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The cost efficiency analysis of Korean life insurance companies by data envelopment analysis[†]

Jungchul Kang[1]

[1]Department of Finance and Insurance, Dong-Eui University

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Abstract

We investigate the effect of introduction of the bancassurance system on cost efficiency in the Korean insurance industry between 1997 and 2012. Our estimation results indicate that introduction of this system contributed positively to efficiency of life insurance companies in Korea. Increase in a one standard deviation of bancassurance increases cost efficiency by 0.08 which is equivalent to 12 percent of mean cost efficiency. Recognising that the bancassurance system is a relatively new concept, our results indicate that the bancassurance system can be a policy measure to improve productivity in an emerging insurance market. The results illustrate that positive effects have accrued particularly to medium-sized companies and domestic companies, contrary to the prevailing perception that increased competition through bancassurance is more beneficial to large companies and foreign companies.

Keywords: Bancassurance, efficiency, emerging market, life insurance.

1. Introduction

This research analyses the effect of introduction of the bancassurance system on cost efficiency of life insurance companies in Korea. The Korean life insurance industry is an interesting case. In particular, introduction of the bacassurance system in September 2003, together with introduction of variable insurance and deregulation of price, has created a new business environment in the industry. Korea's insurance industry has experienced substantial restructuring since the 1997 financial crisis. As a result of this restructuring, the number of companies dropped from 33 before the crisis to 24 in 2012. Meanwhile the industry's total revenue expanded significantly from 48 trillion won (approximately 48 billion USD) in 1997 to 115 trillion won (115 billion USD) in 2012.

Bancassurance refers to banks selling both bank products and insurance policies, or more broadly, banks' integration of insurance company's managerial methods in order to provide a broad range of financial services. The Korean financial industry traditionally had adopted an equivalent of the U.S. Glass-Steagall Act prohibiting commercial banks from engaging in securities activities. This made Korea's financial market compartmentalized, with commercial banks not allowed to sell insurance products. Bancassurance has thus been regarded

[†] This work was supported by Dong-Eui University Foundation Grant. (2015AA089).
[1] Professor, Department of Banking and Insurance, Dong-Eui University, Busan 614-714, Korea. E-mail: jckang@deu.ac.kr

as a crucial development in deregulation against the traditional compartmentalism between banks and the insurance industry.

Some European countries, including France, introduced bancassurance in the 1980s and the US introduced it in 1999. Introduction of the bancassurance system has increased competition and growth of the insurance industry by diversifying sales channels. Vis-'a-vis other insurance industries, the life insurance industry in particular relies heavily on multiple sources of sales channels. This is why the effect of introducing bancassurance is relatively greater on life insurance than on other insurance products. We therefore focus on life insurance in this paper. In Korea, the importance of bancassurance in generating income for life insurance companies has increased since the bancassurance system was introduced in September 2003. The initial premium through the bancassurance system reached 202.9 trillion won (202.9 billion USD) in 2012, which is equivalent to 68 per cent of the insurance industry's total initial premiums that year and more than three times larger than premiums from insurance solicitors.

We address two principal research questions in this paper. The first is whether the bancassurance system has contributed to improved cost efficiency of insurance companies in Korea. Improved cost efficiency is important because it allows companies to minimize their use of (scarce) resources and to reduce the price of insurance products for consumers.

Insurance companies can link insurance business as a conduit to create new business. Justification for the bancassurance system is that it may encourage insurance companies to improve efficiency by reducing production inputs such as insurance solicitors. However, this expected benefit is not always guaranteed. Close cooperation with banks is a precondition for success of the bancassurance system. However, lack of historical relationship and communication problems may hinder cooperation. Insurance companies may also face challenges from internal insurance solicitors. Analysing the introduction of bancassurance is thus an empirical issue. Bancassurance is a relatively new business method, particularly in emerging markets. As such, our results for the Korean case are expected to have direct policy implications for other emerging markets.

Second, if bancassurance has had positive effects on the insurance industry, do these depend on the size and type of the insurance company? Of interest here, the market share of individual companies has changed substantially following the introduction of bancassurance, as we discuss later in this paper. Change in market share affects economies of scale, which in turn may stimulate new ideas and learning-by-doing effects to improve productivity. We thus examine whether the impacts of bancassurance differ among companies of different size and ownership - whether domestic or foreign. This is an important issue given that observers often perceive that large companes and foreign companies benefit more than other companies. If bancassurance creates benefits for large and foreign companies at the expense of smaller domestic companies, the system will eventually lead to the stronger monopoly power of large and foreign companies.

To implement our research goals we first employ data envelopment analysis (DEA) to estimate efficiency using balanced data from 1997 to 2012 (refer to Appendix 1 for DEA method).

2. Literature Review

Our research contributes to existing literature in the following ways. First, the efficiency analysis provides an evaluation of the bancassurance system, with a case study of the Korean insurance industry. While there is literature on the overall effect of policy changes on economic/financial performance in the insurance industry, few studies particularly concern the bancassurance system. A new policy can be justified when it leads to greater efficiency. Financial markets, including the insurance industry, have traditionally been regulated due largely to its importance in economy. Competition within the industry has also been restricted in many countries, following the U.S. tradition. Yet deregulation and globalisation have created new challenges for financial markets. This challenge is particularly important for emerging markets where fast growth substantially stimulates demand for insurance products. How to improve efficiency is thus a crucial issue to ensure sustained growth of the industry and its increased competitiveness in a globalised market. Introduction of bancassurance is expected to affect both the profit structure and the type of competition in the financial market, which is important for both policymakers and academic observers. Under the bancassurance system, changes can be made to the value chain of companies, which in turn affects their source of profits (Jung and Lee, 2003). This study of the Korean case is expected to identify policy implications that may be applicable in other emerging markets. The benefits of bancassurance are still controversial although operation of the system has been successful in France, Portugal and Spain. Gonulal *et al.* (2012) report bancassurance has impacted dramatically on developing sales volumes, attaining market shares above 50 percent in life insurance and above 10 percent in non-life insurance in some developed economies, but with a much lower impact in other developed countries. These authors also found wide ranging strategic benefits in emerging markets.

Second, our results identify implications for informing managers' strategic decision making when markets are deregulated. Small to medium-sized firms often prefer protective industry policies to competing with large firms (Jung, 2000). Domestic firms in emerging markets also argue for protection against global competition. In traditional thinking, industry policies for development of the Korean economy, like many emerging market economies in Asia, have often included government-led M&As to achieve political goals rather than effect management's strategic decisions. Our study reconsiders this belief by investigating the effect of bancassurance on divergent groups - small to medium firms vis a vis large firms, and domestic firms vis a vis foreign firms. Contrary to the traditional view claiming the impact on small to medium firms and on domestic firms is negative, we provide evidence that large and foreign firms do not necessarily benefit more from bancassurance. Our findings illustrate that small to medium firms and domestic firms can benefit more from bancassurance in an enconomy with heavy government regulation and intervention. As Cummins (1999) demonstrated, efficiency analysis is also useful when considering M&As in the insurance industry. The introduction of bancassurance is expected to increase competition in financial markets and create new business opportunities for banks that are not possible under the compartmentalism prevailing before bancassurance. Managerial strategic decisions about alliances and/or M&As are therefore important for materialising business opportunities. Banks will benefit from new business opportunities and insurance companies can benefit from banks establishing a wide range of networks and sales channels.

Empirical researchers have widely used the DEA method to measure the efficiency of

insurance companies. Cummins and Weiss (1993) and Fecher *et al.* (1993) introduced DEA, together with the stochastic frontier method, to analyse efficiency of insurance companies in the U.S. and France respectively. Cummins *et al.* (1996) and Jung and Zi (1999) also used DEA to analyse the efficiency of insurance companies in Italy and Germany respectively. Rather than focussing on a single country, Donni and Fabienne (1997) analysed insurance industries in OECD countries. Cummins and Zi (1998) also worked on the U.S., comparing estimated efficiency using econometric estimation with use of the DEA metho.

Jung (2001) reported the efficiency of Korean life insurance was lower than the average of other OECD members by illustrating that the most efficient Korean firms ranked only at the standard of medium performing OECD members. Kwon *et al.* (2001) used DEA to analyse the efficiency of life insurance companies in Korea between 1992 and 1998. They reported that during the 1997 crisis, the efficiency of Korean companies was lower than that of foreign companies. However, this study focused on a time period mostly prior to the 1997 crisis. Similarly, Shin (2006) reported that the decrease in efficiency in the Korean insurance industry in the mid-1990s had caused a restructuring of the industry. Using the DEA method, Hu (2012) reported that the average efficiency of 22 Korean life insurance companies increased during 2005-2010, whereas the average efficiency of 40 Chinese companies dropped slightly over the same period.

The sample period in our study is 1997 to 2012, which is much longer than in existing studies. Our DEA estimation shows an overall increasing trend in the 2000s and, in contrast to existing literature, in the 1990s a decline from 1997 (refers to Appendix 2 for comparison of input and output variables across the literature). These trends revealed in our study are interesting because the upward turn in the 2000s provides an indicator crucial for assessing the effects of the bancassurance system introduced in 2003.

In research closely related to ours, Kim and Son (2008) and Kim (2007) used DEA and the Malmquist Index to ana the effect of introducing bancassurance in Korea for the period 2000-2005. However, neither study found a positive effect with statistical significance. The five year sample period of these studies is only one third of the 15 years of our study (1997-2012) and covers only three years before and two years following the 2003 introduction. Jung and Lee (2003) also examined the effect of bancassurance on cost efficiency. However, the sample period of their study was before bancassurance was introduced and thus it reports only scenario outcomes. Interestingly, one scenario outcome implies small to medium firms can benefit from introduction of bancassurance, which is consistent with our empirical estimations. Kwon *et al.* (2014) studied some approximations of the ruin probability of the surplus in the classical risk model. Won *et al.* (2013) studied the ruin probabilities of the surplus.

3. Data and Efficiency Estimation

3.1. Selection of data for DEA efficiency measurement

3.1.1. Outputs

Data on inputs, outputs and prices of inputs are essential to measure cost efficiency. In particular, in the insurance industry the selection of outputs is crucial. This is because financial products/services provided to customers are usually invisible. Although insurance companies as production entities use inputs (i.e., labour and capital) to produce outputs

(i.e., financial services), there is no unanimously accepted definition of what comprises the output of the life insurance industry. Insurance companies accept insurance premiums in advance from customers, which is effectively equivalent to taking risks to compensate (i.e., providing services) for possible accidents/casualties occurring to customers in the future. However, services provided by insurance companies differ widely, so measuring outputs is a challenging issue. We measure an insurance company's output based on Berger *et al.* (1997) modified value-added method, using premium income combined operational asset investments and initial premium.

In this modified value-added approach, insurance services are divided into risk pooling and bearing services, financial services and intermediation and the output of insurance companies includes underwriting and intermediation services. Underwriting refers to an insurance company providing services by pooling the risk of individual customers. Services provided by an insurance company can thus be measured by premium income or an initial premium. An insurance company also plays a role as an intermediator since it invests financial resources earned through its underwriting activities in financial securities and lending money. The modified value-added approach assumes that a company's operational asset investment reflects these intermediation activities.

Following the modified value-added method, we use premium income and operational asset investments as the output of insurance companies. Premium income is the most representative output but it is stock value that reflects the accumulation of past performance. Thus, premium income may be limited in capturing the (marginal) effect of introducing the bancassurance system. However, it is controversial whether an initial premium is a good proxy for outputs in the insurance industry. Because of this, we use premium income combined with operational asset investments as our main output measures. The initial premium is used in checking the robustness of our results.

3.1.2. Inputs

To measure efficiency we need data on labour services of employees, on utilisation of capital goods and on other service-related costs. In particular, data on employees' labour is important because it is the largest share of input costs. Capital goods in the insurance industry include equity capital, and physical capital such as branche offices. We ignore equity capital as input and focus only on physical capital because in Korea equity capital often fails to reflect characteristics of capital goods. For example, small and medium-sized insurance companies have larger equity capital than large companies, irrespective of their smaller premium income. Because of this we use the number of employees and insurance solicitors (including numbers of branches) as proxy for labour-related inputs, while we use physical capital goods as proxy for capital services. Data on physical capital goods, which include real estate and leasehold and other deposits, are obtained from the company's balance sheet. Price of labour (employee) input is calculated by the summation of salaries, bonuses and expenses of welfare and retirement grants, scaled by the total number of employees. Price of insurance solicitors is calculated by new business expenses scaled by the number of insurance solicitors. Input price of physical capital goods is calculated by summing communication expenses, water and heating expenses, rents, office administrative expenses and expenses of branch office operations, all scaled by the quantity physical goods.

3.2. Decision Making Units (DMU)

We select 20 life insurance companies as DMU. We exclude IBK Pension and Nonghyup Life Insurance that have both been included in life insurance statistics since 2010. We also exclude Kadif Insurance and KB Insurance because the business maintained by these companies has been irregular since 2000.

All data were obtained from Monthly Statistics published by the Korea Life Insurance Association and Insurance Statistics Yearbook published by the Korea Insurance Development Institute. All price data are scaled by the 2010 CPI-index to convert into real terms.

3.3. Summary of statistics

Table 3.1 presents a summary of statistics. Over the sample period, premium income of the life insurance industry increased by 11.2 per cent, from 3.12 trillion won (approximately 3.1 billion USD) in 1997 to 3.47 trillion won in 2012. In contrast, the initial premium decreased by 14.7 per cent, from 1.14 trillion won in 1997 to 0.97 trillion won in 2012. In contrast, operational asset investments increased by 217.7 per cent, from 5.84 trillion won in 1997 to 18.57 trillion won in 2012. This significant increase in output from insurance companies' intermediation role is due largely to the development of financial markets both domestically and internationally, as well as to appreciation in values of financial assets held by insurance companies.

Table 3.1 Summary statistics (Units: million won, number, %)

	Year	Mean	(change, %)	Standarddeviation	Min	Max
Premium	1997	3,121,217		6,251,120	17,432	24,181,426
income	2012	3,471,362	(11.2)	4,752,457	142,356	20,745,152
Initial	1997	1,143,997		2,176,503	412	7,739,553
premium	2012	975,545	(-14.7)	1,858,080	13,972	8,049,769
Operational	1997	5,844,354		12,419,305	27,876	48,432,086
assets	2012	18,568,408	(217.7)	32,475,086	557,982	141,656,483
No. of employees	1997	1,887		2,861	58	9,714
(labour)	2012	1,450	(-23.2)	1,798	222	6,903
No. of insurance	1997	12,542		22,300	43	72,362
solicitors	2012	8,029	(-36.0)	10,184	307	40,548
Physical capital	1997	588,251		1,300,743	782	5,416,444
goods	2012	715,273	(21.6)	1,462,061	8,676	5,792,028
Input price/	1997	45.775		12.567	30.976	79.659
employee	2012	74.380	(62.5)	13.896	48.976	101.369
Input price/	1997	25.265		16.091	9.316	79.506
insurance solicitor	2012	104.159	(312.3)	34.384	58.480	218.391
Input price/	1997	0.209		0.341	0.012	1.341
physical capital goods	2012	0.454	(117.2)	0.626	0.023	2.354

Note: 1,000 won is approximately 1 USD.

Interestingly, we observe a decrease in inputs such as total number of employees (by 23.2 per cent) and the number of insurance solicitors (by 36.0 per cent) over our sample period. This reduction may reflect the sustained restructuring efforts by companies to improve cost efficiency. In particular, the dramatic decrease in the number of insurance solicitors is closely associated with more diversified sales channels, which include the introduction of bancassurance and on-line sales.

Statistics in the last three rows in Table 3.1 indicate an increase in input prices. This

increase, however, reflects increases in unit sales per employee or in sales channels, which are both closely associated with restructuring in the industry, rather than with the cost of insurance itself.

3.4. Distribution of cost efficiency

Our measured (technical) efficiency is from input-oriented measures that focus on minimum inputs to achieve a level of output. We also employed a variable returns to scale model, assuming not all companies enjoy optimal cost efficiency.

Table 3.2 Cost efficiency of life insurance companies (premium income basis)

Company	DMU	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Big Three	1	0.604	0.622	0.640	0.587	0.616	0.607	0.556	0.654	0.654	0.669	0.617	0.738	0.758	0.635	0.716	0.651
	3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	5	0.773	0.612	0.668	0.870	0.493	0.532	0.593	0.579	0.763	0.752	0.750	0.806	0.835	0.700	0.743	0.635
Others	4	0.630	0.474	0.519	0.463	0.489	0.340	0.360	0.520	0.667	0.708	0.716	0.727	0.862	1.000	0.976	0.797
	6	1.000	0.864	1.000	0.431	0.319	0.281	0.314	0.394	0.467	0.502	0.475	0.761	0.491	0.839	1.000	0.714
	7	0.718	1.000	0.833	0.560	0.563	0.586	0.842	0.718	0.852	0.875	0.864	0.763	0.740	0.984	0.859	0.691
	8	0.602	0.605	0.796	0.863	0.589	0.478	0.448	0.516	1.000	1.000	0.892	0.993	1.000	1.000	0.563	0.480
	9	0.542	0.556	0.628	0.516	0.357	0.339	0.479	0.485	0.463	0.576	0.514	0.586	0.817	1.000	1.000	1.000
	13	0.555	0.549	0.719	0.380	0.321	0.325	0.234	0.251	0.437	0.544	0.607	0.749	0.434	1.000	0.973	0.909
	14	0.518	0.482	0.625	0.368	0.369	0.297	0.357	0.342	0.477	0.549	0.650	0.801	0.918	0.822	0.703	0.811
	15	0.603	0.781	0.928	0.350	0.424	0.378	0.483	0.462	0.543	0.298	0.224	0.357	0.391	0.405	0.691	0.641
	18	0.677	0.689	0.553	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Foreign	2	0.580	0.445	0.449	0.376	0.308	0.321	0.414	0.483	0.535	0.514	0.679	0.636	0.787	0.711	0.596	0.583
	10	0.453	0.594	0.597	0.529	0.461	0.472	0.477	0.372	0.439	0.449	0.370	0.426	0.462	0.320	0.288	0.321
	11	1.000	1.000	1.000	1.000	0.289	0.240	0.305	0.224	0.229	0.265	0.322	0.339	0.279	0.417	0.530	0.392
	12	0.327	0.409	0.394	0.509	0.184	0.121	0.128	0.287	0.241	0.303	0.212	0.265	0.286	0.489	0.658	0.393
	16	0.554	0.584	0.871	1.000	0.794	0.714	0.684	0.736	0.883	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	17	0.496	0.486	0.686	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	19	0.367	0.351	0.395	0.460	0.721	0.641	0.513	0.449	1.000	1.000	0.959	0.945	0.553	0.757	0.752	0.789
	20	0.287	0.308	0.242	0.333	0.232	0.258	0.423	0.495	0.674	0.846	1.000	1.000	0.845	1.000	1.000	0.968
mean		0.614	0.621	0.677	0.630	0.526	0.497	0.531	0.548	0.666	0.693	0.693	0.745	0.723	0.804	0.802	0.739
sd		0.205	0.210	0.219	0.262	0.257	0.264	0.255	0.238	0.259	0.262	0.272	0.243	0.253	0.238	0.209	0.226

Note: 'Others' refers to small to medium companies.

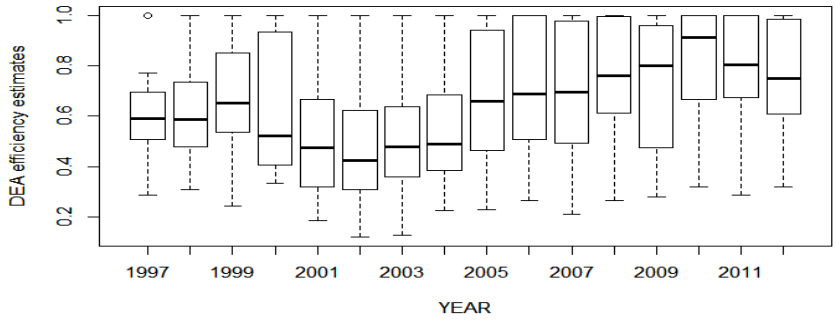

Figure 3.1 Distribution of estimated efficiency score (premium income as output)
Note: Refer to Appendix 3 for DEA efficiency estimates using initial premium as outputs.

The mean value of cost efficiency reported in Table 2.2 is 0.657. This figure indicates around 40 percent of total costs were used inefficiently. The mean value dropped from 0.614 in 1997 to 0.497 in 2002, just before the introduction of bancassurance. This worsened cost efficiency is associated with industry deregulation as observed in other countries, such as in Italy (Cummins *et al.*, 1996) and Germany (Jung and Zi, 1999). This counterintuitive

outcome is possible when the effects of deregulation vary across companies. For example, the mean of estimated (relative) efficiency will drop when deregulation improves for the best performing company more than other companies. The marginal increase in efficiency in 2003 was due to substantial restructuring in 2001.

The mean value of cost efficiency improved substantially following the introduction of bancassurance in 2003. The cost efficiency score was 0.479 in 2002 and increased to 0.739 in 2012. The mean value of cost efficiency increased marginally immediately after the introduction of bancassurance. However, the improvement was noticeable in 2005 and 2006, when the bancassurance system was broadly adopted across the industry. We find the magnitude of the efficiency improvement, with its measurement based on initial premiums, to be somewhat lower than that measured based on premium income (Figure 3.2). However, measured efficiencies based on premium income and initial premium are highly correlated (Figure 3.3).

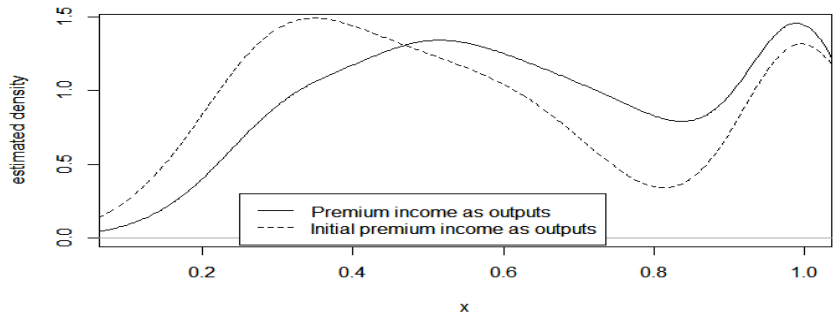

Figure 3.2 Kernel density estimates of estimation scores

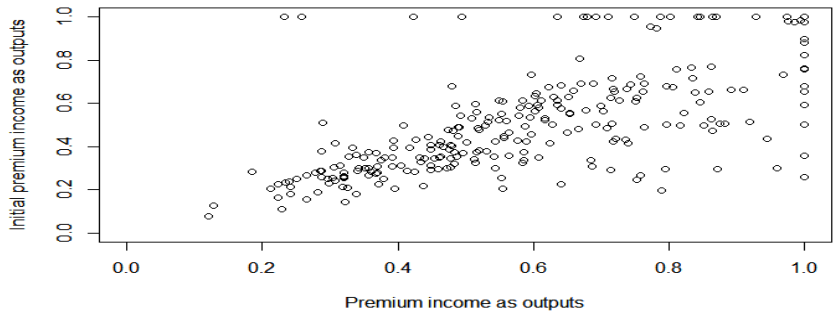

Figure 3.3 Comparison of cost efficiency scores between premium income and initial premium outputs

Table 3.3 and Figure 3.4 show that the improvement of cost efficiency following the introduction of bancassurance was particularly substantial for small to medium companies. Mean value of the efficiency score of small to medium companies increased from 0.447 in 2002 to 0.656 in 2005 and to 0.783 in 2012. This increase in efficiency has been maintained rather than a one-off phenomenon. As a result, the efficiency score of small to medium companies reversed the historical trend and since 2010 became higher than that of large companies. The efficiency of foreign insurance companies also increased from 0.471 in 2002 to 0.625 in 2005. In contrast to the case of small to medium companies, however, this increase was not sus-

tainable. The substantial increase in efficiency of small to medium companies is an expected outcome. Intuitively, the effects of bancassurance will be greater for small to medium companies than for large companies because smaller companies have relatively fewer branches and insurance solicitors. As such, the (unit) effect of bancassurance for small to medium companies per branch or per insurance solicitor will be greater than for large companies. We investigate this intuitive outcome using multivariate regression shortly.

Table 3.3 Cost efficiency score by insurance company size and nationality

Company	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Big Three	0.792	0.745	0.769	0.819	0.703	0.713	0.716	0.744	0.806	0.807	0.789	0.848	0.864	0.778	0.820	0.762
Others	0.649	0.667	0.733	0.548	0.492	0.447	0.502	0.521	0.656	0.672	0.660	0.749	0.739	0.894	0.863	0.783
Foreign	0.508	0.522	0.579	0.651	0.499	0.471	0.493	0.506	0.625	0.672	0.693	0.701	0.652	0.712	0.728	0.681

Note: 'Others' refers to small to medium (domestic) insurance companies

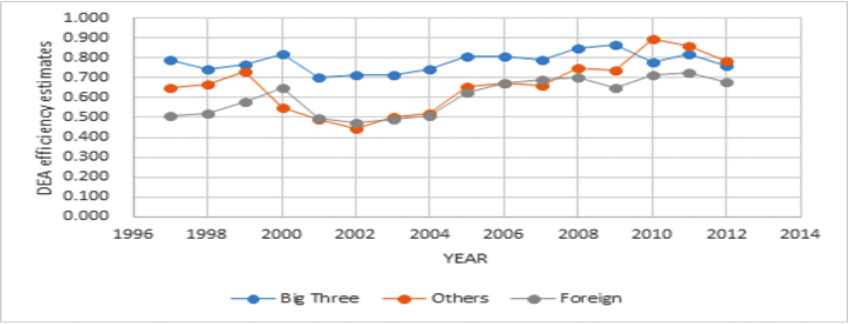

Figure 3.4 Cost efficiency score by insurance company size and nationality
Note: 'Others' refers to small to medium (domestic) insurance companies.

Table 3.4 reports t-test results of efficiency changes between two sub-samples: before and after the introduction of bancassurance. Statistics in the first row indicate that the efficiency difference between the two sub-samples is 0.1002 with statistical significance at 1 percent. Statistics in the last column show the change in efficiency between the two sub-samples is statistically significant, suggesting improvement of efficiency following the introduction of bancassurance is significant across the companies. However, the third column shows the magnitude of changes differs depending on the sub-sample. In particular, the change in efficiency of small to medium companies was 0.1144, which is the largest, followed by foreign companies at 0.1079.

Table 3.4 T-test results on efficiency change between sub-samples: Before and after the introduction of bancassurance

	Prior to introduction of bancassurance	Post bancassurance	Difference	t-value (p-value)
Total	0.5941	0.6943	0.1002	3.5166 (0.0005)
Domestic company	0.6313	0.7263	0.0950	2.8594 (0.0048)
Small-medium company	0.5895	0.7039	0.1144	2.9592 (0.0037)
Foreign company	0.5383	0.6462	0.1079	2.1727 (0.032)

Note: 'Others' refers to small to medium (domestic) insurance companies.

Table 3.5 indicates that the average cost efficiency of a domestic company is higher than that of a foreign company by 0.085, with statistical significance at 1 percent. This may imply that foreign insurance companies are relatively disadvantaged inclose business relationship

with domestic banks. For example, disadvantages from lack of established networks with domestic banks can be greater than the positive image of being a 'foreign' company.

Table 3.5 Difference of efficiency between domestic and foreign life insurance companies

Cost efficiency		Difference	t-value(p-value)
Domestic company	Foreign company		
0.6907	0.6057	0.0850	2.8344(0.0050)

Table 3.6 indicates that company relies highly on bancassurance improved cost efficiency more substantially than other companies following introduction of the bancassurance system in this industry. We define a bancassurance-reliant company as a company whose bancassurance dependence ratio (initial premium from bancassurance scaled by total initial premium) exceeds 50 percent for at least three years during 2003∼2012. The second column shows that the efficiency difference of bancassurance-reliant companies between the two sample periods was statistically signficiant, whereas the difference for other companies was not significant at conventional levels.

Table 3.6 Difference of cost efficiency between companies highly reliant on bancassurance and other companies (on premium income basis)

	Before 2003	After 2003	Difference	t-value (p-value)
Company relieshighly onbancassurance	0.5747	0.6769	0.1202	3.011 (0.0029)
Company does notrely highly onbancassurance	0.6394	0.7348	0.0954	1.842 (0.0694)

Note: 'Bancassurance reliant company' refers to a company whose bancassurance dependence ratio - initial premium from bancassurance scaled by total initial premium - exceeds 50 percent for at least three years during 2003∼2012.

4. Summary and Conclusion

The business environment of Korea's life insurance industry has experienced substantial change since the onset of the 1997 financial crisis and consequent restructuring across the economy. Introduction of the bancassurance system in particular has expedited competition, as well as strategic cooperation, among insurance companies and commercial banks. In this paper we have therefore investigated effects of the introduction of bancassurance on the cost efficiency of life insurance companies. We measured cost efficiency using the DEA method.

Our estimation results using balanced panel data for 1997-2012 indicate that introduction of the bancassurance system contributed positively to the efficiency of life insurance companies. Increase in a one standard deviation of bancassurance, calculated by the ratio of premium income from bancassurance scaled by total premium income, increases cost efficiency by 0.08. This improvement of cost efficiency is (economically) significant as it is equivalent to 12 percent of mean cost efficiency.

Considering that the bancassurance system is a relatively new concept, our result illustrates that the bancassurance system can be a policy measure to improve productivity in an emerging market. Results of our study illustrate that this positive effect applies particularly to medium-sized companies and domestic companies. This finding is contradictory to the prevailing perception that increased competition through bancassurance is more beneficial to large companies and foreign companies. Our estimations rely on efficiency obtained from using the DEA method. While use of DEA has been polular in studies of the insurance industry, we acknowledge that there are other methods to estimate efficiency. These other

methods include the stochastic frontier method and the Olley-Pakes' semi-parametric estimation, among others. Yet as we have explained above, robustness checks by comparing estimated efficiency using these different methods are beyond the scope of this study.

Table 4.1 Comparison of input and output variable in existing DEA estimation of efficiency in insurance industry

Authors	Published year	Inputs variable	Output variables
Cummins and Rubio and Weiss	2001	Labor, business services(material and physical capital), financial debt capital, equity capital	Real losses incurred, reserves, invested assets
Cummins, Tennyson and Weiss	1999	Wage, expenditure for business services, operating expenses, financial capital	Incurred benefits, claims, additions to reserves
Ennsfellner, Lewis and Anderson	2004	Operating expenses, equity capital, technical provisions of reinsurance	Incurred benefits, changes in reserves, claims incurred, total invested assets
Hardwick	1997	Wage rate(by average gross weekly earnins), price of capital(long-term interest rate plus annucal depreciation rate)	Premium income
Hu, Zhang, Hu and Zhu	2009	Equity capital, debt capital, operation expenses, human capital	Premium income
Mahlberg and Url	1998	Administration cos t(expenditures on labor, material, energy, depreciation), distribution cost(commissions paid to intermediaries)	Claims paid, reserves, returned premium
Yao, and Han and Feng	2007	Labor, capital	Premium income, payment and benefits, investment income
Kang and Min	2014	Price of capital goods(physical capital), price of labor, price of insurance solicitors	Premium income, initial premium

Source: Modification from Hu (2012).

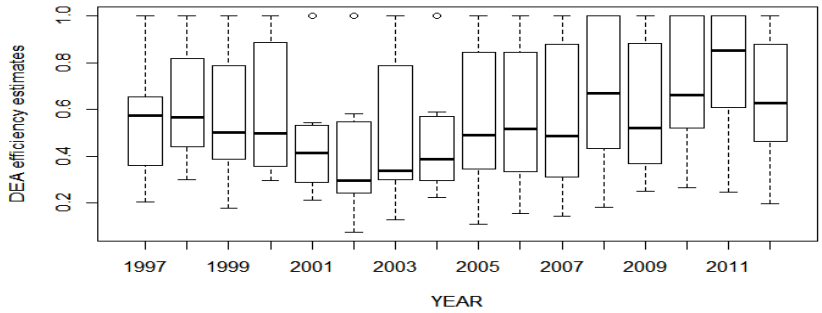

Figure 4.1 DEA estimates of efficiency (Initial premium as outputs)

Appendix 1: DEA method to estimate efficiency

DEA is a method to estimate efficiency without estimating parameters. DEA is particularly popular for relatively small sample. It uses the concept of linear programming to show relative efficiency of a company compared to the most efficient company in the same industry (Farrell, 1957; Charnes *et al.*, 1978).

Farell (1957) defined technical efficiency as the relativity of a vector of inputs of companies compared to a vector of inputs of the most efficient company where allocative efficiency as the best combination of inputs to minimise costs. This technical efficiency is a combination of scale efficiency and pure technical efficiency. Maximum technical efficiency is measured

by unity and the rest efficiency is measured by netting maximum equiproportionate from the unity.

Charnes *et al*, (1978) show input oriented distance function ($D(y,x)$) from the production frontier.

$$D(y,x) = Max\left\{(\theta : \left(\frac{x}{\theta}, y\right) \in S)\right\} \tag{A.1}$$
$$T(x,y) = \frac{1}{D(x,y)}$$
$$D(x,y) \geq 1,\ T(x,y) \leq 1$$

Where, $x \in R^M$ and $y \in R^N$ denote input and output vectors respectively. The level of technology and parameters is S and θ respectively. The second line of the equation suggests that Farell's technical efficiency ($T(x,y)$) is the inverse of this distance function. As such, the minimum value of the distance function is unity.

Coelli *et al.* (1998) assume that n companies produce s outputs using m inputs. Company h's sefficiency (F_h) is measured by relativity of weighted average of inputs to weighted average of outputs as in equation (A.2) subject to maximum value of unity. Then, equation (A.2) is used to identify weights U_i, V_j to maximise F_h.

$$Max\ F_h = \frac{u_1Y_{1h} + u_2Y_{2h} + \cdots + u_sY_{sh}}{u_1X_{1h} + u_2X_{2h} + \cdots + u_mX_{mh}} \tag{A.2}$$
$$\text{s.t. } \frac{u_1Y_{1k} + u_2Y_{2k} + \cdots u_sY_{sk}}{v_1X_{1k} + v_2X_{2k} + v_mX_{mk}} \leq 1$$
$$v_i\, u_j \geq 0,\ i = 1, \cdots, m,\ j = 1, \cdots, s,\ k = 1, \cdots, n$$
$$X_j = i\text{th inputs},\ i = 1, \cdots, m$$
$$Y_j = j\text{th inputs},\ j = 1, \cdots, s$$
$$X_{ik} = i\text{th inputs from company}k,\ k = 1, \cdots, n$$
$$Y_{jk} = j\text{th ouput from company } k$$
$$F_k = \text{techical efficiency of company } k$$

Further, we need another constraint, $\sum_{i=1}^{m} v_i x_{ik} = 1$ to identify a single solution. Then, equation (A.3) combined with dual theory can be collapsed to the following equation (A.3) which shows an input minimisation problem given a level of outputs.

$$Min\ \theta_h = \sum_{i=1}^{m} v_i x_{ih} \tag{A.3}$$
$$\text{s.t. } \sum_{j=1}^{s} = u_j y_{jk} = 1,\ \sum_{j=1}^{s} u_j y_{jk} + \sum_{i=1}^{m} v_i x_{ik} \geq 0$$

where, θ_h is an index to indicate company h's cost efficiency. $0 < \theta \leq 1$ and unity value implies cost (technical) efficient company.

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