Performance Testing Aggregate and Structural Reserving Methods: A Simulation Approach

John W. Rollins, ACAS, MAAA

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A Structural Model of the Claims Process

- Predicted ***Ultimate Claim Costs*** are a function of many variables (structural or explanatory approach)
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- ***Variables*** are partially controllable by management but also depend on external parameters of process
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- ***Parameters*** affecting process cannot always be quantified, so we substitute a statistical distribution for each variable
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- If we have specified the right function, variables and parameters, predicted costs should quickly approach true costs

Canonical Models and Reserving Methods

- Ultimate costs are a function of only ***past costs*** and ***time*** (aggregate or time-series approach)
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- ***Judgment*** about variables and parameters affecting process is "buried" in selection of link ratios and expected losses
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- Observed past costs are affected by shifting parameters over time, but no accurate adjustment is possible

Why Use a Structural Simulation?

- Reduce reliance on consistency and validity of historical aggregate cost data
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- Build models which directly incorporate judgments about the parameters of the client's operation, and allow sensitivity testing of results
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- Easier to compare performance of reserving methods over time, and thus tailor methods to individual client situation
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- Now feasible with today's personal computer applications

Variables Used in Simulation Experiment

Variable	***Distribution***
Exposure Growth Rate	*Normal*
Claim Frequency	*Normal*
Report Lag	*Gamma*
Settlement Lag	*Gamma*
Claim Severity	*Gamma*
Cost Inflation Rate	*Constant*

Algorithm for Simulating Aggregate Data

- User supplies size of matrices (number of accident periods and evaluation intervals) and parameters for each random variable
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- For each period, randomly draw percent exposure growth and claim frequency
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- Number of claims in period = (Exposure) x (Frequency)
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- For each claim, randomly draw accident date, report lag, settlement lag, and (real) severity

Algorithm for Simulating Aggregate Data

- Figure out when claim is reported and settled from accident date, report lag, and settlement lag values
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- Figure out amount of (nominal) ultimate loss and when it is paid from the report lag, settlement lag, and severity values, and the inflation rate assumption.
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- Assign reported counts, closed counts, and paid losses to appropriate cells in matrices. End result is “data triangles”.

An Experiment Using Structural Simulation

- ***Create*** a particular ***scenario*** (size of matrices, choice of distributions and parameter values)
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- ***Generate*** claim database and actuarial triangles using the simulation algorithm and the chosen scenario
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- ***Project*** ultimate losses using competing reserving methods:
  - Aggregate (Paid Chain Ladder)
  - Structural (Closed Claim Cost)
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- ***Test*** prediction error of each method over five calendar years

Aggregate (Paid Chain Ladder) Method

- "Generic" paid loss development approach: losses valued at end of calendar year for each accident period are projected to ultimate using age-to-ultimate development factors
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- Selected age-to-age factor (link ratio) in each interval is weighted average over all prior periods
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- To avoid biases caused by judgment in selection of tail factors, experiment uses "ultimate" losses valued at 120 months instead of true ultimate (tail factor is unity)

Structural (Closed Claim Cost) Method

- Uses data on report lags, settlement lags, historical ultimate severity, and cost inflation as well as aggregate paid loss data to project ultimate losses.
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- Projects open claim counts and severity of unpaid claims separately, then combines projections to determine ***unpaid*** (rather than ultimate) losses.
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- To facilitate a fair performance comparison without potential biases in tail factor selection, also projects unpaid losses at age 120 rather than true ultimate.
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Algorithm for Applying Structural Method

- Step 1: Use the cumulative reported claim count triangle to ***project ultimate counts*** with a chain ladder approach.
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- Step 2: Use the incremental closed claim count triangle and the projected ultimate counts for each period from Step 1 to derive "percent of claims closed" triangle. ***Select an appropriate closure pattern*** based on this history.
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- Step 3: Determine the projected unpaid counts for each period by subtracting number closed at evaluation date from projected ultimate. ***Allocate unpaid counts*** to future intervals based on selected closure pattern.

Algorithm for Applying Structural Method

- Step 4: Use the paid loss triangle and closed counts triangle to determine the historical closed severity in each interval. ***Select a historical average severity*** in each interval.
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- Step 5: Use cost inflation assumptions to select a severity trend in each interval. ***Allocate selected trended severities to future closure intervals.***
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- Step 6: Multiply number of future closed claims in each cell by future trended severity in each cell to ***determine projected unpaid losses in each cell***. Sum of cells is indicated reserve.

Experiment - Parameters of Base Scenario

- Stable company in a moderately inflationary environment (zero average real exposure growth and 5% inflation rate) experiencing an average of 3,250 claims per accident year
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- Premises/Operations line of business, where all payments are lump-sum at date of settlement and severities are moderate (average $20,000 with CV=1)
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- Accidents occur evenly throughout each year, report lags average 12 months with CV=1 and settlement lags average 24 months with CV=1

Experiment - Data Structure and Testing

- Ten trials were run, each simulating a matrix of accident years 1-10 valued annually through 120 months (total of about 325,000 claims)
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- Ultimate and unpaid losses were estimated at end of calendar years 10-14 by both methods
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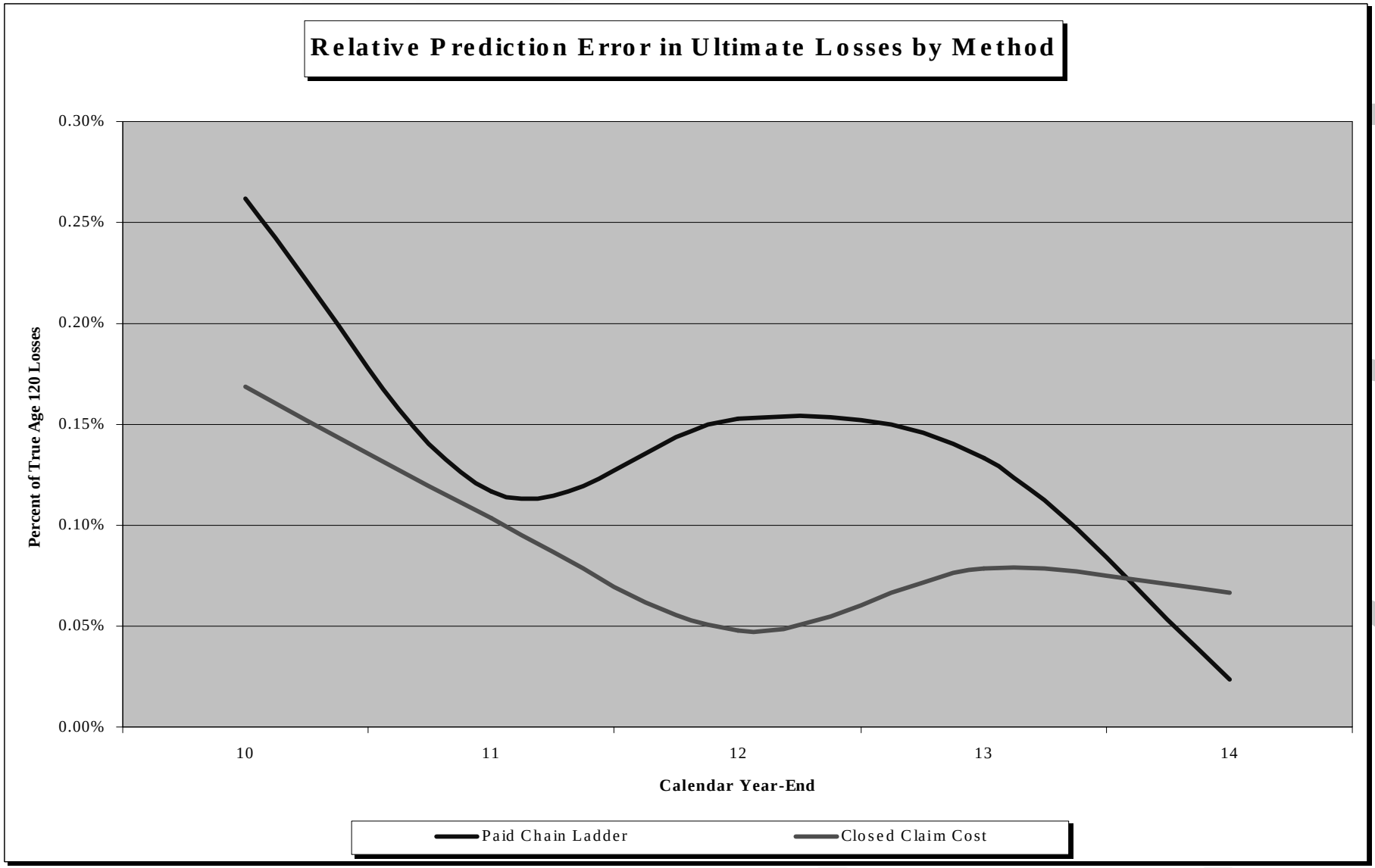
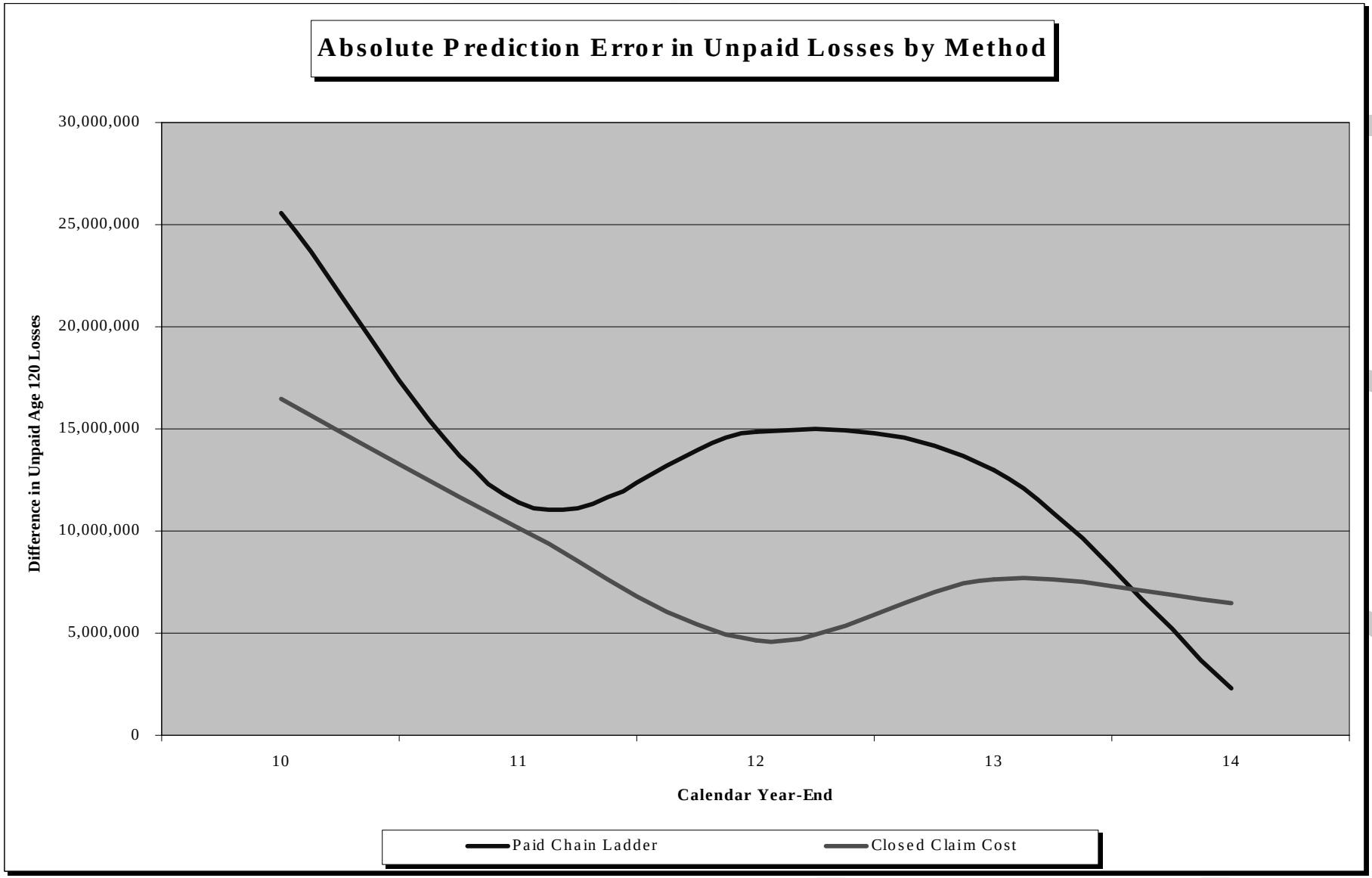
- Absolute, relative and squared error in prediction of both ultimate losses (at 120 months) and unpaid losses at each evaluation date were tabulated

Error Function over Time - Ultimate Losses



Error Function over Time - Unpaid Losses



Key Results and Observations

- Both methods approach actual losses over time, but may be initially biased upward (convergence occurs from above)
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- Closed Claim Cost (structural) method performs better at initial projections, where leverage is highest.
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- Paid Chain Ladder (aggregate) method starts out worse but “catches up” over ensuing calendar years
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- Convergence of neither method is monotonic - initial estimates can get worse before they get better!

Other Applications of Structural Simulation

- Infinite number of testable structures and scenarios
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- ***Operations Management***: estimate potential cost savings due to improvements in reporting or settlement patterns
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- ***Economic Forecasting***: effect of various inflationary assumptions on ultimate claim costs and present value thereof
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- ***Loss Distribution Studies***: impact of changing mix of business among low risk and high risk (highly skewed) lines