



SOCIETY OF ACTUARIES

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## Changes in Consumer Price Index

(Continued from page 1)

home was included for the first time; previously only rents were considered. In 1978, the new indexes will introduce CB radios, some expensive cars, fast-food items, microwave ovens, and assorted sporting goods.

The new index, will reflect the items purchased by all urban households. This distinguishes it from earlier indexes representing purchases by wage earners and clerical workers. The new index adds self-employed workers, the retired population and the unemployed, but continues to exclude rural families.

None of these CPI's is or has been a Cost-of-Living-Index. Each CPI has measured the change in the price of a fixed basket of goods and services, ignoring changes in buying habits which occur when the price of certain goods rises in relation to substitutes. Income taxes and Social Security taxes have been excluded, although they are a considerable part of consumer expenditures.

There are other limitations to the CPI which detract from its use as a cost-of-living index. New products are introduced at infrequent intervals. Up-to-date changes in consumer buying habits are difficult to reflect in the index. The 1978 revision is based on surveys of buying habits made in 1972 and 1973—before the substantial rise in oil prices.

There are also philosophical problems. How does one include the price change of purchasing a home this year, since the house will be used for many years? How does one measure the impact of oil prices on consumer buying habits? Such problems make a cost-of-living index an ideal rather than a reality.

For six months, three indexes will be published: the current one, the updated version and the new CPI. No action has been taken on which index to use to compute automatic increases in Social Security and other federal payments.

CPIs for specific cities will be changed from quarterly indexes to bimonthly indexes. CPIs will be calculated for 28 cities, an increase of four, as well as

## A GRAPHICAL TECHNIQUE FOR WRITING EXPOSURE FORMULAS

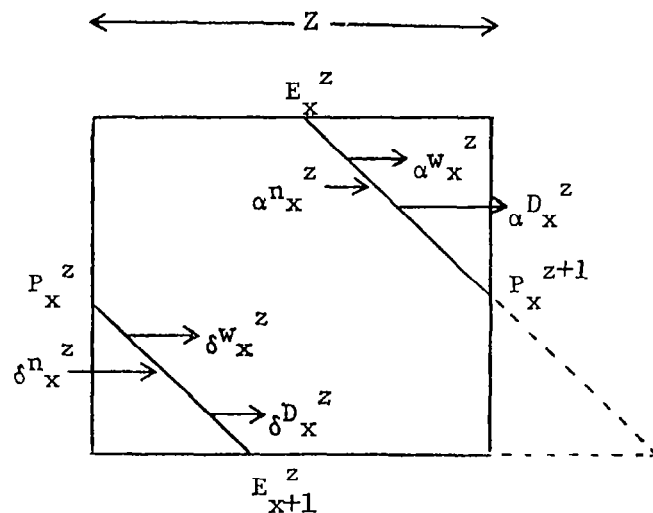
by William L. Roach

Actuarial students usually draw toll road diagrams as a graphical aid for writing exposure formulas. Gershenson explains the use of one-and two-dimensional forms of this device. A third diagram is frequently a useful supplement to those suggested in Gershenson. The steps involved in using this technique are:

- 1) graph the number of people on the toll road as a function of time,
- 2) graphically add back in lines who died so that the graph is consistent with the assumption  $1-tq_{x+t} = (1-t) \cdot q_x$ , and
- 3) compute the desired exposure as the area under the graph.

The technique is illustrated here for Ex. 4.71 from Gershenson.

4.71 (Case 2: Deaths Grouped by Age Last Birthday, Calendar Year Period)



The timing assumptions are

- (1) Births of each calendar year occur a fraction of a year,  $g$ , after the beginning of the year
- (2)  $\alpha_x^n$  and  $\alpha_x^w$  occur a fraction of a year,  $h$ , after attainment of exact age  $x$ . ( $0 \leq h \leq 1 - g$ )
- (3)  $\delta_x^n$  and  $\delta_x^w$  occur a fraction of a year,  $i$ , before attainment of exact age  $x + 1$ . ( $0 \leq i \leq g$ )

continuing five regional indexes for urban areas of different population sizes.

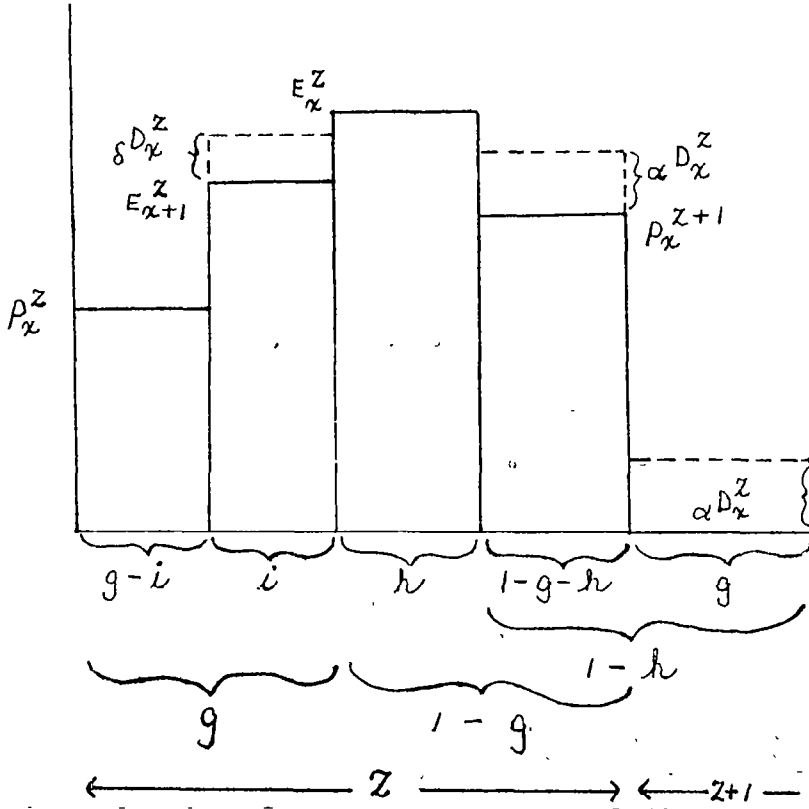
What will the future hold for the CPI? Will a cost-of-living index be attempted? The subjective nature of a cost-of-living index, involving such decisions as quality and substitution buying, would make the composition of such an index difficult to agree upon. On the other hand, making the CPI more meaningful—and current—is an investment which could benefit a changing society. □

### Social Security Notes

Francisco R. Bayo and Howard Shiman, *Mortality of Charter Beneficiaries, 1970-1977*, Actuarial Note No. 92, Social Security Administration, Baltimore, Maryland, November 1977, pp.4.

This Actuarial Note analyzes the mortality experience of Social Security beneficiaries who became entitled to monthly benefits in January 1940 and who continue to be so entitled. Actual survivorship from January 1, 1970 to January

The supplementary diagram is then constructed, using the timing assumptions and the two-dimensional diagram above.



The dotted areas show the effect of adding back in the deaths so that their exposure is consistent with the  ${}_{1-t}q_{x+t} = (1-t) \cdot q_x$  assumptions.

Once the diagram is complete, the exposure can be simply written out as the area under the graph.

$$E_x = (g-i)P_x^Z + iE_{x+1}^Z + hE_x^Z + (1-g-h)P_x^{Z+1} + i\delta D_x^Z + (1-h)\alpha D_x^Z$$

The advantages of this approach over the method of undetermined coefficients are:

- 1) it determines which terms should be included in the exposure formula,
- 2) it does not lose any time writing exposures for types of lines which give redundant information or no information for the determination of the coefficients of the exposure formula, and
- 3) it allows the student to explore the effect of various timing assumptions by simply redrawing the diagram.

**ARCH**

Issue 1977.1

*Matrix Whittaker-Henderson Graduation Formula*, Elias S. W. Shiu

*Use of Amortization Tables to Solve Variable Annuity Problems*, Richard Ziock

*A Comparison of British and American Exposure Formula Theory*, Ralph E. Edwards

*Further Comments on Linear Approximations of Reserves for Fractional Policy Year Durations*, Herbert L. Feay

*Stop-Loss Reinsurance Pools*, Edward W. Frees and James C. Hickman

*Continuous Analysis of the Cash Refund Annuity*, H. H. Panjer

*Variance Reduction Properties of a Split of the Savings and Protection Elements of Life Insurance*, William C. Scheel

*A Review of Social Security Benefits*, Paulette Tino

*Pension Projections and Sylvester's Theorem: A Teaching Note*, James C. Hickman

The new co-editors for ARCH are: Courtland C. Smith, Senior Vice-President & Actuary, Cologne Life Reinsurance Co., Stamford, CT 06904; and Arnold F. Shapiro, Assistant Professor, Pennsylvania State University, 509B Business Admin. Bldg., University Park, PA 16802.

Literary contributions are in much demand for ARCH. If you have a manuscript ready, send a copy to either Courtland or Arnold for inclusion in the next issue.

**Deaths**

Roy R. Benjamin  
A. Charles Howell

1, 1977 is compared with estimates based on 1969-71 United States and 1968-74 Medicare experience. The analysis is given by sex. The group of Charter beneficiaries studied provides a reasonably accurate age data at the higher ages (96 through 103).

Copies of this note may be obtained free of charge from the Office of the Actuary, Social Security Administration, Baltimore, Maryland 21235.

Orlo R. Nichols, *Actual Replacement Rates for Retired Workers*, Actuarial Note No. 93, Social Security Administration, Baltimore, Maryland, October 1977, pp.5.

This note analyzes the replacement rates (the ratio of initial benefits at retirement to pre-retirement earnings) for a sample of nearly nine thousand actual retirement cases under the social security program. Four different measures of pre-retirement earnings are used, each based on varying number, of years' of

earnings which are either unindexed or indexed to wages or CPI.

Tables are presented containing average replacement rates by sex, benefit amount and pre-retirement earnings measure.

Copies of this note may be obtained free of charge from the Office of the Actuary, Social Security Administration, Baltimore, Maryland 21235.