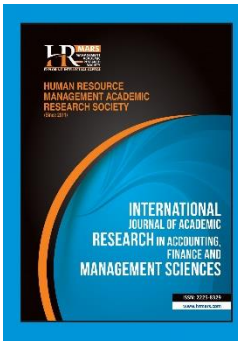

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ISSN: 2225-8329

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To Link this Article: http://dx.doi.org/10.6007/IJARAFMS/v3-i1/10291 DOI:10.6007/IJARAFMS /v3-i1/10291

Received: *13* January *2013,* ***Revised:*** *14* February 2013*,* ***Accepted:*** *27* February 2013

Published Online: 25 March 2013

In-Text Citation: (Suri & Sinha, 2013)

To Cite this Article: Suri, M., & Sinha, R. K. (2013). An Indirect Approach to Construct Insurance Service Price Index. *International Journal of Academic Research in Accounting Finance and Management Sciences*, *3*(1), 315–332.

Vol. 3, No. 1, 2013, Pg. 315 - 332

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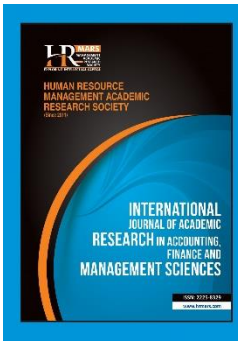
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An Indirect Approach to Construct Insurance Service Price Index

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Abstract
We propose an indirect method to construct the price index for insurance sector, which does not require (or partially requires) the knowledge of prices of various products across time. It is important to appreciate that pricing of products is done actuarially with statistical adjustments by the insurance provider, which have underlying assumptions and several bases, such as, mortality rate, discounting rate (or interest rate), lapse rate etc. These bases do change over time, which leads to corresponding changes in the price of insurance products. Nevertheless, the mathematical framework remains the same. Accordingly, rather than tracking the prices of products as such, it is demonstrated to track the changes in these said bases over time, which could indirectly measure the change in prices of products without knowing them. The paper provides illustrations from hypothetical products and displays very interesting applications. In the end, it discusses the need to have close coordination between the government's statistical office/regulator, the constructor of index, and the insurer, one of the users of index. This is because the knowledge of changes in the bases rests with the insurer, which would be required to construct the indices under the proposed approach.
Keywords: Base Price, Deflator, Discounting Factor, Mortality, Sum Assured, Underwriting

Introduction

Amongst the various service sectors and more particularly the financial sector, the banking and insurance sectors are the most important and crucial sectors, which deliver various financial services to cater to the various needs of customers. The nature of traditional banking is accepting deposits from the surplus sector and lending back to the borrowing sector (at a rate, higher than the deposit rate referred to in the banking parlance as the spread). This way, the banks make profits after adjusting for the costs of various expense heads. Although, modern banking is not limited to the traditional banking, as it also offers many non-traditional and ancillary businesses, nevertheless, this segment operates in less uncertainty as compared to the insurance business.

The underlying principle of insurance is pooling of risks and it works on the law of large numbers. Premium, Investment Income, Claims and Expenses (including commissions) are the four major components, which dictate the financial health (solvency position) of an insurance company. The first two are the inflows for the company, while the last two are the outflows.

Insurance company normally collects premium at the beginning of the policy and pays the insured on the happening of an event. As there is a time lag between these events, insurers invest the money collected and earn interest income including capital gains thereof from this investment. In this strict sense, the money belongs to the policyholders and is held in the fund by the insurer. Therefore, insurers have to depend on premiums collected to discharge their liabilities. Any company in all likelihood aims for a premium income, which is higher than the total of aggregate claims and expenses including commission, so that the profit made by the company is positive.

At the time of writing business, the claims and expenses for a company are unknown. Accordingly, for policies in an insurance company, the company has to price it keeping in view the uncertainty regarding the claim amount besides aiming for a surplus on the business. The nature of insurance is quite complicated as its payouts, in terms of claim payments largely depends on some contingent event, such as death/survival of a person during the term of a policy, occurrence of a catastrophe, etc.

If a company prices the policies lower than the optimal price, it may sell many policies but may not collect sufficient premium to discharge its liabilities. On the other hand, if a company sells the policies at a higher premium, it may not be able to sell many as potential buyers of insurance may turn towards other available insurers in the market or look for alternate financial instruments for parking their savings.

With the above reasons, the companies have to necessarily price their products in a close band. The mispricing (either way) of products will result in a discomfort scenario for the company, impacting its productivity, efficiency and performance negatively. Nevertheless, the impact of mispricing will depend upon many other factors too, such as, the level of concentration / competition and liberalization / deregulation in the market.

One of the major complexities in insurance business is the uniqueness of products. While there are a variety of insurance products, which are launched in the market to cater to the needs of various customers, a particular product may also be sold to different customers at different prices. For example, the price (premium) of a life policy may depend on various demographic factors, such as, age, gender, smoking status, etc. of the person. Similarly, the premium of a motor insurance policy may vary by motor type, sum assured, drivers' past record of claims, etc.

The above aspect is known as the "Underwriting", which is taking a decision to accept or decline or defer providing insurance to a particular risk, and charging appropriate premium rate for a particular risk, in case of accepting it. The "Underwriting Process" is an important aspect of insurance pricing in any insurance company, which uses historical data of the company heavily in addition to the generally available data in the public domain.

Accordingly, as indicated above, although the insurance companies run on the law of large numbers, wherein their risks (in terms of uncertainties) are pooled, minimized and averaged out, nevertheless, they operate in substantial amount of risk. The complications are reflected in the financial statements of insurers, which are prepared with a number of underlying assumptions, such as, valuation basis, reserving basis, actuarial judgments, etc. More so, the financial statements of insurance company are not the only information, which could dictate the health of the insurer, as there could be many other influencing factors, impacting the overall performance of insurer.

The paper is divided into five Sections. The first Section is introductory. The related literature pertaining to the present paper is reviewed in second section of the paper. The methodology to develop price index is given in third section. We have provided various

examples with dummy data to illustrate how the same could be carried out. The fourth section discusses the results and conclusions. In the last section, a few potential related studies have been proposed, which could be carried out using the approach, as discussed in the paper.

Literature Review

The role and responsibility of construction of insurance service price/production indices normally rests with the Governments/Regulators. Accordingly, a major source of literature on this area is from the Government and regulatory offices of various countries. Additionally, there is availability of good number of papers from the academicians and researchers of various academic institutions, who have provided vast theoretical inputs to the compilers and practitioners working on this area.

The Government, regulators and other stakeholders need to track the insurance companies to assess their performance, efficiency, production and output. There are many studies (Barros et al., 2010; Coelli et al., 1998; Cummins and Weiss, 2000; Gardner and Grace, 1993) etc on the measurement of these parameters. In fact, some of the studies have used these terminologies interchangeably, arguing that they mimic/represent each other. For example, Ibiwoye (2010) measured the productivity of insurance firms using their performance, which was measured by the frontier efficiency method. These measures are impacted heavily by the pricing of the insurance products, which is largely determined by the actuaries. The level of appropriate pricing or the mispricing (over-pricing or under-pricing) of products is an important factor, which impacts the level of productivity/efficiency/performance of the firm.

In many of the economies (emerging as well as developed), there have been considerable efforts by their respective Government / Regulator to study the changes in the level of price and production of various services sectors, which essentially facilitates in forming policies and developing sectors in an efficient manner. In addition, continuous efforts are being made by the international bodies (such as, Voorburg Group on Services Statistics, Ottawa Group on Price Indices etc.). As the insurance sector is the most complex component of the services sector, in terms of its pricing and productivity measurement, the insurance sector price and production indices have not yet been constructed/implemented without ambiguity, while other service sector indices are largely well developed and under are under publication as well. One of the main reasons of this is the acute conceptual and methodological difference by economies as well as by researchers, which leads to low confidence in any methodology, once selected.

The approaches for the construction of insurance sector production indices can be broadly categorized into two groups, viz. the national accounting approach and the group of traditional approaches (rest all other approaches), which use a suitable output (or combination of two or more outputs) to measures relative changes in the output over time, assuming these as indicators for the production. Researchers have considered different output(s) to measure it. For example, Houston & Simon (1970) used premium underwritten. Geehan (1977) considered the weighted average of product volumes with measures of real unit costs as the weights. The study of Kellner & Mathewson (1983) demonstrated the index construction with number of policies written, while Fields (1988) took the number of various policies and in-force annuities into consideration. The commission paid to agents was taken as output by Fields & Murphy (1989). The study of Doherty (1981) illustrated the index construction through the claims paid as output. Weiss (1986) considered three outputs, viz.

the sum of selling costs, operating expenses, taxes and capital costs per unit, in combination for the index. Recently, Chessa (2011) demonstrated the index construction by combining administration costs, new number of policies underwritten and claim handling, as outputs with appropriate weights to be determined statistically.

The variations in outputs, as indicated above, show how the approaches could vary in terms of derived indices. Accordingly, it may be noted that these output(s) or their combinations may lead to different sets of indices with the same dataset. In case, they vary considerably, which one is the most appropriate, becomes an issue and may lead to low confidence in implementing it. In summary, there are wide variations in the selection of output for the insurance production. This is despite the presence of international bodies (Voorburg, Ottawa etc.), which have been attempting consistently in moving towards convergence of methodologies across the globe.

The other approach (National Accounting approach) is based on the accounting information, as captured through various financial statements of the insurance companies. The Organization for Economic Co-operation and Development (OECD) has given guidelines to define output for the insurance sector, defined separately for the life insurance and the non-life [Property & Casualty (P&C) in international parlance] insurance segments. The output is defined as:

Life Insurance Output = Total Premium Earned + Premium Supplements – Benefits Due ± Technical Reserves (1)

Similarly,

Non-life Insurance Output = Total Premium Earned+Premium Supplements – Adjusted Claims (Net Paid Claims) (2)

This is in accordance with the System of National Accounts (SNA) 2008, which recommends Adjusted Claims as against Actual Claims, as prescribed in the SNA 1993. One of the major limitations in the SNA 1993 was that the Output could become negative, in the bad years of insurers, in which there have been unusual high claims due to reasons, such as, occurrence of a catastrophe etc. The SNA 2008 guidelines, which works on adjusted claims, averages out such unusual high claims over the adjacent years. This way the negative output, which is hard to interpret, is less likely. However, this cannot be ruled out especially, when the insurers are new/small.

The National Accounting approach defines the insurance output, which is a measure of production. However, it does not discuss on various aspects of corresponding price of insurance products. Accordingly, for the construction of insurance service price index, one needs to stick largely to the traditional methods. Further, there are wide variations in these traditional approaches, as proposed by many researchers. The existence of different approaches and ambiguity involved amongst these are mainly due to the complicated nature of pricing of insurance products, which are priced by the actuaries. In addition, insurance products change very fast with time, especially in an economy, like India, which is at the initial years of the post-liberalized era. This provides a lot of scope for product innovations to the insurers in the presence of acute price competitions. The insurers in India have so far launched around 3600 insurance products in the post-privatized era as on date, of which only a small proportion is in existence as of now.

The price index for the insurance sector is similar to any other index, which measures changes in the price over two time period. As indicated above, it is common that the insurers change feature of their products rapidly over time, which results in termination of old products and launching of new products. Accordingly, one of the major challenges in constructing the insurance price index is to find two identical products at two points of time with their respective prices, which may rarely be available.

Recently, Yocom et al (2011) demonstrated two approaches viz. model pricing approach and unit value approach for the price index of Property and Casualty (P&C) insurance in Canada. The model pricing approach uses sampling techniques, which is based on the model transaction approach, as recommended by the OECD 2005 Manual. Under this approach, sampled units are surveyed initially to obtain information on a "typical" service that is provided, irrespective of the fact whether the transaction actually took place or not. Even in the instance where an initial period price is observed, subsequent period data may not reflect the actual fulfillment of service if the exact service was not actually provided in that period. This could be very common in case of insurance, wherein products do change very rapidly.

The second approach (unit value approach) classifies the products into homogeneous groups and computes the group-wise prices as the ratio of total net premium underwritten in the group to the number of policies in-force under the group. This approach does not require involvement of insurers as such information is expected to be readily available at the national statistics/regulatory offices. One of the big limitations is the availability of homogeneous product groups, which may not exist. Secondly, the net underwritten premiums are reported cumulatively Yocom et al., 2011), while the number of policies in-force is only the active policies.

The present paper argues that for the construction of insurance service price index, which essentially measures change in price over time, one need to know how pricing is done by the actuaries of the insurance companies. In this paper, we demonstrate that the pricing of insurance products, which is done actuarially, uses a set of assumptions, which the actuaries assume. These could be the assumptions on the interest rate, mortality, lapse rate, etc. Our approach is based on the knowledge of these assumptions at two points of time, which suffices for the purpose of construction of price index without looking into the product prices directly. It is the use of the mathematics and the mathematical equations, which do not change with the change of parameter values under various assumptions over time. Accordingly, this is the input (source), which is used to derive output, in terms of the prices of products with different features. We demonstrate our approach in the following section both for the life insurance and the non-life insurance segments.

Methodology of Research

The nature of life and non-life insurance business differs significantly and hence their pricing too. The non-life insurance products are short-term products, which typically run through a year. In contrast, the life insurance products, especially the traditional ones, cover lives for many year and sometimes whole life (until death). As indicated above, we demonstrate our approach separately for life and non-life insurance. However, the paper primarily focuses on the life insurance.

Life Insurance

The traditional life insurance products can be categorized into four groups, namely the whole life assurance, term life assurance, pure endowment and the mixed endowment. The

whole life assurance pays the sum assured on the policyholder's death. The term life assurance contracts pay the sum assured on the policyholder's death up to a term only and does not pay anything if the policyholder survives during the term. In contrast to the term life assurance, the pure endowment is the contract, which does not pay anything if the policyholder dies during the term, but pays the sum assured if the policyholder survives till the end of the term. The last type of contract is the mixed endowment life assurance, which is the combination of a term life assurance and a pure endowment life assurance. Thus, under this contract, the policyholder receives the sum assured certainly. Only the timing of payment is variable, which is either on death, if it happens or, on the maturity if the death does not happen during the term. Accordingly, the theoretical price (in terms of premium) of a mixed endowment should be the sum of price of a term assurance and a pure endowment assurance if all three amounts of sum assured are identical.

The above four types of life insurance contracts are the basic ones, and so there could be many additional features and add-ons, such as bonuses, riders, critical illness benefits etc. Nevertheless, the techniques of pricing these products are based on the mathematical set up of these four basic contracts and all are based on select assumptions.

Further, the premiums could be single or regular. The regular premiums could be level (equal) or unequal. In case of unequal premium, it could be increasing or decreasing over the term. The frequency of regular premium could be annual or could be different (monthly, quarterly etc.). This way there are variations in the frequency and amount of the premiums but again the pricing uses the same actuarial and mathematical approach.

We now provide a few examples of how a pricing of insurance products is done, what are the basic assumptions used and impact on change of assumption(s) on price of products.

Term Assurance – Change in Interest Rate

Let a term life assurance of 20 years, which pays USD 10000 of sum assured at the end of year of death of a policyholder aged 40 years. It is a single premium policy, which is paid at the onset. We need to know the value of this premium, which is the price of the contract. Let the expenses are nil and the company does not desire to make any profit/loss from this contract. In this case, the premium should be equal to the present value of the sum assured. As the sum assured of USD 10000 could be paid (if at all it is paid) if life either dies in this (first) year, or dies in the second year, or in the third year, and so on… , or dies in the twentieth year. If the life survives till the end of 20 years, he/she will not get anything. Accordingly, the insurer needs to make an assumption about the mortality profile of the insured. Secondly, the insurer need to know the present value of USD 10000 as on today, which could be paid at the end of year with (20 possibilities of timings of the payment). The present value of USD 10000 would be more if life dies early (say, during 3rd year) as compared to later (say, death in the 16th year of term). So insurer needs to know the average interest rate during the next 20 years to discount the future payment to the current date.

Mathematically, the present value of this death benefit (USD 10000) should be the premium amount, ignoring expenses and profits. Actuarially, this is, P = 10000 $A^{1}_{40:20\text{-}|}$@i%. It is interesting to note that this equation depends on Sum Assured (which is USD 10000 in this case), interest rate and, age (which is 40 years), term of insurance (which is 20 years) and the mortality profile of the person during his age 40 to age 60 years. Let the insurer makes the following assumptions:

Interest rate: Annual effective rate of interest = 6 per cent

Mortality: AM 92 Life Table (Ultimate)

Expenses: Nil

Profit: Nil

This leads to a premium of USD 270.77, which needs to be charged (Table 1).

Table 1. Calculation of Premium (i = 0.06, v = 0.943396, q_x = AM 92-Ultimate)

Age x	**l_x**	**q_x**	**$v^{k+1} * {}_{k\|}q_x$**
40	9856.2863	0.000937	0.000884
41	9847.0510	0.001014	0.000902
42	9837.0661	0.001104	0.000925
43	9826.2060	0.001208	0.000954
44	9814.3359	0.001327	0.000987
45	9801.3123	0.001465	0.001027
46	9786.9534	0.001622	0.001071
47	9771.0789	0.001802	0.001121
48	9753.4714	0.002008	0.001176
49	9733.8865	0.002241	0.001236
50	9712.0728	0.002508	0.001302
51	9687.7149	0.002809	0.001372
52	9660.5021	0.003152	0.001448
53	9630.0522	0.003539	0.001529
54	9595.9715	0.003976	0.001615
55	9557.8179	0.004469	0.001706
56	9515.1040	0.005025	0.001802
57	9467.2906	0.005650	0.001901
58	9413.8004	0.006352	0.002005
59	9354.0040	0.007140	0.002113
60	9287.2164		
Σ			**0.027077**

Premium = USD 10000 * 0.027077 = USD 270.77

Let after one year, the insurer is selling this product and all the assumptions remain the same except one that is the interest rate has changed from 6 per cent to 5.5 per cent. Now the premium, which should be charged, is USD 286.81 (Table 2).

Table 2. Calculation of Premium (i = 0.055, v = 0.947867, q_x = AM 92-Ultimate)

Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
40	9856.2863	0.000937	0.000888
41	9847.0510	0.001014	0.000910
42	9837.0661	0.001104	0.000938
43	9826.2060	0.001208	0.000972
44	9814.3359	0.001327	0.001011
45	9801.3123	0.001465	0.001057
46	9786.9534	0.001622	0.001107
47	9771.0789	0.001802	0.001164
48	9753.4714	0.002008	0.001227
49	9733.8865	0.002241	0.001296
50	9712.0728	0.002508	0.001371
51	9687.7149	0.002809	0.001452
52	9660.5021	0.003152	0.001540
53	9630.0522	0.003539	0.001634
54	9595.9715	0.003976	0.001734
55	9557.8179	0.004469	0.001840
56	9515.1040	0.005025	0.001952
57	9467.2906	0.005650	0.002070
58	9413.8004	0.006352	0.002194
59	9354.0040	0.007140	0.002322
60	9287.2164		
Σ			**0.028681**

Premium = USD 10000 * 0.028681 = USD 286.81

With this, we can compute the insurance service price index for this product as:

Price Index = 100 * p_1/p_0 = 286.81/270.77 = 105.92. This price index reflects the change in the insurer's assumption of interest rate (from 6 per cent to 5.5 per cent), keeping all other assumptions and factors unchanged.

Term Assurance – Change in Mortality

We now repeat our above example but change the assumption of mortality. We assume that the policyholders continue to follow mortality experience of AM 92 (Ultimate) but the mortality improves by 2 per cent (revised q_x-type probabilities = 0.98 * old q_x-type probabilities) during the age interval (40, 60). We keep all other assumptions unchanged (including the annual effective interest rate as 6 per cent). Now, we compute the revised premium as equal to USD 265.47 (Table 3).

Table 3. Calculation of Premium (i = 0.06, v = 0.943396, Revised $q_x = 0.98*q_x$ of AM 92-Ultimate)

Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
40	9856.2863	0.000918	0.000866
41	9847.2357	0.000994	0.000884
42	9837.4503	0.001082	0.000907
43	9826.8070	0.001184	0.000935
44	9815.1736	0.001300	0.000968
45	9802.4094	0.001436	0.001007
46	9788.3361	0.001590	0.001050
47	9772.7769	0.001766	0.001099
48	9755.5185	0.001968	0.001153
49	9736.3213	0.002196	0.001211
50	9714.9385	0.002458	0.001276
51	9691.0607	0.002753	0.001345
52	9664.3830	0.003089	0.001420
53	9634.5301	0.003468	0.001499
54	9601.1155	0.003896	0.001584
55	9563.7049	0.004380	0.001673
56	9521.8195	0.004925	0.001767
57	9474.9293	0.005537	0.001865
58	9422.4666	0.006225	0.001967
59	9363.8122	0.006997	0.002073
60	9298.2917		
Σ			**0.026547**

Premium = USD 10000 * 0.026547 = USD 265.47

The reduction in the premium justifies the fact that as the mortality of policyholders improves its probability of death during the period of 20 years is lower than earlier as also in case of death, the expected time of death during the 20 years interval has increased. This leads to the product becoming cheaper. It is important to note that the product would have become costlier in case of a pure endowment policy, which rewards for surviving. Now, we compute the price index as:

Price Index = $100 * p_1/p_0 = 265.47/270.77 = 98.04$. This price index reflects the change in the insurer's assumption of mortality, keeping all other assumptions and factors unchanged.

Term Assurance – Change in Interest Rate and Mortality

We now repeat our exercise but change both the assumptions (interest rate as well as mortality). We assume that both the annual effective rate of interest and the mortality change simultaneously in one year's time. The changes are same as described in the above two examples, that is, the annual effective rate of interest changes from 6 per cent to 5.5 per cent and the q_x-type probabilities improves by 2 per cent for the age range 40 years to 60 years. Now we compute the premium as equal to USD 281.20 (Table 4).

Table 4. Calculation of Premium (i = 0.055, v = 0.947867, Revised $q_x = 0.98*q_x$ of AM 92-Ultimate)

Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
40	9856.2863	0.000918	0.000870
41	9847.2357	0.000994	0.000892
42	9837.4503	0.001082	0.000920
43	9826.8070	0.001184	0.000953
44	9815.1736	0.001300	0.000991
45	9802.4094	0.001436	0.001036
46	9788.3361	0.001590	0.001085
47	9772.7769	0.001766	0.001141
48	9755.5185	0.001968	0.001203
49	9736.3213	0.002196	0.001270
50	9714.9385	0.002458	0.001344
51	9691.0607	0.002753	0.001424
52	9664.3830	0.003089	0.001510
53	9634.5301	0.003468	0.001602
54	9601.1155	0.003896	0.001700
55	9563.7049	0.004380	0.001804
56	9521.8195	0.004925	0.001915
57	9474.9293	0.005537	0.002030
58	9422.4666	0.006225	0.002152
59	9363.8122	0.006997	0.002278
60	9298.2917		
Σ			**0.028120**

Premium = USD 10000 * 0.028120 = USD 281.20

Accordingly, the price index is computed as:

Price Index = $100 * p_1/p_0 = 281.20/270.77 = 103.85$. It is interesting to see that this index viz. 103.85 is simply the product of the two price indices, as computed in the first two examples. That is,

1.0385 = 1.0592 * 0.9804.

In fact, this is because both the assumptions are not only independent from each other, in this case, but could be factorized. This is because the q_x-type probabilities are revised by multiplying a constant (=0.98), so could be taken outside the summation. In case of a shift in the mortality curve, the nature of independence of mortality with the discount rate 'v' (and hence the interest rate) is not such that as it could be factorized. Accordingly, it is not always the case that assumptions could be factorized and decomposed appropriately. We now illustrate other variations, which could not be factorized, in the following examples:

Term Assurance – Change in Age

We now repeat our exercise but change the age of policyholder from 40 years to 45 years and keep all assumptions unchanged (as per Illustration 01). We get the required price of the product as USD 348.86 (Table 5).

Table 5. Calculation of Premium (i = 0.06, v = 0.943396, Age 45 years, q_x = AM 92-Ultimate)

Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
45	9801.3123	0.001465	0.001033
46	9786.9534	0.001622	0.001077
47	9771.0789	0.001802	0.001127
48	9753.4714	0.002008	0.001183
49	9733.8865	0.002241	0.001243
50	9712.0728	0.002508	0.001309
51	9687.7149	0.002809	0.001380
52	9660.5021	0.003152	0.001457
53	9630.0522	0.003539	0.001538
54	9595.9715	0.003976	0.001624
55	9557.8179	0.004469	0.001716
56	9515.1040	0.005025	0.001812
57	9467.2906	0.005650	0.001912
58	9413.8004	0.006352	0.002016
59	9354.0040	0.007140	0.002125
60	9287.2164	0.008022	0.002236
61	9212.7143	0.009009	0.002350
62	9129.7170	0.010112	0.002466
63	9037.3973	0.011344	0.002583
64	8934.8771	0.012716	0.002701
65	8821.2612		
Σ			**0.034886**

Premium = USD 10000 * 0.034886 = USD 348.86

The price index is computed as:
Price Index = 100 * p_1/p_0 = 348.86/270.77 = 128.84

Term Assurance – Change in Interest Rate

We now repeat our exercise but change the annual effective rate of interest to 7 per cent from 6 per cent, in Illustration 01. The premium is computed as USD 242.04 (Table 6).

Table 6. Calculation of Premium (i = 0.07, v = 0.934579, Age 40 years, q_x = AM 92-Ultimate)

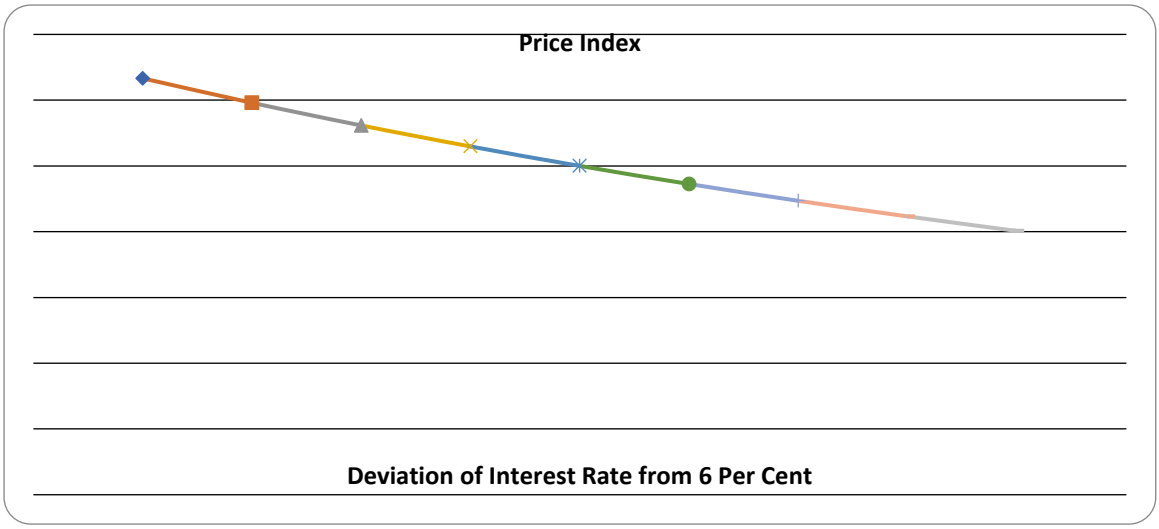
Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
40	9856.2863	0.000937	0.000876
41	9847.0510	0.001014	0.000885
42	9837.0661	0.001104	0.000899
43	9826.2060	0.001208	0.000919
44	9814.3359	0.001327	0.000942
45	9801.3123	0.001465	0.000971
46	9786.9534	0.001622	0.001003
47	9771.0789	0.001802	0.001040
48	9753.4714	0.002008	0.001081
49	9733.8865	0.002241	0.001125
50	9712.0728	0.002508	0.001174
51	9687.7149	0.002809	0.001226
52	9660.5021	0.003152	0.001282
53	9630.0522	0.003539	0.001341
54	9595.9715	0.003976	0.001403
55	9557.8179	0.004469	0.001468
56	9515.1040	0.005025	0.001536
57	9467.2906	0.005650	0.001606
58	9413.8004	0.006352	0.001678
59	9354.0040	0.007140	0.001751
60	9287.2164		
Σ			**0.024204**

Premium = USD 10000 * 0.024204 = USD 242.04

Accordingly, the price index is computed as:

Price Index = 100 * p_1/p_0 = 242.04/270.77 = 89.39. Similarly, Price indices could be computed for different values in the interest rate. A set of indices with various values of interest rate (deviations from base interest rate of 6 per cent) is provided in Chart 1.

Chart 1: Price Index under various interest rates (base interest rate = 6% for Index = 100.00)



Term Assurance – Change in Age and Interest Rate

We now repeat our exercise and change both Age (40 years to 45 years) and Interest Rate (6 per cent to 7 per cent), as in Illustration 01. The premium is computed as USD 297.26 (Table 7).

Table 7. Calculation of Premium (i = 0.07, v = 0.934579, Age 45 years, q_x = AM 92-Ultimate)

Age x	l_x	q_x	$v^{k+1} * {}_{k\|}q_x$
45	9801.3123	0.001465	0.000976
46	9786.9534	0.001622	0.001009
47	9771.0789	0.001802	0.001046
48	9753.4714	0.002008	0.001087
49	9733.8865	0.002241	0.001131
50	9712.0728	0.002508	0.001181
51	9687.7149	0.002809	0.001233
52	9660.5021	0.003152	0.001289
53	9630.0522	0.003539	0.001349
54	9595.9715	0.003976	0.001411
55	9557.8179	0.004469	0.001476
56	9515.1040	0.005025	0.001544
57	9467.2906	0.005650	0.001615
58	9413.8004	0.006352	0.001687
59	9354.0040	0.007140	0.001761
60	9287.2164	0.008022	0.001836
61	9212.7143	0.009009	0.001911
62	9129.7170	0.010112	0.001987
63	9037.3973	0.011344	0.002062
64	8934.8771	0.012716	0.002136
65	8821.2612		
Σ			**0.029726**

Premium = USD 10000 * 0.029726 = USD 297.26

Accordingly, the price index is computed as:

Price Index = 100 * p_1/p_0 = 297.26/270.77 = 109.78. Interestingly, it may be noted that 1.0978 is not equal to 1.2884 * 0.8939, which is 1.1517.

We now classify the factors, which are based on various assumptions and could be used as multiplier in the construction of price index. We propose that the factors could be classified in three groups, namely:

f_j : The factor, which reflects the Inflation Rate. This is the inverse of deflator, used in construction of price index

f_m : The factor, which is derived from the changes in the assumptions, which is directly in-built in the actuarial pricing equation. These are the discounting rate (derived from interest rate), mortality basis (which takes care of age and gender of policyholder and the term of policy, if it is not the whole life policy).

f_o : The factor, which is influenced by all other assumptions, other than associated with f_j and f_m. These could be many, for example, demand for and supply of insurance products, state of competition and concentration in the industry, price competition/war, cross selling,

state of de-tariffication, assumptions of expenses, assumption of underwriting profits, insurers' level of underwriting etc. etc.

Thus the price index could be equivalent to:

$100 * p_1/p_0 = 100 * f_j * f_m * f_o$

Here, it is important to note that the first factor (f_i) can play the role of deflator, which is the reciprocal of f_i.

The insurance companies price the product on the basis of the above mentioned assumptions, which have the corresponding factors. Once these factors are known or estimated (if not known readily), the corresponding price index could be constructed. If all the factors are known, the price index could be derived without the knowledge of the actual price of various products, being sold. However, if some of the factors are known and rest is not known, then these unknown factors could be derived by the knowledge of price of products being sold.

This also helps to compare two products, which have different features, and so price index is possible to construct. The same is demonstrated in the subsequent examples. Let there are two products (product A and product B) available at two points of time (t=0 and t=1). Their features are given as below:

Pure Endowment Policy – Product Variations

We now provide an illustration of a Pure Endowment policy, which has multiple variations, viz. with regard to term of policy, gender of policyholder, interest rate, premium amount and sum assured.

Product A (at t=0)	**Product B (at t = 1)**
Pure Endowment Policy	**Pure Endowment Policy**
Term = 15 years	Term =10 years
Age of Policyholder = 35 years	Age of Policyholders = 55 years
Gender of Policyholder = Male	Gender of Policyholder = Female
Mortality = ELT (Males)	Mortality = AM 92 (Ultimate)
Annual effective rate of interest = 8 per cent	Annual effective rate of interest = 6 per cent
Sum Assured = USD 20000	Sum Assured = USD 16000
Price = USD 6200 (It is single premium)	Price = USD 8500 (It is single premium)
Expenses = Nil	Expenses = Nil
Profit = Nil	Profit = Nil

We intend to find the price index for the time (t = 1) with base year (t = 0). It may be noted that these products are not similar and their features differ a lot. The price index is not possible through traditional methods. The reason is simply that their prices (USD 6200 and USD 8450) are not comparable, in view of their different features. We compute the price index over one year time through the following steps:

- It is important to realize that price of product increases with the sum assured. Accordingly, one needs to compare the price with same sum assured. However, the same will hardly available in practice. We introduce 'price per unit of currency of sum assured" as the basis for comparison in order to construct price index. We compute these for both the products as:
  Price per 1 USD of sum assured = 6200/20000 = 0.310000 (For Product A)
  Price per 1 USD of sum assured = 8500/16000 = 0.531250 (For Product B)

- We now compute the price per 1 USD of sum assured with the basis, as given under the two scenario as:
  Price per 1 USD of sum assured = 0.304714 (For Product A)
  Price per 1 USD of sum assured = 0.515363 (For Product B)
  (Table 8)

Table 8. Calculation of Premium (Product A and Product B)

	Product A		**Product B**
Sum Assured	20000	Sum Assured	16000
i	0.080000	i	0.060000
1+i	1.08000	1+i	1.060000
v	0.925926	v	0.943396
l_{50}	93925.0000	l_{65}	8821.2612
l_{35}	97170.0000	l_{55}	9557.8179
Price per 1 $ of SA	0.304714	Price per 1 $ of SA	0.515363
Price of Product	6094.28	Price of Product	8245.81

- The Price Index = 100 * (0.531250/0.310000) * (0.304714/0.515363) = 101.32

Thus, the approach is to first convert and transform the price of one product to the equivalent price of the other product, so that both prices could be compared and price index could be determined. This process could be generalized by letting a particular product as the base product so that all other products could be transformed into it. It is important to note that all the additional features of a product (such as riders, bonus etc.) are derived from a basic product and so their prices could be transformed back to the basic level. The assumptions and change in these assumptions during two points of time could then be used to construct the price indices. We now discuss this approach for the non-life business in the following section.

Non-life Insurance

The above approach could be extended to the non-life insurance products. The non-life products are simpler to price as compared to the life insurance products. The ratemaking in non-life business is done for various attributes, which could be factored mostly as multipliers and sometimes as additive factors. There exists a base price for a particular combination of attributes for a given sum assured (usually in a round figure, say USD 1000). Prices of products with other combinations of attributes could be derived accordingly, using these various factors. This information of factors could facilitate in transforming one product with some set of attribute to other product with different attribute. Accordingly, price index could be constructed from different products, which is otherwise not possible through the traditional methods. A set of examples of attributes could be seen in Werner (Chapter 2, pp-13-35), which discusses ratemaking in property and casualty (P&C) lines of business. It describes the rating manual, the insurer's documentation to appropriately classify each risk and to calculate the applicable premium associated with each risk. This information is available with the insurers, which could be used to construct the price index.

Discussions & Conclusions

The nature of insurance products is genuinely complicated and these products are priced actuarially. The pricing is done under strong mathematical and statistical framework and carries a set of assumptions, known as bases. This set of assumptions changes over time, based on the historical data of various experiences, besides general macroeconomic scenario. The construction of insurance service price index is all about knowing prices of insurance products at two (or more) points of time, so that its ratio could be computed. As these products change too fast, it is difficult to find common products, which could be used for index.

There are many approaches and studies, which have developed several methodologies for the construction of insurance service price indices. However, none of these are free from their conceptual and methodological limitations. One of the approaches is to sample the products, rather than taking all products, for which comparison is feasible. However, this limits the coverage of data and thus scope of the index. We have proposed an indirect method to construct the price index for insurance sector, which does not require the knowledge of prices of various products across the time. We have demonstrated in the paper that rather than tracking the prices of products as such, one could track the changes in these said bases, which could indirectly measure the change in prices of products without knowing them. We provide illustrations from hypothetical examples.

Further Studies

The authors believe that while the approach is new, it provides many insights into the underlying pricing process, which is the directly linked to the price index. While, it suggests a (indirect) method to compute price index without the knowledge of price, it can also be used to derive various prices based upon the knowledge of price index. The paper suggests that the following research projects, amongst others, may be carried out:

- A Study on the Impact of major Policy change, such as, Deregulation, Privatization etc. on the Price/Price Index of insurance products through change in the underlying assumptions.
- A Study on the Impact of Market Concentration/Competition on Price/Price Index of insurance products through change in the underlying assumptions.
- Future Projection of Price/Price Index with the knowledge of “Historical Assumptions” of the insurance companies.
- Development of Fan Chart for the future Price Index.

Acknowledgement

The Authors are thankful to their employer “Insurance Regulatory and Development Authority” for supporting this study. The views expressed in this paper are of the authors and do not necessarily represent the organization they belong to.

References

Barros, C. P., Ibiwoye, A., and Obijiaku, L. E. (2010). A study of the relative efficiencies of Nigerian Insurance Companies using data envelopment analysis, journal of Business Research,

Chessa, A. G. (2011). A new method for price and volume measurement of non-life insurance services: A Statistical Approach, Paper presented at the 26th Voorburg Group Meeting, Newport, United Kingdom, September 19-23, 2011.

Coelli, T., Rao, D. S. P., and Battese, G. E. (1998). An introduction to efficiency and productivity analysis, Kluwer Academic Publishers.

Cummins, J. D., and Weiss, M. A. (2000). Analyzing firm performance in the insurance industry using Frontier Efficiency Methods, In Dionne, G (ed), Handbook of Insurance. Boston, Kluwer, Ch.24.

Doherty, N. A. (1981). The Measurement of Output and Economies of scale in Property Liability Insurance, Journal of Risk and Insurance, 48:390-402.

Fields, J. A. (1988). Expenses Preference Behavior in Mutual Life Insurers, Journal of Financial Services Research, 1:113-129.

Fields, J. A., and Murphy. (1989). An Analysis of Efficiency in the Delivery of Financial Services. The Case of Life Insurance Agencies, Journal of Financial Services Research, 2:341-356.

Formulae and Tables. (1980). Institute and Faculty of Actuaries, UK.

Gardner, L. A., and Grace, M. F. (1993). X-efficiency in the US life insurance industry, Journal of Banking and Finance, 17:497-410.

Geehan, R. (1977). Returns to Scale in the Life Insurance Industry, Bell Journal of Economics, 8:497-514.Hancock, Diana, 1985.

Houston, D. B., and Simon, R. A. (1970). Economics of Scale in Financial Institutions: A Study in life Insurance, Econometrica, 38:856-864.

Ibiwoye, A. (2010). Evaluating financial ser5vices productivity: A comparison of ratios, index numbers and frontier methods, Journal of Economics and Engineering, February, 2010.

Kellner, S., and Mathewson, G. F. (1983). Entry, Size Distribution, Scale, and Scope Economies in the Life Insurance Industry, Journal of Business, 56:25-44.

Organization for Economic Co-operation and Development. (2005). Methodological Guide for Developing Producer Price Indices for Services.

Weiss, M. A. (1986). Analysis of Productivity at the Firm Level: An Application to Life Insurers, Journal of Risk and Insurance, 53:49-83.

Weiss, M. A. (1987). Macroeconomic Insurance Output Measurement, Journal of Risk and Insurance, 54:582-593.

Yocom, J., Opsitnik. L., and Neofotistos, S. (2011). Direct Insurance Carriers Services in Canada, SPPI Mini Presentation, 26th Voorburg Group Meeting, Newport, United Kingdom, September 19-23, 2011.