A cost efficiency analysis of the Insurance Industry in Mexico

Ana María Reyna & Hugo Fuentes

Abstract

Regarding the commencement of the admission of insurers with 100% foreign capital to Mexico, this paper examines the cost variations decomposition of the insurance companies from 2000 to 2012. Following a decomposition model based on Data Envelopment Analysis, cost variations are explained by seven effects: price, quantity, activity, productivity, technical change, technical efficiency and allocative efficiency. The model, which is intertemporal, shows in monetary terms by firm how each effect impacted positively or negatively its costs and it allows to infer market trends. In this research, claims are treated as undesirable outputs, and firms are grouped based on their specialty into Life, Non-Life and Mix insurers for analytical purpose. According to the results, all groups in average did not reduce their costs because of productivity gains, except some companies that did not influenced in the global performance of the industry due to their size.

Clasificación JEL: C14 C67, D61, G14, G22

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I. Introduction

In 2000, the North American Free Trade Agreement (NAFTA) marked the beginning of the entry of insurance companies with 100% foreign capital in Mexico. Since then, the number of insurance companies has grown by 29% and the market has seen a steady growth. Notwithstanding the aforementioned, the penetration, measured as a proportion of directly paid premiums to the annual average GDP, has gradually grown from 1.36% in 2000 to 2.3% in 2013.

These figures are still low compared with other Latin American countries, as the sector represents about 4% in Chile and Brazil[1].

As a result of the deregulation, an increased competition was expected, and with it the occurrence of a series of phenomena. First, the entry of new players in the industry would stimulate the improvement in productivity of the insurance companies (Eckardt, 2007; Yaisawarmg, 2010; Barros, 2008, Luhnen, 2004) to bring about market differentiation through price and the qualitative aspects of products[2]. Second, the competitiveness brought about by way of greater efficiency would enable the companies to transfer the reduction in their costs to their clients and, thereby potentially gain greater market share or maintain profits greater than those of their competitors (Ben-Shakar & Logue, 2012).

The productivity would particularly increase as a result of reducing the input wastage, a better mixture thereof from their prices and incorporating innovations that would lead to technological progress. The companies will be able to improve their costs as well from economies of scale and price management, to the extent of their bargaining power in the market.

The period subject to the analysis, from 2000 to 2012, is close to the complete opening-up of the sector to foreign investment as has been mentioned, and therefore, it can be expected that cost management has been an important strategy in the wake of the entry of new players in the market.

The aim behind this research is to analyze the behavior of costs by identifying the financial sources leading to the variations therein in the companies pertaining to the insurance sector. It is, therefore, possible to visualize improvements in the operations of the companies competing in

[1] Bank of Mexico (2012, p.55; 2013, p.62)

[2] Hardick and Dúo (1998, p. 41)

the market, improvements that were predicted owing to the opening-up to the setting-up of foreign entities, especially in the sphere of productivity, particularly in terms of technological change, technical and allocative efficiency.

The analysis is carried out by estimating the intertemporal tendencies of cost variations, breaking them down into the effects of the changes in prices and input quantity, company activities, changes in technology and efficiency, both technical and allocative. The results of the intertemporal model can help the regulators show the response of the sector from the liberalization of the market in terms of improvements in productivity. In turn, this model is useful for both the shareholders and the managers in that it provides information on the performance of their company and group while discovering the available possibilities of production and the areas of opportunity for their company.

The research assumes the technological model of joint production of financial protection products and compensatory services for financial losses arising out of pure risk, with the understanding that the insurance companies are motivated to expand their market share while controlling the frequency and severity of accidents (Schlesinger and Venezian, 1986; Ben-Shakar & Logue, 2012). On the other hand, the customers do not expect to use a policy at the time of buying one, and buy it just to have a financial protection in the event of a potential loss[3].

It is for this reason that claims are treated as undesired products and insurance policies as desired ones. The methodological focus of this research is a contribution to the literature to resolve some of the contradiction in the studies carried out in the insurance industry that consider the payment of claims as a product belonging to the insurers. For example, under this approach

[3] Kunreuther, Pauly and McMorrow (2013, p. 5) illustrate this situation with the insurance buyer's mantra: "*the best return is no return at all*"

the companies with solvency-related issues achieve high productivity indices, which do not make much sense from the financial point of view (Triplett and Bosworth, 2004).

Although the presence of a random element in the claims cannot be denied, insurance companies seek to minimize them, since not doing so would mean jeopardizing their very existence. On the one hand the companies make ex-ante strategies for the claims, such as risk inspection and conditioning of payments to the compliance with safety measures. Similarly, they promote good behavior of the insured by offering discounts for experience, or by deploying technological devices that monitor and prevent the use of illegal tools such as GPS and Smartbox[4]. Similarly, they require medical examinations, laying down exclusions in the insurance agreements and employing risk sharing measures with their clients by way of deductibles and copayments. On the other hand, companies also prepare ex-post strategies for claim management, for example through the review of claims reported through claim adjusters, monitoring the automobile and medical service providers, and the activation of exclusions laid down in the policies.

It is important to point out that for the purpose of this research, the Mexican market was analyzed by groups, which are organized on the basis of the specialty of the companies dedicated to persons, property or both. The results show that all the groups witnessed incremental costs not only due to the increase in the number of policies, but also because of real increases in the prices of inputs, inefficiencies and for not having made the most of the productive prospects of the industry. Some companies did manage to improve their costs due to some of the stocks analyzed under this research; however, the size of these stocks did not offset the industry trend. These results are not unexpected, for the studies of the productivity evolution of the insurance industry

[4] http://www.co-operativeinsurance.co.uk/youngdriverinsurance?lid=HP-yd-FOM (last visit 08.18.2013)

generally point out a very slow improvement, even in the wake of trade liberalization (Barros et al., 2005; Barros et al., 2008; Bernstein, 1999; Fuentes et al., 2001; Fukuyama and Weber, 2001; Garg and Deepti, 2009; Kasman and Turgutlú, 2009; Wolff, 1991).

The document is organized as follows: Section II includes the literary review; Section III shows the behavior of the sector from 2000 to 2012, Section IV describes the technological model of production for the insurance industry where claims are an undesired product; Section V provides the methodology for estimation put forward by the Grifell-Tatjè and Lovell Model (2000) for including claims in its components; Section VI is dedicated to the definition of inputs and products required for the estimation of the determinants of variation in the input costs and the source from where the data pertaining to the variables was obtained; Section VII presents the most significant results obtained from empirical evidence; finally, Section VIII enumerates the conclusions and final remarks.

II. Literary Review

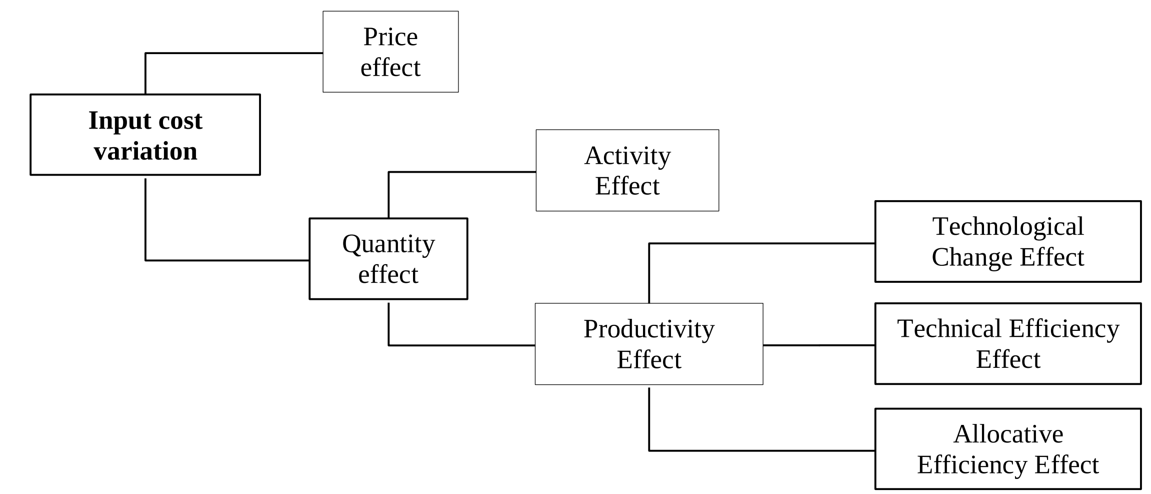
The growing interest in measuring the technical efficiency in the insurance sector has created a whole gamut of articles with different research objectives, but the cost efficiency of the insurance companies has been a less explored territory.

These few studies have been focused on the estimation of cost efficiency and its relation with other variables. Cummins and Weiss (1993), who studied the insurance companies engaged in property coverage in the United States during the 1980s so as to determine whether inflation in the price of insurance policies was related to cost inefficiency, Rai (1996), who, on the other hand, analyzed the cost efficiency of multinational insurance companies in eleven countries; and Jameti and Von Ungem-Stemberg (2005), who compared the cost efficiency of public and private Swiss firms stand out as an example in the field of parametric methods. As regards the non-parametric methods, we find that the comparison of cost efficiency of German insurance companies in accordance with their distribution channels in Trigo-Gamarra and Growitsch (2010), and the evaluation of the relation existing between the conditions of corporate governance and cost efficiency of Takaful companies in Islamic nations in Abdul, Adams and Hardwick (2010).

In Mexico, Fuentes (1993), Ugalde (1993) and Huidobro (2002) value the cost efficiency of Insurance companies with the help of parametric methods in order to explore the existence of economies of scale and scope, in the 1980s and 1990s, before the complete opening-up of the market to companies with hundred percent foreign capitals.

Unlike the aforementioned studies, this proposal seeks to come close to the financial sources of the input cost variations, following the formulation of Grifell-Tatjè and Lovell (2000). The breakdown of cost differential between two adjacent periods is carried out in three stages as is illustrated in Figure 1. The first stage seeks the isolated contribution of the price and quantity effect on cost variation; the second stage separates the effect of the quantities between the contribution of activity and productivity; and in the final stage, the effect of productivity is broken down in order to arrive at the contribution made by the technological change, the technical and allocative efficiency on the input cost variations.

Figure 1. Intertemporal decomposition of the input cost variation



In the literature, we come across a study with some resemblance to the goals of this research in Turchetti and Daraio (2004). These authors, with the Data Envelopment Analysis and the Malmquist Index, take into consideration the evolution of cost efficiency, technological change, technical efficiency and the scale efficiency of the automobile insurers in Italy, while this proposal isolates and expresses the contribution of seven sources of cost variation in monetary terms, instead of indices, and includes the valuation of the contribution of prices, which have been relevant in the previous studies in the price inflation analysis of the insurance policies (Cummins and Weiss, 1993).

The companies subject to research are all insurance companies operating in Mexico between 2001 and 2012, apart from those insurance companies that have been classified by the National Insurance and Finance Commission (CNSF) in a category other than Insurance, i.e. those engaged in Pensions, Health, Financial and Reinsurance Guarantees[5].

[5] All the figures describing the insurance market provided herein are limited to the companies classified by CNSF under the Insurance category.

For analytical purposes, three groups of companies were formed using the classification of the Bank of Mexico[6]: I) Life, when policies are issued to people, that is spheres pertaining to Life and Accidents and diseases, II) Non-life, if policies for property are issued, corresponding to the Automobile policies and the other branches of Damages, and III) Mixed, when policies are issued both for the protection of persons and property.

The grouping of insurance companies according to their specialization encourages the consistent comparison among companies, by increasing the technological similarities of production of the institution pertaining to each group. The grouping also provides disintegrated information regarding the performance and response of the insurance companies in the event of an increase in competition owing to the deregulation[7], besides generating information to arrive at common conclusions for the sector.

III. The insurance sector from 2000 to 2012

In accordance with the figures published by CNSF, the total number of companies in the insurance category in 2002 was 53 and the number had gone up to 68 in 2012, as is illustrated in Table 1. The growth in the number of Non-life institutions to exceed twice its initial number, and the decrease in the Mixed companies' group stand out in the market evolution. It is imperative to mention that in Mexico, from the year 2002, new insurance companies can deal in products exclusively meant for people or property and only those companies having the approval prior to this change in legislation can market both types of risks[8].

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[6] Bank of Mexico (2007, p. 162)

[7] Fuentes et al. (2005, p. 8)

[8] Article VII of the General Act of Institutions and Mutual Insurance Companies.

The dynamics of the entry of new players in the insurance market from the approval for the entry of companies with 100% foreign capital is better seen by jointly reviewing the number of new companies authorized to operate and the exits from the Mexican insurance market.

Table 1. Active Insurance Firms and Industry Concentration

Group		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2000-2012 variation
Life	Num.	11	10	12	11	15	14	16	16	15	15	15	17	19	73%
	HH	58%	44%	60%	82%	78%	72%	64%	63%	63%	64%	64%	63%	64%	
Non-Life	Num.	11	13	14	16	18	18	21	21	25	24	24	25	25	127%
	HH	18%	12%	14%	14%	13%	13%	11%	10%	10%	10%	9%	9%	10%	
Mixed	Num.	31	30	30	29	26	26	26	26	25	25	25	26	24	-23%
	HH	23%	26%	28%	25%	24%	24%	24%	27%	24%	20%	20%	19%	20%	
Total active insurance firms		53	53	56	56	59	58	63	63	65	64	64	68	68	28%
HH All companies		15%	10%	11%	10%	10%	9%	8%	7%	7%	7%	7%	7%	7%	

Notes.
Num. = number of active insurance firms, HH = Herfindahl e Hirschman index defined as the sum of the squares of the market shares of all firms.
Data come from CNSF (2000-2012a) and CNSF (2001-2011b)

During the period 2000-2012, 60 new companies or changes in corporate names were approved, the latter usually associated with the takeover or merger of companies. Of the total, 22 were incorporated under the Non-life group, 20 under Life and 18 under Mixed. It is worth noting that 55% of the new companies entered into the market between 2000 and 2004. As regards the exit, out of the 36 companies that were withdrawn or whose corporate name was inactive from 2000 to 2012, 20 pertain to the Mixed group, 12 to Life, and only 4 to Non-life. Thus, the Non-life group, with the most entries and least number of exits, significantly increased its number, while the number of members of the Mixed companies' group went down.

The participation of foreign shareholders grew from 2000 to 2012 mainly through the establishment of multinational insurance subsidiaries and to a lesser extent with the foray of international financial groups in the insurance industry, mainly in the form of bancassurance. CNSF reports show that 26 of the 56 companies of the Insurance category operating in 2000 had a mainly foreign capital, and this number had gone up to 37 out of 71 companies in 2012[9]. The market shares of the subsidiaries of MetLife, AXA and Mapfre, whose arrival in the country was carried out by taking over already established companies, stand out. As regards the financial groups, there are various forms of participation in the industry, for instance Santander, HSBC and BBVA followed the bancassurance model by taking advantage of the economies of scope of the simple insurance sales at their bank branches, while the subsidiaries of Ally Financial Inc. and GE Capital engaged in insurance business[10] set up their subsidiaries in Mexico.

In Figure 2, one can observe the important growth of the companies with foreign capital in the insurance market. Measuring the share on the basis of direct premiums, the insurance companies with mainly domestic capital decreased their market share from 83% in 2000 to 39% in 2012; on the other hand, companies with mainly foreign capital exceeded the amount of direct premiums of domestic companies from the year 2008 with 49% of the total during that year; and the international financial group bancassurances[11] grew to levels ranging between 13% and 15% of market share in recent years.

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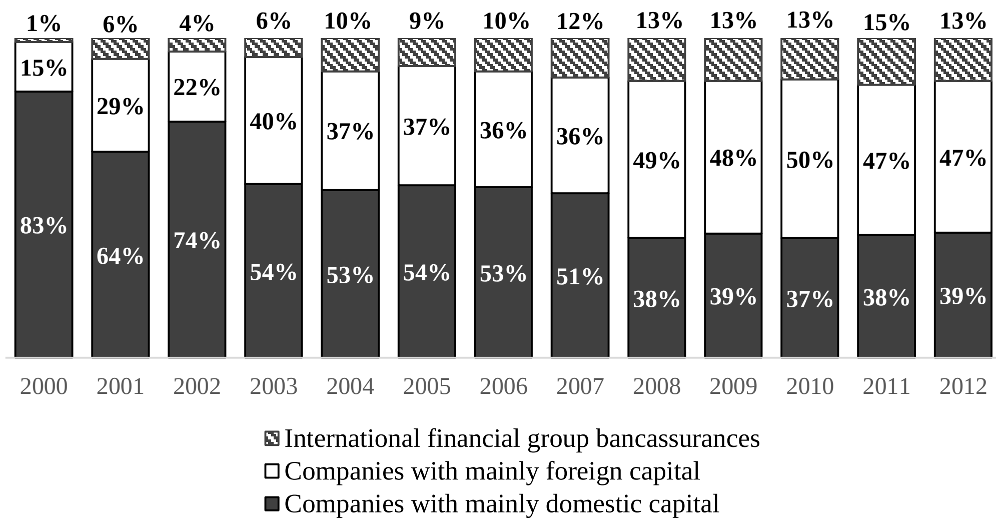
[9] National Insurance and Finance Commission (2001a, 2012a)

[10] GMAC Insurance Holdings Inc., subsidiary of Ally Financial Inc., was the main shareholder of ABA Insurance from 2000 to 2012. Meanwhile, General Electric Capital Assurance Company, subsidiary of GE Capital, was the main shareholder of GE Insurance from 2003 to 2007.

[11] The insurance companies with majority ownership of BBV, BBVA, Citigroup, HSBC and Santander were included in this category.

Figure 2. Market share of insurance firms according to stockholders origin



Note. Figures include only data from firms classified as Insurance by the CNSF
Source: CNSF (2000-2012b)

As for the total of the premiums issued from the sector, in real terms, there has been a growth in all the products (see Table 2). Non-automobile Damages doubled their size with a growth rate of 6.2%, Accidents and diseases has been 1.5 times greater than what it was in 2000 with the highest growth rate among the four products at 8%, while the premiums for Life and Automobiles witnessed an increase of almost 70% with growth rates of 4.9% and 4.5% respectively. Table 2, with premiums issued in constant pesos for each year, only exposes a backward movement in the growth in some years: in the life insurance sector in 2003 owing to accounting reclassifications and fall in the group and collective sales; in 2005 due to a decrease in individual life and damages-related sundries' sector; in 2009 as a result of a fall in sales in the automobile sector; and in 2010 because of a fall in the fire insurance sector.

Table 2. Written premium from 2000 to 2012

Thousands of 2012 pesos

Year	Life	Accidents and Health	Automobiles	Property & Casualties
2000	67,343	16,754	36,607	28,504
2001	57,637	18,378	41,649	29,281
2002	63,154	20,269	46,830	33,702
2003	62,701	22,284	47,485	37,404
2004	75,557	23,949	46,724	39,189
2005	72,400	27,334	47,670	35,459
2006	87,899	30,638	50,550	35,339
2007	96,101	35,762	54,900	41,891
2008	98,612	36,777	54,920	41,505
2009	107,396	37,932	53,285	48,234
2010	103,755	39,866	53,668	47,921
2011	112,719	42,578	58,434	57,012
2012	119,476	42,314	62,014	58,952
Variation	77%	153%	69%	107%
Compound annual growth rate	4.9%	8.0%	4.5%	6.2%

Source: CNSF (2000-2012b)

The most distinguished aspects among the industry watchers[12] in order to explain the increase in premiums during this period are the economic growth measured in terms of GDP per capita[13], the expected potential demand arising from the low penetration level in comparison with developed economies, the increase in home and new automobile loans, the profitability of the industry with levels similar to the ones observed in more developed markets[14], the development of alternative channels with an outreach to wider sections of the society, opening-up to foreign investment, and tax sops for Life and Medical Expenses' insurance premiums.

[12] "Analysis: LatAm's widely differing regulations"(2013), Bank of Mexico (2012), Ceniceros (2008), CNSF(2004b), Harris (1997), Insurance in emerging markets: growth drivers and profitability (2011)

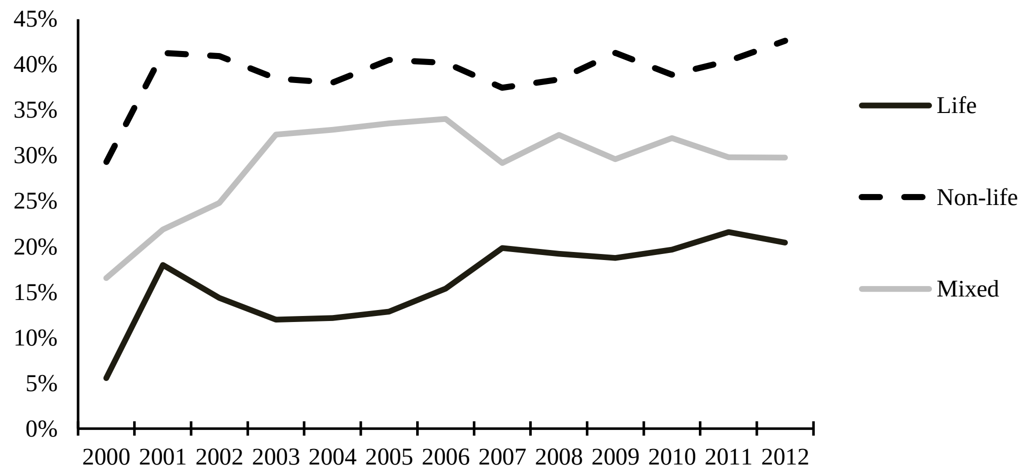
[13] The World Bank (2014) points out an increase in the GDP per capita from 6.6 dollars in 2000 to 9.8 dollars in 2012 in Mexico.

[14] Bank of Mexico (2008, p. 165; 2010, p. 90)

The concentration of companies engaged solely in Insurance, measured with the help of Herfindahl-Hisrchman Index, went down from 15% to 7% during the period 2000-2012, as is shown in Table 1. The Life sector, with the presence of MetLife, the leading company in terms of market sales, has the highest concentration out of the three groups; while among the Non-life companies, the concentration came down to almost half, after the entry of new insurance companies, without a monopoly of any of them. In the Mixed sector, the index was at similar levels, being slightly less in 2012 compared to what it was at the start of the decade.

As far as the costs are concerned, their share in direct premiums has been growing across the three Insurance groups, as is illustrated in Figure 3. It was seen across all the groups that the proportion of cost to premiums are approximately 15% higher in 2012 compared to 2001. The least share of premium costs is found in Life insurance companies, possibly because of the fact that the accounting records of direct premiums also include the savings of the policyholders. On the other hand, the group of companies pertaining to the Non-life sector witnesses the highest cost proportion. The possible reasons behind this are the competition in automobile insurance prices and the difficulty in achieving economies of scale in order to minimize the costs in the group accommodating the highest number of competitors. The companies in the Mixed insurance sector apparently stabilized their costs at the end of the period, thereby halting the growth trend witnessed in the initial years. The aim of this research, which seeks to make contributions to the knowledge of the insurance industry by analyzing it from the inputs' point of view, is to ascertain the financial sources that explain the cost behavior.

Figure 3. Average share of input cost in written premium



Source: CNSF (2000-2012b)

IV. Conceptual framework of the production technology

Taking the environmental efficiency of production technology with externalities, the modeling of the insurance industry herein includes two outputs, the first of which is the market risk coverage in the form of insurance policies to represent the desired output (*good output*); and the second is the payment service for financial losses, also known as claim settlement, considered as an undesired output (*bad output*).

For the representation of production technology with undesired output from the input approach and following the Kumbhakar and Lovell notation, (2003), assume a non-negative input vector $x = (x_1, \dots, x_N) \in R_+^N$, a vector of non-negative desired outputs $y = (y_1, \dots y_M) \in R_+^M$, another non-negative vector of undesired outputs $b = \left(b_1, \dots b_J\right) \in R_+^J$, K number of firms and period of time T. The representation of technology is mentioned in the form (4.1), including all the desired and undesired outputs that can be created with the help of a given input vector.

$L^t(y^t, b^t) = \{x^t : x^t \; can \; create \; (y, b)\}$ (4.1)

It is assumed that the non-negative input vectors can produce zero output at least, besides the set of inputs is closed, bounded, and convex and with strong disposability of inputs and desired outputs, as is shown in (4.2).

$$0 \notin L^t(y^t, b^t) \ for \ y^t \geq 0 \ and \ b^t \geq 0 \qquad (4.2)$$

$$The \ sets \ L^t(y^t, b^t) \ are \ closed$$

$$x^t \ is \ finite \Rightarrow x^t \notin L^t(y^t, b^t) \ if \ (y^t, b^t) \ are \ infinite$$

$$x^t \in L^t(y^t, b^t) \Rightarrow \lambda x^t \in L^t(y^t, b^t) \ for \ \lambda \geq 1$$

$$x'^t \geq x^t \in L^t(y^t, b^t) \Rightarrow x'^t \in L^t(y^t, b^t) \ and \ y'^t \geq y^t \Rightarrow L^t\left(y'^t, b^t\right) \subseteq L^t(y^t, b^t)$$

The joint production technology relies on three more assumptions for the asymmetric treatment of desired and undesired outputs. The first assumes the existence of zero quantities produced by each type of product only jointly (*null-jointness*) among good and bad outputs (Färe, Grosskopf, Noh, Weber, 2002). That is, zero undesired (*bad outputs*) outputs are created if the desired output (*good outputs*) is also zero. In keeping with the nature of the insurance business, risk coverage is also linked to the probability of the occurrence of claims.

$$If \ (y^t, b^t) \in L^t(y^t, b^t) \ and \ b^t = 0, \ then \ y^t = 0 \ (4.3)$$

The second additional assumption is the weak disposability of undesired outputs in contrast to the free disposability of desired outputs (Färe, Grosskopf, Lovell, Pasurka, 1989; Färe et al., 2002). Under this assumption, the reduction of undesired outputs or claims up to a certain proportion in this case is not free when it is accompanied by a decrease in the number of desired[15] outputs given a fixed number of inputs.

$$(y^t, b^t) \in L^t(y^t, b^t) \Rightarrow (y'^t, b^t) \in L^t(y^t, b^t) \ for \ y'^t \leq y^t (4.4)$$

[15] Färe et al. (2005, p. 3)

The third assumption provides for a weak disposability of desired and undesired outputs together and ensures the simultaneous contraction of both outputs if there were a fall in inputs x (Färe et al., 1989, Färe et al., 2005). The decrease in good outputs, or premiums issues, is accompanied by a proportional decrease in claims, and vice versa *ceteris paribus*.

$$If\ (y^t, b^t)\ \in L^t(y^t, b^t)\ and\ 0\ \leq \theta\ \leq 1,\ then\ (\theta y^t, \theta b^t) \in L^t(y^t, b^t) \quad (4.5)$$

Apart from the aforementioned assumptions, it is assumed that all vector x^t belong to their contemporary set $L^t(y^t, b^t)$, although not all of them will be in the input isoquant defined by:

$$I^t(y^t, b^t)\ = \{x^t : x^t \in L^t(y^t, b^t), \theta x^t\ \notin L^t(y^t, b^t), \theta < 1\} \quad (4.6)$$

In view of the aforementioned, it is noteworthy to estimate the distance between the input vectors x^t and the input isoquant which is arrived at with the help of the radial distance function expressed in (4.7).

$$D(x^t, y^t, b^t)\ = \max\{\theta : x^t/\theta \in L^t(y^t, b^t)\} \quad (4.7)$$

The radial distance function $D(x^t, y^t, b^t)$ shall be equal to 1 if the vector x^t belongs to the isoquant, and will be greater than 1 for the remaining input vectors included in $L^t(y^t, b^t)$.

The model followed in this research uses the dual input distance function, i.e. the cost frontier shown in (4.8). While the joint production frontier is the best production technique, the cost frontier describes the most economic way of implementation, with a standard for measuring the financial performance of enterprises (Kumbhakar and Lovell, 2003).

$$c^t(w^t, y^t, b^t) = min_x\{(w^T x) : x\ \in L^t(y^t, b^t)\} \quad (4.8)$$

$$= min_x\{(w^{tT} x) : D(x, y^t, b^t) \geq 1\}, t = 1, \dots, T$$

This frontier indicates the minimum cost required to produce the product vectors (y^t, b^t) with the price vectors w^t and the input quantities x^t under the existing technology; it is a nondecreasing function in (y^t, b^t), concave and homogenous of +1 degree in w^t.

Companies having minimum cost are characterized by being efficient, both technically for consuming the least amount of inputs and allocatively for combining the inputs and prices so as to minimize the cost.

Grifell-Tatjè and Lovell added other functions to their model: $L^{t+1}(y^t, b^t)$ to describe the set of required inputs to produce the vectors (y^t, b^t) during the period $t+1$; the isoquant of the adjacent period $I^{t+1}(y^t, b^t)$ with the corresponding input distance function $D^{t+1}(x^t, y^t, b^t)$; and the dual cost function wherein w may be w^t or w^{t+1} in (4.9)

$$c^{t+1}(w, y^t, b^t) = min_x\{(w^T x): x \in L^{t+1}(y^t, b^t)\}$$

$$= min_x\{(w^T x): D^{t+1}(x, y^t, b^t) \geq 1\} \qquad (4.9)$$

IV. Methodological framework of intertemporal analysis

The analysis of the variation in the input cost change over time by following the Grifell-Tatjè and Lovell model takes place in three stages. In the first stage, the breakdown, illustrated in (5.2), the change in input cost is bifurcated into the contribution of price change, given the fixed quantities, and the contribution of the change in input quantities, given the fixed prices. The differences between the prices and the quantities used to adjust the changes in variables are expressed with Bennet[16] indicators of the type mentioned (5.1).

$$\bar{x} = \frac{1}{2}\left(x^{t+1} + x^t\right) \qquad (5.1)$$

[16] Bennet indicators are preferred to Laspeyres and Paasche indices to avoid weights in excess of the years with highest price or quantity levels, especially in the comparisons of years with significant differences. The axiomatic proof of this advantage is that the Bennet indicators are found in Diewert (2005) and the graphical representation thereof in Sahoo and Tone (2009).

$$\overline{w} = \frac{1}{2}\left(w^{t+1} + w^{t}\right)$$

The sign of price effect is positive in case of input price inflation, otherwise it is negative. Similarly, the positive sign of the quantity effect means an increase in the cost arising from the increase in the quantities of the inputs consumed in the production process, and the negative sign corresponds to the decrease therein[17].

$$c^{t+1} - c^{t} = w^{t+1}x^{t+1} - w^{t}x^{t} \qquad (5.2)$$

$$\bar{x}\left(w^{t+1} - w^{t}\right) \qquad \textit{Price effect}$$

$$\overline{w}\left(x^{t+1} - x^{t}\right) \qquad \textit{Quantity effect}$$

The next step of the model entails the separation of the quantity effect on the effect of the company's operations and on the effect of the productivity, both weighted prices.

$$\overline{w}(x^{B} - x^{E}) \qquad \textit{Activity effect} \qquad (5.3)$$

$$\overline{w}\left[(x^{t+1} - x^{B}) - (x^{t} - x^{E})\right] \qquad \textit{Productivity effect}$$

The activity effect will have a positive sign owing to the increase in the quantity of output produced in the previous year; similarly, the decrease in the number of units produced is depicted with the help of a negative quantity in this component.

In Figure 4, this effect is represented by the distance between cost efficient points x^{B} and x^{E} with the quantities produced during the base period y^{t}, b^{t} as against the period that is being compared y^{t+1}, b^{t+1}, assuming the production possibilities for the comparison period L^{t+1} in

[17] A summary of the contribution to cost variation of all the effects according to the sign of the estimated quantity has been shown in Table 3.

both cases, in order to compare the quantities and see if over time the company increases or decreases its production possibilities with respect to its size of operations.

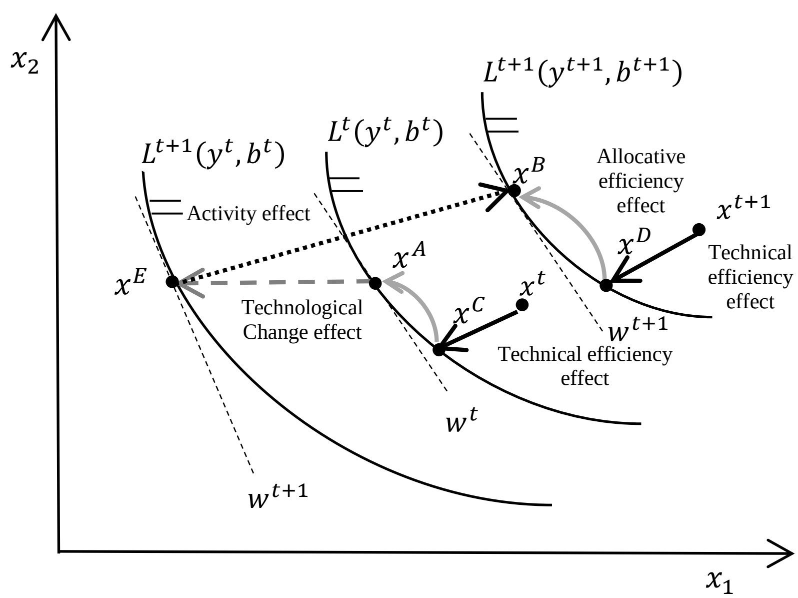
The effect of productivity, in a third step is broken down into three effects that are also graphically represented in Figure 4 and expressed in (5.4). The first is the technical efficiency, when the input quantities are the least possible for the level of production. On the graph one sees the measuring of this component from the distance between observations x^t, x^{t+1} and their projections x^C, x^D on the efficient frontier. The second component of productivity is the allocative efficiency, related to the input quantities required to minimize the costs, given their prices. It is graphically seen as a displacement from the efficient points x^C and x^D, to the points x^A and x^B where the cost efficient frontier intersects the isoquant. The third component of productivity is the technological change that shows the progress or regression in the production possibilities, conceptually referred to in Figure 4 with the distance between the efficient points in cost x^A and x^E assuming the same quantity of production of the base year y^t, b^t under the two production technologies, the prevalent one and the one pertaining to the year that is being compared.

The positive sign of any of the three components of productivity imply a deterioration in the company's performance by increasing the total input cost, whether due to a proportional increase in inputs greater than the increase in the quantities produced by parting from the input combination required for optimizing the costs, or by producing a quantity lesser than what is feasible in accordance with the existing technology for its input level. On the other hand, the negative sign points to the total costs associated with improvements in its production processes whether due to a decrease in inputs, improvement in the input mix in order to minimize the costs or owing to the advent of innovations, which boost the possibilities of production with the same amount of inputs.

$$\bar{w}[(x^{t+1} - x^{D}) - (x^{t} - x^{C})] \quad \text{Technical Efficiency effect} \tag{5.4}$$
$$\bar{w}[(x^{D} - x^{B}) - (x^{C} - x^{A})] \quad \text{Allocative Efficiency effect}$$
$$+ \bar{w}(x^{E} - x^{A}) \quad \text{Technological Change effect}$$

To solve the model described in (5.3) and (5.4) it is necessary to bring the technologies closer to each other since they are not known, and calculate the unobserved vectors $x^{A}, x^{B}, x^{C}, x^{D}$ y x^{E} from the known information and technological approximation.

Figure 4. Productivity effect decomposition



In order to estimate the empirical frontier in this research, the non-parametric technique of Data Envelopment Analysis, abbreviated as DEA in the sequential version of Tulkens and Vanden (1995), has been used herein. Thus, the set of reference production for each period is arrived at with the consecutive addition of the observations taken during that year while retaining the ones taken during previous years; the underlying assumption is that the technological capacities remain viable throughout the time, i.e. technology is remembered and the method of production deployed during the previous years is always an available option, thereby doing away with the possibility of technological regression in the model. On the other hand, the sequential method reduces the effects of the magnitude of the problem, arising from a less number of observations related to unknown variables.

This research is faced with an unusual situation in the literature by estimating in the space of inputs a joint production technology of desired and undesired outputs modeled with the assumptions mentioned in (4.1-4.6). The asymmetric treatment of the desired and undesired outputs has had various representations with the DEA. For example, Färe et al. (1989) proposed a hyperbolic solution in direct methods, without changing the undesired outputs, and variation of the DEA model appear in Färe et al. (1994), Färe et al. (1996), Färe & Grosskopf (2003), Kuosmanen (2005) and Kuntz & Sülz (2010). These authors amended the intensity variables that contract or expand the individual observations of the firms in order to create convex combinations of inputs and outputs. It is not clear as to which of the models proposed in the literature is the correct or most convenient one to tackle the problem in hand. Tests of the indicated models with real data showed that Kuosmanen technology discriminated against the companies without overestimating the efficiency and did not assign the highest indices to the "most polluting" companies, i.e. those companies with the highest proportion of claims with respect to the number of policies issues, as was found in other algorithms. Therefore, the estimation of cost frontier and minimum costs in this research for each company was calculated with the help of a model made on the basis of the Kuosmanen proposal by adding a couple of Färe and Grosskopf's (2005) restrictions to meet all the joint production technological properties that were mentioned earlier. The linear programs created from Kuosmanen technology provide for the weak disposability of the undesired outputs equally in the restriction for undesired outputs and the separation of the weighted intensity λ^k in two parts as is observed in (5.5). The first part is the proportion of the products that can be reduced $\mu^k = (1-\theta^k)\lambda^k$), and the second is the part that remains active ($\nu^k = \theta^k\lambda^k$), assuming that θ^k is the reduction factor of the non-uniform products for all firms.

$$\lambda^k = \nu^k + \mu^k \qquad (5.5)$$

Only the inputs can be weighted by the sum of the components of λ^k, while the products are weighted by the part that firm k may reduce from its production by bringing down its activities.

The vectors x^A, x^B and x^E are estimated with the linear program (5.6) with the aforementioned features and variable returns to scale.

$$c^t(y^{ot}, b^{ot}, w^{ot}) = \min_{x,\nu^k,\mu^k} w^{otT}\,\tilde{x} \qquad (5.6)$$

$$\text{subject to} \qquad \sum_{k=1}^{K}(\nu^k+\mu^k)x_n^k \le \tilde{x}_m^o\,, n = 1,\dots,N$$

$$\sum_{k=1}^{K}\nu^k y_m^k \ge y_m^o\,, m = 1,\dots,M$$

$$\sum_{k=1}^{K}\nu^k b_j^k = b_j^o\,, j = 1,\dots,J$$

$$\sum_{k=1}^{K}(\nu^k+\mu^k) = 1$$

$$\nu^k, \mu^k \ge 0, k = 1,\dots,K$$

$$\sum_{k=1}^{K} b_j^k > 0, \qquad j = 1, \ldots, J$$

$$\sum_{j=1}^{J} b_j^k > 0, \qquad k = 1, \ldots, K$$

Vector x^A is estimated on the basis of the observations of the input quantities and prices, plus the quantities of the products of the base period; x^B is arrived at by substituting the observations of the base period by the observations of the period $t+1$ in (5.6). For vector x^E it is necessary to combine the information of the output quantities of time t with the input prices and quantities of the period $t+1$.

Vectors x^C and x^D are the projections of x^t and x^{t+1} on the efficient frontier as is illustrated in Figure 4. The calculation of these vectors is carried out with the following linear program:

$$[D(,x^o,y^o,b^o)]^{-1} = \min_{\theta,\nu^k,\mu^k} \theta \tag{5.7}$$

$$subject\ to \qquad \sum_{k=1}^{K} (\nu^k + \mu^k) x_n^k \leq \theta\, x_n^o,\ n = 1, \ldots, N$$

$$\sum_{k=1}^{K} \nu^k y_m^k \geq y_m^o,\ m = 1, \ldots, M$$

$$\sum_{k=1}^{K} \nu^k b_j^k = b_j^o,\ j = 1, \ldots, J$$

$$\sum_{k=1}^{K} (\nu^k + \mu^k) = 1$$

$$\nu^k, \mu^k \geq 0, k = 1, \ldots, K$$

$$\sum_{k=1}^{K} b_j^k > 0, \qquad j = 1, \dots, J$$

$$\sum_{j=1}^{J} b_j^k > 0, \qquad k = 1, \dots, K$$

The value of θ estimated with the observations of the base year is used to calculate $x^C = \theta^C x^t = x^t / D^t(x^t, y^t, b^t)$, and by substituting the observations of inputs and products of the period t by those of period $t+1$ in (5.7) it is possible to estimate x^D analogously.

The interpretations of all the effects wherein the cost intertemporal changes are bifurcated according to the sign of the values are summarized in Table 3. Assume that, in the intertemporal model, the positive sign always entails an increase in the total input cost and vice versa when the sign is negative.

Table 3. Interpretation of each effect of the intertemporal model according to its sign

Effect	**Origin of the cost increment (positive sign)**	**Origin of the cost reduction (negative sign)**
Price	Increase in input prices	Decrease in input prices
Quantity	Increase in input quantity	Decrease in input quantity
Activity	Growth in company's operations	Fall in company's operations
Productivity	Deterioration in financial performance	Improvement in financial performance
Technical efficiency	Increase in the difference between the quantities required for the production level in accordance with the existing technology and the input quantities used, without taking into consideration the input prices	Decrease in the difference between the quantities required for the production level in accordance with the existing technology and the input quantities used, without taking into consideration the input prices
Allocative efficiency	Increase in the difference between the quantities that minimize the cost according to their prices and the input quantities used	Decrease in the difference between the quantities that minimize the cost according to their prices and the input quantities used
Technological change	Use of more inputs according to the new production possibilities owing to the use of a previous technology	Use of fewer inputs than earlier because of tapping new production possibilities

VI. Data

The described models are solved from input prices and quantities and products organized in an unbalanced panel, built on the basis of the information contained in financial statements and annual reports of CNSF, the regulatory body of the insurance sector in Mexico. For those companies for which there is no information available in the annual reports of CNSF and the breakdown of some expenditure items, the information was obtained from the database furnished by the Mexican Association of Insurance Institutions (AMIS).

In order to describe the input quantities there have been little differences in the literature, in most of the studies analyzed, labor, capital and other operational expenses are considered as inputs in the insurance industry. In the labor input, some authors add agent information, whether or not they are employees of the companies[18]. Representations of both physical and financial capital have been used in the definition of capital, and as regards the operational expenses, some authors consider administrative expenses without the labor costs and others group both costs together, it is worth pointing out that the outsourcing of services is covered under this input.

Although generally obtaining input prices is carried out by using price indices, no price index for the insurance sector of any country was found in the literature, consumer price indices are used on a regular basis.

Expenses are divided among administrative, acquisition and adjustment expenses[19]. This division can be approved for input costs. The acquisition expenses comprise of intermediary

[18] Examples in Berstein (1999), Fuentes, et al. (2001), Barros, et al. (2008), Garg and Deepti (2009) and Mahlberg and Url (2010)

[19] Regulation in Mexico also marks the recording of other types of expenses that are not directly related with the risk premium operations, for example the expenses of analogous and related services associated with complementary services provided by the insurers to the insured, for instance in the management of copayment of medical services. See CNSF (2011)

costs, both bonus and commissions like the other costs related to sales. The adjustment expenses cover structures, installations, hired services and other inputs meant for catering to claims without including the compensatory payments. Finally, the labor and other input costs for operations that are neither related to sales nor adjustments are covered under administrative expenses.

Considering the economic viewpoint of company's inputs and the financial viewpoint of its expenses, this research uses four inputs: employee $w_1x_1$and intermediary w_2x_2, in order to represent labor as a resource required for the operations of the insurance companies; and the remaining inputs are divided among other administrative expenses w_3x_3 and among adjustment expenses w_4x_4. This proposal, besides approaching the information contained in the Income Statements directly, helps in examining the role of all types of expenses in the presentation of incomes.

It was initially assessed to use the number of active employees during each year for the period under study; however, the information was ruled out because 18% of all the observations between 2001 and 2012 showed companies with zero, one or two employees. On the other hand, a review of the figures corresponding to operational expenses reported in the Income Statements leads us to the conclusion that some companies transferred their employees to subsidiaries and increased the outsourcing of workforce recruitment to third parties. Thus, the total input cost is approximated to be the amount of remuneration and benefits plus the amount of fee of operating expenses. Price w_1 is represented with the help of a price index, in this case the annual increase in minimum wages, and the amount x_1, is the result of the division of input cost between its price. Various studies have followed this approximation when real prices have not been available, for example Grifell-Tatjè and Lovell (2008), Hadley and Irz (2008), and Lim and

Lovell (2008). It is worth mentioning that not the entire employees' cost of the insurance companies is covered under administrative expenses, once, on average, 2 to 4 percent of the acquisition and adjustment expenses correspond to the expenses of the employees engaged in sales and claim settlement.

The total cost of intermediaries is approximated on the basis of the items of the Income Statement known as Agents' Commission, Additional Compensations to Agents and Other Acquisition Expenses. The price of intermediaries w_2 is equal to the percentage of total intermediary cost to the income by way of sales of insurance policies, which in turn acts as the intermediary input quantity x_2 in the model.

The cost of the third input, other administrative expenses, is estimated on the basis of the sum of operating expenses, amortizations and depreciations by deducting the input cost used. The price w_3 used for this input is the cost percentage of other operating expenses among the value of fixed assets that will represent amount x_3. The price of the adjustment expenses w_4, is calculated with the percentage of these expenses in relation to the direct claims x_4, therefore, the data pertaining to the claims that represent the undesired output are net of the input cost required for processing the claims.

There are different perspectives on the researches for measuring efficiency and productivity as far as measuring the product of the insurance industry is concerned. For instance, from the widespread value added approach, the *proxy* of the product quantity of an insurance company pertaining to the Non-life group is the present value of the incurred or expected claims, and for the life insurance companies, the benefits paid to the insured during the year and the additions to reserves (Cummins and Weiss, 1998; Doherty, 1981). This approach, because of being based on the claims is subject to the variability and the enormous fluctuations during the years in which catastrophic events took place. Triplett and Bosworth (2004), meanwhile, highlight the case of companies that are inefficient or unfortunate with the payment of claims that exceed their income, that under the value added approach they shall generate a negative output, besides being classified as highly productive, both situations that do not make any financial sense.

Another trend originates from considering the insurance companies as a financial intermediary with income from interests arising from investments, not only for maximizing profits but also to be able to settle claims within a short time and meet the fiduciary obligations in the long run (Brockett et al., 2004; Liverty and Grace, 2010). This approach is out of the scope since the research is aimed at only insurance activities.

Table 6. Inputs and Outputs

Inputs		
Administrative expenses		
Employee	w_1	Average change in the minimum wage[20]
	x_1	($) Annual labor cost divided between w_1
Other administrative expenses	w_3	(%) Share of other operating expenses with respect to the value of fixed assets
	x_3	($) Value of fixed assets at the end of the year
Intermediary acquisition expenses	w_2	(%) Share of annual acquisition expenses with respect to the direct premiums of the year
	x_2	($) Annual direct premiums
Adjustment expenses	w_4	(%)Share of annual amount of adjustment expenses with respect to the settlement of claims or direct claims during the year
	x_4	($) Value of direct claims
Outputs		

[20] Source: National Minimum Wages Commission. Table of average general minimum wages in Mexico. http://www.conasami.gob.mx/pdf/salario_minimo/sal_min_gral_prom.pdf Last visit July 6, 2014

Insurance policies issued and paid	p_y	($) Average premium per product line (Life, Accidents and Diseases, Automobiles and Damages)
	y	Total policies issued and paid during the year by product line
Reported claims (unwanted products)	p_b	($) Average cost of claims per product line
	b	Total of reported claims per product line

In the approach taken up in this research, the insurance companies have put those products on sale that the clients are ready to buy (Sherwood, 1999; Weiss, 1986), i.e. the consumers pay the price of the insurance policies in order to protect themselves from the risk assumed by the insurance companies. In view of the above, from a practical viewpoint (O'Brien 1991, and Bosworth and Triplett 2004) the policies sold are not products of insurance companies. Premiums are foregone in order to measure the product, according to Cummins and Weiss (1988) since "premiums represent price formulation by the product's quantity, not the product"[21]. The amount of the output is then approximated on the basis of the number of policies issued, which decides the information required to represent the number of desired products. In the undesired output approach, the number of claims reported each year represent the industry-wise number of this type of products. Table 5 summarizes the list of quantities and prices of the inputs and products used to decide the estimation models for this research.

VII. Intertemporal analysis results

The results for the year are shown in Table 6, where the reader can see increases in the input costs, without any decrease in any of the years, in the first column of each group. The changes are relevant in some periods, for example, in 2001-2002, the average cost went up by 160.918 million pesos in the Non-life companies owing to the significant growth in policies and

[21] Cummins and Weiss (1988, p. 27)

the resultant growth in their inputs, mainly in those of ABA, Quálitas and Zurich Daños; and also by 299.465 million pesos in the Mixed-group companies due to an increase in operations, in case of Comercial América Insurance and Grupo Nacional Provincial. Other significant increases took place in 2011-2012 due to similar reasons, the increase of 119.298 million pesos in the Non-life group is explained due to the expansion of Quálitas and of 325.396 million pesos in the Mixed group is owing to the rise in the expenses of mainly AXA and the Grupo Nacional Provincial.

In the average per period, both the price effect and the quantity effect are positive for the three groups, with the quantity effect making a greater contribution to the cost increase; however, the proportion is different for the three groups. From 2001 to 2012, on average, the price effect has a share of a mere 3% in the Life insurance companies, in stark contrast to the Non-life companies with 17%, and the Mixed-group companies with 19%. These results, and the growth in the life insurance premiums and medical expenses expressed in terms of the quantity effect, reveal a better input price management in the Life insurance companies.

On the other hand, the positive sign of the price effect shows a growth in the input prices, notwithstanding the efforts to bring down the prices in some years reflected by the negative signs in Table 6. Although the price effect is proportionally higher in Mixed-sector companies, it points to the efforts to control them.

The most detailed explanation of the price effect of each group can be deduced from Table 7 with the breakdown on the basis of the type of expense, grouped in periods of three years, only to facilitate the trend analysis. The price effect in the Life insurance companies, where it represents the least percentage of cost increase, shows decreases, especially in administrative expenses with an average of 1.235 million pesos, fall in acquisition expenses in some periods and rise in adjustment expenses by an amount lesser than in other types of expenses. Meanwhile, in the Non-life insurance group, the decrease brought about in acquisition expenses does not offset the hike in administrative and adjustment expenses. The Mixed insurance group shows a hike in the input prices of the three types of expenses, although the group managed to bring about some reductions, especially in the prices of its adjustment expenses.

Although prices are typically considered as variables exogenous to firms, the three types of expenses have inputs on the basis of which the companies can influence prices, for example, with their ability to negotiate based on their scale or by deciding the input mix that they shall be using in view of the prices. The companies pertaining to the Mixed insurance group, where most of the major companies of the market belong, have a room for improvement in reducing the administrative and acquisition expenses. The companies belonging to the Non-life insurance sector also have opportunities to reduce the administrative and even the adjustment expenses, their cost reduction strategies must possibly rest on a better input mix, since most of the companies are without scale so as to influence the market.

According to the cost variation analysis, with the quantity effect it can now be concluded that the increase in costs from 2001 to 2012 is largely explained by the increase in the operations of the insurance industry and to a lesser extent by a hike in the input prices. The breaking down of quantity effect in activity effect and productivity effect shown in Table 8 provides more information in order to differentiate what part of the cost increase is owing to the expansion and the extent of the contribution of the financial performance of the companies to improve or worsen these costs.

Table 6. Price and Quantity effects

Average data per period, thousands of 2012 pesos

Period	Group I. Life			Group II. Non-life			Group III. Mixed		
	Input cost variation	Price effect	Quantity effect	Input cost variation	Price effect	Quantity effect	Input cost variation	Price effect	Quantity effect
2001-2002	71,318	-47,913	119,231	160,918	95,635	65,283	299,465	116,125	183,340
2002-2003	84,234	13,286	70,948	68,254	-24,673	92,928	71,163	153,173	-82,010
2003-2004	34,412	-10,552	44,964	85,280	-5,703	90,983	276,468	190,282	86,186
2004-2005	49,249	6,853	42,397	82,803	34,035	48,768	103,135	-68,899	172,034
2005-2006	81,721	34,567	47,154	44,528	5,124	39,405	246,316	72,568	173,748
2006-2007	188,792	114,662	74,129	49,662	31,479	18,184	107,635	-132,688	240,323
2007-2008	51,689	-153,205	204,894	43,063	-19,515	62,578	151,357	-8,591	159,948
2008-2009	55,605	3,322	52,283	7,900	-23,400	31,300	94,802	-113,305	208,107
2009-2010	77,234	77,723	-490	28,353	-9,499	37,853	113,938	142,944	-29,006
2010-2011	60,732	87,201	-26,468	99,363	31,093	68,271	303,799	-32,866	336,666
2011-2012	29,771	-101,724	131,495	119,298	16,544	102,755	325,396	71,687	253,709
Average	71,342	2,202	69,140	71,766	11,920	59,846	190,316	35,494	154,822
Proportion		3%	97%		17%	83%		19%	81%

Table 7. Price effect per input

Average data per period, thousands of 2012 pesos

Period	Group I. Life			Group II. Non-life			Group III. Mixed		
	Price effect administration expenses	Price effect acquisition expenses	Price effect adjustment expenses	Price effect administration expenses	Price effect acquisition expenses	Price effect adjustment expenses	Price effect administration expenses	Price effect acquisition expenses	Price effect adjustment expenses
2001-2004	-412	-16,822	2,174	28,700	-12,776	5,829	69,403	66,804	16,986
2004-2007	48,653	3,293	81	19,160	2,799	1,586	8,458	-36,968	-14,497
2007-2010	-19,215	-5,054	216	-15,179	-5,553	3,260	-11,887	22,711	-3,809
2010-2012	-33,967	26,408	3,765	6,928	4,171	7,203	23,860	-6,453	2,546
Average	-1,235	1,956	1,559	9,902	-2,839	4,469	22,459	11,523	307
Standard deviation	50,933	27,526	2,161	23,393	10,387	4,660	34,255	62,944	14,488

The Life insurance group in Table 8 again appeals to the attention, since the hike in costs takes places in 49% of the bulk input amount required for the expansion of its operations, whereas the other two groups witness a hike in costs due to increased operations of a mere 8% in the Non-life sector and 16% in the Mixed sector. With these percentages, the companies pertaining to the Life insurance sector seem to have an upper hand on the other groups in cost control, both in the management as was pointed out earlier and in the financial performance that is explained by examining the productivity effect.

The productivity effect column in Table 8 in all the sectors comprises of positive numbers in almost all the periods and in the three sectors, which states that adequate changes in efficiency or implementation of improvements in production to reduce costs for the entire industry did not take place. The costs went up owing to a fall in the productivity by 35.218 million pesos in Life insurance companies, 54.786 million pesos in Non-life insurance companies and 130.820 million pesos in Mixed sector companies. It is required to proceed to the next level of breaking down to understand the origin of these amounts and review the results of the company in order to distinguish whether any of them managed to decrease their costs due to improvements in productivity, though they are indistinguishable in the global industry results.

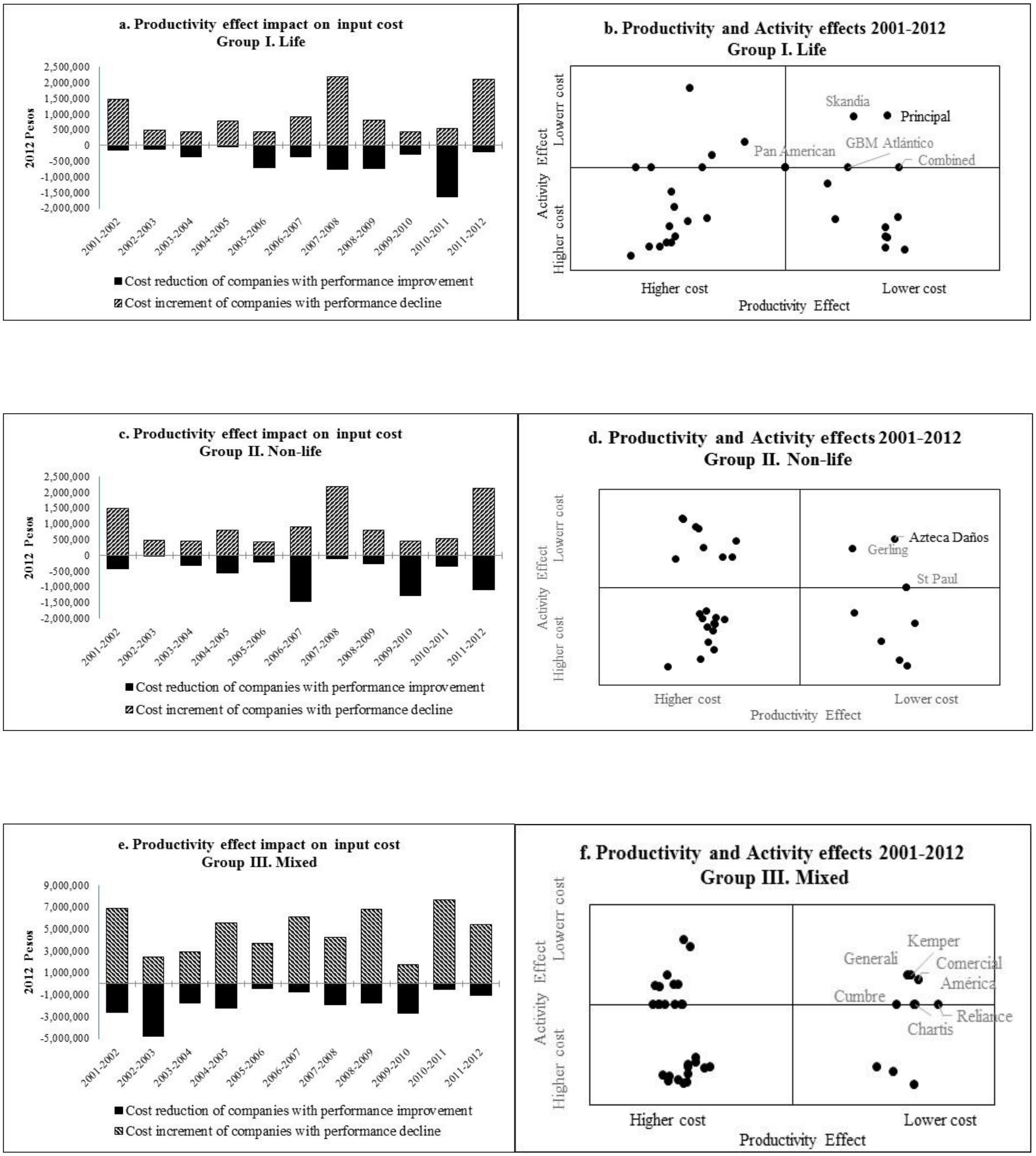
Figure 5 contains two types of graphs for each group. The first (5a, 5c y 5e) makes period-wise additions of all the cost reductions brought about by the companies who improved their performance and also adds all the additional costs borne by the companies operating below the production possibilities of the industry, either due to inefficiency or because of not having adopted technological changes. The magnitude of the cost overruns exceeds the savings of some companies, especially in the Mixed sector.

The second type of graph (5b, 5d y 5f) has four quadrants to show where each company stands according the reduction or increase in its cost due to activity and productivity effects during the period 2001-2012. In the companies pertaining to the Life Sector, Principal is the only currently active company that is placed in the quadrant of the companies with the best financial performance, i.e. for having managed to reduce its costs by capitalizing on the increase in operations and improvements in its productivity. In contrast, almost half the companies pertaining to Life insurance sector are placed in the quadrant where the costs went up due to both effects.

In the Non-life group, Azteca Daños is the only existing company that is located in the quadrant to which the companies with the best performance belong. Most of the companies in this sector worsened their costs because of any of the components of productivity, even when a third of the total managed to bring down their costs by increasing the volume of operations.

The graph of Mixed sector companies does not reveal any existing companies in the quadrant of best performance and only three companies reduced their costs due the productivity effect although it was not because of the activity effect. Most of the companies did not reduce their costs due to improvements in the productivity and activity effect, only seven of them managed to reduce their costs on account of an increase in the volume of operations. Although the graphs 5b, 5d and 5f do not show the amount of savings or cost overruns, they are consistent and complementary to interpret the results of Table 8.

Figure 5. Evolution of input costs per group



Note.

Graphs 5b, 5d and 5f were built with the natural logarithm of the Productivity and Activity effects average per firm from 2001 thru 2012

Table 4. Activity and Productivity effects

Average per period, thousands of 2012 pesos

Period	Group I. Life		Group II. Non-life		Group III. Mixed	
	Activity effect	Productivity effect	Activity effect	Productivity effect	Activity effect	Productivity effect
2001-2002	-2,595	121,826	-8,053	73,336	-2,631	185,972
2002-2003	29,977	40,972	-121,401	214,328	18,462	-100,472
2003-2004	39,271	5,693	22,638	68,345	35,316	50,870
2004-2005	-11,421	53,818	24,128	24,640	36,079	135,955
2005-2006	65,684	-18,530	3,327	36,077	26,369	147,379
2006-2007	42,091	32,038	55,344	-37,160	27,447	212,876
2007-2008	110,137	94,757	-65,190	127,768	53,919	106,029
2008-2009	48,317	3,967	-22	31,323	7,131	200,976
2009-2010	-10,094	9,604	49,681	-11,828	11,370	-40,376
2010-2011	43,321	-69,789	-29,965	98,235	14,137	322,529
2011-2012	18,449	113,046	125,169	-22,414	36,427	217,282
Average	33,922	35,218	5,060	54,786	24,002	130,820
Proportion	49%	51%	8%	92%	16%	84%

The last stage of the analysis deals with the breakdown of the productivity effect whose results appear in Table 9. In the Life group, although the productivity effect is smaller in amount and percentage of the three groups, it did not improve the costs, since neither the technological change nor the technical or allocative efficiency contributed to improve the same. On the other hand, the three effects had a negative influence with 21.194 million pesos, 9.231 million pesos and 4.794 million pesos respectively.

The Non-life and Mixed groups, on average, show reductions in their costs due to the components of productivity. If anything, it must be noted that the technical efficiency effect in the Mixed-group is the least among the three groups with an average cost overrun of 3.880 million pesos.

The results of the effect of technological change of the three groups point out that only some companies moved the production frontier and the others were left behind these possibilities.

In conclusion, the evolution of the costs of the insurance industry show the expansion of the sector from 2001 to 2012, increases in the rising real prices of their inputs and the industry's difficulty to extend technological progress and efficiency to cost as was achieved by some companies. The proofs led to the conclusion that despite being in the growth stages, the industry did not manage to optimize its costs through improvements in products, as could be expected due to the increase in competition. In no group's average was cost reduction on account of technical or allocative efficiency observed. On the other hand, the costs were affected by the inefficient condition of the insurance companies.

Table 5. Productivity effect decomposition

Average per period, thousands of 2012 pesos

Period	Group I. Life			Group II. Non-life			Group III. Mixed		
	Technological Change	Technical Efficiency effect	Allocative Efficiency effect	Technological Change	Technical Efficiency effect	Allocative Efficiency effect	Technological Change	Technical Efficiency effect	Allocative Efficiency effect
2001-2002	127,312	3,005	-8,492	63,582	1,806	7,948	169,906	15,565	501
2002-2003	-22,101	53,744	9,328	83,856	73,596	56,876	-100,784	-4,578	4,890
2003-2004	-16,958	22,450	201	83,111	7,641	-22,407	59,048	717	-8,895
2004-2005	32,175	11,014	10,629	40,614	-13,055	-2,919	148,904	-11,984	-965
2005-2006	23,637	-38,233	-3,934	11,881	25,814	-1,617	131,702	12,239	3,438
2006-2007	-3,294	21,382	13,950	36,828	-59,803	-14,185	185,001	5,306	22,569
2007-2008	103,890	4,968	-14,101	-29,384	62,914	94,238	112,229	8,764	-14,964
2008-2009	-4,510	-4,334	12,811	11,954	67,557	-48,189	117,528	3,313	80,135
2009-2010	-2,651	15,636	-3,380	18,864	-50,239	19,546	-10,156	9,934	-40,153
2010-2011	-86,202	2,412	14,000	35,396	69,467	-6,628	255,180	-29,079	96,428
2011-2012	81,834	9,494	21,718	-11,749	-61,784	51,119	216,246	32,483	-31,447
Mean	21,194	9,231	4,794	31,359	11,265	12,162	116,800	3,880	10,140
Proportion	60%	26%	14%	57%	21%	22%	89%	3%	8%

VIII. Concluding remarks

The financial sources that explain the cost variations of the insurance companies in the stage after liberalizing the market for the setting-up of companies with 100% foreign capitals until 2012 have been analyzed herein with the help of a model based on the non-parametric DEA frontier analysis. The analysis of the cost variations was made in three steps: the first one identifies price and quantity effects, the second decomposes quantity effect into activity and productivity effects contribution, and the third disaggregates productivity effect into technical and allocative efficiency as well as technological change. With this approach, breaking down the details by company and year, it was possible to determine whether the prices, growth of operations and productivity boosted the input costs or not.

The results indicate the increase in costs arising from the changes in the prices and quantities of inputs and outputs. As far as the prices are concerned, only the Life insurance companies were able to manage their input costs, so that the price effect accounted for a mere 3% of the increase in costs, in contrast to the Mixed insurance companies that witnessed 19% cost change due to the hike in their input prices.

The improvement in productivity, which was expected to take place on account of the increase in competition and its potential positive effects on the costs, is weak only because it took place in a few companies without spreading across the industry. On breaking down the productivity in technological change, technical and allocative efficiency, no significant contribution thereof to the improvement in costs of the three insurance groups can be seen.

An incentive to reduce the policy costs from the improvements in productivity has not been observed ever since liberalization, not at least in the results obtained. Efforts for price management and input mix, that perhaps are the first options that managers have in hand in their pursuit of price competitiveness, are noticed. The introduction of technological change and the technical and allocative efficiencies entail operating differently, with the advent of process innovation. This is a significant challenge for the companies because it would eventually imply producing at lower costs, which will, therefore, give birth to the possibility of cutting prices charged to the consumer resulting in greater penetration of insurance in the society.

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