EFFICIENCY OF NON-LIFE INSURANCE MARKET IN US

Sara Suárez-Fernández
Raquel Quiroga-García
Eva Suárez-Alvarez
Isabel Manzano-Pérez

FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 769/2015

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

ISSN: 1988-8767

EFFICIENCY OF NON-LIFE INSURANCE MARKET IN US

Suárez-Fernández Sara*

Quiroga-García Raquel*

Suárez-Alvarez Eva+

Manzano-Pérez Isabel*

ABSTRACT

This study analyses the technical efficiency of the insurance market in the United States for the period 2007-2012 using an input-oriented DEA model. In addition, the Malmquist index has been included, which corroborates the results obtained by the DEA and, therefore, it allows more solid conclusions. The results show the existence of a high degree of efficiency in the insurance sector. The main conclusion to be drawn is that small businesses are usually more efficient than the largest ones. This is due to scale inefficiency observed in the largest insurers, which are, in most cases, oversized. Meanwhile, the pure technical efficiency reflects an outstanding management in the U.S. insurance market.

Key words: Insurance, efficiency, DEA, Malmquist.

JEL classification: G22, C61

Corresponding autor: Raquel Quiroga García. Dept. of Quantitative Economics, School of Economics and Business, University of Oviedo, Avda del Cristo s/n, (33006) Oviedo, Asturias, Spain. Email: rquiroga@uniovi.es

* Dept. of Quantitative Economics, School of Economics and Business, University of Oviedo

+ Dept. of Accounting, School of Economics and Business, University of Oviedo

1. Introduction

The development of the new methodology of business efficiency measurement through the comparison with the efficiency frontier has meaningful implications for the insurance sector, as it is possible to see in Cummins and Weiss, 2011. Throughout history, there have been many studies that compare insurance companies with other businesses in the financial sector (Berger and Humphrey 1997), a comparison that was carried out through conventional financial ratios. Some of the problems associated with the measurement of insurance company's efficiency through financial ratios are, for example, the impossibility to identify the company with the best practice (the most efficient one). This is due to the improbability that every ratio chooses the same company, and if they point at different companies, it is complicated to choose which ratio will be more important in the comparison of the decision making units. Furthermore, the comparisons should be made between similar companies, so that a company will be considered inefficient if in some way it is less efficient than another one with the same features. On the other hand, ratios do not allow companies to identify the source of their inefficiency (Diacon et al 2002).

The measures based on the comparison with an efficient frontier are a better choice, because they are able to summarize in one measure the whole performance of the company, defined by the differences between it and the other companies in the same industry, in a way that has its roots in the economic theory (Cummins and Weiss 2012).

The present study has made an analysis of the efficiency in the insurance market on the United States with a nonparametric methodology called DEA (data envelopment analysis). It has been considered that a firm is efficient when it is able to maximize the production obtained while using the minimum quantity of resources.

This has been done with an input orientation, which involves the optimization of the company by the minimization of its inputs in the production of a given level of outputs. DEA estimates the efficiency of a production making unit through the comparison between this unit and the efficient frontier, formed by the company or group of companies that define the benchmarking of the market. In addition, the Malmquist index has been included to measure the evolution of the efficiency rates along the period that has been studied. With this methodology, an analysis of the evolution of the efficiency of the 20 biggest American companies of the insurance market in the period 2007 – 2012 has been made.

This paper is organized as follows. Section two provides a brief explanation of the methodology employed to measure the efficiency of the companies. Section three contains the data and the proxies that have been chosen to calculate the efficiency level. Section four contains the results that have been found. Finally, section five concludes.

2. Methodology

Technical efficiency of insurance was calculated using the nonparametric methodology called Data Envelopment Analysis, which measures the efficiency of each production making unit comparing each unit with the efficient frontier formed by the company or group of companies that define benchmarking or the best practices in the market.

2.1 Data Envelopment Analysis

DEA methodology can be considered an extension of the work done by Farrell (1957), which is a mathematical programming technique introduced by Charnes, Cooper and Rhodes (1978). The DEA is essentially a technique to construct an efficient frontier from the observed data of the production making units that will be studied. The observed units that determine the frontier are the units that are considered efficient, and those located outside are considered inefficient. A production making unit is inefficient compared to companies that are the benchmarking. The DEA methodology allows an evaluation of the relative efficiency of each production unit analysed by solving a mathematical optimization program, solving a linear program for each observed productive unit.

Inside the DEA methodology, two models can be distinguished: the DEA – CCR, developed by Charnes, Cooper and Rhodes (1978), and the DEA – BBC, developed by Banker, Charnes and Cooper (1989). These two models differ by the type of returns to scale.

The model DEA - CCR assumed constant returns to scale, while the model DEA - BBC relaxes this assumption and allows variable returns to scale, that is, constant, increasing or decreasing yields. This enables the DEA – BBC model to show scale inefficiency, associated with the production size of the company. This makes it easier to find the source of inefficiency that may appear in companies.

As seen in Coll and Blasco (2006), the enveloping form is:

For each company $j = 1, \ldots, N$ which utilizes M inputs to produce S outputs, the input and output vectors are expressed as follows:

$$x = (x_{1j}, x_{2j}, \ldots, x_{mj})$$

$$y = (y_{1j}, y_{2j}, \ldots, y_{sj})$$

Where x_{mj} and y_{sj} represent the quantity used of the input m and output s of the j prouction making unit.

So the program that the DEA resolve is

$$\begin{aligned}
& Min\ \theta \\
& s.a.: \\
& \sum_{j=1}^{N} y_{sj}\lambda_j \geq y_{si}, \quad s = 1, \ldots, S \\
& \sum_{j=1}^{N} x_{mj}\lambda_j \leq \theta x_{mi}, \quad m = 1, \ldots, M \\
& \lambda_j \geq 0, \quad j = 1, \ldots, N
\end{aligned}$$

Where θ is the score of technical efficiency of the production making unit.

The efficiency of the unit is between zero and one, so the solution is optimal for $\theta = 1$ when the production making unit is efficient, and the production unit will be inefficient for $\theta < 1$.

The DEA - BBC model relaxes the assumption of constant returns to scale, allowing the existence of other types of returns. This is an extension of the DEA - CCR that includes the inefficiency associated with the production scale.

The enveloping form for the DEA with variable returns to scale is:

$$
\begin{aligned}
& Min\ \theta \\
& s.a.: \\
& \sum_{j=1}^{N} y_{sj}\lambda_j \geq y_{si}\ , \quad s = 1,\ldots,S \\
& \sum_{j=1}^{N} x_{mj}\lambda_j \leq \theta x_{mi}\ , \quad m = 1,\ldots,M \\
& \sum_{j=1}^{N} \lambda_j = 1 \\
& \lambda_j \geq 0\ , \quad j = 1,\ldots,N
\end{aligned}
$$

The unique difference between both models is the inclusion of the constraint $\sum_{j=1}^{N} \lambda_j = 1$.

Pure technical efficiency calculated by the model of variable returns will always be greater than or equal to technical efficiency calculated with the model of constant returns. This is due to the fact that the measure of efficiency obtained by the DEA - CCR is a measure of global technical efficiency (GTE), which can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE), associated with the type of existing returns to scale.

$$GTE = PTE \cdot SE$$

2.2 Malmquist Index

The Malmquist index is used to analyse the change in total factor productivity over time. The index may vary due to two components: the change in the efficient production frontier over time, representing technical change, and the change of location of the company regarding the efficient production frontier over time, which represents the change in the technical efficiency.

The Malmquist index has been chosen because, as Cummins y Weiss (2012) say, it allows to separate the proper variation of global technical market change (change in the efficient units or benchmarking) to the change due to the technical efficiency associated with the company, as is the case of the DEA methodology.

The Malmquist Index measures changes in productivity, measured as the amount of output obtained per unit of inputs used. It can be decomposed into the productivity that has varied due to the variation in the efficiency, and technique productivity that has varied due to the movement of the efficient frontier between two periods, Coll and Blasco (2006).

Malmquist Index = Technical change · Efficiency change

An input oriented Malmquist Index with constant returns to scale was applied.

3. Data, Inputs and Outputs

The American insurance market is vast. To obtain solid conclusions we need to analyse the greatest market share as it is possible. That is the reason why the 20 biggest companies of the American insurance market were considered, so that a study that can be representative of the whole market can be made.

The database we analyse has been obtained from the Global Credit Portal, created by the international agency Standard & Poor's. The 20 companies that have been chosen were selected from the ranking of the 100 biggest insurance business of the United States of America on the 2012. They are ranked by the quantity of net premium, and published on the issue of July of "Property Casualty 360º" in 2013.

The period studied is 2007 - 2012, since data of the balance of 2013 was not available yet in the database.

The data envelopment analysis is the assessment of the efficiency through the relationship between inputs and outputs in the production process of a company. The determination of the variables that represent the inputs and outputs depends on the sector of activity and the market at which the company or the group of companies that are being evaluated operates. In the case of insurance companies, the selection of variables is not intuitive, especially the output ones. This is because, as it happens with other types of financial firms, intermediate goods and services have characteristics as inputs and outputs simultaneously.

As reflected in Cummins and Weiss (2012), insurers are firms whose outputs are primarily services, many of them intangible, which make them difficult to measure. Thus, the difficulty lies in finding the services provided by insurance companies and the measures that can be used as an approximation, because they correlate with those intangible outputs (Diacon et al 2002).

To measure the output, the value-added approach was adopted, which counts outputs as those with significant added value to the company. It was necessary to find a variable that approximates the amount of services provided by each company, which is strongly correlated with the volume of financial services provided (Cummins et al 2010) which are: the mechanism by which consumers and businesses can diversify risks, provide financial planning, manage and prevent risks, and act as financial intermediaries that lend funds of policyholders and invest in financial assets.

The variable used as a proxy for the amount of diversified risk is ‘incurred losses’. The incurred losses are the economic assessment of the costs of accidents that happened. The use of incurred losses is consistent with economic theory on insurance, which makes risk-averse individuals pay premiums in exchange for transferring the risk to the insurer. The second used variable is the investment in assets, calculated as the sum of bonds, stocks, the state debt, and affiliates. This is how the volume of the intermediary of the insurance company is approximated. Finally, the third variable is the technical provisions, which have the function of collecting the amount of risks and expenses to be covered by the company to correspond with the period not elapsed to date (Cummins et al 2010).

The variables used to approximate the inputs are: equity capital, debt capital and operating expenses. Equity capital has been calculated as the sum of the capital accounts of shareholders funds, and it reflects the resources available to the insurer. Debt capital, which is made up of the sources of business financing, has been calculated as the difference between total liabilities and technical provisions. Finally, operating expenses have been selected as a third input, as they are the main costs incurred by the company in the development of the productive activity. Operating expenses include various accounts, the most important of which are the staff and administration costs. With the selected inputs, we intend to approximate the financial and nonfinancial resources available to the insurance companies to develop their business.

4. Results

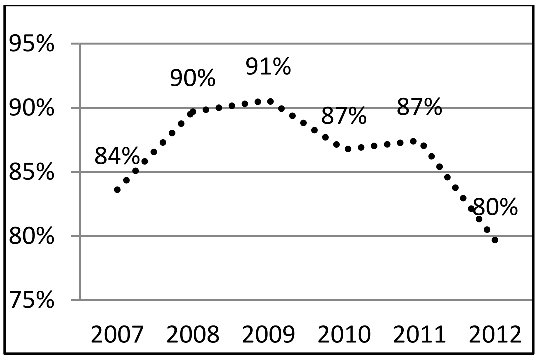
The analysis of the efficiency on the branch of non-life insurance industry in the United States for the period between 2007 and 2012 provides positive results. This sector does not present efficiency problems.

4.1 Results of DEA – CCR

First of all, the results obtained with the DEA constant returns model are presented below. Results can be seen in the appendix, Figure A.

As seen in Figure 1.1, the average efficiency of the 20 largest insurers is comprised between 80% (2012) to 91% (2009). Overall, an improvement in efficiency between 2007 and 2009 is observed, increasing from 84% to 90% and 91% in 2008 and 2009 respectively. However, from 2009 there is a drop in efficiency, reaching a minimum in 2012.

Figure 1.1 Average of global technical efficiency

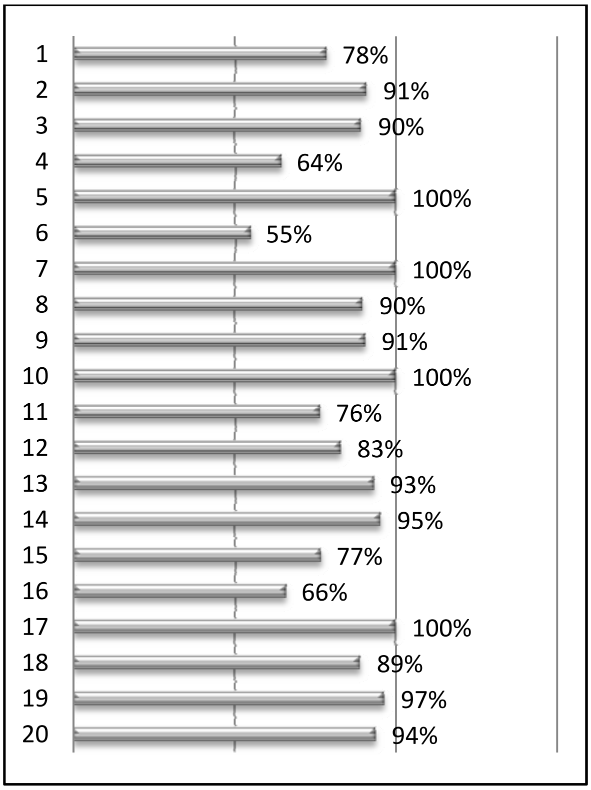


Source: Authors

As seen in Grahamand Xiaoying (2007), an important issue in the branch of non – life insurance market is controlling catastrophic losses, both directly, since some insurances coverage specifically addresses these risks, and indirectly, for example through home or car insurance. The fall observed in 2012 may therefore be due to Hurricane ‘Sandy’, which took place in the month of October in New Jersey.

Studying company by company (Figure 1.2), there are four technically efficient firms throughout the study period and, despite what one might expect, these companies are not those with the largest premium volume. They are the fourth, seventh, tenth and seventeenth in size. After this, there is a second group which comprises eight insurers that exhibit average efficiency scores above 90%, which is also a very positive result. These companies are also relatively small. More than half of the companies surveyed have average efficiency ratings of over 90%, which only have to reduce inputs at a rate below 10% for reach efficiency.

Figure 1.2 Average efficiency of each of the insurance companies sorted by premium volume.



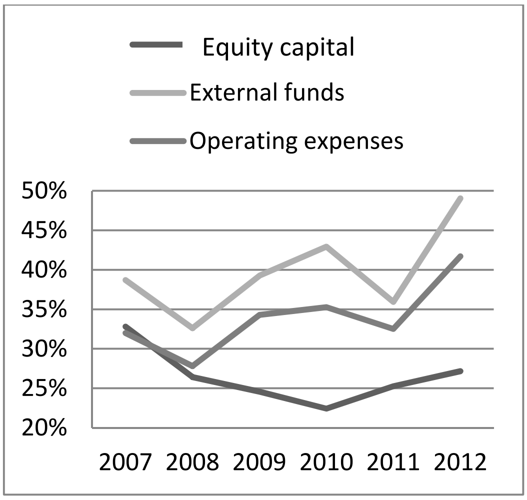
Source: Authors

The most important conclusion to be drawn is that the largest insurers are not the most efficient. The reasons why a small business can be more efficient than a large company may be very different. First, small businesses may be focused on one type of insurance (auto, home...) and so, even though they grow a lot, they do not become as large as a company that is not specialized on covering a larger number of types of insurance. But specialisation makes these small businesses very efficient at the kind of insurance they provide and, in many cases, more efficient than a large company that covers most types of insurance.

Secondly, insurers may focus on a single state, so that an insurer can work in one state and be very efficient, but not reach the size of the companies that operate nationally or internationally. In addition, because they operate at a national or international level, very large businesses can have high fixed costs that reduce their efficiency.

Figure 1.3 shows the average proportional reductions to be made in the inputs of inefficient insurance companies to achieve the efficient frontier, as seen in appendix E.

Figure 1.3 Average proportional reductions to achieve efficiency.



Source: Authors

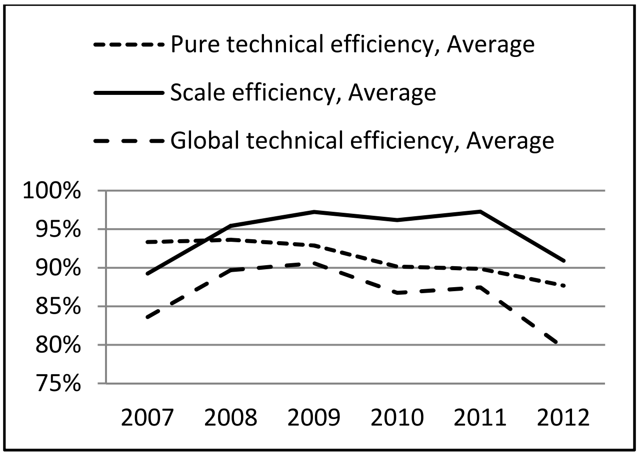
The input that should be reduced to a greater extent is external funds. As it can be seen, in the last year the average reduction that should be performed to achieve the efficient frontier is an average of 49%. The following input that requires significant average reduction is the operating expenses. The evolution of the required percentage reduction of both inputs is very similar, and in both cases a strong rise in 2012 is observed. Equity capital requires a much smoother reduction of about 25%. Therefore, inefficient firms should reduce their debt and costs. It is relevant to note that reducing operating expenses is not an easy task, since they include staff costs and brokerage, which are of great relevance for the sector.

4.2 Results of DEA – BBC

Once the results obtained with the resolution of the DEA for the assumption of constant returns have been analysed, the disaggregation of this efficiency into its two components is presented. They are pure technical efficiency and scale efficiency, since the resolution of the DEA allows variable returns to scale. Results can be seen on the appendix, Figure A.

In the first place, it should be noted that, except in 2007, the pure technical efficiency is below average scale efficiency. Furthermore, it can be seen that the evolution of the average global technical efficiency is closely related to the evolution of the scale efficiency. The maximum and minimum are in both series in the same years, and the path described is very similar.

Figure 1.4 Breakdown of global technical efficiency into pure technical efficiency and scale efficiency.



Source: Authors

Besides, the downward trend seen in the overall technical efficiency over the period is of special attention. The decrease in this index is not very pronounced, but it remains in time. In all the analysed years, this means a drop of 5 percentage points from 93% in 2007 to 88% in 2012.

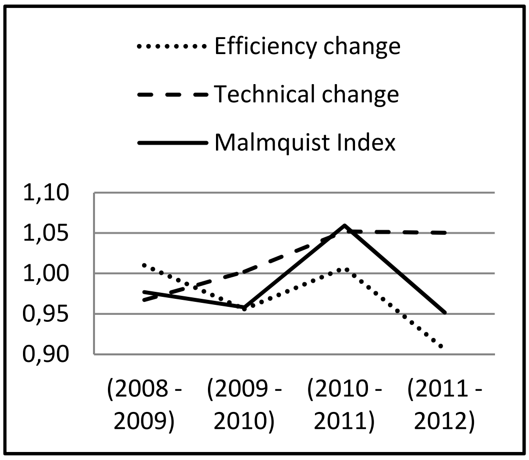
Continuing with the analysis of efficiency disaggregated into pure technical efficiency and scale efficiency, there are two years that reflect the situation of the sector. The tables showing the results associated with these years appear in appendix Figures B and C, while other results are available upon request. 2009 is the year with a highest level of efficiency, with an average global technical efficiency of 91%. By contrast, 2012 has the lowest level, with an average of 80%. In both years it is clear that the efficiency of scale of large companies is lower than those of small businesses operating in the majority of cases with optimal size levels. This situation can be observed in varying degrees for the entire studied period.

4.3 Malmquist Index

The average Malmquist index only takes a value above 1 for the period 2010 - 2011 On average, productivity improved by 6% between these two years. This is because, as seen in the breakdown of the index, there is an improvement of the overall efficiency of the enterprises (1%) and of technology (5%). This result is consistent with those obtained by the DEA analysis. Results can be seen in the appendix, Figure D.

In the other analysed periods, the index falls. It is below 1, especially in the period 2011 - 2012, with an average fall of 5%. This value is due entirely to a reduction in efficiency, worsening by 9%, as technology continues to evolve favorably.

Figure 1.5 Malmquist Index.



Source: Authors

The change in the efficiency of insurance companies does not show good results, because it falls 4% and 9%, and in the periods of improvement, the index only improves in 1%. The change in technology, however, presents a favorable evolution along the period studied, increasing by 5% in the last two periods.

5. Conclusions

The results obtained with the DEA input-oriented model are very positive. In general, throughout the analysed period, efficiency levels are observed above 80% for most of the studied companies. In many cases, they reach efficiencies above 90%. However, in the analysed group of companies two profiles can be seen. In the first place, the biggest insurers reflect pure technical efficiency levels, which change over the years, but, in general, they exhibit scale inefficiency. Secondly, small insurers are, in most cases, more efficient because they reflect higher levels of efficiency of scale, and in some cases also higher pure technical efficiency.

These differences between small and large insurers can be explained by the thorough analysis of the business characteristics. Overall, these results may be due to several reasons. On the one hand, differences in pure technical efficiency may appear because of the geographical area in which the company operates, the level of specialisation, or the type of property. Differences in scale efficiency are due to the fact that they operate in an inadequate size. Consequently, it can be concluded that large companies are oversized, because they are operating in the area of diminishing returns, and therefore they have scale inefficiency. Conversely, small businesses operate, in most cases, with an optimum size, and no problems of scale inefficiency.

Additionally, small businesses have good results for pure technical efficiency, probably because they are companies that specialise in one type of insurance, and in a small geographical area. By contrast, large insurance companies cover a wider market, both in the type of insurance and geographically, they have higher fixed costs and are likely to have a large number of branches and brokers dedicated to the marketing of their products. In addition, the need by inefficient firms of reducing their operating expenses in a significant proportion is consistent with this interpretation of the reasons that cause the inefficiency of scale in the larger companies.

In conclusion, America's largest insurance companies are not the most efficient. Smaller companies are able to optimise their business management and get dial benchmarking. Larger companies, mostly oversized, should review their organisational shape and scope, in order to improve their overall technical efficiency, and particularly their scale efficiency.

6. References

ÁLVAREZ PINILLA, A., 2001. *La medición de la eficiencia y la productividad*. Pirámide.

BANKER, R. D., CHARNES, A., y COOPER, W. W., 1989. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science,* 30. 1078–1092

BERGER, A. y HUMPHREY, D., 1997. Efficiency of Financial Institutions: International Survey and Directions for Future Research. *European European Journal of Operations Research,* 98, 175-212

CHARNES, A., COOPER, W. W., y RHODES, E., 1978. Measuring the Efficiency of Decision Making Units*. European Journal of Operational Research,* 2. 429–444

COLL SERRANO, V., BLASCO BLASCO, O., 2006. *Evaluación de la eficiencia mediante el análisis envolvente de datos.* Ed. Eumed.net. Málaga

CUMMINS, J. D., WEISS, M. A., XIAOYING, X. y HONGMIN, Z., 2010. Economies of scope in financial services: A DEA efficiency analysis of the US insurance industry. *Journal of Banking & Finance*, 1525–1539

CUMMINS, J. D., WEISS, M. A., 2012. *Analysing Firm Performance in the Insurance Industry Using Frontier Efficiency and Productivity Methods*. Dionne, G. en Handbook of Insurance Economics. Kluwer Academic Publishers

DIACON, S.R., STARKEY, K., O'BRIEN, C., 2002. Size and efficiency in European Long-term Insurance Companies: an international comparison. *The Geneva Papers on Risk and Insurance,* 27, 444–466

FARRELL, M. J., 1957. The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society,* Series A (General), 120, No. 3

GRAHAM, L., XIAOYING, X., 2007. *The United States Insurance Market: Characteristics and Trends, Huebner International Series on Risk* en Cummins, J. D. y Verned, B., en Handbook of International Insurance: Between global dynamics and local contingences, Springer

HEMENWAY, C., 2013. Still Some Surprises in NU's Annual List of Top 100 P&C Performers, *Property Casualty 360º,* July

APPENDIX

Figure A: Technical efficiency results period 2007 – 2012.

	2007	2008	2009	2010	2011	2012
1. State Farm Mutual Auto. Ins. Co.	0,77	0,87	0,91	0,83	0,76	0,56
2. Allstate Ins. Co.	0,73	0,95	1,00	1,00	0,98	0,81
3. State Farm Fire & Casualty Co.	0,69	0,92	0,90	0,93	1,00	0,93
4. Nationwide Mutual Ins. Co.	0,55	0,68	0,70	0,64	0,66	0,64
5. Government Employees Ins. Co.	1,00	1,00	1,00	1,00	1,00	1,00
6. Liberty Mutual Ins. Co.	0,58	0,58	0,55	0,52	0,53	0,53
7. National Indemnity Co.		1,00	1,00	1,00	1,00	1,00
8. Farmers Ins. Exchange	0,83	0,81	0,90	0,97	0,92	0,96
9. Federal Ins. Co.	0,95	1,00	1,00	0,86	0,90	0,73
10. Continental Casualty Co.	1,00	1,00	1,00	1,00	1,00	1,00
11. United Services Auto. Assoc.	0,92	0,86	0,78	0,66	0,75	0,62
12. American Family Mutual Ins. Co.	1,00	1,00	0,89	0,76	0,71	0,62
13. American Home Assurance Co.	0,79	0,97	1,00	0,98	0,98	0,88
14. St. Paul Fire & Marine Ins. Co.	1,00	1,00	1,00	0,90	1,00	0,83
15. National Union Fire Ins. Co.	0,71	0,79	1,00	0,82	0,68	0,59
16. Travelers Indemnity Co.	0,61	0,59	0,62	0,71	0,72	0,70
17. Progressive Casualty Ins. Co.	1,00	1,00	1,00	1,00	1,00	1,00
18. Zurich American Ins. Co.	0,92	0,92	0,86	0,90	0,92	0,82
19. USAA Casualty Ins. Co.	0,86	1,00	1,00	1,00	1,00	0,94
20. Erie Insurance Exchange	1,00	1,00	1,00	0,88	0,98	0,77
Average	0,93	0,94	0,93	0,90	0,90	0,88

Source: Authors.

Figure B: Efficiency results, variable return to scale (2009).

	DMU	TE	PTE	SE	Return to scale
State Farm Mutual Automobile Ins. Co.	1	0,91	1,00	0,91	Decreasing
Allstate Ins. Co.	2	1,00	1,00	1,00	Constant
State Farm Fire & Casualty Co.	3	0,90	1,00	0,90	Decreasing
Nationwide Mutual Ins. Co.	4	0,70	0,80	0,87	Decreasing
Government Employees Ins. Co.	5	1,00	1,00	1,00	Constant
Liberty Mutual Ins. Co.	6	0,55	0,59	0,93	Decreasing
National Indemnity Co.	7	1,00	1,00	1,00	Constant
Farmers Ins. Exchange	8	0,90	0,92	0,98	Decreasing
Federal Ins. Co.	9	1,00	1,00	1,00	Constant
Continental Casualty Co.	10	1,00	1,00	1,00	Constant
United Services Automobile Assoc.	11	0,78	0,78	1,00	Increasing
American Family Mutual Ins. Co.	12	0,89	0,90	0,98	Decreasing
American Home Assurance Co.	13	1,00	1,00	1,00	Constant
St. Paul Fire & Marine Ins. Co.	14	1,00	1,00	1,00	Constant
National Union Fire Ins. Co.	15	1,00	1,00	1,00	Constant
Travelers Indemnity Co.	16	0,62	0,72	0,86	Increasing
Progressive Casualty Ins. Co.	17	1,00	1,00	1,00	Constant
Zurich American Ins. Co.	18	0,86	0,87	1,00	Increasing
USAA Casualty Ins. Co.	19	1,00	1,00	1,00	Constant
Erie Insurance Exchange	20	1,00	1,00	1,00	Constant
Average	-	0,91	0,93	0,97	-

Source: Authors

Figure C: Efficiency results, variable return to scale (2012).

	DMU	TE	PTE	SE	Return to scale
State Farm Mutual Automobile Ins. Co.	1	0,56	1,00	0,56	Decreasing
Allstate Ins. Co.	2	0,81	1,00	0,81	Decreasing
State Farm Fire & Casualty Co.	3	0,93	1,00	0,93	Decreasing
Nationwide Mutual Ins. Co.	4	0,64	0,75	0,85	Decreasing
Government Employees Ins. Co.	5	1,00	1,00	1,00	Constant
Liberty Mutual Ins. Co.	6	0,53	0,64	0,82	Decreasing
National Indemnity Co.	7	1,00	1,00	1,00	Constant
Farmers Ins. Exchange	8	0,96	1,00	0,96	Decreasing
Federal Ins. Co.	9	0,73	0,77	0,94	Increasing
Continental Casualty Co.	10	1,00	1,00	1,00	Constant
United Services Automobile Assoc.	11	0,62	0,67	0,92	Increasing
American Family Mutual Ins. Co.	12	0,62	0,63	0,98	Decreasing
American Home Assurance Co.	13	0,88	0,88	1,00	Decreasing
St. Paul Fire & Marine Ins. Co.	14	0,83	0,99	0,84	Increasing
National Union Fire Ins. Co.	15	0,59	0,68	0,88	Increasing
Travelers Indemnity Co.	16	0,70	0,72	0,97	Increasing
Progressive Casualty Ins. Co.	17	1,00	1,00	1,00	Constant
Zurich American Ins. Co.	18	0,82	0,84	0,98	Increasing
USAA Casualty Ins. Co.	19	0,94	1,00	0,94	Increasing
Erie Insurance Exchange	20	0,77	0,96	0,80	Increasing
Average	-	0,80	0,88	0,91	-

Source: Authors

Figure D: Malmquist index (2008 - 2012)

DMU	Efficiency change 2008-09	Efficiency change 2009-10	Efficiency change 2010-11	Efficiency change 2011-12	Technical change 2008-09	Technical change 2009-10	Technical change 2010-11	Technical change 2011-12	MI 2008-09	MI 2009-10	MI 2010-11	MI 2011-12
1	1,05	0,91	0,91	0,74	0,94	1,09	1,03	1,11	0,99	0,99	0,95	0,82
2	1,05	1,00	0,98	0,82	0,97	1,03	1,07	1,04	1,02	1,03	1,05	0,85
3	0,98	1,03	1,08	0,93	0,92	0,98	1,06	0,96	0,90	1,01	1,14	0,90
4	1,03	0,91	1,04	0,96	0,92	0,97	1,06	1,11	0,95	0,88	1,10	1,07
5	1,00	1,00	1,00	1,00	1,09	0,88	1,06	1,04	1,09	0,88	1,06	1,04
6	0,95	0,94	1,02	1,00	0,91	0,98	1,03	1,02	0,87	0,92	1,05	1,02
7	1,00	1,00	1,00	1,00	0,83	0,68	1,53	0,81	0,83	0,68	1,53	0,81
8	1,11	1,07	0,95	1,04	0,89	0,98	1,04	0,98	0,99	1,05	0,98	1,03
9	1,00	0,86	1,04	0,81	1,21	1,03	0,98	1,23	1,21	0,89	1,03	0,99
10	1,00	1,00	1,00	1,00	1,00	1,20	1,00	1,07	1,00	1,20	1,00	1,07
11	0,91	0,85	1,12	0,83	0,96	1,20	1,00	1,08	0,87	1,02	1,12	0,90
12	0,89	0,85	0,94	0,88	0,93	0,99	1,06	1,10	0,83	0,84	0,99	0,97
13	1,04	0,98	1,00	0,90	0,89	0,93	1,03	1,01	0,92	0,91	1,03	0,91
14	1,00	0,90	1,12	0,83	1,13	1,20	1,01	1,14	1,13	1,07	1,12	0,95
15	1,26	0,82	0,82	0,88	0,93	1,13	1,03	1,10	1,17	0,93	0,84	0,96
16	1,04	1,14	1,02	0,97	0,92	0,97	1,04	1,01	0,96	1,11	1,05	0,97
17	1,00	1,00	1,00	1,00	0,90	1,05	0,97	1,07	0,90	1,05	0,97	1,07
18	0,94	1,04	1,03	0,90	0,90	0,95	1,02	1,03	0,84	0,99	1,05	0,92
19	1,00	1,00	1,00	0,94	1,11	0,95	1,07	1,05	1,11	0,95	1,07	0,99
20	1,00	0,88	1,12	0,78	1,09	1,01	1,06	1,12	1,09	0,88	1,19	0,88

Source: Authors

Figure E: Proportional reductions to achieve efficiency.

	2007	2008	2009	2010	2011	2012
Own funds	33%	26%	25%	22%	25%	27%
External funds	39%	33%	39%	43%	36%	49%
Operating expenses	32%	28%	34%	35%	33%	42%
Average	34%	29%	33%	34%	31%	39%

Source: Authors