Pertanika J. Soc. Sci. & Hum. 28 (3): 2343 - 2358 (2020)

PERTANIKA JOURNALS

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

An Investigation of the Factors Influencing the Financial Performance of Agricultural Cooperatives in Thailand

Prajya Ngamjan[1] and Jiroj Buranasiri[2]*

[1]Faculty of Liberal Arts and Management Science, Kasetsart University Chalermphrakiat Sakonnakhon Province Campus, Chiangkrua, Muang, Sakonnakhon 47000, Thailand
[2]Innovation College, Thammasat University, Pranakhon, Bangkok 10200, Thailand

ABSTRACT

This study investigates the factors influencing the financial performance of 1,766 agricultural cooperatives in Thailand by applying the DuPont analysis framework. Financial performance, measured using ROE (return on equity), was decomposed to three contributing factors, *viz*., profitability, asset efficiency, and financial leverage. Linear regression and quantile regression analyses were employed to respectively estimate the conditional mean and conditional quantiles. Profitability was found to be the strongest driver of ROE. Asset efficiency and financial leverage were also positive contributors to ROE. An alternative regression model was carried out, where the financial performance construct ROE was replaced with ROA (return on assets). The findings suggest that increasing leverage leads to decreasing performance, contradicting the earlier results. This implies that whether leverage hurts or benefits performance can depend on the variable choice. Employed as control variables, location and age were found to be associated with performance. In particular, the cooperatives in the central region, in general, appeared to have the lowest financial performance. The study empirically pointed out that negative equity led to violations of the ordinal and interpretable properties of ROE. Thus, ROE components should be carefully examined. Regarding cooperative management policy, cooperatives should concentrate on both operating and financial performances with the priority given to profitability, which

ARTICLE INFO

Article history:
Received: 19 March 2020
Accepted: 20 July 2020
Published: 25 September 2020

E-mail addresses:
prachya.ng@ku.th (Prajya Ngamjan)
jirojb@gmail.com (Jiroj Buranasiri)
*Corresponding author

ISSN: 0128-7702
e-ISSN 2231-8534

involves the efficiencies of cost and sales management.

Keywords: Cooperative, DuPont identity, financial performance, quantile regression

INTRODUCTION

It is widely acknowledged that cooperatives play a crucial role in improving the socio-economic conditions of their members and communities (United Nations [UN], 2009). Likewise, over the past century, since the first cooperative in Thailand, the Wat Chan Cooperative Unlimited Liability, was established in 1916, cooperatives have played a crucial role as economic contributors to the economy (Krasachat & Chimkul, 2009; Patrawart & Sriurai, 2016). In 2018, there were 6,626 cooperatives with more than 12 million members (about 17% of the country's population), and they contributed THB 2.188 trillion (13% of the GDP) to the nation's GDP (Cooperative Promotion Department of Thailand, 2019).

The cooperatives in Thailand can be classified according to seven types, namely, agricultural, fishery, land settlement, consumer, service, thrift and credit, and credit union. The largest type is the agricultural cooperative, which accounts for more than half of all cooperatives, totaling 3,367 cooperatives and 6.52 million members (Cooperative Auditing Department of Thailand, 2019b). However, in terms of profitability, it was found that 30.53% of agricultural cooperatives were unprofitable compared to 14.18% of the other six types of cooperatives. In addition, in terms of financial performance, the return on equity (ROE) of agricultural cooperatives was 4.85% compared to 6.82% of the other cooperatives' ROE (Cooperative Auditing Department of Thailand, 2019c). Therefore, agricultural cooperatives in Thailand suffer both low profitability and low financial performance. However, one may argue that cooperatives are not necessarily profiting maximizers, as cooperatives also have a duty to promote the welfare of their patrons. That is, cooperatives have been noted to have dual objectives (Draheim, 1952). Nonetheless, in order to serve the function of promoting the well-being of society, it is necessary for cooperatives to be successful in their business operations (Dogarawa, 2010). In other words, before becoming socially successful, cooperatives should be financially successful (Rochin, 1983). The financial performance of cooperatives determines the capability to support their members and the viability of the cooperatives *per se*. Every cent of the return from investment in cooperatives signifies not only support for each member's well-being but also a contribution to the growth of the economy as a whole.

The objectives of this study were twofold; namely, to explore the factors driving the performance of agricultural cooperatives in Thailand by employing the DuPont analysis, and to make recommendations for improvement. Not only will the management of cooperatives be able to adapt the findings of this study to improve cooperatives' strength, but also policymakers may be able to employ the

findings for policy development in order to promote the performance of cooperatives.

This paper is organized into four sections: first, the introduction is presented; second, the methodological framework and a review of the literature are discussed; third, the data, variables, and model estimation are described; and last, a conclusion and discussion are made, and recommendations are proposed.

METHOD

Applied research on cooperative performance can be grouped according to two general approaches, *viz.* financial measurements and non-financial measurements (Soboh et al., 2009). On the one hand, financial or economic measurements, in general, measure profitability or efficiencies by using accounting data. On the other hand, nonfinancial measurements involve, for instance, member satisfaction, member ownership and controls, and community development (Monaghan & Sadler, 2013). This study adopted a financial measurement method, namely, DuPont analysis, as discussed in the next section, along with a related literature review.

DuPont Analysis

The DuPont analysis is a framework for analyzing financial performance made known by the DuPont Corporation since 1912 (Flesher & Previts, 2013). The analysis involves decomposing ROE, defined as net income divided by equity, into three different contributors, as shown in equation [1].

$$\begin{aligned} &ROE \\ &= profitability \\ &\times asset\ efficiency \\ &\times financial\ leverage, \end{aligned} \quad [1]$$

This allows tracking down the strength and weakness of a cooperative into three areas; namely, *profitability*, *asset efficiency*, and *financial leverage*, which are, respectively, proxied by the following constructs: profit margin = net income/sales, asset turnover = sales/assets, and equity multiplier = assets/equity.

In brief, the net profit margin variable is the result of the cooperatives' ability to control their expenses—mainly interest expenses and operating expenses. The asset turnover variable reflects the efficiency of the cooperatives' asset utilization. The higher the ratio, the higher is the efficiency. The equity multiplier variable shows the use of financial leverage. The higher the cooperative's debt financing, the larger is the equity multiplier.

The DuPont equation can further be expanded into five components, as shown in equation [2].

$$\begin{aligned} &ROE \\ &= \frac{NI}{EBT} \times \frac{EBT}{EBIT} \times \frac{EBIT}{Sales} \\ &\times \frac{Sales}{Assets} \times \frac{Assets}{Equity}, \end{aligned} \quad [2]$$

where EBT is earnings before taxes, and EBIT is earnings before interest and taxes. Equation [2] further decomposes the profit margin ratio into measures on tax burden (NI/EBT), interest burden (EBT/EBIT), and operating profit margin (EBIT/sales). However, according to s. 39 and s. 69 (bis) of the Thai Revenue Code, the cooperatives in Thailand are not liable for corporate taxes. Therefore, this study concentrated on the DuPont framework of equation [1].

Literature Review

DuPont applications are widely carried out on corporate performance (de Wet & du Toit, 2007; Keown et al., 2008). However, only a small amount of research has applied the DuPont analysis to agricultural financial performance (Grashuis, 2018). Grashuis and Ye (2019) offered an excellent review of cooperative performance. This section offers a brief and selective literature review, concentrating on measuring cooperative financial performance *via* the DuPont expansion analysis. Mishra et al. (2009) used the DuPont expansion to examine agricultural profitability on the state-level data of ten U.S. Economic Research Service regions between 1960 and 2004. The study found that a perpetually low-profit margin and low asset efficiency were the causes of low profitability. Mishra et al. (2012) further employed the DuPont expansion method with a system of equations to analyze farm-level data from the U.S. Department of Agriculture's Agricultural Resource Management Survey in order to evaluate the factors driving profitability between 1996 and 2009. The drivers of the DuPont's components were specialization, farm size and typology, contracting, and level of government payments. Additionally, Grashuis (2018) studied the financial performance of the largest 1,000 U.S. farmer cooperatives using the extended DuPont on efficiency, productivity, and leverage. The author employed the quantile regression method and found that financial performance was largely associated with the operating profit margin.

Data Analysis and Results

Data. The annual data for the year 2018 of all agricultural cooperatives in Thailand were retrieved from the Cooperative Auditing Department (Cooperative Auditing Department of Thailand, 2019a). Due to data availability, the initial sample set contained 2,663 agricultural cooperatives, which could be classified according to the attributes of their net income and equity, as shown in Table 1.

Table 1 reveals that, out of 2,663 cooperatives, 1,908 were profitable, whereas 755 suffered a financial loss. Furthermore, 272 cooperatives reported negative equity (liabilities exceeding assets), implying they were experiencing financial distress. The last column of Table 1 reports that 1,860 cooperatives had both positive net income and positive equity, and 224 were experiencing negative net income and negative equity. Since the DuPont analysis concentrates on the financial performance measure, ROE, the next section discusses the empirical problems concerning ROE.

Table 1

Agricultural cooperatives by the sign of ROE's components (net income and equity)

Sign	Net Income	Equity	Net income and Equity
Positive	1,908	2,391	1,860
Negative	755	272	224
Sum	2,663	2,663	2,084

ROE Issues. Financial ratios such as ROE and ROA are widely employed as financial performance measures (de Wet & du Toit, 2007; Mubashar & Tariq, 2017; Şamiloğlu et al., 2017). If the denominator of such index variables is negative, the construct validity is violated in two ways; namely, 1) these indices will lose their ordinal property; and 2) it is difficult or impossible to interpret the meaning of such indices (Thornblad et al., 2018). This is the case for ROE since the denominator shareholders' equity can become negative if the level of debt exceeds total assets. Each row *a* in Table 2 summarizes the plausible cases of ROE, while row *b* presents related numerical examples taken from the empirical data of this research with fictitiously renamed cooperatives A, B, C, D, and E.

Cooperatives A and B both reported positive ROEs of roughly 1%, implying a favorable return on equity. However, this

Table 2

ROE – ordinal and interpretational problems: *empirical evidence*

co-op		Equity	Net income	ROE	Interpretation
A	a	positive	positive	positive	normal operation
	b	40,615,783.67	429,543.28	0.0106	
B	*a*	negative	negative	positive (falsely)	financially distressed
	b	-1,282,953.48	-13,597.93	0.0106	
C	*a*	positive (low figure)	positive	positive	likely to be over-leveraged
	b	8,711.74	25,582.41	0.3405	
D	*a*	positive	negative	negative	losses (temporary or long-term)
	b	5,858,957.45	-1,362,066.58	-0.2325	
E	*a*	negative	positive	negative	not meaningful, debts exceed assets
	b	-1,286,718.65	457,345.77	-0.355	

Note: Each row *a* of the fictitiously renamed cooperatives A, B, C, D, and E summaries the plausible cases of ROE, where row *b* presents related selected numerical examples taken from the empirical data

was not the case for B, since the positivity was a result of negative earnings and negative equity, falsely interpreting B as generating a positive return on equity is misleading. The ROE of co-op C was 34% due to the low equity value. A closer look reveals that the debt-to-equity (D/E) and debt-to-asset (D/A) ratios were respectively 9.62× and 0.91×, implying high leveraging. The negative ROE of D correctly indicated that a loss incurs to the equity. However, the negative ROE of E was difficult to meaningfully interpret, since it came from negative equity. Cases B, C, and E represented problems of ordinality and interpretability. A problem arises when the denominator equity is in the range of low positive to negative values. If this problem is not addressed, the results and interpretations can be spurious. The following remedies are proposed; namely, 1) drop negative equity ROE out of the sample, which however may lead to sampling bias (Trimbath, 2006); 2) employ a transformation of the index that will preserve the ordinality and interpretability; and 3) use an alternative profitability measure that is not affected by a negative denominator. In this respect, ROA is a good alternative since the divisor's total assets cannot be negative.

In addition to ROE, this research thus employs ROA as an alternative performance measure. Furthermore, in order to ensure well-specified data, 224 positive ROE cooperatives that were generated from negative net income and negative equity were opted out from the sample set, whereas 5% of both tails of the data were excluded. The final sample set contains 1,766 cooperatives.

Variable Characteristics

The attributes of the variables are summarized in Table 3. The sample-set includes 1,766 agricultural cooperatives in Thailand for the year 2018. NI.Sales (profit margin) is the ratio of net income to sales; Sales.Assets (asset turnover ratio) is the ratio of sales to total assets; Debt.Equity is the ratio of debt to equity; Debt.Asset is the ratio of debt to total assets; and Age is the age (in years) of the cooperative as of 31 December 2018. Table 4 reports the correlation coefficients of the independent variables.

Table 3
Summary statistics

Statistics	ROE	ROA	NI.Sales	Sales. Assets	Debt. Equity	Debt. Asset	Age
Mean	0.0836	0.0461	0.1940	2.8112	1.905	0.4495	25.509
Median	0.0653	0.0293	0.0752	0.2833	1.008	0.5019	24.776
Std.Dev.	0.0724	0.0549	0.3719	11.4865	4.336	0.2885	14.084
Range	0.4110	0.4112	10.4532	201.411	105.382	0.9906	67.317

Table 3 *(Continued)*

Statistics	ROE	ROA	NI.Sales	Sales. Assets	Debt. Equity	Debt. Asset	Age
Minimum	0.0037	0.0007	0.0002	0.0037	0.000	0.000	0.5306
Maximum	0.4147	0.4119	10.4535	201.4147	105.382	0.9906	67.847
Observation	1766	1766	1766	1766	1766	1766	1766

Table 4

Correlation matrix

	NI.Sales	Sales.Assets	Debt.Equity	Debt.Asset	Age
NI.Sales	1				
Sales.Assets	-0.1170	1			
Debt.Equity	-0.0901	-0.0701	1		
Debt.Asset	-0.2025	-0.2285	0.4792	1	
Age	-0.1068	-0.2311	0.0135	0.3356	1

Model Estimation

Ordinary least squares (OLS) regression is the main workhorse in applied econometrics (Granger, 2010). However, OLS relies on a set of rigorous assumptions regarding the characteristics of the data. For example, if the assumptions on homoscedasticity and normality are not satisfied, the OLS may no longer be a good estimator (best linear unbiased estimator properties may not hold). Alternatively, quantile regression, introduced by Koenker and Bassett (1978), does not make an assumption on the distribution of the residuals and is more robust to outliers. It is known that mean is not always an accurate measure of the central tendency of the entire data, particularly in the presence of outliers and skewed distributions. Rather than focusing on a single estimation of a conditional mean, quantile regression offers a mechanism to estimate the conditional median function of the entire conditional distribution of the response (Rodriguez & Yao, 2017). Therefore, in addition to the OLS, this research also employed quantile regression estimation.

The estimations of all of the regression models were carried out in the R programming environment. In particular, the "robustbase" and "quantreg" libraries were employed for robust estimation and quantile regression. Under the framework of DuPont analysis equation [1], without loss of generality, in order to make the interpretation of the leverage effect on the profitability more straightforward, a proxy

of financial leverage, namely, debt-to-equity ratio, replaces the equity multiplier ratio in equation [1]. In addition, a set of control variables is included in equation [3], where the variable definitions are offered in Table 5.

$$\begin{aligned} ROE_i &= \beta_0 + \beta_1 \left(\frac{NI}{Sales}\right)_i \\ &+ \beta_2 \left(\frac{Sales}{Assets}\right)_i \\ &+ \beta_3 \left(\frac{Debt}{Equity}\right)_i \\ &+ \beta_4 Age_i + \beta_5 S1_i \\ &+ \beta_6 S2_i + \beta_7 S3_i \\ &+ \eta_i, \end{aligned} \quad [3]$$

The subscript i refers to cooperative i. β_i, i = 1 ... 7, are the corresponding parameters for the independent variables. η_i is the classical linear regression error term. The control variables are Age_i and regional dummies (S1, S2, S3, and $S4_i$), where $S4_i$ is opted out as the base case. The following briefly details the agricultural activities in each region. The central region includes: rice, fruits, vegetable crops, field crops, and livestock. The north-eastern region includes: rice, rubber, cassava, jute, mulberry, soybean, mungbean, peanut, sesame, and some vegetable crops. The northern region includes: rice, soybean, mungbean, corn, cotton, sorghum, and fruits. The southern region includes: rubber, rice, fruits, vegetables, oil palm, marine fisheries, and prawn farms (Chainuvati & Athipanan, 2001; Poapongsakorn, 2011).

Table 5
Variable working definition

Variable	Working Definition
DuPont Components	
return on assets =	*net income / assets*
return on equity =	*net income / equity*
profit margin =	*net income / sales*
asset turnover =	*sales / assets*
debt-to-equity =	*debt / equity*
debt-to-asset =	*debt / asset*
Control Variables	
Age_i = age (in years) of the cooperative as of 31 December 2018.	
Regional dummy variables	
$S1_i$=	1 if the cooperative is in the central region, 0 otherwise
$S2_i$=	1 if the cooperative is in the north-east region, 0 otherwise
$S3_i$=	1 if the cooperative is in the northern region, 0 otherwise
$S4_i$=	1 if the cooperative is in the south, 0 otherwise

The various estimation models employed are as follows: Model 1 is an OLS regression with MM-type robust estimators (Koller & Stahel, 2011; Yohai, 1987). Models 2, 3, and 4 are quantile regressions where the data are classified into 25th, 50th, and 75th quantiles. A set of models called 1a, 2a, 3a, and 4a were also employed, where two variables of Models 1 to 4 (equation [3])—namely, ROE and debt-to-equity ratio—were replaced with ROA and debt-to-asset ratio, respectively. The reason was to investigate the variability of the results using the alternative financial performance and capital structure measures. The estimation results for Models 1 to 4 (for OLS and quantile regressions) are presented in Table 6.

OLS Regression Results. The MM-type regression Model 1 revealed that all of the DuPont components were positively and

Table 6

Regression results [a]

dependent variable: ROE	OLS Regression	Quantile Regression		
		25th	50th	75th
indep. variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Intercept	0.0545***	0.0275***	0.0681***	0.1233***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
NI/Sales	0.0528***	0.0447***	0.0437***	0.0440***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sales/Assets	0.0041***	0.0010**	0.0024***	0.0035***
	(0.0000)	(0.0143)	(0.0012)	(0.0000)
Debt/Equity	0.0039***	0.0012*	0.0041***	0.0071***
	(0.0000)	(0.0891)	(0.0000)	(0.0000)
Age	-0.0001	0.0002*	-0.0004***	-0.0013***
	(0.3978)	(0.0504)	(0.0016)	(0.0000)
S1	-0.0169***	-0.0167***	-0.0188***	-0.0154**
	(0.0000)	(0.0000)	(0.0001)	(0.0121)
S2	-0.0093***	-0.0075**	-0.0122***	-0.0156***
	(0.0058)	(0.0435)	(0.0022)	(0.0048)

Table 6 *(Continued)*

dependent variable: ROE	OLS Regression	Quantile Regression		
		25th	50th	75th
indep. variable	Model 1	Model 2	Model 3	Model 4
S3	-0.0083*	-0.0040	-0.0110***	-0.0098*
	(0.0169)	(0.3673)	(0.0098)	(0.0899)
Adjusted R^2, [b]	0.314	n.a.	n.a.	n.a.
Psudo-R^2, [b]	n.a.	0.0535	0.0694	0.0338
Sample size	1,766	1,766	1,766	1,766

Note: ***, **, * significant at 1%, 5%, and 10% levels, respectively

[a] The dependent variable of Models 1, 2, 3, and 4 is ROE: Model 1 is a linear regression model with MM-type estimators. Models 2, 3, and 4 are quantile regressions where the data are separated into 0.25, 0.50, and 0.75 quantiles

[b] *Psudo-*R^2 is reported since R^2 is not an applicable goodness-of-fit metric for quantile regressions, as they are calculated by minimizing the absolute values of the weighted residuals, not the sum of the squared errors.

significantly associated with ROE at the 1% level, i.e. for profitability (*NI/Sales*): β_1 = 0.0528, implying that a one percentage point increase in profit margin is significantly related to a 0.0528 percentage point increase in ROE, asset efficiency (*Sales/Assets*) β_2 = 0.0041; and financial leverage (*Debt-to-equity*) β_3 = 0.0039. *NI/sales* were the factor with the strongest marginal effect on ROE. *Age* was not statistically significant. Regarding the regional dummy variables, the agricultural cooperatives in the south on average had the highest ROE, followed by the northern, the north-eastern, and the central regions, respectively.

Quantile Regression Results. This study employed quantile regression in order to investigate whether the factors affected the profitability differently for different quantiles for the entire distribution. The estimations were carried out on 0.25, 0.50, and 0.75 quantiles. All of the DuPont components were still found to be significantly and positively associated with ROE. For *NI/sales*, the positive effect on ROE was relatively constant across quantiles, at 0.0447, 0.0437, and 0.044 for the 25th, 50th, and 75th quantiles, respectively. This implies that the marginal effect of the profit margin on ROE is strong and relatively constant among cooperatives with different levels of performance. The positive effect of *sales / assets* on ROE was more profound on the higher quantiles. That is, a one percentage point increase in *sales / assets* led to a statistically significant increase of 0.0010, 0.0024, and 0.0035 percentage point increases in ROE for the 25th, 50th, and 75th quantiles, respectively. The positive effect of *debt-to-equity* was found to be stronger for the higher quantiles. That is,

a one percentage point increase in *debt-to-equity* led to increases in ROE at 0.0012, 0.0041, and 0.0071 percentage points for 25th, 50th, and 75th quantiles, respectively. Regarding Age, for low ROE cooperatives (at the 25th quantile), the older cooperatives were positively related to higher ROE, but for medium and high ROE cooperatives the relationship was reversed. That is, for medium and high ROE cooperatives, as cooperatives become older they will be less profitable. The cooperatives in different regions appeared to have different levels of ROE, although not all regional dummies were statistically significant.

Additional Analysis. An alternative regression model was carried out in order to investigate the variability of cooperative performance should different proxies of financial performance and leverage be employed. The performance measure ROE was replaced with ROA, and in order to be on the same scale as ROA, the financial leverage debt-to-equity ratio was replaced with the debt-to-asset ratio. The model is represented by equation [4]

$$\begin{aligned} ROA_i &= \beta_0 + \beta_1 \left(\frac{NI}{Sales}\right)_i \\ &+ \beta_2 \left(\frac{Sales}{Assets}\right)_i \\ &+ \beta_3 \left(\frac{Debt}{Assets}\right)_i \\ &+ \beta_4 Age_i + \beta_5 S1_i \\ &+ \beta_6 S2_i + \beta_7 S3_i \\ &+ \eta_i, \end{aligned} \qquad [4]$$

The same procedure was observed, and the estimated results are presented in Table 7 below.

Table 7

Regression results

dependent variable: ROA	OLS Regression	Quantile Regression		
		25th	50th	75th
indep. variable	Model 1a	Model 2a	Model 3a	Model 4a
Intercept	0.0331***	0.02487***	0.05195***	0.09162***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
NI/Sales	0.0432***	0.03284***	0.03151***	0.02724***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sales/Assets	0.0045***	0.00069**	0.00246***	0.00373***
	(0.0000)	(0.0414)	(0.0000)	(0.0000)
Debt/Assets	-0.0277***	-0.02283***	-0.04328***	-0.07195***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age	0.0004	0.00005*	-0.00007**	-0.00036***
	(0.22012)	(0.0960)	(0.0605)	(0.0000)

Table 7 *(Continued)*

dependent variable: ROA	OLS Regression	Quantile Regression		
		25th	50th	75th
indep. variable	Model 1a	Model 2a	Model 3a	Model 4a
S1	-0.0053***	-0.00627***	-0.00896***	-0.00839***
	(0.0025)	(0.0000)	(0.0000)	(0.0036)
S2	-0.0027*	-0.00287**	-0.00553	-0.00678***
	(0.0802)	(0.0114)	(0.0003)	(0.0182)
S3	-0.0011	-0.0020*	-0.00421***	-0.00616***
	(0.4912)	(0.0864)	(0.0074)	(0.0292)
Adjusted R^2	0.6886	n.a.	n.a.	n.a.
Psudo-R^2	n.a.	0.1727	0.2162	0.2155
Sample size	1,766	1,766	1,766	1,766

Note: ***, **, * significant at 1%, 5%, and 10% levels, respectively

It can be seen from the adjusted R^2 and *Psudo-* R^2 that the explanatory powers significantly improved over the original model. Interestingly, almost all of the previous results were confirmed apart from the financial leverage proxy, debt-to-asset, which was now significantly but negatively associated with ROA, and appeared to be stronger for cooperatives with higher ROA. That is, a one percentage point increase in debt-to-asset led to a decrease of 0.02, 0.04, and a 0.07 percentage point decrease in ROA for the 25th, 50th, and 75th quantiles, respectively. This is discussed in the next section. The control variable Age was not significant in Model 1a, but the quantile regression Models 2a and 4a revealed that the cooperatives in the central region on average had the lowest ROA. Nevertheless, not all regional dummies were statistically significant in Model 3a.

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

The robust estimator regression estimation results showed that all of the DuPont components—namely, profitability, asset efficiency, and financial leverage—were positively associated with the financial performance measure, ROE. The most salient factor in terms of boosting the ROE was the profit margin or the effectiveness of the manager to generate net profit from sales. This positive association is consistent with Grashuis (2018) and Mishra et al. (2009). The second most important factor was financial leverage. The age of the cooperatives was found to be irrelevant in terms of financial performance. Not all of the regional dummies were significant in every model estimated. It appeared that the cooperatives in different regions exhibited different financial performance. In particular,

most models suggested that the cooperatives in the central region appeared to have the lowest financial performance in terms of ROE and ROA. The quantile regression estimations confirmed the regression results and provided a more complete picture of the factors affecting the performance on different quantiles. All of the DuPont components were still found to be positively associated with the ROE. The marginal impact of profit margin was still consistently the strongest and was relatively constant across the quantile spectrum of ROE. In terms of asset efficiency and financial leverage, impacts were found to be greater for cooperatives with stronger performance. The regional dummy variables were found to be consistent with the OLS regression results. Age and ROE were positively correlated for low ROE cooperatives (25% quantile), but were negatively correlated for medium and high ROE cooperatives (50^{th} and 75^{th} quantiles), implying that medium and high-performance cooperatives are less profitable as they become older.

An additional analysis was carried out in order to investigate the response of cooperative performance on different proxies of financial performance and leverage, where ROE was replaced with ROA, and debt-to-equity with debt-to-asset. The findings confirmed almost all of the previous results. However, the leverage construct debt-to-asset was found to be negatively associated with the performance measure ROA, contradicting the earlier results when ROE was used as the performance measure. In the absence of debt, the cooperative's level of assets is the same as its shareholders' equity, rendering ROE equal to ROA. The introduction of debt comes with an attached interest expense, which in turn lowers net income and, hence, reduces ROA. In addition, increasing debt reduces the proportion of equity, which results in an increase in ROE. Therefore, different performance measures may lead to different conclusions. This study finds that, on the one hand, employing ROE leads to the conclusion that increasing leverage induces an increase in financial performance. On the other hand, when ROA is employed, an increase in leverage hurts the performance, particularly for cooperatives in higher profitability quantiles. Increasing leverage may initially induce higher ROE. However, if the return on assets is lower than the additional cost of debt, this will ultimately take a toll on the profit and the ROE. On the other hand, if the ROA is greater than the additional cost of debt, this implies that using leverage is favorable. This can be summarized in the following DuPont equation [5] proposed by Newman and Briggeman (2016).

$$ROE = ROA + \left[\left(ROA - \frac{Interest\ Expense}{Debt}\right) \times \left(\frac{Debt}{Equity}\right)\right] \quad [5]$$

This implies that leverage should be employed to boost the ROE as long as the rate of return on assets is greater than the cost of interest expense. In addition,

should ROE be employed as a financial performance measure, the researcher should be aware of the negative denominator problem, which can violate the ordinal property and confound the interpretation (discussed in section 3.1 above). Under the circumstance of a negative denominator, a construct that can hold the ordinal and interpretable properties is preferred.

Regarding management policy, cooperatives should pay close attention to managing both sides of performance, namely, operating and financial. Operating performance involves profitability and asset efficiency. Financial performance concerns financial leverage. The first priority should be given to profitability, which involves the efficiencies of cost and sales management. The second priority is leverage, which can either boost or hurt financial performance according to the variable choice. Thus, the leverage decision should depend on the net benefits to leverage. Lastly, the efficiency of asset management concerns the focus on increasing sales revenue over the assets of the cooperative.

ACKNOWLEDGEMENTS

The first author would like to acknowledge the research grant provided by the Faculty of Liberal Arts and Management Science, Kasetsart University, Chalermphrakiat Sakon Nakhon Province Campus.

REFERENCE

Chainuvati, C., & Athipanan, W. (2001). Crop diversification in Thailand. In M. K. Papademetriou & F. J. Dent (Eds.), *Crop diversification in the Asia-Pacific region* (pp. 130-146). Bangkok, Thailand: Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific. Retrieved May 23, 2020, from http://www.fao.org/3/a-x6906e.pdf

Cooperative Auditing Department of Thailand. (2019a). *Financial data*. Retrieved May 11, 2019, from http://intranet.cad.go.th/cad2005/cad_search/search/condition_search_input.php

Cooperative Auditing Department of Thailand. (2019b). *Financial information of cooperatives in Thailand 2018*. Retrieved May 22, 2020, from https://www.cad.go.th/ewtadmin/ewt/statistic/download/information61/cooperative.pdf

Cooperative Auditing Department of Thailand. (2019c). *Rāyngān p̄hl kār dảnein ngān læa ṯ̄hāna thāngkārngein: S̄h̄krṇ̣ thuk prapheth pracả pī 2561* [Performance and financial status: All types of cooperatives in Thailand 2018]. Retrieved May 22, 2020, from https://www.cad.go.th/ewtadmin/ewt/statistic/download/report_info/61/all_2_61.pdf

Cooperative Promotion Department of Thailand. (2019). *Annual statistics of cooperatives, agricultural groups and vocational group in Thailand*. Retrieved May 11, 2019, from https://app1.cpd.go.th/annual-statistics-of-cooperatives-31122561/mobile/ index.html#p=1

de Wet, J. H. v. H., & du Toit, E. d. (2007). Return on equity: A popular, but flawed measure of corporate financial performance. *South African Journal of Business Management, 38*(1), 59-69.

Dogarawa, A. B. (2010). *The role of cooperative societies in economic development*. Retrieved May 11, 2019, from https://mpra.ub.uni-muenchen.de/23161/1/MPRA_paper_23161.pdf

Draheim, G. (1952). *Die genossenschaft als unternehmungstyp* [The cooperative association as a business enterprise]. Göttingen, Germany: Vandenhoeck und Ruprecht.

Flesher, D. L. P., & Previts. G. J. (2013). Donaldson Brown (1885-1965): The power of an individual and his ideas over time. *Accounting Historians Journal, 40*(1), 79-102.

Granger, C. W. J. (2010). Spurious regressions. In S. N. Durlauf & L. E. Blume (Eds.), *Macroeconometrics and time series analysis* (pp. 265-268). London, England: Palgrave Macmillan UK.

Grashuis, J. (2018). A quantile regression analysis of farmer cooperative performance. *Agricultural Finance Review, 78*(1), 65-82.

Grashuis, J., & Ye, S. U. (2019). A review of the empirical literature on farmer cooperatives: Performance, ownership and governance, finance, and member attitude. *Annals of Public and Cooperative Economics, 90*(1), 77-102.

Keown, A. J., Petty, J. W., & Scott, D. F. (2008). *Foundations of finance: The logic and practice of financial management* (6th ed.). Upper Saddle River, USA: Pearson.

Koenker, R. W., & Bassett, G. (1978). Regression quantiles. *Econometrica*, *46*(1), 33-50.

Koller, M., & Stahel, W. A. (2011). Sharpening wald-type inference in robust regression for small samples. *Computational Statistics & Data Analysis*, *55*(8)*,* 2504-2515.

Krasachat, W., & Chimkul, K. (2009). Performance measurement of agricultural cooperatives in Thailand: An accounting-based data envelopment analysis. In J. D. Lee & A. Heshmati (Eds), *Productivity, efficiency, and economic growth in the Asia-Pacific region* (pp. 255-266). Heidelberg, Germany: Physica-Verlag Heidelberg. Retrieved December 29, 2019, from https://link.springer.com/content/pdf/10.1007%2F978-3-7908-2072-0.pdf

Mishra, A. K., Moss, C. B., & Erickson, K. W. (2009). Regional differences in agricultural profitability, government payments, and farmland values: Implications of DuPont expansion. *Agricultural Finance Review, 69*(1), 49-66.

Mishra, A. K., Harris, J. M., Erickson, K. W., Hallahan, C., & Detre, J. D. (2012). Drivers of agricultural profitability in the USA: An application of the Du Pont expansion method. *Agricultural Finance Review, 72*(3), 325-340.

Monaghan, P., & Sadler, E. (2013). *Simply performance: A guide to creating member value by aligning co-operative strategy, performance measurement and reporting*. Retrieved December 29, 2019, from https://www.uk.coop/sites/default/files/uploads/attachments/simply_performance_0.pdf

Mubashar, A., & Tariq, Y. B. (2017). Application of financial ratios as a firm's key performance and failure indicator: Literature review. *Journal of Global Economics, Management & Business Research, 8*, 18-27.

Newman, C., & Briggeman, B. C. (2016). *Cooperative earns, turns, and leverage: The DuPont profitability model.* Retrieved February 8, 2019, from https://accc.k-state.edu/research/factsheets/FS8_DuPontModel.pdf

Patrawart, J., & Sriurai, S. (2016). The new challenges in the 2nd century of agricultural cooperatives development in Thailand. In *11th ICA Asia Pacific Regional Research Conference on Cooperatives and Sustainable Development.* Bangkok, Thailand: Cooperative Academic Institute (CAI), Faculty of Economics, Kasetsart University.

Poapongsakorn, N. (2011). R&D and performance of the Thai agriculture and food processing industry: The role of government, agribusiness firms, and farmers. In P. Intal, S. Oum, & M. Simorangkir (Eds.), *Agricultural development, trade and regional cooperation in developing East Asia* (pp. 401-475). Jakarta, Indonesia: Economic Research Institute for ASEAN and East Asia. Retrieved May 23, 2020, from https://www.eria.org/Full%20Report.pdf

Rochin, R. (1983). Can low-income producer co-ops survive in California's Ag climate? *Farmer Cooperatives*, *49*(11), 10-14.

Rodriguez, R. N., & Yao, Y. (2017). Five things you should know about quantile regression. *Proceedings of the SAS Global Forum*, 1-19. Retrieved December 29, 2019, from https://support.sas.com/resources/papers/proceedings17/SAS0525-2017.pdf

Şamiloğlu, F., Öztop, A. O., & Kahraman, Y. E. (2017). The determinants of firm financial performance: Evidence from Istanbul stock exchange (BIST). *IOSR Journal of Economics and Finance, 8*(6), 62-67.

Soboh, R. A. M. E., Lansink, A. O., Giesen, G., & van Dijk, G. (2009). Performance measurement of the agricultural marketing cooperatives: The gap between theory and practice. *Applied Economic Perspectives and Policy, 31*(3), 446-469.

Thai Revenue Code s. 39. Retrieved December 29, 2019, from https://www.rd.go.th/publish/37749.0.html#section39

Thai Revenue Code s. 69 (bis). Retrieved December 29, 2019, from https://www.rd.go.th/publish/37764.0.html

Trimbath, S. (2006). Financial ratios in quantitative data analysis: A practical guide. In Z. Hoque (Ed.), *Methodological issues in accounting research: Theories, methods and issues* (pp. 411-425). London, England: Spiramus Press.

Thornblad, D. B., Zeitzmann, H. K., &, Carlson, K. D. (2018). Negative denominators in index variables: The vulnerability of return on equity, debt to equity, and other ratios. *The Electronic Journal of Business Research Methods, 16*(1), 1-10.

United Nations. (2009). *Cooperatives in a world in crisis*. Aide-Mémoire Expert Group Meeting. Retrieved December 29, 2019, from https://www.un.org/esa/socdev/egms/docs/2009/cooperatives/aidememoire.pdf

Yohai, V. J. (1987). High breakdown-point and high efficiency robust estimates for regression. *The Annals of Statistics, 15*(2), 642-656.