shortage nplratio
2012	−42.45	−77.83	92.52	110.37	72.81	−43.53	−76.67	313.28	313.28	−86.98
2013	−39.20	−78.83	80.71	113.59	67.30	−60.05	−76.75	208.31	193.30	−87.87
2014	−15.30	−67.91	178.25	182.24	130.19	−52.37	−69.32	302.65	266.80	−88.36
2015	−13.46	−62.22	336.35	321.56	283.49	−33.71	−54.52	616.01	578.71	−77.96
2016	−18.41	−63.91	363.81	365.76	304.93	−42.60	−55.96	520.55	480.77	−81.52
2017	−12.63	−62.53	352.24	383.87	308.38	−47.22	−52.52	561.55	510.51	−81.39
2018	−12.19	−62.92	358.54	375.18	311.68	−55.32	−37.64	410.10	378.88	−82.93

<SH>	Division 1					Division 2				
	Shortage officer	Shortage tasset	Excess deposit	Excess loan	Excess asset	Shortage sga	Shortage security	Excess inter	Excess rev	Shortage nplratio
2012	−38.66	−75.34	134.57	195.69	127.77	−47.37	−58.12	367.09	344.99	−88.48
2013	−32.82	−75.53	124.48	242.38	129.51	−61.19	−59.32	278.68	261.97	−90.33
2014	−16.20	−61.54	215.55	315.75	187.81	−58.34	−55.98	352.41	330.31	−88.85
2015	−14.54	−52.49	390.91	524.06	342.18	−49.10	−45.89	675.82	627.54	−85.23
2016	−18.02	−52.86	425.76	598.26	371.78	−53.56	−45.32	546.97	506.77	−86.98
2017	−13.73	−50.76	422.21	691.80	398.30	−57.61	−49.97	614.40	575.16	−84.85
2018	−11.49	−49.98	541.39	617.20	465.27	−59.88	−76.84	490.30	454.20	−85.31

tangible assets, was decreasing. However, the shortfall of output factors was increasing. This might reflect the difficulties in securing deposits and loans due to the prolonged low−interest rates and increased competition in the Korean banking system. With the above−mentioned macroeconomic problems faced, the banks need to be improved on their own, for instance, a structural change of the organization, which may enhance the level of profits.

On Division 2, it seems that the inefficiency of the output factors such as interest income and operating income is very high, and the ratio of sub−stand and below loans to total loans was improved but not significantly. This implies that Korea had put effort into increasing the soundness of the banking system through the reduction of bad loans. However, as a result, the profitability of the MFCs has been lowered due to for example, a conservative loan system. That is, the expansion of loans and generating various ways of creating profits besides the interest income are urgently needed in the Korean MFC industry.

4.4 Malmquist Productivity Index Analysis

According to the Table 8, results of the Malmquist Productivity Index(MPI) analysis, the overall MPI shows 1.2% − a positive productivity growth: MG showed the highest rate, 3.0%, while NH and SH resulted in 2.8% and minus 2.1%, respectively. In Division 1, it is surprising that SH showed the highest rate of 4.1%, while NH and MG showed 4.1% and 3.4%, respectively. In Division 2, MG and NH showed 2.8% and 1.9% growth rates, while SH resulted in minus 2.1% growth. It seems that there had been a large gap of efficiency between Division 1 and Division 2 for SH: SH had difficulty in generating profits due to the continued low− interest rates and a

Table 8. Results of the Malmquist Productivity Index Analysis

	Div1	Div2	Overall
Total Average	1.039	0.990	1.012
NH	1.041	1.019	1.028
MG	1.034	1.028	1.030
SH	1.042	0.925	0.979

Table 9. Results of Malmquist Index, Catch-up & Frontier-Shift Effects (2012~2018, Geometric mean)

Malmquist index	Total		NH		MG		SH	
	Div 1	Div 2	Div 1	Div 2	Div 1	Div 2	Div 1	Div 2
Malmquist	1.039	0.990	1.041	1.019	1.034	1.028	1.042	0.925
Catch-up	0.947	0.995	0.978	0.990	0.920	1.007	0.933	0.991
Frontier-Shift	1.101	0.997	1.070	1.033	1.124	1.021	1.117	0.933

more competitive environment in the banking system in Korea. Table 9 illustrates the decompositions of the productivity index of the Division 1 and Division 2 into the catch-up and frontier-shift effects. According to Table 9, on Division 1, the production-stage, the geometric means of the catch-up effects for the NH(0.978) was the highest form 2012 to 2018, while the catch-up effects for MG and SH show 0.920 and 0.933, respectively. On the frontier-shift effect, MG resulted in the highest rate of 1.124, illustrated that the production function shifted outward by 12.4% due to the technical progress, while NH and SH showed 1.070 and 1.117.

On Division 2, the profit-stage, the geometric means of the catch-up effects for the MG(1.007) was the highest ratio during the same period, while the catch-up effect for NH and SH showed minus growth, 0.990 and 0.991, respectively. On the frontier-shift effect, MG resulted in the highest rate of 1.021, while NH and SH showed 1.033 and 0.933.

5. Conclusion

The cooperatives in the financial market in Korea have been struggling with low-interest rates, a long period of economic recession, and rapid growth of the financial innovation. This paper examined the efficiency and productivity of the three largest Mutual Financial Cooperatives(MFCs), NongHyup(NH), Saemael Gumgo (MG), and ShinHyup(SH) with 540 DMUs in the regions of Daejeon City and Chungnam/Chungbuk Provinces during the period of 2012-2018. The methodology used is a Dynamic-Network Slacks-Based Measure(DNSBM) Model of DEA(Data Envelopment Analysis), which differs from the conventional Black-Box models of CCR and BCC used in various ways.

The findings from an empirical study include that first, NH(0.225) showed the highest overall efficiency, followed by SH (0.128) and MG(0.126). However, after 2015, most of the MFCs' term-efficiency scores had risen up to 2018. It seems to be due to the continuous growth of their deposits and loans, as the role of MFCs in Korea has increased since the global financial crisis.

Second, the measured average efficiency scores by various types in each cooperative bank show that the regions were the most efficient in the period examined, while Chungnam showed the highest efficiency score.

Third, in divisional analysis, this paper found that the inefficiency in creating the high profitability-stage, which includes the sales activity of the cooperatives, had been greater

than the establishing-funds-stage. The results of Division 1's efficiency showed that NH had a stronger performance in efficiency(0.350) than other competitors, SH(0.253) and MG(0.228). In Division 2, NH also showed the highest score of 0.160 than others, MG(0.087) and SH(0.072). It is believed that inefficiency at the profit-stage increases because it is difficult to secure the profitability of mutual financial institutions due to a prolonged low interest rate and low growth and intensified competition between financial institutions. Therefore, mutual financial institutions need to secure interest income and risk management efforts to improve efficiency.

Fourth, in projection analysis, we have found that the inefficiency of the output factors such as interest income and operating income was very high: Korea had put effort into increasing the soundness of the banking system by the reduction of bad loans. However, our analysis shows that the Korean MFCs' profitability had been lowered because of a conservative loan system. Thus, we may suggest that the expansion of loans and the creation of various ways of creating profits besides the interest income are urgently needed in the Korean MFC industry. In the analysis of efficiency decomposition, it was also determined that inefficiency in the output factors was high due to difficulties in securing the profitability of mutual financial institutions.

Fifth, in the Malmquist Productivity Index(MPI) analysis, the empirical results show that the overall MPI shows 1.2% - a positive productivity growth: MG showed the highest rate, 3.0%, while NH and SH resulted in 2.8% and minus 2.1%, respectively. All three MFCs' productivity rates are meager enough not to overcome the difficult macroeconomic situation. Both the catch-up effect of the frontier-shift effect in all divisions resulted in very low rates. The catch-up effects in Division 1 were especially insignificant, minus growth rates for all three MFCs, while the frontier-shift effects are moderate in both divisions. Since 2012, the effect of technology change has been steadily growing as loans, and deposits of mutual financial institutions have increased. On the other hand, the catch-up effect decreased due to the deterioration of profitability of some individual combinations due to intensified competition among financial institutions and continued low-interest rate growth.

Through the above results, this study suggests a management strategy for sustainable development by increasing the efficiency and productivity of mutual financial cooperatives.

First, the mutual financial cooperatives that rely on interest income have to make efforts to secure stable profitability. Mutual financial cooperatives need more aggressive loan business activities to secure interest income, such as expanding service to members and developing various financial products in connection with the living economy.

Second, in addition to interest income, it is necessary to secure various profit bases, including commission received, commission deducted, other commission in credit received, and non-operating profit through asset management.

Third, the mutual financial cooperatives need to manage non-profit loans and secure stability and soundness of profits through risk management such as strengthening loan review, including collateral, and strengthening employee expertise.

The next researchers may focus on a more critical issue of the MFCs or people's financial institutions such that what is being effective or being efficient: Being efficient could have nothing to do with doing the right things for the poor in the region, rather we should put a big emphasis on effectiveness, doing things right. That is, a more systematic and thorough analysis of the social efficiency point of view needs to be developed.

REFERENCES

[1] A. Charnes, W. Cooper & E. Rhodes. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2(6),* 429-444.

[2] R. Banker, A. Charnes & W. Cooper. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30(9),* 1078-1092.

[3] J. S. Hwang. (2003). The Analysis on Management Efficiency for the Regional Agricultural Cooperatives. *Journal of Industrial Economics and Business, 16(4),* 29-43.

[4] H. A. Kang & C. H. Park. (2016). A comparative study of management efficiency in credit business of unit Nonghyup and Unit SuHyup. *Korean Journal of Cooperative Studies, 34(3),* 45-71.

[5] J. H. Jung & S. M. Lim. (2014). Investigation of efficiency and productivity of Saemaul Credit Cooperatives by Using DEA-Malmquist Productivity Measure. *Korean Journal of Financial Engineering, 13(1),* 79-100.

[6] B. C. Kim. (2013). Union efficiency change by using non-radial SBM Model and DEA Window Model. *Journal of Professional Management, 16(3),* 39-60.

[7] D. H. Rho & S. W. Hahn. (2001). A Study on the Management Efficiency of Gunsan Credit Cooperatives by Data Envelopment Analysis. *Regional Development Study, 2(1),* 71-89.

[8] M. S. Lee & U. S. Beon. (2003). A Study on Improvements of Efficiency of Community Credit Cooperatives. *Korean Academic Society of Accounting, 8(2),* 79-98.

[9] B. Y. Hong & J. O. Gu. A Data Envelopment Analysis of the Efficiency of Credit Unions. *Management Study, 17(4),* 121-138.

[10] S. S. Koh. (2003). Management efficiency measurement of credit union in Jeonrabukdo district. *Accounting Information Review, 19,* 221-236.

[11] E. K. Kang. A measurement of credit union efficiency by slack-based measure. *Journal of Business Research, 2015, 30(4),* 1-26.

[12] J. D. Kim, Y. S. Cho and S. C. Park. (2014). Managerial efficiency of local credit unions using bootstrap DEA. *Korean Journal of Financial Engineering, 13(1),* 101-127.

[13] J. U. Baek. (2001). An efficiency analysis of Korean thrift institutions through DEA. *Journal of Industrial Economics and Business, 24(3),* 1363-1378.

[14] Y. H. Hahn & Y. S. Kim. Analysis of efficiency for community credit cooperative by DEA. *Korea International Accounting Review, 66,* 99-120.

[15] B. Amoah, K. Ohene-Asare, G. Bokpin & A. Aboagye. (2018). Technical efficiency: the pathway to credit union cost efficiency in Ghana. *Managerial Finance, 44(11),* 1292-1310.

[16] H. Fukuyama & W. L. Weber. (2012). Estimating two-stage network technology inefficiency, an application to cooperative Shinkin Banks in Japan. *International Journal of Operations Research and Information Systems, 3(2),* 2012, pp. 1-23.

[17] H. Fukuyama & W. L. Weber. (2015). Measuring Japanese bank performance: a dynamic network DEA approach. *Journal of Productivity Analysis, 44,* 240-264.

[18] P. Wanke & C. Barros. (2014). Two-stage DEA: an application to major Brazilian banks. *Expert Systems With Applications, 41(5),* 2337-2344.

[19] S. Akther, H. Fukuyama & W. Weber. (2013). Estimating two-stage network slacks-based inefficiency: an application to Bangladesh banking. *Omega, 41,* 88-96.

[20] S. Malmquist. (1953). Index Numbers and Indifference Surfaces. *Trabajos De Estatistica, 4,* 209-242.

[21] R. S. Fare, S. Grosskopf & C. A. Lovell. (1994). *Production Frontiers.* Cambridge University Press.

[22] J. K. An. (2001). Analysis on the Efficiency of Domestic Banks in the Process of Restructuring: DEA and Malmquist Index Approaches. *Journal of Korean Economic Studies, 6,* 5-39.

[23] F. Pasiouras & E. Sifodaskalakis. (2007). *Total Factor Productivity Change of Greek Cooperative Banks.* University of Bath Working Paper. 2007.

[24] A. Bonfiglio. (2006). *Efficiency and Productivity Changes of the Italian Agrifood Cooperatives: A Malmquist Index Analysis.* Working Paper 250, Universita' Politecnica delle Marche(I), Dipartimento di Scienze Economiche e Sociali,

[25] B. S. Bassem. (2014). Total Factor Productivity Change of MENA Microfinance Institutions: A Malmquist Productivity Index Approach. *Economic Modelling, 39,* 182-189.

[26] B. Z. Gebremichae & D. I. Rani. (2012). Total Factor Productivity Change of Ethiopian Microfinance Institutions (MFIs): A Malmquist Productivity Index Approach (MPI). *European Journal of Business and Management, 4(3),* 105-114.

[27] G. Krishnasamy. (2004). A. Ridzwa, and P. Vignesan, "Malaysian Post-merger Banks' Productivity: Application of Malmquist Productivity Index. *Management and Finance, 30,* 63-74.

[28] F. Sufian. (2007). Total Factor Productivity Change in Non-bank Financial Institutions: Evidence from Malaysia Applying A Malmquist Productivity Index (MPI). *Applied Econometrics and International Development, 7(1),* 177-186.

[29] H. C. Kim. (2017). An analysis of efficiency for credit union in Daejeon and Chungcheong by employing dynamic and network SBM. *Journal of Industrial Economics and Business, 30(1),* 189-215.

[30] H. Fukuyama & W. L. Weber. (2017). Measuring bank performance with A dynamic network Luenberger indicator. *Annals of Operations Research, 250(1),* 85-104.

[31] F. Serrano, L. Guerrero, G. Waeselynck, G. Cheng and P. Zervopoulos. (2014). *A dynamic network DEA model: an application to Mexican commercial banks before and after the 2008 global financial crisis.* Proceedings of the 12th International Conference of DEA.

[32] K. Tone & M. Tsutsui, (2014). Dynamic DEA with network structure: a slacks-based measure approach. *Omega, 42,* 124-131.

[33] W. W. Cooper, L. M. Seiford & K. Tone. (2007). Some models measures for evaluating performances with DEA : past accomplishments and future prospects. *Journal of Productivity Analysis, 28(3),* 151-163.

[34] A. Berger & D. Humphrey. (1997). *Measurement and Efficiency Issues in Commercial Banking.* in Output Measurement in the Service Sectors, edited by Z. Griliches, University of Chicago Press.

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