Technical and Scale Efficiency in the Thai Non-life Insurance Industry[1]

Asst. Prof. David L. Eckles, Ph.D.*
Asst. Prof. Narumon Saardchom, Ph.D.**

Abstract

The Thai non-life insurance is strictly regulated in many aspects including the premium rate. To compete in the market, non-life insurance companies in Thailand have to concentrate on production technology rather than price competition. An efficiency score measured by frontier methodology can thus provide better performance indicator than traditional measurements evaluated by financial ratios. We apply frontier methodology to the accounting data of non-life insurance firms reported to the Department of Insurance in order to calculate efficiency scores by firm and by year. We find a wide dispersion in efficiency scores among non-life insurance firms in Thailand. Average technical efficiency scores of the Thai non-life insurance industry ranges between 0.691 and 0.791. Moreover, over the entire sample period, 41.7% of the firms are operating with constant returns to scale. 25.1% are operating with decreasing returns to scale and the remaining 33.3% are operating with increasing returns to scale. The larger the firm, the more likely they are to be operating with decreasing returns to scale.

** Terry College of Business, University of Georgia*
*** Graduate School of Business Administration, National Institute of Development Administration (NIDA)*

1. Introduction

The Thai non-life insurance industry has undergone several changes over the past ten years. The number of non-life insurance companies in Thailand has increased from 67 companies in 1994 to 76 companies in 2004. The total direct premiums in the Thai non-life insurance industry have increased from 44,424 million baht in 1994 to 70,970 million baht in 2003. In 2003, there were only eight companies that had direct premium larger than 2,000 million baht. Eleven companies had direct premium between 1,000 and 2,000 million baht; thirty three companies had direct premium between 200 and 1,000 million baht. The rest of the industry had direct premium lower than 200 million baht. In the past decade, the premium rate of Thai non-life insurance products increased by 5.3% each year on average.

In 2002, the Thai non-life insurance industry was ranked the 40th out of non-life insurance markets from 91 countries. The total direct premium of the Thai non-life insurance industry accounted for 0.13 percent respectively of the world non-life insurance market. The top three largest non-life insurance markets are the US, Japan, and the UK, who accounted for 47.7 percent, 8.4 percent, and 7.1 percent of the world non-life insurance market. In 1994, the ratio of the total non-life insurance premium to the Gross Domestic Product (GDP) of Thailand was 1.2 percent, compared to an average of 3.4 percent worldwide. This ratio has not varied much over the past ten years, and was 1.1 percent in 2003. The level of non-life insurance premiums per person in Thailand was about $24 in 2003, compared to a worldwide average of $176. As Compared to the world averages, the Thai non-life insurance industry still has a lot of room for expansion.

Non-life insurance companies in Thailand vary not only in their direct premium but also in their economic capital. In 2002, four companies had negative economic capital while there were eleven companies that had capital holdings larger than 1,000 million baht and forty-one companies had capital between 300 and 1,000 million baht.

The Thai non-life insurance industry grew very rapidly during 1994 and 1995, which resulted from an excessive growth of the Thai economy during this period. The growth rate in terms of direct premium was about 15 to 20 percent per annum. Direct premium of automobile insurance tremendously increased and amounted to more than half of total direct premium for the entire Thai non-life insurance market. Two main reasons for this phenomenon were the enforcement of the Protection for Motor Vehicle Accident Victims Act and the excessive sale volumes of automobiles in Thailand. The Thai non-life insurance industry began to slow down in 1996, right before an economic crisis in 1997. It experienced a huge drop in direct premium during 1997 and 1999, after which the Thai non-life insurance industry recovered and experienced an excessive growth again. The total direct premium increased from 48,701 million baht in 2000 to 70,970 baht in 2003. Such an increase in direct premium amounted for about 13.4% per annum during this period. This increase in direct premium is due to a substantial increase in the demand for miscellaneous insurance after the 9/11 terrorist attack in New York. Both the number of issued policies and premium rates of industrial all-risk insurance products have increased after the 9/11 event. Total direct premium of miscellaneous insurance products increased from 17.7 percent of the total market in 2000 to 26.8 percent in 2003; and thus, miscellaneous insurance products became the second largest line of insurance in terms of direct premium, next to the automobile insurance.

The Thai non-life insurance industry underwent the recession period during 1997 and 1999. The market improved every year except 2001, when the loss ratio was high. The average loss ratio increased from 54.1 percent in 2000 to 56.9 percent in 2001 due to the huge flood claims in Songkla and Udornthani provinces. The industry loss ratio has since declined and reached the lowest level of 43.8 percent in 2003, resulting in an increase in profit of 20.9 percent that year. The average loss ratios over the last ten years are 63.5 percent, 49.4 percent, 36.6 percent, and 30.4 percent for automobile insurance, miscellaneous

insurance, marine insurance, and fire insurance, respectively.

Using a traditional approach to measure the efficiency of the non-life industry, the high loss ratio indicates lower efficiency. Another financial ratio that is often used to measure the efficiency is the expense to premium ratio. A higher expense ratio suggests lower efficiency. In the past ten years, the average expense ratio of the Thai non-life insurance industry is 34 percent. It has increased from 29.6 percent in 1995 to the highest level of 38.3 percent in 1999. After the economic crisis in 1997, the expense to premium ratio has remained above the average ratio of 34 percent every year, except only in 2002 (33 percent.) In 2003, the expense to premium ratio was still high at 35.3. Such an increase therefore indicates that the efficiency of the Thai non-life insurance industry has declined over the past decade. This is mainly because most non-life insurance companies are small in size (measured by total assets) and thus cannot achieve economy of scale in their productions. The average expenses to premium ratios over the last ten years are 35.1 percent, 24.2 percent, 29.0 percent, and 42.3 percent for automobile, miscellaneous, marine, and fire insurance respectively. Note that fire insurance has the smallest loss ratio, but the largest expense ratio.

From this past experience, the factors that contribute to the efficiency and future expansion of the Thai non-life insurance industry include the level of economic expansion in Thailand, government policies and regulations, and significant events that affect both the Thai and world economy.

The five biggest non-life insurance companies-Viriya Insurance, Dhipaya Insurance, Bangkok Insurance, Sampanth Insurance, and Deves Insurance,-together had market share of about 36.9% in 2003. The rest of the industry had less than 5% market share and forty seven companies had less than 1% market share. Thus, the Thai non-life insurance industry is mostly comprised of the medium and small companies. In contrast to the Thai non-life insurance industry, the five biggest Thai life insurance companies together has market share of

about 90%. Moreover, while Viriya insurance, the biggest non-life insurance company, has about 13% of market share, the biggest life insurance company has over 50% market share.

Even though this statistics indicate that the degree of competition in the Thai non-life insurance industry should be larger than that in the Thai life insurance industry, the non-life insurance business in Thailand is strictly regulated by the government. The regulations restrict the reserve amount, capital fund, investment policy, insured amount, agent commission rate, the issuance of a new insurance product, and premium rate. As a result, the degree of competition in terms of products and prices are very limited. Many non-life insurance companies were penalized and fined from conducting business out of the rules set by the Commissioner. This strict regulation is believed to have helped protect both the consumers-benefits and the small insurance companies from being taken advantage of by the bigger firms. On one hand, given this strict regulatory system, the non-life insurance industry was not as affected and recovered very fast, relative to other industries during the economic crisis. On the other hand, rather than competing with products and prices in the Thai non-life insurance market, the Thai non-life insurance firms have to emphasize on production and operating efficiency. Therefore, for the Thai non-life insurance indicator, the frontier methodology introduced in this paper can provide better performance indicator than the traditional approach using financial ratios.

The measurement of Thai non-life insurance firm performance has been done using only conventional financial ratios such as the return on equity, return on assets, and expense to premium ratios. With the emergence of frontier methodology for estimating efficiency and productivity, the conventional methods have become outdated. This traditional methodology assumes that all firms maximize profits and minimize costs. Frontier methodology, on the other hand, provides efficiency measure by comparing firms to the efficient frontier formed by the dominant firms in the industry. Thus, it provides more

meaningful and reliable measures of firm performance. In this paper, we apply this new technique to measure an efficiency of non-life insurance firms in Thailand.

2. Efficiency Methodology

For each year in the sample we estimate a "best practice" production frontier. The computed frontier is made up of the firms in the Thai property/liability insurance industry that are found to be the most efficient. These best practice firms are assigned an efficiency score of one. All other firms in the industry are then compared to the best practice firms and are given a score between zero and one.

In estimating the production frontier, there are two competing methodologies. The statistics-based econometric approach takes an assumed production function and measures efficiency based on both random and firm specific (in)efficiency component. This method then requires assumptions to be made for the production function, the distribution of the random error component, as well as the distribution of the firm-specific inefficiency component. Unless you precisely know the components required for the analysis, the model will be mis-specified.

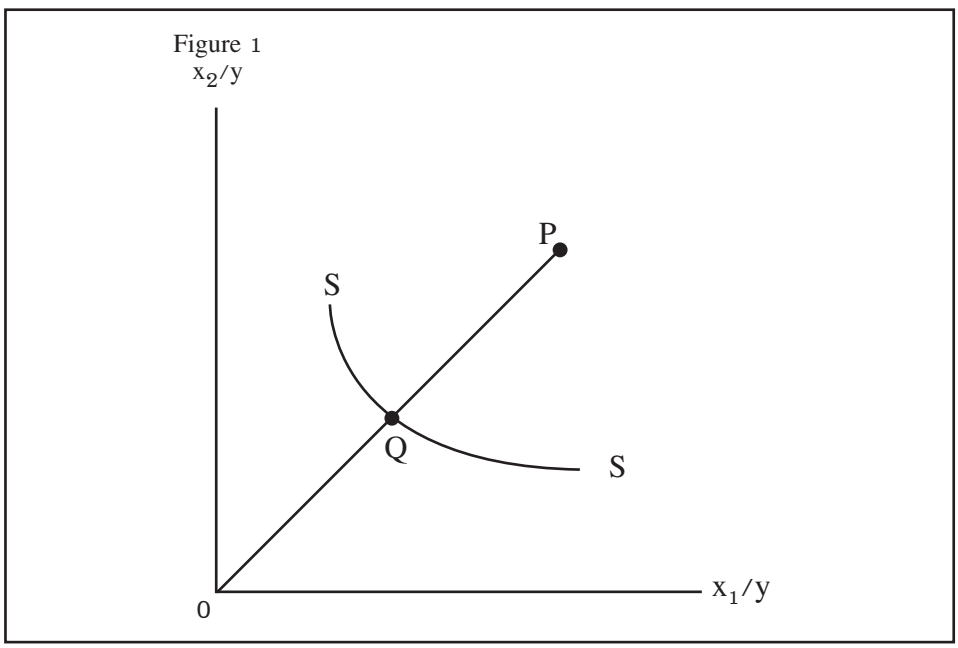
The alternate method for estimating firm efficiency involves a mathematical programming approach. One such mathematical programming approach is data envelopment analysis (DEA). DEA constructs a convex hull from linear combinations of the best practice firms. The remaining firms are then given efficiency scores based on their distance from the efficient frontier. DEA methodology is non-parametric and does not require any assumptions regarding the production function or error term distribution. A potential drawback to using the DEA methodology is that DEA treats all inefficiency as firm specific inefficiency. That is, unlike stochastic frontiers, DEA does not allow for any random inefficiency component.

Despite the aforementioned problematic feature of DEA, Banker (1993) and Korostelev, Simar, and Tsybakov (1992, 1995) have shown

that DEA has the properties of a maximum likelihood estimator for firm efficiency. Further, Kneip, et al. (1998), Grosskopf (1996) and Korostelev, Simar, and Tsybakov (1992, 1995) have shown that the DEA estimator is consistent and converges faster than other estimators (again, the stochastic frontiers are hampered by the uncertainty over the production and error distribution functions). Finally, ex-post regression analysis will allow for random variation in efficiency.

We estimate input oriented technical efficiency scores for firms in the Thai property/liability insurance industry. Farrell (1957) defines technical inefficiency as deviation from the production possibilities frontier. Imagine a firm using two inputs, x_1 and x_2, to produce one output, y. The most efficient production technology is given by SS' in Figure 1 below.

Figure 1



Firms (such as Q) on SS' are considered fully technically efficient. Firms (such as P) are inefficient in the sense that they could proportionally reduce their inputs and maintain the same level of outputs. The degree to which firm P is inefficient is the distance from P to SS':

$$TE_P = \frac{0\mathrm{Q}}{0\mathrm{P}}$$

We operationalize this measure by constructing SS' from the best practice firms in the industry. The firms that do not make up the frontier are then given an efficiency score based upon their distance from the frontier. We use DEA to construct the frontier (and obtain the efficiency scores). Consider *M* firms using an *N*-dimensional input vector $x = (x_1, ..., x_N)^T \in \Re_+^N$ to produce an *O*-dimensional output vector. $y = (y_1, ..., y_O)^T \in \Re_+^O$ In constructing the frontier, we use the following linear programming model:

$$\min_{\phi,\lambda} \phi_i$$

Subject to

$$\phi x_{ni} \geq \sum_j \lambda_j x_{sj} \qquad \forall n$$

$$y_{mi} \leq \sum_j \lambda_j y_{sj} \qquad \forall o$$

$$\lambda_j \geq 0$$

where λ_i is a weighting parameter for firm i representing the combination of firms that form the production frontier for firm i. $1-\phi_i^*$ represents the proportional reduction in inputs that firm i could endure while maintaining the same level of output. A firm with $\phi_i^* = 1$ is said to be fully technically efficient, and is operating on the efficient frontier. A firm with $\phi_i^* < 1$ is operating off the frontier and can reduce its inputs by $1 - \phi_i^*$ and maintain the same level of output.

The above program returns the technical efficiency score assuming constant returns to scale. Requiring the $\sum \lambda_i = 1$ returns the technical efficiency score allowing for variable returns to scale. This result,

denoted TE_{VRS} , also creates a "tighter" convex hull and returns the *pure technical efficiency (PTE)* score. The ratio of the TE_{CRS} score and the TE_{VRS} score is the scale efficiency *(SE)*. If a firm's *SE* score is equal to one, then the firm is operating with constant returns to scale. A firm not operating with constant returns to scale is either operating with increasing or decreasing returns to scale. In order to distinguish between increasing and decreasing returns to scale, we must then change the constraint in the above program to $\sum \lambda_i \leq 1$. Implementing this constraint then returns the technical efficiency score assuming *non-increasing* returns to scale (TE_{NIRS}). If $TE_{VRS} = TE_{NIRS}$ then the firm is characterized by decreasing returns to scale. If $TE_{VRS} \neq TE_{NIRS}$ then the firm is characterized by increasing returns to scale.

3. Data

Insurance firms are financial institutions that primarily sell services. As such, measuring the output of an insurance firm is not always easy. Berger and Humphrey (1992) suggest a method by which to measure the outputs of financial institutions that they call a "modified value-added" approach. This approach considers as outputs those functions of firms that have significant operating cost allocations. Prior literature in the US insurance industry (Berger, Cummins, and Weiss 1997; Cummins, Eckles, and Zi 2004; Cummins and Weiss 1993; Cummins, Weiss and Zi 1999; Xie 2002) defines insurer service output as 1) risk pooling/risk bearing, 2) "real" financial services related to insured losses, and 3) intermediation.

The risk pooling/risk bearing service provided by insurers allows consumers (individuals and businesses) to minimize their idiosyncratic risk by pooling their risk with other insureds. Insurance firms incur significant expenses in this underwriting process. The capital held by insurers provides value by acting as a pool bearing the residual risk.

In addition to the risk bearing service provided, insurers often also provide "real" financial services to consumers. These "rea" services are usually in the form of risk management consulting, financial planning

consulting, and loss control consulting. In the case of liability coverage, insurers are also a significant provider of legal services to the insured.

Finally, insurers are much like banks in the intermediation service they provide. Instead of taking deposits, insurers take in up-front premiums that they hold and invest until a claim is made.

In keeping consistent with the US property/liability literature, we define 5 outputs designed to proxy for the aforementioned services provided by insurers. As a proxy for the risk bearing and real services outputs, we consider the incurred losses and loss adjustment expenses for four lines of insurance (fire, marine, auto, and miscellaneous). Since incurred losses are those expected to be paid as a result of providing insurance, it is a good proxy for the risk bearing service. Loss adjustment expenses are considered a reasonable proxy for the "real" services provided by insurers. We also consider a firm's invested assets as a proxy for the intermediation service provided by the insurers.

Insurers have three main inputs used in the production of their outputs. Labor, business services, and capital are all used extensively by insurers. We further distinguish between administrative labor and agent labor. We define the administrative labor input as the salary/welfare reported to the Insurance Commissioner at the Department of Insurance, Ministry of Commerce, Thailand. Agent labor input is similarly defined by the amount of commissions reported to the Commissioner. Business expenses are then defined to be the remaining expenses reported on the income statement. The capital input is given as the capital levels reported to the Commissioner.

It is worth mentioning that the labor and business services inputs are not the ideal variables to use. The variables used here are actually the total cost of the input and not the level of input. Ideally, we would like to know the price of the input so that we could infer the level of input (total input divided by price). However, data limitations prevent us from making this calculation. However, it should be noted that this limitation does not prevent us from calculating the efficiency scores. Several efficiency papers (i.e. Cummins, Eckles, Zi 2004) make the

assumption that the prices for each input are the same for each firm within a year. It seems reasonable, especially for Thailand, that every insurance firm would face the same price for labor or business services. As such, the total costs of each input are essentially being scaled down by the price of the input. Since DEA is units invariant, a simple scaling of the variable (or lack thereof) will have no effect on our results.[2]

4. Results

We estimate the technical efficiency for the Thai non-life insurance industry for the years 1997 through 2002. Table 1 shows the average efficiency scores for the time period.

Table 1: Average Efficiency Scores

Year	Technical Efficiency	Scale Efficiency
1997	0.709408	0.783221
1998	0.757318	0.828569
1999	0.691181	0.800297
2000	0.773974	0.865246
2001	0.772399	0.896345
2002	0.791005	0.875321

Over the entire sample period, technical efficiency scores range from 0.691 to 0.791. Technical efficiency rose between 1997 and 1998, but experienced a significant drop in 1999. This drop occurred at a time when the Thai non-life insurance industry experienced the lowest total direct premiums (45,869 million baht) and the highest expense to premium ratio (38.3). Moreover, the interest rate cut in 1999 resulted in a dramatic drop in the average investment income of the non-life insurance industry; from 5,153.8 million baht in 1998 to 2,814.8 million baht in 1999, a 45.4% decline in one year. Scale efficiency scores rose between 1997 and 2001, but have fallen in 2002.

Table 2 reports the “best” firms during each year of this period.

These are firms that have technical efficiency scores of one. They represent the "best practice" firms that make up the efficient frontier for any given year. Notice that the most efficient firms are not the biggest. Among the top ten largest firms in terms of written premium, only Bangkok Insurance has consistently ranked as one of the most efficient firms. Viriyah Insurance and Dhipaya Insurance are the best efficient firms in 1997, 2000, 2001, and 2002. Sri Muang Insurance, ranks around the 40th in terms of written premium, but is one of the most efficient firms in the sample. Another example is Internation Assurance. International Assurance ranks around the 50th in term of premium written, yet it has an efficiency score of one throughout the entire sample period.

Table 2: "Best" Firms by Year (Technical Efficiency of 1)

1997	1998	1999	2000	2001	2002
A.I.A	A.I.A	A.I.A	A.I.A	A.I.A	A.I.A
Ambassador	Asia Dynamic	ACE	ACE	ACE	ACE
Apex Health	Ayudhaya	Apex Health	Allianz C.P. General	Allianz C.P. General	Allianz C.P. General
Asia International	Bangkok Thonburi	Asia International	Ayudhaya	Apex Health	Apex Health
Ayudhaya	Bangkok	Bangkok	Apex Health	Bangkok	Bangkok
Bangkok Thonburi			Bangkok Health	Thonburi	Thonburi
Bangkok Union			Bangkok Thonburi	Bangkok Union	Bangkok Union
Bangkok	Blue Cross	Blue Cross	Bangkok Union	CGU (Thai)	Blue Cross
	China (Thai)		CGU (Thai)		China (Thai)
	Cigna Property				

Table 2: "Best" Firms by Year (Technical Efficiency of 1) (Continued)

1997	1998	1999	2000	2001	2002
Blue Cross Charoen Pokphand Cigna Property Commercial Union	Deves	CGU Charoen Pokphand China (Thai)	Dhipaya Guardian (Thai) International Khoom Khao	Dhanavat	Commercial
Deves	Dhanavat General Accident Guardina (Thai) International Khoom Khao Mitsui Marine	Deves International Mitsui Marine	Liberty Mitsui Marine New Hampshire	Dhipaya Guardian (Thai) International Khoom Khao	Dhanavat
Dhipaya General Accident Guardina (Thai)	New Hampshire	Ocean	New India	Liberty Mitsui Marine New Hampshire	Dhipaya
Insurance One	Ocean	QBE Road Victims		New India	General International
International Khoom Khao	Pornpat Royal and Sun Alliance	Royal and Sun Alliance	Patchara Road Victims Royal and Sun Alliance	Patchara	Kamol Sukosol
Mitsui Marine	Sampanth	Sampanth	Sampanth	Pornpat	Khoom Khao Mitsui Sumitomo

Table 2: "Best" Firms by Year (Technical Efficiency of 1) (Continued)

1997	1998	1999	2000	2001	2002
Narai International	South East	Sri Muang	Sri Muang Synmunkong	Road Victims Royal	Mittare
New Hampshire	Sri Muang	Thai Health	Thai Charoen	and Sun Alliance	New Hampshire
Phatara Royal and Sun Alliance	Synmunkong	Thai Charoen Thai Development	Thai Health	Sampanth	Osotspa
Sampanth	Thai Health	Thai Setakit	Thai Zurich	Sri Muang	QBE Royal and Sun Alliance
Sri Muang	Thai Thai Metropole Zurich Thai Sreshtakich	Universal	Universal	Synmunkong Thai Charoen	Sri Muang Synmunkong
Synmunkong	Universal	Universal	Viriyah	Thai Health	Thai Charoen
Thai Health Thai Metropole Thai Prasit			Wilson	Thai Zurich	Thai Health
Thai Thai Sreshtakich Union Prospers Viriyah				Universal Viriyah Wilson	Thai Setakij Thai Zurich The Safety Union Prospers Viriyah

Table 3 reports the ten firms with the lowest non-zero technical efficiency score each year and Table 4 reports those firms with scores of zero. The firms with scores of zero had little to no output, but incurred quite a bit of expenses.

Table 3: Lowest Technical Efficiency Scores by Year

1997		1998	
Company	Technical Efficiency	Company	Technical Efficiency
Samaggi Insurance	0.5867	Kamol Sukosol	0.6116
Navakij Insurance	0.5782	Assets Insurance	0.5989
Wilson Insurance	0.5499	Thai United	0.5807
Commercial Insurance	0.5489	Commercial Insurance	0.5762
Charan Insurance	0.5475	Paiboon Insurance	0.5731
Assets Insurance	0.5299	Thai Commercial	0.5194
Chubb Insurance	0.4927	Chubb Insurance	0.5069
Paiboon Insurance	0.4348	Erawan Insurance	0.3858
Thai Development	0.4298	Thai Development	0.3856
Thai Medical Care	0.1919	Thai Medical Care	0.2855
1999		**2000**	
Company	Technical Efficiency	Company	Technical Efficiency
Sahawattana Insurance	0.444	Thai Thanakit Insurance	0.61
Assets Insurance	0.4368	Thai Commercial Insurance	0.5953
Ambassador	0.419	Paiboon Insurance	0.586
The Safety Insurance	0.3862	Charan Insurance	0.5605
Chubb Insurance	0.385	Navakij Insurance	0.549
Thai - Yasuda Insurance	0.3636	Asia International Insurance	0.5473
Nam Seng Insurance	0.3116	Erawan Insurance	0.5167
Commercial Insurance	0.2799	South East Insurance	0.4962
Erawan Insurance	0.274	Assets Insurance	0.4464
Thai Medical Care	0.1221	Thai Medical Care	0.1965

Table 3: Lowest Technical Efficiency Scores by Year (Continued)

2001		2002	
Company	Technical Efficiency	Company	Technical Efficiency
Paiboon Insurance	0.5677	Thai Commercial Insurance	0.5532
Charan Insurance	0.5664	BT Insurance	0.5462
Ambassador Insurance	0.5549	Combined Insurance	0.5424
Union Prospers Insurance	0.5512	Thai Development	0.5186
Liberty Insurance	0.5341	Charan Insurance	0.5118
Thai Development	0.4786	Assets Insurance	0.5104
Thai Commercial Insurance	0.4697	Union Insurance	0.5103
Erawan Insurance	0.4503	Asia International Insurance	0.5057
Assets Insurance	0.3676	Erawan Insurance	0.5057
Thai Medical Care	0.1640	Thai Medical Care	0.4767
			0.2876

Table 4: "Worst" Firms by Year (Technical Efficiency of 0)

1997	1998	1999	2000	2001	2002
Advance Asia	Ambassador	Bangkok Health	Ambassador Asia	Patchara	Ambassador
Dynamic	Chao Phaya Cigna Ins.	Chao Phaya	Dynamic Bangkok		Patchara Road
Chao Phaya	Asia Pacific	Expert	Health		Victims
Dhanavat	Expert	General	Commercial		Sampanth
	Narai	Narai			Bangkok
Expert	International Road	International	Expert		Health
MP	Victims Union	Thai Prasit	Thai Setakij		Kurnia
National	Prospers				
Osotspa	Vanich				
Photthatham					
Pornpat					
Rattanakosin					
ThaiCharoen					
Vanich					

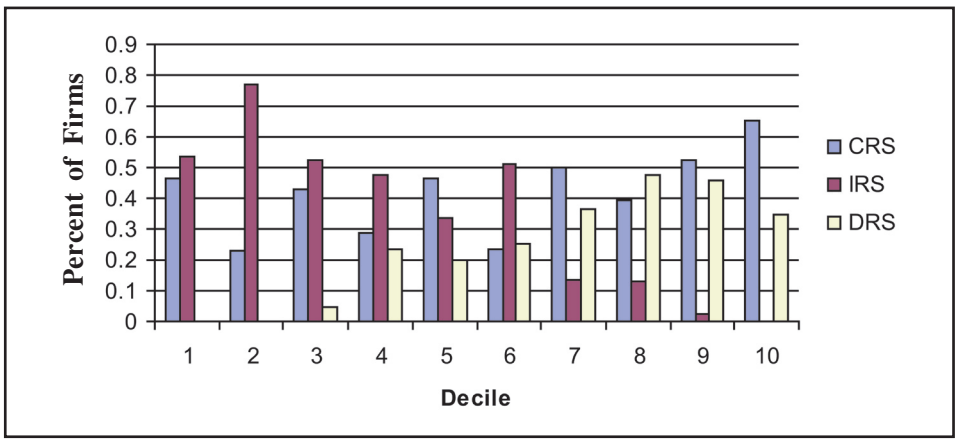
Efficiency scores for some firms changed so much every year. For example, Road Victims Protection's technical efficiency scores improved from the worst score of zero in 1998 to the best score of one from 1999 to 2001, but dropped to zero again in 2002. It should be noted that some of the firms listed in Table 4 were relatively new firms in the year listed. For instance, Osotspa Insurance was one of the worst firms in term of technical efficiency (score = 0) in 1997, but according to the data had zero written premiums for any lines during that year. However, Osotspa did improve across the years, and eventually became one of the "best" firms (score = 1) in 2002. Similarly, Thai Charoen Insurance was listed as one of the worst firms in 1997 (because of no written premiums) and became the "best" firm between 1999 and 2002.

There are, however, some firms whose performance declined over the years. For instance, Sampanth Insurance had an efficiency score of one from 1997 to 2001, but then its score fell zero in 2002. In addition, the level of efficiency has remained steadily low for some firms.Thai Medical Care Insurance had its efficiency scores in the lowest efficiency group for almost every year from 1997 to 2002. Another example is Erawan Insurance that had efficiency scores in the lowest efficiency group from 1998 to 2002. The most extreme case is Ambassador Insurance. It was the worst firm in terms of technical efficiency in 1998, 2000, and 2002, and finally shut down its business in 2003.

We can also determine which firms are operating at constant, decreasing, or increasing returns to scale. Over the entire sample period, 41.7% of the firms are operating with constant returns to scale. 25.1% are operating with decreasing returns to scale and the remaining 33.3% are operating with increasing returns to scale. Figure 2 below shows the returns to scale results by size.

As expected, as firms get larger (as measured by total assets), more and more of them operate with decreasing returns to scale. Conversely, those firms operating with increasing returns to scale tend to be the smaller ones.

Figure 2: Returns to Scale by Decile



5. Conclusion

This paper is serves as an introduction of modern frontier efficiency methodology into the Thai non-life insurance industry. We show that Thai firms are not unlike most firms, in terms of scale economies. For instance, the larger the firm, the more likely they are to be operating with decreasing returns to scale. Conversely, the smaller firms are more likely to be operating with increasing or constant returns to scale.

Finally, we include a brief discussion of the relative rankings of the firms in the industry. This does not intend to mortify any firm, but rather to provide a new metric by which to evaluate non-life insurers in Thailand.

In addition, we plan to perform efficiency comparison between Thai-owned firms and foreign-owned firms.ส In particular, we would like to test statistically the difference between these two groups of firms whether differences occur by chance or they are statistically significant. We will use non-parametric statistics, which is independent of the distribution of the DEA score to provide such test. One of the statistics to be used is the rank-sum-test developed by Wilcoxon-Mann-Whitney.

Footnotes

[1] This paper is a brief version of my dissertation submitted to the Joint Doctoral Program in

[2] Note that this is not true if one is calculating cost efficiency (since the relative prices of the inputs would matter) or if the firms face considerably different prices for inputs.

References

Banker, Rajiv D., 1993, "Maximum Likelihood, Consistency, and Data Envelopment Analysis: A Statistical Foundation," *Management Science* 39 (10), 1265-1273.

Berger, Allen N., J. David Cummins, and Mary A. Weiss, 1997, "The Coexistence of Multiple Distribution Systems for Financial Services: The Case of Property-Liability Insurance," *The Journal of Business,* 70 (4): 515-546.

Cooper, William W., Lawrence M. Seiford, and Kaoru Tone, 1999, "Data Envelopment Analysis," Kluwer Academic Publishers.

Cummins, J. David, David Eckles, and Hongmin Zi, 2004, "Exporting Best Practices: Are Foreign-Owned Insurers More or Less Efficient In the U.S. Life Insurance Market?" Working Paper.

Cummins, J. David, Sharon Tennyson and Mary A.Weiss, 1999, "Consolidation and Efficiency in the U.S. Life Insurance Industry," *Journal of Banking and Finance,* 23, 325-357.

Cummins, J. David and Mary A Weiss, 1993, "Measuring Cost Efficiency in the Property-Liability Insurance Industry," *Journal of Banking and Finance,* 17, 463-481.

Cummins, J. David, Mary A. Weiss, and Hongmin Zi, 1999, "Organizational Form and Efficiency: The Coexistence of Stocks and Mutual Property-Liability Insurers," *Management Science,* 45 (9): 1254-1269.

Farrell, Michael J., 1957, "The Measurement of Productive Efficiency," *Journal of the Royal Statistical Society* A 120: 253-281.

Grosskopf, Shawna, 1996, "Statistical Inference and Nonparametric Efficiency: A Selective Survey," *The Journal of Productivity Analysis,* 7, 161-176

Kneip, Alois, B.U. Park, and L. Simar, 1998, "A Note on the Convergence of Nonparametric DEA Estimators for Production Efficiency Scores," *Economic Theory,* 14, 783-793.

Korostelev, A.P., L. Simar, and A.B. Tsybakov, 1992, "Efficient Estimation of Monotone Boundaries," *Annals of Statistics,* 23: 476-489.

Korostelev, A.P., L. Simar, and A.B. Tsybakov, 1995, "On Estimation of Monotone and Convex Boundaries," *Publications de l'Institut de Statistique de l'Universite de Paris,* 39, 3-18.

Lovell, C.A.K., 1993, "Production Frontiers and Productive Efficiency," The Measurement of Productive Efficiency, Oxford university Press.

Xie, Xiaoying, 2004, "Economies of Scale and Efficiency Analysis in the United States Property-Liability Insurance Industry," Working Paper.