Global Review of Business and Economic Research, Vol. 13 No. 1, (2017) : 77-95

COST AND PROFIT EFFICIENCY OF THAILAND INSURANCE INDUSTRY: A STOCHASTIC COST AND PROFIT FRONTIER APPROACH

Mohd Zaini Abd Karim
Universiti Utara Malaysia, Malaysia

ABSTRACT

The purpose of this paper is to partially fill the gap in the existing literature by conducting an analysis of cost and profit efficiency in Thailand's insurance industry. The analysis makes use of a detailed database on Thailand's life and non's life insurance companies over the period 1997-2003. A stochastic frontier approach base on a translog functional form was employed to generate efficiency scores which are estimated using truncated normal, exponential, and half normal model. The results show that there is significant difference between truncated normal and half normal for both cost and profit efficiency measures. The average scores for both cost and profit efficiency from the exponential estimator are relatively higher than truncated normal and half normal. In addition, the results indicate that, on average, insurance firm in Thailand used 34.3 to 40 percent more input than it should be and wasted 25 to 40 percent of their potential profits. The results also show that the cost and profit efficiency results are inconsistent in terms of ranking, indicating that cost efficient does not necessarily reflect profit efficient.

1. INTRODUCTION

Few works on insurance industry efficiency have been done in the developing countries although there are numerous studies carried out in developed countries particularly, the US. Since the nature of developing countries is significantly different, study on developing countries can provide guidelines in improving insurance industry policies in these countries. The purpose of this paper is to partially fill the gap in the existing literature by conducting an analysis of cost and profit efficiency in Thailand's insurance industry. The analysis makes use of a detailed data base on Thailand's life and non's life insurance companies over the period 1997-2003. A stochastic frontier approach base on a translog functional form will be employ to generate efficiency scores which are estimated by three estimation method. There are truncated normal model, exponential model, and half normal model. In addition, we want to determine whether there is difference between profit and cost efficiency among the different type of insurers and the relationship between cost and profit efficiency scores.

Profit efficiency is a more inclusive concept than cost efficiency, because it takes into account the cost and revenue effects of the choice of the output vector, which is taken as given in the measurement of cost efficiency. Thus, a insurer could improve profit efficiency without improve cost efficiency if the reconfiguration of outputs by insurers increases revenues more than it increase costs, or if it reduces costs more than it reduces revenues.

2. LITERATURE REVIEW

Theoretically, efficiency frontier can be studied under four types of frontier; production, cost, revenue and profit frontier (Kumbhakar and Lovell, 2000) and that almost every study on frontier were focus on production and cost frontiers (Berger and Humphrey, 1997). For example, Cummins and Weiss (1993) measured cost efficiency in the property liability insurance industry in the U.S. over the period 1980-1988. Yuengert (1993) used a mixed error cost frontier to study U.S. life insurance. Gardner and Grace (1993) used cost efficiency to study the U.S. life insurance industry from period 1985-1990. Cummins *et al.* (1996) used DEA approaches to study productivity and technical efficiency in the Italian insurance industry. Cummins and Rubio-Misas (2002) used the DEA approach with cost efficiency to investigate deregulation and consolidation within the Spanish insurance industry. They found that costs are relatively low in the Spanish insurance industry and the results show evidence that deregulation and consolidation have had beneficial effects on efficiency in the Spanish insurance industry.

Berger *et al.* (1993) surveyed cost efficiency frontier that is applied to insurance industry. They found that lack of studies on profit and revenue efficiency being studied in insurance industry. However, a number of studies which analyze bank efficiency by estimating profit frontier are; Pulley *et al.* (1994), Berger and Mester (1994), Berger and Mester (1997a,b), DeYoung and Hasan (1998), Berger and Mester (1999), Marten and Urga (2001), Maudos *et al* (2002), Clark and Siems (2002), and Berger and Humphrey (1997).

Cost efficiency is measured as the deviation from minimum cost when the actual cost increase in producing a bundle of output is compared to the minimum cost which is necessary for production of the same bundle. This estimate of cost inefficiency includes both technical and allocative efficiency. The technical efficiency is defined as the use of too much input to produce a given output. The allocative efficiency is defined as the use of a sub optimal proportion of each of inputs given the prevailing market price (Martousek, 2004).

Berger and Mester (1997) study is one of the important study in measuring profit efficiency of banks. They used both cost and profit efficiency where they separated profit efficiency into two types; standard and alternative profit efficiency. They may have been the first who applied these types of profit efficiency methods. They add some positive number to profit of each of the firms should to ensure that profit (loss) can be transform into logarithm. They proposed the alternative profit efficiency that when some of the underlying assumptions cost and standard profit efficiency is not met. Alternatively, profit efficiency is measured by how close a bank comes to earning maximum profit given its output levels rather than its output prices.

Maudos *et al.* (2002) stated that profit efficiency takes into account the effects of the choice of vector of production on both cost and revenue. Thus, profit efficiency concept is broader than cost efficiency alone. Profit can be separated into two concepts that are dependent on whether market forces are taken into account or not. These are standard and alternative profits. In standard profit, the market for inputs and outputs are assumed to be in perfect competition. In alternative profit, markets for inputs and outputs are assumed to be imperfect with regard to competition.

3. METHODOLOGY AND DATA

Cost Efficiency

The cost efficiency is derived from cost functions in which the variable costs are dependant on quantities of outputs and input prices. Hence, cost function may be written as follow.

$$C_{it} = f_t^C\left(y_{it}, w_{it}\right)V_{it}, U_i \tag{1}$$

The inefficiency and random error terms are assumed to be multiplicatively separable from the rest of the cost function and both sides are represented in natural logs:

$$\ln C_{it} = \ln\ f_t^C\left(y_{it}, w_{it}\right) + \ln(V_{it}) + \ln(U_i) \tag{2}$$

Where:

C_{it} = the total cost of firms *i* in year *t*,

f_t^C = the industry cost function in year *t*,

y_{it} = the output quantities of firm *i* in year *t*,

w_{it} = the input prices of firm *i* in year *t*,

V_{it} = the random error of firm *i* in year *t* and

U_{it} = the inefficiency factor that pushes the firm's costs above those of the most efficient companies of firm *i* in year *t*.

The term In(U_i) is assumed to be orthogonal to the regressors in the cost function. The composite error term [In(V_{it}) + In(U_i)] can be estimated for each form. Therefore, the random error term In(V_{it}) are allowed to change for each year, while In(U_i) remain constant over time.

Profit Efficiency

The profit efficiency will be capsulated by estimating a separate standard and alternative profit function. The standard profit would be applied when output markets are perfectly competitive. On the other hand, alternative profit would be applied in the case of imperfectly competitive market.

This study would apply both the standard and alternative profit concepts. Since, Thailand's insurance industry can be characterized as both imperfect and perfectly competitive market.

(i) Standard profit function

Profit as the dependent variables allows for change in revenues that can be obtained by varying outputs as well as inputs. Input prices are exogenous and allow for inefficiency in the choice of outputs when responding to the price or other arguments of the profit function. The standard function in implicative form and log form are shown below.

$$\pi_{it} = f_t^\pi\left(w_{it}, p_{it}\right)V_{it}, U_i \tag{3}$$

$$\ln(\pi_{it} + \theta) = \ln\ f_t^\pi\left(w_{it}, p_{it}\right) + \ln(V_{it}) - \ln(U_i) \tag{4}$$

where;

π_{it} = the variable profit of firm *i* in year *t*,

f_t^{π} = the standard profit function,

θ = the constant that is added to the variable profit of each firm to ensure that natural logs take a positive number.

w_{it} = the input prices of firm *i* in year *t*,

p_{it} = the output prices of firm *i* in year *t*,

V_{it} = the random error of firm *i* in year *t* and

U_{it} = the inefficiency factor that pushes the firm's profit under those of the most efficient company of firm *i* in year *t*.

(ii) Alternative Profit Function

The independent variables in the alternative profit function are the same as in the cost function. The alternative function in implicative form and the log form are shown below.

$$\pi_{it} = f_t^{\pi}\left(y_{it}, w_{it}\right)V_{it}, U_i \qquad (5)$$

$$\ln(\pi_{it} + \theta) = \ln\ f_{it}^{\pi}\left(y_{it}, w_{it}\right) + \ln(V_{it}) - \ln(U_i) \qquad (6)$$

where;

π_{it} = the variable profit of firm *i* in year *t*,

f_t^{π} = the standard profit function,

y_{it} = the quantities of output of firm *i* in year *t*,

w_{it} = the input prices of firm *i* in year *t* ,

V_{it} = the random error of firm *i* in year *t* and

U_{it} = the inefficiency factor of firm *i* in year *t* that pushes the firm's profit under those of the most efficient firm.

Translog Functional Form

Transcendental logarithmic or translog propose by Aigner and Chu (1968) was used to represent both cost and profit function. Hunter and Timme(1995) found that the standard translog specification fits the bank cost data well.

The translog functional form for cost frontier function in the case of one outputs and four inputs are as follow.[1]

$$\ln COST_{it} / w_4 = \varphi_0 + \varphi_1 \ln w_1/w_4 + \varphi_2 \ln w_2/w_4 + \varphi_3 \ln w_3/w_4 + \varphi_4 \ln y$$
$$+\varphi_5 \ln w_1 w_2/w_4^2 + \varphi_6 \ln w_1 w_3/w_4^2 + \varphi_7 \ln w_2 w_3/w_4^2 + \varphi_8 \ln w_1 y/w_4$$
$$+\varphi_9 \ln w_2 y/w_4 + \varphi_{10} \ln w_3 y/w_4$$

$$+0.5\varphi_{11}\, w_1^2 / w_4^2 + 0.5\varphi_{12}\, w_2^2 / w_4^2 + 0.5\varphi_{13} \ln w_3^2 / w_4^2 + 0.5\varphi_{14} \ln y^2 \ + \ln V_{it} + \ln U_t \qquad (7)$$

Greene (2003) noted that the standard translog cannot work due to singularity problem but can be solve by dropping one variable. He divides all terms in the equation with the price of the last inputs w_m. In this study, to solve the singularity problem, for example in the cost function, w_1, w_2, w_3, w_4 were divided by w_4 before taking logarithm.

The Stochastic Frontier Approach (SFA) is used to measure both cost and profit efficiency. In the model, the composite error term takes a specific functional form. The random component, V_{it} is independently and identically distributed (*iid*) according to standard normal distribution, $N\left(0, \sigma_v^2\right)$. The insurance firm inefficient component, U_{it}>0 are identically and independently distributed according to a truncated-normal distribution, $N\left(\mu_u, \sigma_u^2\right)$. In SFA, the inefficiency is assumed to be non-negative.

Data

This study uses data obtained from the "Annual Insurance Report of Thailand 1997-2003" from the Department of Insurance and Ministry of Commerce. The sample size is 99 firms out of the 103 life and non-life insurance firms in Thailand. It consists of 25 life insurance firms, 65 domestic and five foreign branches of non-life insurance firms, and four health insurance firms.

Variables

Outputs of insurers are specified by their primary services similar to other financial institution consist of three principle approaches. These three approaches have been used to define outputs in the financial sector. The first is the asset or intermediation approach, second, the user-cost approach and third, the value added approach (Berger and Humphrey, 1992). The value added approach is appropriate for investigating output of insurance industry firms and counts as important outputs that have significant value added, as judged using operating cost allocation (Cummins *et al.* 1998). The value-added approach considers all assets and liability categories to have some output characteristics rather than distinguishing inputs from outputs in a mutually exclusive way (Cummins *et al.*, 1996).

Cummins *et al.* (1996) defined inputs into four categories; acquisition inputs (mainly agent labor), managerial and administrative labor, fixed capital and financial equity capital. Cummins & Zi (1997, 1998) separates input into three categories; quantity of labor, quantity of financial capital and quantity of materials. Cummins *et al.* (1998) also defined inputs into three types but they further separated labor into office labor and agent labor. Cummins and Rubio-Misas (2002) and Cummins *et al* (2003) defined inputs into four categories; labor, business services (including material and physical capital), financial debt capital and equity capital. They measure labor by including only employee or office labor but excluding agent labor.

Following Cummins and Rubio-Misas (2002), Cummins *et al.* (2003) and Karim and Jhantasana (2005), the output for this study is; benefit or losses incurred (*y*). The inputs are labor (x_1), business services (including material and physical capital) (x_2), financial debt capital (x_3) and equity capital (x_4). Their prices are the average monthly wage for employee(w_1), amount of business services divided by the total number of policies sold and terminated during the year (w_2), the one-year Thai Treasury bill rate (w_3) and the rate of total return on the Thai Stock Exchange Index for each year of the sample period (w_4) respectively. They defined labor to include only office labor.

Descriptive Statistics of Data

Table 1 presents the descriptive statistic for, cost, revenue, profit, output quantity, output price, input quantities and input prices. The cost variables is calculated from the total value of inputs quantities multiplied by input price variables while the revenue variable comes from the result of output quantity multiplied by its price. Profit is the results of revenue minus the cost. The mean cost is USD 7.81 million while the minimum and maximum cost is USD 0.0052 and 289.59 million, respectively. The mean revenue is USD 38.26 million while the minimum and maximum revenue are USD -0.0986 and 1,951.74, respectively. The mean profit is USD 30.20 million while minimum and maximum profit are USD -6.6933 and USD 1,654 million, respectively. The mean output quantity is USD 15.26 million while its minimum and maximum are USD 0.01 million and USD 387.51 million, respectively. The mean output price is USD 0.58 while it's minimum and maximum are USD 0.0002 and USD 36.42, respectively.

The inputs for this study are labor, underwriting expense, financial debt capital and equity capital where its mean value are 316.14, USD 9.03 million, USD 15.65 million and USD 70.60 million, respectively while its maximum value are 4,112, USD 102.80 million, USD 397.20 million, and USD 70.60 million, respectively. The mean value of input prices are USD 800.33, USD 287.64, USD 0.02, and USD 0.002, respectively while its maximum value are USD 9,958.63, USD 23.74, USD 3.80, and USD 0.0021, respectively.

Table 1
The Data Description and Construction of Variables

Variables	*Unit*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
Cost	mil. USD	7.8121	24.1360	0.0052	289.59
Revenue	mil. USD	38.2652	179.7312	-0.0986	1,951.74
Profit	mil. USD	30.2000	156.19	-6.6933	1,654.00
y (output)	mil. USD	15.2630	39.9222	0.0066	387.51
p (price of output)	USD	0.5796	2.1844	0.0002	36.41
x_1 (labor)	No. of labor	316.15	487.4300	1	4,112
x_2 (underwriting)	mil. USD	9.0287	487.4300	1	102.8000
x_3 (Financial debt capital)	mil. USD	15.6450	40.9200	0.0068	397.2000
x_4 (Equity capital)	mil. USD	70.6000	314.1000	1.5000	448.1500
w_1 (price of x_1)	USD(monthly)	800.33	744.69	5.9866	9,958.6300
w_2 (price of x_2)	USD	287.64	1,647.20	0	23,736
w_3 (price of x_3)	USD	0.0161	6.5712	0.0000	3.7985
w_4 (price of x_4)	USD	0.0015	0.0127	0.0011	0.0021

4. EMPIRICAL RESULTS

Parameters Estimation

This study estimates cost, standard profit, and alternative profit using the three estimators which consists of truncated normal, exponential and half normal for translog functional form. Tables 2 to 4 are estimates of the parameter estimates of cost and profit frontier function with truncated normal, exponential and half normal inefficiency distribution.

All of the models are statistically significance where the lambda, sigma, theta and sigma are highly significance at the 1% level with quite a number of the independent variables statistically significant.

Table 2
Parameter Estimates of the Translog Cost Efficiency Function

Parameters	*Models*	*Truncated Normal*		*Exponential*		*Half Normal*	
	Variables	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*
φ_0	Constant	2.0469	0.2381***	2.1478	0.2059***	1.9754	0.2290***
φ_1	$\text{In}(w_1/w_4)$	0.2244	0.0839***	0.2377	0.0843***	0.2936	0.0837***
φ_2	$\text{In}(w_2/w_4)$	0.0984	0.0342***	0.1008	0.03509***	0.0914	0.0345***
φ_3	$\text{In}(w_3/w_4)$	0.1434	0.1400	0.1430	0.1287	0.1165	0.1385
φ_4	$\text{In}(y)$	0.0933	0.0514*	0.0893	0.0507*	0.0873	0.0524*
φ_5	$\text{In}(w_1 w_2/w_4^2)$	-0.0245	0.0111**	-0.0240	0.0110**	-0.0290	0.0107*
φ_6	$\text{In}(w_1 w_3/w_4^2)$	-0.0151	0.0381	-0.0660	0.0370*	-0.0670	0.0400*
φ_7	$\text{In}(w_2 w_3/w_4^2)$	0.0340	0.0158**	0.0353	0.0148**	0.0382	0.0157**
φ_8	$\text{In}(w_1 y/w_4)$	-0.0345	0.0124***	-0.0301	0.0124**	-0.0376	0.0126***
φ_9	$\text{In}(w_2 y/w_4)$	-0.0981	0.0059*	-0.0101	0.0058*	-0.0091	0.0059
φ_{10}	$\text{In}(w_3 y/w_4)$	0.0359	0.0193*	0.0302	0.0176*	0.0332	0.0195*
φ_{11}	$0.5\ \text{In}(w_1^2/w_4^2)$	0.0372	0.0353	0.0623	0.0365*	0.0710	0.0359**
φ_{12}	$0.5\ \text{In}(w_2^2/w_4^2)$	-0.0212	0.0061***	-0.0188	0.0064***	-0.0181	0.0061***
φ_{13}	$0.5\ \text{In}(w_3^2/w_4^2)$	0.0930	0.1280	0.1453	0.1189	0.1577	0.1292
φ_{14}	$0.5\ \text{In}(y^3)$	0.0163	0.0085*	0.1850	0.0081**	0.0173	0.0087**
Log likelihood function		-441.1652		-433.2840		-446.3827	
Wald Test, X^2		20.98***		22.97***		24.09***	
Variance parameters for compound error							
	Mu/SgmaU						
	Lambda[a]	2.9688	0.5589***	2.6035	0.1944***	2.5748	0.2949***
	Sigma[b]	0.8686	0.1752***	0.2898	0.0206***	0.7124	0.0278***
	$\text{Sigma}^2(\text{v})$	0.0768		0.0840		0.0665	
	$\text{Sigma}^2(\text{u})$	0.6776		0.1475		0.4410	

a; In Exponential model is Theta.
b; In Exponential model is SigmaV.
*p<0.10; **p<0.05; ***p<0.01.

Table 3
Parameter Estimates of the Translog Standard Profit Efficiency Function

Parameters	*Models*	*Truncated Normal*		*Exponential*		*Half Normal*	
	Variables	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*
φ_0	Constant	7.3077	0.0667***	7.3071	0.0624***	7.4115	0.0859***
φ_1	In(w_1/w_4)	0.0463	0.0339	0.0463	0.0323	0.0597	0.0426
φ_2	In(w_2/w_4)	-0.1633	0.0095*	-0.01705	0.0091*	-0.0198	0.0121
φ_3	In(w_3/w_4)	0.1958	0.0761**	0.1917	0.7205***	0.1428	0.1004
φ_4	In(p)	-0.0213	0.0289	-0.0229	0.1960	-0.0320	0.0253
φ_5	In(w_1w_2/w_4^2)	-0.0080	0.0058	-0.0076	0.0055	-0.0114	0.0077
φ_6	In(w_1w_3/w_4^2)	-0.2490	0.02203	-0.0243	0.0210	-0.0432	0.0275
φ_7	In(w_2w_3/w_4^2)	0.0111	0.0074	0.1165	0.0071	0.0163	0.0094*
φ_8	In(w_1p/w_4)	-0.0161	0.0101	-0.0153	0.0098	-0.1880	0.0134
φ_9	In(w_2p/w_4)	-0.0055	0.0028*	-0.00494	0.0027*	-0.0055	0.0036
φ_{10}	In(w_3p/w_4)	0.6061	0.0110***	0.0621	0.0105***	0.0722	0.0142***
φ_{11}	0.5 In(w_1^2/w_4^2)	-0.0108	0.0238	-0.0096	0.0228	-0.0121	0.0299
φ_{12}	0.5 In(w_2^2/w_4^2)	-0.0038	0.0032	-0.0035	0.0031	-0.0031	0.0040
φ_{13}	0.5 In(w_3^2/w_4^2)	0.5651	0.0650***	0.5686	0.0615***	0.6275	0.0854***
φ_{14}	0.5 In(y^3)	0.0040	0.0062	0.0050	0.0059*	0.0075	0.0076
Log likelihood function		99.2792		111.3538		-6.927	
Wald Test, X^2		99.46***		113.24***		68.40***	
Variance parameters for compound error							
	Mu/SgmaU	7.1943	5.1432				
	Lambda[a]	6.2703	1.5377***	7.1611	0.2063***	2.6071	0.4028***
	Sigma[b]	1.0299	0.2800***	0.1561	0.0076***	0.3857	0.0049***
	Sigma^2(v)	0.0263		0.0243		0.0190	
	Sigma^2(u)	1.0344		0.0195		0.1297	

a; In Exponential model is Theta.
b; In Exponential model is SigmaV
*p<0.10; **p<0.05; ***p<0.01.

The Mean and Variance Difference Test of Efficiency Scores

Table 5 and 6 show the results of mean difference test and variance difference test of efficiency scores, respectively.

In the cost efficiency model, the result of the mean difference test shows that there is no significance different between truncated normal and exponential. However, there is significant difference between truncated normal and half normal and also between exponential and half normal.

In the standard profit efficiency model, the result of the mean difference test show that there is significant difference between truncated normal and half normal and between exponential and half normal. However, there is no significance difference in efficiency scores between truncated normal and exponential. In the alternative profit efficiency model, the result

Table 4
Parameter Estimates of the Translog Alternative Profit Efficiency Function

	Models	*Truncated Normal*		*Half Normal*	
	Variables	*Coef.*	*S.E.*	*Coef.*	*S.E.*
φ_0	Constant	6.9161	0.2605***	5.6648	0.1846***
φ_1	$\text{In}(w_1/w_4)$	0.4874	0.1231***	0.4325	0.1175***
φ_2	$\text{In}(w_2/w_4)$	-0.6668	0.0403***	-0.6540	0.0397***
φ_3	$\text{In}(w_3/w_4)$	0.5446	0.3063*	0.9368	0.2983***
φ_4	$\text{In}(y)$	-0.0256	0.0712	0.2289	0.0591***
φ_5	$\text{In}(w_1 w_2/w_4^2)$	0.0815	0.0242***	0.0135	0.0299
φ_6	$\text{In}(w_1 w_3/w_4^2)$	0.0260	0.0808	-0.0480	0.1178
φ_7	$\text{In}(w_2 w_3/w_4^2)$	-0.0179	0.0319	0.0055	0.0377
φ_8	$\text{In}(w_1 y/w_4)$	-0.0359	0.0299	-0.0518	0.0336
φ_9	$\text{In}(w_2 y/w_4)$	0.1653	0.0153***	0.1678	0.0154***
φ_{10}	$\text{In}(w_3 y/w_4)$	0.0042	0.0365***	-0.0649	0.0423
φ_{11}	$0.5\ \text{In}(w_1^2/w_4^2)$	-0.1937	0.0804**	0.0117	0.0955
φ_{12}	$0.5\ \text{In}(w_2^2/w_4^2)$	-0.0653	0.0146***	-0.0413	0.0140
φ_{13}	$0.5\ \text{In}(w_3^2/w_4^2)$	-0.3953	0.3054	-0.2605	0.3265
φ_{14}	$0.5\ \text{In}(y^2)$	0.2753	0.0179***	0.2494	0.0174***
Log likelihood function		-950.8859	-937.0933		
Wald Test, X^2	11.91***	2.31			
Variance parameters for compound error					
Mu/SgmaU		0.7737	0.7187***		
Lambda	2.8528	0.3173***	1.5907	0.1832***	
Sigma	1.8315	0.2155***	1.2843	0.0362***	
Sigma2(v)		0.3670		0.4672	
Sigma2(u)		2.9874		1.1824	

*p<0.10; **p<0.05; ***p<0.01.

of the mean difference test show that there is significance difference between truncated normal and half normal.

Table 6 shows the result of the variance difference test. The results indicate that there is no significance different between truncated normal, exponential and half normal.

Average Efficiency Scores by Year

The average cost efficiency scores by year are presented in Table 7. The results show that the cost efficiency decreases from 1997 to 1999. However, the cost efficiency scores tend to increase from 2000 to 2003 but are still lower than the result in 1997. The average cost efficiency scores range from 0.5911 to 0.6732 and from 0.5327 to 0.6190 in the case of truncated normal and half normal, respectively. The average cost efficiency scores are the lowest in 1999 which may be cause by the financial crisis that occurs in 1997. The financial crisis has somewhat affected the average cost efficiency of insurance industry. The liquidity problem in the Thai's banking sector affected the Thai economy where the real GDP growth showed decline of 0.40% compared to 5.50% growth in 1996. Consequently, in 1998, Thai economy experienced stagnation both in real production and financial sector where real GDP decrease by 8.5 percent compared to 1997. As a result, financial crisis has somewhat causes the cost efficiency scores to decrease from 1997 to 1999. On the other hand, the cost efficiency scores tend to increase

Table 5
The Mean Difference Test of SFA Translog Cost, Alternative and Standard Profit

		Cost Efficiency			*Standard profit Efficiency*			*Alternative profit efficiency*	
		Truncated Normal	*Exponential*	*Half normal*	*Truncated normal*	*Exponential*	*Half normal*	*Truncated Normal*	*Half normal*
Cost Efficiency	Truncated Normal								
	Exponential	-0.0249 (0.0228)							
	Half normal	0.0566 (0.0229)**	0.0814 (0.0231)***						
Standard profit	Truncated Normal	-0.0673 (0.0221)***	-0.0424 (0.0223)	-0.1239 (0.0224)***					
	Exponential	-0.0875 (0.0220)***	-0.0626 (0.0222)***	-0.1441 (0.0223)***	-0.0202 (0.0215)				
	Half normal	-0.002 (0.0220)	0.0228 (0.0222)	-0.0585 (0.0223)***	0.0653 (0.0215)***	0.0855 (0.0214)***			
Alternative profit efficiency	Truncated Normal	-0.0225 (0.0227)	0.0023 (0.0229)	-0.0791 (0.0230)***	0.0448 (0.0222)	0.0650 (0.0221)	-0.0205 (0.0221)		
	Half normal	0.0555 (0.0235)**	0.0801 (0.0237)***	-0.0013 (0.0238)	0.1226 (0.0230)	0.1428 (0.0229)***	0.0572 (0.0229)**	0.0777 (0.0236)***	

* P <0.10; ** P < 0.05; *** P < 0.01.

Table 6
The Variance Difference Test of Translog Cost, Alternative and Standard Profit

		Cost Efficiency			*Standard profit Efficiency*			*Alternative profit efficiency*	
Cost Efficiency	*Truncated Normal*	*Truncated Normal*	*Exponential*	*Half normal*	*Truncated Normal*	*Exponential*	*Half normal*	*Truncated Normal*	*Half normal*
Standard profit	Exponential								
Efficiency	Half normal	1.0257							
		(1.0236)							
	Truncated	1.0498	1.0234						
	Normal	(1.0481)	(1.02180)						
Alternative profit	Exponential	1.0965	1.1248	1.1551					
efficiency		(1.0927)	(1.1239)	(1.1549)					
	Half normal	1.1216	1.1501	1.1774	1.0228				
		(1.1238)	(1.1508)	(1.1781)	(1.0231)				
	Truncated	1.1204	1.1493	1.1762	1.0218	1.0010			
	normal	(1.1286)	(1.1489)	(1.1696)	(1.0239)	(1.3111)			
Cost Efficiency	Half normal	1.0173	1.0083	1.0319	1.1154	1.1410	1.1398		
		(1.0193)	(1.0089)	(1.0323)	(1.0988)	(1.3421)	(1.7411)		
	Truncated	1.1563	1.1015	1.1015	1.2680	1.2970	1.2956	1.1366	
	Normal	(1.1572)	(1.1028)	(1.1028)	(1.2612)	(1.1689)	(1.1426)	(1.2700)	

* P <0.10; ** P < 0.05 ; *** P < 0.01.

from 2000 to 2003 due to recovery in the Thai's economy. The Thai economy expanded by 4.2, 4.3, 2, 5.4, and 6.8 percent in 1999, 2000, 2001, 2002 and 2003, respectively. Comparing the scores across estimators, the average cost efficiency scores are quite consistent. The average cost efficiency scores from the exponential estimator are relatively higher than truncated normal and half normal, respectively (The mean difference test in Table 5 show there is significant difference between exponential and half normal and between truncated normal and half normal). In all cases, the average cost efficiency scores decreases from 1997 to 1999 but increases onwards.

Table 7
Average Translog Cost Efficiency Scores by Year

Year	*Truncated Normal*	*Exponential*	*Half Normal*
1997	0.6732	0.6999	0.6190
1998	0.6579	0.6835	0.5926
1999	0.5911	0.6156	0.5327
2000	0.6255	0.6535	0.5658
2001	0.6208	0.6464	0.5621
2002	0.6335	0.6516	0.5738
2003	0.6210	0.6434	0.5662
Average	0.6571	0.6820	0.6005

Table 8
Average Translog Profit Efficiency Scores by Year

	Standard Profit			*Alternative Profit*	
	Truncated Normal	*Exponential*	*Half Normal*	*Truncated Normal*	*Half Normal*
1997	0.6830	0.7029	0.6128	0.6474	0.5535
1998	0.6915	0.7183	0.6114	0.6731	0.5465
1999	0.6830	0.7041	0.6193	0.6304	0.5536
2000	0.7123	0.7309	0.6568	0.6446	0.5710
2001	0.7196	0.7363	0.6705	0.6650	0.5986
2002	0.6928	0.7153	0.6259	0.6488	0.5781
2003	0.7268	0.7485	0.6486	0.6316	0.5602
Average	0.7244	0.7447	0.6591	0.6796	0.6018

Table 8 show the average profit efficiency scores by year for both standard and alternative type of profit efficiency scores. The translog standard profit efficiency scores for truncated normal range between 0.6830 in 1997 and 1999 to 0.7268 in 2003. The estimates of standard profit efficiency scores for exponential are higher than truncated normal and half normal by about 2.02% and 8.55%, respectively (The mean difference test in Table 5 show no significance difference between truncated normal and exponential).

The average translog alternative profit efficiency score by year for truncated normal ranges from 0.6304 in 1999 to 0.6731 in1998 while the average alternative profit efficiency score for half normal ranges from 0.5465 in year 1998 to 0.5986 in 2001. The average translog alternative profit efficiency score for truncated normal are higher than the half normal by about 7 to 13% (The mean difference test in Table 5 show no significance difference between truncated normal and exponential).

Efficiency Scores by Firm

Table 9 columns 3, 4, 5 show the average cost efficiency scores by firm. The average cost efficiencies using translog functional form for truncated normal, exponential and half normal are 0.6571, 0.6820 and 0.6005, respectively. The result indicate that the average translog cost efficiency from the exponential estimator is higher than the results from truncated normal and half normal by about 3% and 8%, respectively (The mean difference test in Table 5 show significant difference between exponential and truncated normal and between exponential and half normal). The Millea Life has the lowest average cost efficiency score, 0.1438 while Thai Health has the highest average cost efficiency score, 0.9031.

Table 9
The Translog Cost, Revenue and Profit Efficiency Score

No.	*Firm*	*Cost Efficiency*			*Profit Efficiency*			*Alternative Profit Efficiency*	
		Truncated Normal	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Half normal*
1	Bangkok Life	0.7406	0.7757	0.6535	0.8415	0.8583	0.7688	0.8020	0.7095
2	Krungthai Axa Life	0.3532	0.3635	0.3131	0.6061	0.6318	0.5553	0.7407	0.6556
3	Allianz C.P. Life	0.6966	0.7129	0.6551	0.7820	0.8042	0.6713	0.7020	0.6036
4	TPI Life	0.7607	0.7788	0.7302	0.7520	0.7810	0.6597	0.7537	0.6779
5	Millea Life	0.1438	0.1439	0.1278	0.1808	0.1882	0.1589	0.1496	0.1241
6	Thai Life	0.7359	0.7740	0.6441	0.7789	0.8069	0.6776	0.7727	0.6812
7	Nationwide Life	0.6759	0.7115	0.5945	0.8903	0.8995	0.8463	0.8974	0.8959
8	Siam Commercial New York Life	0.6727	0.7096	0.5868	0.9104	0.9165	0.8587	0.8825	0.8496
9	Thai Cardiff Life	0.2395	0.2404	0.2150	0.6651	0.6899	0.6203	0.6098	0.5446
10	Ocean Life	0.6762	0.7139	0.5898	0.6336	0.6563	0.5659	0.7565	0.7264
11	Zurich National Life	0.6452	0.6690	0.5837	0.6465	0.6726	0.5811	0.4956	0.4138
12	Ayudhaya Allianz C.P. Life	0.5699	0.6097	0.4783	0.8141	0.8269	0.7570	0.6799	0.5663
13	Generali Life	0.5712	0.5968	0.5094	0.6749	0.6947	0.6128	0.6988	0.6067
14	Prudential TS Life	0.5148	0.5449	0.4460	0.8685	0.8817	0.8092	0.9027	0.8987
15	Muang Thai Life	0.6404	0.6808	0.5487	0.7898	0.8144	0.6947	0.8275	0.7447
16	ACE Life	0.5282	0.5466	0.4835	0.7920	0.8300	0.7326	0.7356	0.6492
17	Max Life	0.7520	0.7773	0.6997	0.6900	0.7178	0.6144	0.7631	0.6866
18	Siam Samsung Life	0.7853	0.8062	0.7435	0.6955	0.7243	0.6133	0.7581	0.6656
19	Siam Life	0.8166	0.8379	0.7737	0.8785	0.8909	0.8086	0.8890	0.8766
20	Saha Life	0.7983	0.8215	0.7430	0.8789	0.8904	0.8221	0.7655	0.6843
21	South East Life	0.6322	0.6659	0.5500	0.8594	0.8742	0.7933	0.8042	0.7654
22	Interlife John Hancock	0.7474	0.7707	0.6907	0.8784	0.8914	0.8107	0.7785	0.7084
23	Advance MLC	0.2676	0.2685	0.2454	0.7216	0.7394	0.6726	0.7826	0.7499
24	ING Life	0.2730	0.2766	0.2467	0.5921	0.6181	0.5314	0.6409	0.5485
25	AIA Life	0.7189	0.7593	0.6357	0.5586	0.5785	0.4884	0.6512	0.5568
26	Kamolsukosol	0.7549	0.7840	0.6915	0.8618	0.8734	0.8063	0.8190	0.7705
27	Bangkok	0.8750	0.8875	0.8626	0.3053	0.3279	0.2641	0.1169	0.0935
28	Krungthai Panich	0.8009	0.8254	0.7533	0.4938	0.5217	0.4262	0.4127	0.3145
29	Road Accident Victims Protection	0.4722	0.4941	0.4159	0.5039	0.5052	0.4952	0.6130	0.5960
30	Aviva	0.5530	0.5854	0.4787	0.5606	0.5841	0.4846	0.5067	0.4059

contd. table

No.	Firm	*Cost Efficiency*			*Profit Efficiency*			*Alternative Profit Efficiency*	
		Truncated Normal	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Half normal*
31	Khoom Khao	0.8716	0.8861	0.8515	0.9274	0.9299	0.8996	0.8969	0.8821
32	Charan	0.5689	0.6008	0.5046	0.5390	0.5619	0.4742	0.7225	0.6071
33	QBE	0.6062	0.6425	0.5212	0.8419	0.8600	0.7602	0.7597	0.6621
34	Allianz C.P.	0.8039	0.8265	0.7544	0.7530	0.7711	0.6872	0.7769	0.6943
35	Chao Phaya	0.5834	0.6053	0.5300	0.8634	0.8755	0.8133	0.6987	0.6649
36	Chubb	0.6298	0.6531	0.5630	0.8222	0.8328	0.7778	0.7936	0.7839
37	China	0.6797	0.7073	0.6194	0.8600	0.8708	0.8159	0.7583	0.7293
38	Dhipaya	0.7916	0.8183	0.7329	0.7576	0.7934	0.6541	0.4672	0.3570
39	Deves	0.7987	0.8223	0.7541	0.6182	0.6498	0.5323	0.5052	0.3839
40	Sompo Japan	0.6211	0.6478	0.5576	0.8361	0.8523	0.7817	0.8081	0.7662
41	Thai Charoen	0.8266	0.8458	0.7975	0.6084	0.6336	0.5475	0.7976	0.7178
42	Thai	0.7008	0.7342	0.6235	0.7781	0.8022	0.6950	0.7087	0.6042
43	Mittare	0.3320	0.3494	0.2847	0.4754	0.4968	0.4191	0.4807	0.3815
44	Thai United	0.3299	0.3446	0.2883	0.6442	0.6700	0.5683	0.7428	0.6272
45	Thai Commercial	0.7241	0.7545	0.6581	0.7584	0.7817	0.6814	0.7073	0.6070
46	Thai Zurich	0.5454	0.5784	0.4720	0.3681	0.3874	0.3155	0.2857	0.2187
47	Thai Setakij	0.5495	0.5857	0.4713	0.7947	0.8204	0.7070	0.8048	0.6865
48	Ocean	0.8043	0.8276	0.7651	0.5946	0.6233	0.5144	0.5872	0.4515
49	National Insurance	0.7724	0.7989	0.7143	0.7328	0.7576	0.6532	0.7929	0.7092
50	Dhanavat	0.8110	0.8309	0.7775	0.6675	0.6889	0.6064	0.7787	0.7124
51	Navakij	0.7118	0.7466	0.6351	0.5920	0.6236	0.5096	0.5056	0.3939
52	Narai	0.5539	0.5909	0.4659	0.6618	0.6859	0.5980	0.4834	0.3900
53	Nam Seng	0.7423	0.7746	0.6657	0.6581	0.6928	0.5730	0.5222	0.4139
54	Bangkok Union	0.7062	0.7401	0.6344	0.5526	0.5804	0.4779	0.5268	0.4124
55	Safety	0.7911	0.8183	0.7264	0.7926	0.8245	0.6900	0.5786	0.4582
56	Thaivivat	0.8133	0.8374	0.7634	0.8082	0.8339	0.7149	0.6981	0.5630
57	Sri Muang	0.7658	0.7846	0.7313	0.6584	0.6920	0.5708	0.5074	0.4045
58	International	0.7594	0.7874	0.7004	0.8303	0.8461	0.7647	0.8257	0.7721
59	Generali	0.7634	0.7801	0.7260	0.8454	0.8609	0.7754	0.8159	0.7765
60	Bangkok Thonburi	0.8465	0.8628	0.8242	0.8060	0.8244	0.7362	0.7376	0.6710
61	Patchara	0.5220	0.5511	0.4465	0.8108	0.8317	0.7466	0.6753	0.5809
62	Commercial	0.4717	0.4959	0.4123	0.7570	0.7823	0.6791	0.7164	0.6256
63	Phutthatham	0.6760	0.6963	0.6285	0.7197	0.7427	0.6539	0.7589	0.6878
64	Paiboon	0.5413	0.5752	0.4676	0.6604	0.6902	0.5809	0.6444	0.5235
65	Universal	0.5608	0.5863	0.5024	0.7187	0.7458	0.6454	0.7974	0.7254
66	Phatra	0.6545	0.6888	0.5885	0.3012	0.3158	0.2568	0.3990	0.2831
67	Muang Thai	0.6714	0.7080	0.5913	0.7378	0.7690	0.6416	0.6941	0.5761
68	Royal And Sun Alliance	0.7096	0.7402	0.6359	0.7787	0.8071	0.6830	0.5908	0.4908
69	Liberty	0.6116	0.6477	0.5292	0.6172	0.6441	0.5525	0.5166	0.4205
70	BT.	0.5467	0.5806	0.4708	0.8272	0.8454	0.7512	0.7894	0.7011
71	Wilson	0.7226	0.7490	0.6661	0.8373	0.8542	0.7662	0.8053	0.7654
72	Viriyah	0.6961	0.7349	0.6075	0.8522	0.8721	0.7868	0.5845	0.4884
73	Ayudhya	0.7687	0.7920	0.7306	0.1685	0.1780	0.1420	0.1359	0.0938
74	Thai Development	0.4518	0.4785	0.3871	0.8170	0.8335	0.7497	0.7808	0.7046
75	Siam City	0.5654	0.5993	0.4881	0.8404	0.8545	0.7834	0.8082	0.7593
76	Union	0.7505	0.7772	0.6922	0.8278	0.8435	0.7657	0.7685	0.7144
77	Union Prospers	0.5909	0.6134	0.5377	0.8059	0.8247	0.7376	0.7499	0.6895
78	Sahawattana	0.8373	0.8554	0.8049	0.8463	0.8584	0.7964	0.7427	0.6809

contd. table

No.	*Firm*	*Cost Efficiency*			*Profit Efficiency*			*Alternative Profit Efficiency*	
		Truncated Normal	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Exponen-tial*	*Half normal*	*Truncated Normal*	*Half normal*
79	Sampan	0.8181	0.8398	0.7708	0.9104	0.9179	0.8757	0.8311	0.7642
80	Samaggi	0.7947	0.8210	0.7433	0.6532	0.6886	0.5578	0.5529	0.4205
81	Assets	0.6581	0.6935	0.5768	0.8332	0.8513	0.7616	0.7862	0.6953
82	Synmunkong	0.7391	0.7722	0.6574	0.7568	0.7860	0.6771	0.5496	0.4362
83	South East	0.4668	0.4974	0.3973	0.5820	0.6065	0.5180	0.5007	0.4128
84	Indara	0.8505	0.8669	0.8276	0.8216	0.8403	0.7491	0.8047	0.7182
85	Kurnia	0.3893	0.4052	0.3410	0.6708	0.6898	0.6215	0.6310	0.5551
86	Asia	0.5770	0.5950	0.5248	0.7844	0.7973	0.7407	0.5867	0.5624
87	Erawan	0.4504	0.4753	0.3890	0.6861	0.7149	0.6075	0.6573	0.5451
88	AXA	0.7496	0.7805	0.6791	0.7924	0.8171	0.6983	0.7387	0.6317
89	Advance	0.7053	0.7102	0.6861	0.8783	0.8846	0.8363	0.5604	0.4797
90	Osotspa	0.8720	0.8829	0.8664	0.7867	0.8057	0.7100	0.8262	0.7772
91	ACE	0.4632	0.4838	0.4065	0.8270	0.8430	0.7814	0.8136	0.7749
92	New India	0.7628	0.7865	0.7082	0.8700	0.8776	0.8333	0.7411	0.7240
93	New Hampshire	0.6625	0.7004	0.5774	0.6942	0.7268	0.6027	0.5341	0.4231
94	Mitsui Sumitomo	0.8837	0.8957	0.8757	0.8211	0.8447	0.7295	0.7984	0.6731
95	AIA. Non-Life	0.8068	0.8277	0.7701	0.6501	0.6819	0.5687	0.4595	0.3885
96	Thai Health	0.9031	0.9118	0.8998	0.8257	0.8386	0.7800	0.8070	0.6122
97	Blue Cross	0.8333	0.8543	0.7795	0.9313	0.9321	0.9129	0.8240	0.7756
98	Bangkok Health	0.3959	0.4047	0.3521	0.8608	0.8664	0.8312	0.7464	0.6970
99	Thai Medical Care	0.7012	0.7247	0.6304	0.6075	0.6023	0.6225	0.7904	0.7298
	Average	0.6571	0.6820	0.6005	0.7244	0.7447	0.6591	0.6796	0.6018

There are forty firms that have average cost efficiency scores below the industry average cost efficiency scores. The forty firms which have average cost efficiency score below the industry average consist of twenty-seven and thirteen firms that commence operation before and after 1997, respectively.

In 1997 to 1998, twenty-seven insurance firms start to commence their operation and they are expected to have average cost efficiency score that are lower than the industry cost efficiency scores. However, the study show that only thirteen of these firms have average cost efficiency scores that are lower than the average industry cost efficiency score. Surprisingly, this study finds that the fourteen of the so called "new firm" obtain higher than the industry average cost efficiency score. The new firms produce less output but used more resources thus receiving lower average cost efficiency score. Their balance sheets lack both revenue and outputs (claim). Although most of them have cooperation with foreign firm (except for two firms), the process of merging only occurs from year 2000 onwards. Hence, these firms could not improve their cost efficiency during the study period. However, there are five firms where average cost efficiency has improved over the range of this study period.

Table 9 columns 6, 7 and 8 show the result of average standard profit efficiency score by firm. The result shows that 41 insurers have standard profit efficiency score lower than the industry average. The 41 insurers consist of eleven life and thirty non-life insurers. Out of the eleven, the nine life insurers are relatively new insurers with each insurers has market share less than 1% while the relatively old insurers have market share of 3.16 and 30%.

Among the thirty non-life insurers that have profit efficiency less than the industry average, Bangkok Insurance, Deves Insurance and New Hampshire have market share of 2.28%, 1.29% and 1.06% of the market, respectively. Each of the other twenty –seven non-life insurers has market share less than 1%. In terms of age, there are seven relatively new insurers and twenty-three relatively old insurers which have scores below the industry average. Most of these thirty non-life insurers have very large loss incurred, underwriting expense and loss adjustment expenses which almost equal to their premium. Although, most of the thirty non-life insurers obtained profit from their investment and other incomes, they have scores below the industry average because they use more inputs compared to other insurers. Non–life insurers faced very low commission and brokerage cost. Thus, the source of inefficiency may come from high loss incurred, underwriting expense and loss adjustment expense or claim processing cost.

The translog standard profit efficiency scores from truncated normal estimators are less than the exponential by about 2.02% but higher than half normal by about 6.53% and exponential scores is higher than half normal of 8.55% (The mean difference test in Table 5 show no significance difference between truncated normal and exponential but there is significant difference between truncated normal and half normal and between exponential and half normal).

Table 9 columns 9,10 and 11 shows the alternative profit efficiency scores by firm using truncated normal and half normal. In the truncated normal model, there are thirty-five insurers which have scores below the industry average. This is almost the same group in the case of translog standard profit efficient insurers which have scores below the industry average. However, there are thirteen insurers that have scores below the industry average.

The thirty-five insurers in translog alternative profit which have scores below the industry average consists of five life insurers and thirty non-life insurers or nine relatively new insures and twenty-six relatively old insurers. In terms of market share, AIA Life has market share of about 30%, while the other seven non-life insures have market share of 1% to 4%. The others twenty-seven insurers each has market share less than 1%. The characteristics of the thirty-five insurers are similar to the case of standard profit that has scores lower than the industry average. Life insurers have very large disbursements in commission and brokerage, underwriting expense and life policy reserves while non-life insurers have very large loss incurred, underwriting expense and loss adjustment expense. To improve their profit efficiency, these thirty-five insurers should use more information technology or paperless system in all stage of the operations including investigating the appropriate and suitable distribution channels and products. This is particularly important in the case of claim processing for non-life insurers. Furthermore, the claims processing could be improve hence, reducing the cost of underwriting and loss adjustment expenses.

6. CONCLUSION

The purpose of this paper is to estimate cost and profit efficiency in Thailand's insurance industry by employing the translog stochastic frontier approach. In the cost efficiency model, the result of the mean difference test shows that there is significant difference between truncated normal and half normal for both cost and profit efficiency scores. The average cost efficiency scores range from 0.5911 to 0.6732 and from 0.5327 to 0.6190 in the case of truncated normal and half normal, respectively. In all cases the average cost efficiency scores decreases from 1997 to 1999 but increases onwards.

The standard profit efficiency scores for truncated normal range between 0.6830 in 1997 and 1999 to 0.7268 in 2003 while the average alternative profit efficiency score by year for truncated normal ranges from 0.6304 in 1999 to 0.6731 in1998. The average alternative profit efficiency score for half normal ranges from 0.5465 in year 1998 to 0.5986 in 2001. The average translog alternative profit efficiency score for truncated normal are higher than the half normal by about 7 to 13%.

The average cost efficiency for the whole study period for truncated normal, exponential and half normal is 0.6571, 0.6820 and 0.6005, respectively. The results indicate that, on average, insurance firm in Thailand used 34.3 to 40 percent more input than it should be. The results also indicate that the average translog cost efficiency from truncated normal estimator is higher than the results from half normal by about 9%. The average profit efficiency for the whole period range from 0.6018 to 0.7447. This indicates that, on average, Thai insurers wasted 25 to 40 per cent of their potential profits.

The results also show that the cost and profit efficiency are inconsistent in terms of ranking indicating that cost efficient does not necessarily reflect profit efficient.

Note

1. Similarly, the translog functional form of standard and alternative profit can be derived.

References

Aigner, D. J., Chu, S. F. (1968), *On Estimating the Industry Production Function*. *American Economic Review* 58(4), pp. 826-839.

Benson, G. J., Hanweck, G. A. and Humphrey, D. B. (1982), Scale Economies In Banking : A Restructuring and Reassessment. *Journal of Money Credit and Banking*, Vol. 4(4), Part 1, 435-456.

Berger, A. N. (1993), Distribution-free Estimates of Efficiency in the U.S. Banking Industry and Tests of the Standard Distributional Assumptions, *Journal of Productivity Analysis*, Vol. 4, pp. 261-292.

Berger, A. N. and Mester, L. J. (1997), Inside the Black Box: What Explains Differences in the Efficiencies of Financial Institutions? *Journal of Banking and Finance,* Vol. 21, pp. 895-947.

Berger, A. N., Hancock, D. and Humphrey, D. B. (1993), Bank Efficiency Derived from the Profit Function, *Journal of Banking and Finance,* Vol. 17, pp. 317-347.

Coelli, T. J., Rao, D. S. P. and Battese G. E. (1998), *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Publishers: USA.

Cummins, J. D., Weiss, M. A. (1993), Measuring Cost Efficiency in the Property-Liability Insurance Industry, *Journal of Banking and Finance,* Vol. 17, pp. 463-481.

Cummins, J. D. Turchetti, G. and Weiss, M. A. (1996), Productivity and Technical Efficiency Italian Insurance Industry, Working Paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D., Tennyson, S. L. and Weiss, M. A. (1998), Consolidation and Efficiency In the U.S. Life Insurance Industry, Working Paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D., Tennyson, S. L., Weiss, M. A. (1999), Efficiency Scale Economies and Consolidation, *Journal of Banking and Finance,* Vol. 23, No. 2-4, pp. 325-351.

Cummins, J. D. and Weiss, M. A. (1998), Analyzing Firm Performance in the Insurance Industry using Frontier Efficiency Methods, Working Paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D. and Zi, H. (1997), Measuring Cost Efficiency in the U.S. Life Insurance Industry: Econometrics and Mathematical Programming Approaches, Working Paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D. and Zi, H. (1998), Comparison of Frontier Efficiency Methods: An Application to the U.S. Life Insurance Industry, *Journal of Productivity Analysis*, Vol. 10, No. 2, pp. 131-152.

Cummins, J., Weiss, M. A. and Zi, H. (1997), Organization form and Efficiency: An analysis of Stock and Mutual Property-Liability Insurers, Working Paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D. and Maria R. M. (2002), Deregulation, Consolidation, and Efficiency: Evidence From the Spanish Insurance Industry, working paper, Wharton Financial Institutions Center, Philadelphia, PA.

Cummins, J. D., Maria R. M. and Zi, H. (2003), Organization Structure and Efficiency: Evidence From the Spanish Insurance Industry, working paper, Wharton Financial Institutions Center, Philadelphia, PA.

Diewert, W. E. (1974), Functional Form for Revenue and Factor Requrement Functions. *International Economics Review*, Vol. 15, No. 1, pp. 199-130.

Färe R., Grosskopf, S. and Lovell, C. A. K. (1985), The Measurement of Efficient of Production. Kluwer· Nijhoff Publishing.

Farrell, M. J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, Vol. 120, pp. 252-290.

Fuss, M. and McFadden, D. (1978), Production Economic: A Dual Approach to Theory and Applications Volume II: Application of the Theory of Production. Amsterdam, North-Holland.

Greene, W. H. (1993), The Econometric Approach to Efficiency Analysis." In H. O. Fried, C. A. K. Lovell, and S. S. Schmidt, eds., The Measurement of Productive Efficiency: Techniques and Applications. New York: Oxford University Press.

Greene, W. H. (1995), *LIMDEP (Version 7): User's Manual and Reference Guide*, Econometric Software Inc., New York.

Greene, W. H. (2003), *Econometric Analysis, 5th ed*. Pearson Education, Inc., Upper saddle River, New Jersey, 07458.

Humphrey, D. B. and Vale, B. (2003), Scale Economies, Bank Mergers, and Electronic Payment: A Spline Function Approach, *Journal of Banking and Finance,* Vol. 28, pp. 1671-1696.

Karim, M. Z. A. (2001), Comparative Bank Efficiency across Select ASEAN Countries, ASEAN Economics Bulletin, Vol. 18, pp. 289-304.

Karim, M. Z. A. and Jhantasana, Ch. (2005), Efficiency and Profitability In Thailand's Life Insurance Industry: A Cost Frontier Function and Hausman test, 1997-2002. *International Journal of Applied Econometrics and Quantitative Studies*,Vol. 2.

Kumbhakar, S. C. (1997), Modeling Allocative Inefficiency in a Translog Cost Function and Cost Share Equations: An Exact Relationship. *Journal of Econometrics* Vol. 76, No. 1/2, pp. 351-356.

Kumbhakar, S. C. and Lovell, C. A. K. (2000), Stochastic Frontier Analysis, New York, New York: Cambridge University Press.

McAllister, P. H. and McManus, D. (1993), Resolving the Scale Efficiency Puzzle in Banking, *Journal of Banking and Finance* Vol. 17, pp. 389-405.

Mitchell, K., and Onvural, N. M. (1996), Economies of Scale and Scope at Large Commercial Banks: Evidence from the Fourier Flexible Functional form, *Journal of Money, Credit, and Banking,* Vol. 28, pp. 178-199.

Moon, W. S. (2001), Currency Crisis and Stock Market Integration: A Comparison of East Asia and European Experience. *Journal of International and Korea Studies*, Vol. 8, No. 1, pp. 41-56.

Pulley, L. B., Berger, A. N. and Humphrey, D. B. (1994), Do Consumer Pay for One-stop Banking? Evidence from a Non-standard Revenue Function, Working Paper No. 94-01, Wharton Financial Institutions Center, Philadelphia, PA.

Lau, L. J. (1978), "Testing and Imposing Monotonicity, Convexity and Quasiconvexity Constraints," in Production Economics: A Dual Approach to Theory and Applications, Vol. 1, (Amsterdam: North-Holland), 409-453.

Maggi, B. and Rossi, S. P. (2004), An Efficiency Analysis of Banking System: Comparison of European and United States Large Commercial Banks Using Difference Functional Forms. Working paper No. 063, Economics Department, University of Vienna.

Matousek, R. (2004), Efficiency and Scale Economies in Banking: Empirical Evidence From Eight Accession Countries. Department of Economics, Finance and International Business, London Metropolitan University, London, England.

Rime, B. and Stiroh, K. J. (2003), The Performance of Universal Banks: Evidence from Switzerland. *Journal of Banking and Finance*, Vol. 27, pp. 2121–2150.

Yildirim, H. S. and Philippatos, G. C. (2003), Efficiency of Bank: Recent Evidence from the Transition Economies o Europe, 1993-2000. College of Commerce University of Saskatchewan, Saskatoon, SK S7N 5A7, Canada.

Yuengert, A. (1993), The Measurement of Efficiency in Life Insurance: Estimates of a Mixed Normal-Gamma Error Model, *Journal of Banking and Finance* 17, 483-96.