PROPERTY-CASUALTY INFLATION INDEXES

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When reviewing a paper, one cannot help but be somewhat awed by the amount of effort and time that is consumed in the preparation and execution of this task. One is also drawn to the conclusion that more needs to be done. One can also be thankful.

Mr. Masterson's paper falls into all of these categories. His paper is in fact a sequel to one published in these Proceedings. (11) That paper spawned much discussion and paved the way for future work; we find the sequel in much the same condition.

In reviewing this paper I will present my own views of the content. Having thoroughly reviewed it, I feel that there is much more here than a continuation or recompilation of a series of members. I will also present some background on Index Number Theory and several avenues of future work which may be of interest to the serious reader.

Finally, two comments are worth making. First, the importance of bridging the gap between ratemaker and ratepayer could never be overemphasized. The obligation we all have of refining or expanding on terms of art and computational methods so that they are as clear as possible should be assumed vigorously. What bigger offense is there than an argument lost or a decision made under erroneous conclusions steeped in shallow understanding or an unchallenged abuse of semantics. Extending the boundaries of knowledge are just as important as the non-technical restatement of that knowledge.

While all of this may be clear to the reader it should be no less clear that in coming to terms with complexities we are all victims of attempting to reduce our observations to simplist terms: to the researcher, it is an atomistic view; to the lay reviewer of insurance, it may be generalities, which upon reflection, may not be as generally true as at first hoped.

Mr. Masterson grapples with this problem when he cites the importance of explaining the often used and commonly referred-to benchmarks of inflation, the Consumer Price Index (CPI).

In explaining any technical subject in non-technical language, there is a loss of information. What is lost is the perception of how the building blocks interact-how the dissection can reveal a recombination, more powerful than the original. This should be borne in mind while examining this paper.

However, the gap must be bridged. We find the structure as laid out by Mr. Masterson looming in the shadow. We can be thankful for that much.

The Bridge

To read this paper without returning to the predecessor would be wasteful. There, the purpose and scope of the construction of the indices are set forth. In that work, Mr. Masterson took on the task of explaining the cost movements of property and liability insurance claims through a comparison to known movements in well known economic indices and combinations of those indices. One reason for doing so is that such economic series are readily available and, to some degree, time-honored.

The degree to which anything is really explained by such comparisons is limited- that's expected. The fact that workers' compensation claim costs are rising faster than the CPI does not serve to explain why those costs are rising. Even the fact that such claim costs are moving parallel to a composite of such indices once again avoids the question. Nor does Mr. Masterson claim the contrary - but it is a noteworthy trap.

The indices are constructed though a weighting of indices and components of those indices already constructed. Both the weights and choices of series are selected based upon a combination of judgement and observation.

The constructed indices are then compared historically with the CPI.

In addition to claim cost indices the author reviews the hedge known as investment income. While it is not appropriate for the reviewer to engage in the noble debate in this article, the fundamental comparisons should give some pause. But as in the comparisons made in the other lines of insurance, there is more to say.

Index Number Theory

Any review of the literature on this subject reveals a large variety papers, theories and conclusions. It is useful for the reader to be exposed to this information. Since I will not delve deeply into the matter, I will refer the reader to the several articles listed in the Bibliography.

The problem of index numbers generally arises whenever we want a quantitative expression for a complex that is made up of individual measurements for which no common physical unit exists. In lines of insurance, such a unit does indeed exist namely the dollar cost of claims. Therefore, any construction of such indices is actually geared toward a comparison of known movements against so-called "general movements". This point is crucial.

It was in fact one of the moving forces behind the inception of the CPI. The Shipbuilding Labor Adjustment Board determined in November, 1917 that in arriving at a "fair wage scale", wages in the yards should be adjusted whenever the cost of living had increased generally. Thus began the creation of a market basket and by 1921 the regular publication of the National CPI.

The general construction of indices is as much a problem in economic theory as it is one of statistical technique. While neither approach is clearly noted in Mr. Masterson's work, surely both are present.

The approaches to index numbers can be categorized into two basis classes, atomistic and functional. In the former approach, given the prices and quantities for several commodities in two time periods, a functional relationship is assumed which gives a plausable expression for "general movement". In the latter approach, certain functional relationships are observed between prices and quantities and assumed in constructing the indices. Mr. Masterson is in between both.

Two simple indices can be created without much theoretical foundation. Given prices (Po) and (P1) and corresponding quantities (Qo) and (Q1) measured in time period o and 1 we have the outlays in these time periods as $\sum$ Po Qo and $\sum$ P1 Q1, respectively. Here the summation is taken over all the commodities in the basket.

One index would be constructed by determining the total outlay for commodities (Qo) if prices (P_1) were paid. By comparing this to the same quantities at prices (Po) we have the index.

$$Po_1^{\ La} = \sum P_1 \, Qo \ / \sum Po \, Qo$$

This is known as the Laspeyres index.

Alternatively, the comparison could be in the form

$$Po_1^{\ Pa} = \sum P_1 \, Q_1 \ / \sum Po \, Q_1$$

This is known as the Paasche index.

While each measure a change in the "general movement", the quality actually being sought is something else, namely, given the price structure at time $_1$ and the mix of commodities, (Q) that would have been selected at time o, what would have been the total outlay, $\sum P_1 \, Q$. The sought-after index is then

$$Po_1 = \sum P_1 Q \ / \sum Po \, Qo$$

The difficulty here is that in general (Q) is not known. However, under certain, not too, restrictive conditions.

$$Po_1^{Pa} < Po_1 < Po_1^{La}$$

RGD Allen (3) investigates the 24 ordinal relationships among the quantities.

$$\sum Po \, Qo, \sum P_1 \, Qo, \sum P_1 \, Qo, \sum P_1 \, Q_1$$

He concludes, however, that indexes may be valid only over short time spans. The reason is the same as the difficulty in assessing the commodity mix, (Q), above. Choice and preference are a fundamental part of any selection under the assumption of finite resources. Using some modestly well-behaved functional relationships, this so-called preference map changes slightly under small changes in time. However, this is not valid over longer time spans.

Leontiff [2] comes to the same conclusion and in fact goes further in arriving at some interesting contradictions under seemingly harmless assumptions.

Fisher [9] investigated an axiomatic approach to index numbers. This so-called Test Approach consisted of formal tests regarding the function that expresses the price level change from one situation to another. These are listed in the appendix for the more curious.

Several others have devised indexes with various characteristics which are listed in the appendix.

Finally, there is another approach first formulated by Rutherford which may pose some interesting research possibilities. In his Principal Factors approach he considered the composition of several series of indices ${}_rI_t$ where $_r$ denotes the $_r$th series, at time $_t$. This fundamental model is:

$$(1) \quad {}_rI_t = A_r F_t + {}_rE_t$$

Here F_t is the value of the "general movement" and E_t are the error terms. His objective was to find constants (K_r) such that a new variable M_t is given by

$$(2) \quad M_t = \sum_r K_r \, {}_rI_t$$

where

(i) Total variance of (M_t) is 1

(ii) The variance in random part of M_t is a minimum.

In this way M_t approximates F_t. The solution to such a problem is well known (See Appendix) and in fact can be extended to a collection (F_t)

Workers' Compensation

Having cited some avenues of work that may be taken, let me as well point out the effect of a constant mix assumption for workers' compensation costs. It can be assumed, for example, that a constant medical indemnity split of claim costs occurs. The split was .65, .35 for indemnity and medical, respectively. These are based on observed relations from the unit statistical plan. While this may be a typical mix, it can importantly depend upon the actual benefit. This mix can depend not only on the statutory benefit structure, but on the judicial process encountered in paying benefits.

It has been observed by the research actuaries and economists at the National Council that the movement in claim distribution by type of injury over time has had the effect of increasing costs; not only in terms of noticable shifts from non-compensable medical cases to temporary totals but completely within the indemnity loss category. This is manifested by a shift in the distribution of claims by type from temporary totals to more costly permanent partial and permanent total injuries.

The impact of this leverage can be very large and in fact has been measured to be as much as a factor of 3 %. Using only a medical-indemnity split would overlook such as impact.

Even within the medical cost measures there are certain effects which are unmeasurable through CPI components. While it may be true that the cost per service behaves generally like the medical component of the CPI, the number of such services per case may charge over time.

Such changes in preference were recognized above to have an affect on the usefulness of indices in the long term - however it is conceivable that such service intensification measures can and do exist.

Finally, economists and actuaries at the National Council on Compensation Insurance are evaluating the effect on costs of changes in benefit utilization due to changes in the benefit level. Increases in temporary total cases in one state was observed to increase by 1% for each 1% change in wage replacement rate. Such effects on costs are not readily observable to the series described by the author.

As a final exhibit we offer a comparison of claim cost movements for several states and the workers' compensation index as developed by Mr. Masterson. Note that there is consideraable variation by location in the actual movements compared to the index movement. In light of the comments offered above, this comes as no surprise.

I would also warn the reader that refinements to the CPI take place over time. Examples can be found in the BLS bulletins cited in the appendix. Before launching into any such series constructions, the refinements noted in these bulletins should be reviewed.

Finally, we should offer our thanks to Mr. Masterson for his efforts in compiling a commendable work and extending his previous results. I look forward to more work of this sort hopefully generated by avid students and practitioners.

APPENDIX I

Let P_{01} be an index measuring change from time period o to time periods. Let (Po), (Qo), (Q_1) be the collection of commodity prices and quantities expended in time o and time 1, respectively.

$$P_{01} = \sqrt{P_{01}^{La} \; P_{01}^{Pa}}$$

Fishers ideal formula

$$P_{01} = \frac{\sum P_1 \; (Q_0 + Q_1)}{\sum P_0 \; (Q_0 + Q_1)}$$

Edgeworth

$$P_{01} = \frac{\sum P_1 Q}{\sum P_0 Q}$$

Constant Weights

$$P_{01} = \frac{\prod P_1^{\alpha}}{\prod P_0^{\alpha}} = \frac{(P_1^{1})^{\alpha 1} \ldots (P_1^{\alpha})^{\alpha n}}{(P_0^{1})^{\alpha 1} \ldots (P_0^{n})^{\alpha n}}, \quad \sum \alpha = 1$$

Geometric

$$P_{st} = \frac{P_{01} \; P_{1z} \ldots P_{t-1,t}}{P_{01} \; P_{1z} \ldots P_{s-1,s}}$$

Marshall

APPENDIX II

Test Approach

Let P_{01} be the Index Number

Identity Test:	$P_{oo} = 1$
Point Reversal Test:	$P_{o1} P_{1o} = 1$
Circular Test:	$P_{o1} P_{12} = P_{o2}$
Commensurability Test:	P_{o1} does not change by changing the unit of measurement for any of the individual goods.
Determinateness Test:	P_{o1} does not become zero, infinite or indeterminate, if any individual price or quantity becomes zero.
Proportimality Test:	If all prices have changed in the same proportion from time o to time 1, P_{o1} shall be equal to the common factor of proportimality.

It has been shows that conmensurability, determinateness and circular tests cannot be satisfied at the same time.

APPENDIX III

The movel is formulated as in (1) and (2). The solution is obtained by solving the system.

$$\left.\begin{array}{l} K_1\ (1-\lambda) + K_2\ r_{12} + \dots + K_p\ r_{1p} \\ K_1\ r_{1p} + K_2\ r_{2p} + \dots + K_p\ (1-\lambda \end{array}\right\} = 0$$

where is the largest root of the determinant

$$\begin{vmatrix} 1-\lambda & r_{12} & \cdots & r_{1p} \\ & & \vdots & \\ r_{1p} & r_{2p} & \cdots & 1-\lambda \end{vmatrix} = 0$$

and r_{em} is the simple regression coefficient between ${}_eI_t$ and ${}_mI_t$.

AVERAGE CLAIM COST INDICES

	1		2		3		4		5		6		
	M	I	M	I	M	I	M	I	M	I	M	I	Index
71	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
72	1.073	1.229	1.080	1.080	1.040	1.076	1.043	1.102	1.024	1.148	1.120	1.052	1.078
73	1.173	1.343	1.135	1.216	1.113	1.138	1.174	1.199	1.194	1.383	1.280	1.262	1.192
74	1.427	1.653	1.368	1.505	1.338	1.227	1.435	1.370	1.424	1.462	1.464	1.321	1.314
75	1.745	1.987	1.834	2.474	1.556	1.413	1.727	1.456	1.667	1.784	1.832	1.734	1.519
76	1.791	2.332	1.908	2.781	1.642	1.521	1.919	1.538	1.939	2.105	2.176	2.005	1.702

Source: Unit Statistical Plan

BIBLIOGRAPHY

1. Ragnar Frisch, - "The Problem of Index Numbers", Econometrica, 4 (January 1936), 1-38

2. Wassily Leontiff, - "The Composite Commodities and the Problem of Index Numbers", Econometrica, 4 (1936), 39-59

3. R.G.D. Allen,-" The Economic Theory of Index Numbers", Econometrica, 16 (August 1949), 197-203

4. Richard Stone and S.J. Prais, - "Systems of Aggregative Index Numbers and their Compatibility", Economic Journal (September 1952), 565-83

5. R.S.G. Rutherford - "The Principal Factors Approach to Index Number Theory", Economic Record, 30 (November 1954), 200-208

6. The Consumer Price Index: Concepts and Content over the Years U.S. Department of Labor Bureau of Labor Statistics May 1978

7. BLS Handbook of Methods, Chapter 13-14

8. "Improving the Measurement of Produces Price Changes", Monthly Labor Review (April 1978)

9. Franklin M. Fisher and Karl Schell, - "The Economic Theory of Price Indexes (New York, 1972)

10. Relative Importance of Components in the Consumer Price Indexes, 1977 U.S. Department of Labor (April 1980)

11. Masterson, N., - "Economic Factors in Property and Liability Insurance Claims Costs",(PCAS, Liv. (1974)

12. Frank Harwayne, Vice President - NCCI - Unpublished

13. John D. Worrall, Vice President - NCCI - Unpublished