DISCUSSION BY JEFFREY T. LANGE

The standard ratemaking techniques for most lines of insurance incorporate some recognition of the increasing cost of settling claims. It is generally recognized that the current cost level has changed and that the future cost level will be different from that at the time of occurrence of the claims included in the detailed statistical data underlying the calculation of the rates. For most lines the adjustment to compensate for such change is based upon an analysis of insurance data.

In his paper, N. E. Masterson explains that claim payments are made to reimburse the claimant for the procurement of goods and services purchased outside the insurance system. Claim costs are affected by external economic conditions, particularly price and wage levels. Using various well known economic series, Masterson constructs for each line of insurance a series of indices which measure the pressure economic factors exert on claim costs. These indices are helpful in explaining how insurance costs increase in response to price and wage changes in our economy. In addition, they can be of use in making more sophisticated projections of future claim costs.

In 1957, J. E. Faust (*PCAS* XLIV) presented a paper in which he projected automobile claim costs with a formula which related changes in claim costs to the changes in the consumer price index. His method worked fairly well for his purposes at that time, but more recently automobile insurance claim costs have moved upward at a rate which is significantly different from the consumer price index. The indices presented by Masterson provide a means of refining Faust's work by including an economic series more closely related to insurance claim costs than were those available to Faust.

An econometric model may be defined as an equation (or set of equations) which relates an endogenous variable (an economic series) to one or more other endogenous and/or exogenous variables. These other variables may simply be related economic series or may be exogenous variables which in some sense influence the variable of interest and are external to the model. For example, automobile property damage claim costs are influenced by the wage level paid to repairmen, the cost of parts, and the price level for used cars (as a measure of replacement costs). The values of these latter variables are determined outside the insurance system and are independent of it. In addition, wage levels are determined by contracts

spanning several years and price changes are frequently announced in advance. Thus information about these exogenous variables may be available before corresponding claim cost data. Furthermore, since the economic variables are influenced by long term contracts and government policy, they can sometimes be forecast more accurately than can the trends in claim costs, which are the result of the interaction of these economic factors. Hence, more accurate projections of future claim costs might be made by first estimating such independent economic variables and then estimating claim costs from these variables using an econometric model.

Masterson has constructed a series of indices for each insurance line in which appropriate economic indices were weighted to produce an average which represents the economic pressure on claim costs. Historical values of his series and the insurance claim costs can be used to obtain the structural equations of a model into which later values of his series (and values based on projected economic series) could be substituted in order to forecast insurance claim costs. For example, in 1968 insurance data would be available for 1967; however, 1968 wage and price levels would be known. In addition, wage contracts would probably be in effect dictating increases for 1969 and price levels for 1969 could probably be forecasted with some degree of accuracy. In an econometric model, this data about 1968 and 1969 wage and price levels can be used to forecast 1968 and 1969 claim costs. During periods of economic change, the forecasting of claim costs using economic data may be much more accurate than the traditional approach of relying only on past insurance data to forecast costs since the traditional method implicitly assumes a continuation of current rates of wage-price changes. If the rate of wage-price change itself accelerates (as it did in 1965-1966), then traditional approaches will underestimate claim cost trends until the insurance data fully reflects the new level of wage-price increases. Unfortunately, this could be several years after the initial change in the trend. Properly applied, econometric methods can be much more sensitive to such a change in trend rate.

In order to illustrate the possible use of Masterson's series in projecting claim costs, two familiar claim cost series have been selected: automobile bodily injury liability average paid claim costs (limited to $5,000 per claim) and automobile property damage liability average paid claim costs for all companies reporting statistics to the Insurance Rating Board. These series were selected since they are often used to project auto insurance loss costs and appear in auto rate filings in most states. Since these series exclude loss adjustment expense, Masterson's corresponding auto bodily injury and

property damage loss indices were used. (The claim cost indices in Masterson's Exhibit I are the weighted average of his loss index and his loss adjustment index for each line.) Twelve years of annual data — the maximum available for the claim cost series — have been used to derive linear equations in which claim costs are first expressed as a function of time, which corresponds to current projection procedures, and then are also expressed as a function of Masterson's indices. (See Tables.)

For bodily injury coverage, the average difference between the observed claim costs and those computed as a function of time is about two percent while the difference between the observed value and that computed as a function of Masterson's loss index is approximately one percent. The respective average differences for property damage were four percent and two percent. Thus, the use of Masterson's indices gives a better fit (in an intuitive sense) than simply fitting a straight line to the data. Using slightly more sophisticated methods, it was observed that higher indices of determination and tighter confidence limits were obtained for the models incorporating the loss indices than for the line.

In order to use Masterson's indices in making a projection it would be necessary to forecast each of the underlying variables. It would be very desirable to refine the indices to a quarterly, rather than an annual basis. Some attention should be given to the form of the structural equations themselves and to the number of data points to be included. Such refinements would contribute to greater accuracy, but are beyond the scope of a discussion of a paper. The preliminary calculations in the Table do indicate that Masterson's work provides a valuable tool in predicting insurance loss costs and that there is room for additional research in this area.

Masterson constructed the indices by the application of percentage weights to selected economic indices. While this standard way of producing index numbers produces logical results in this case, it is also possible to combine the component economic series in other ways. For example, the claim costs might be directly regressed on the component series, thus empirically determining the weights of the indices. The components of Masterson's auto bodily injury loss index are Office of Business Economics' per capita personal income, and Consumer Price Index hospital charges and physicians' fees. When auto bodily injury claim costs are regressed on these component series, the resulting estimated claim costs are closer to the actual costs than were the estimates discussed in previous paragraphs and the implicit weights developed in the regression equation are different from

Masterson's weights in that he gives much greater relative weight to personal income than is given in the regression procedure. However, the significance of the regression analysis was reduced by the limited number of available data points and by the interrelationship of the variables (multicollinearity). In addition neither the regression analysis nor Masterson's indices consider the possibility that price changes may have a delayed effect on claim costs (lagged variables) or that the time series problem (auto correlation) may distort the results.

Inflation has been one of the factors contributing to the generally unsatisfactory casualty underwriting results in recent years. In his paper Mr. Masterson has given the practicing actuary a valuable tool for measuring the impact of inflation and for forecasting insurance loss costs. For the research actuary, he has opened a profitable area of inquiry which includes many challenging problems. His paper is a statistically significant contribution to the *Proceedings.*

Private Passenger Automobile Liability Insurance
Bodily Injury Average Paid Claim Costs
(Limited $5000 per Claim)

Year Ended December 31	Observed Claim Cost	Claim Cost Computed as a Function of	
		Time	Masterson's Auto B.I. Loss Index
(1)	(2)	(3)	(4)
1956	699	694	707
1957	726	712	722
1958	742	731	732
1959	750	749	747
1960	769	767	760
1961	783	786	774
1962	797	804	792
1963	791	823	808
1964	807	841	826
1965	835	859	851
1966	887	878	886
1967	954	896	936
Index of determination		.88	.97

Column (3): Claim Cost = 675.227 + 18.4266 (Year − 1955)
Column (4): Claim Cost = 385.832 + .347686 (Masterson's Loss Index)

Property Damage Liability Average Paid Claim Costs

Year Ended December 31	Observed Claim Cost	Claim Cost Computed as a Function of	
		Time	Masterson's Auto P.D. Loss Index
(1)	(2)	(3)	(4)
1956	113	109	115
1957	124	117	122
1958	129	124	123
1959	134	132	132
1960	138	139	137
1961	140	147	140
1962	146	155	149
1963	152	162	158
1964	161	170	166
1965	175	177	178
1966	192	185	190
1967	208	193	202
Index of determination		.92	.98

Column (3): Claim Cost = 101.864 + 7.55944 (Year − 1955)

Column (4): Claim Cost = −35.9218 + .161639 (Masterson's Loss Index)