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Evidence from Large Indemnity and Medical Triangles

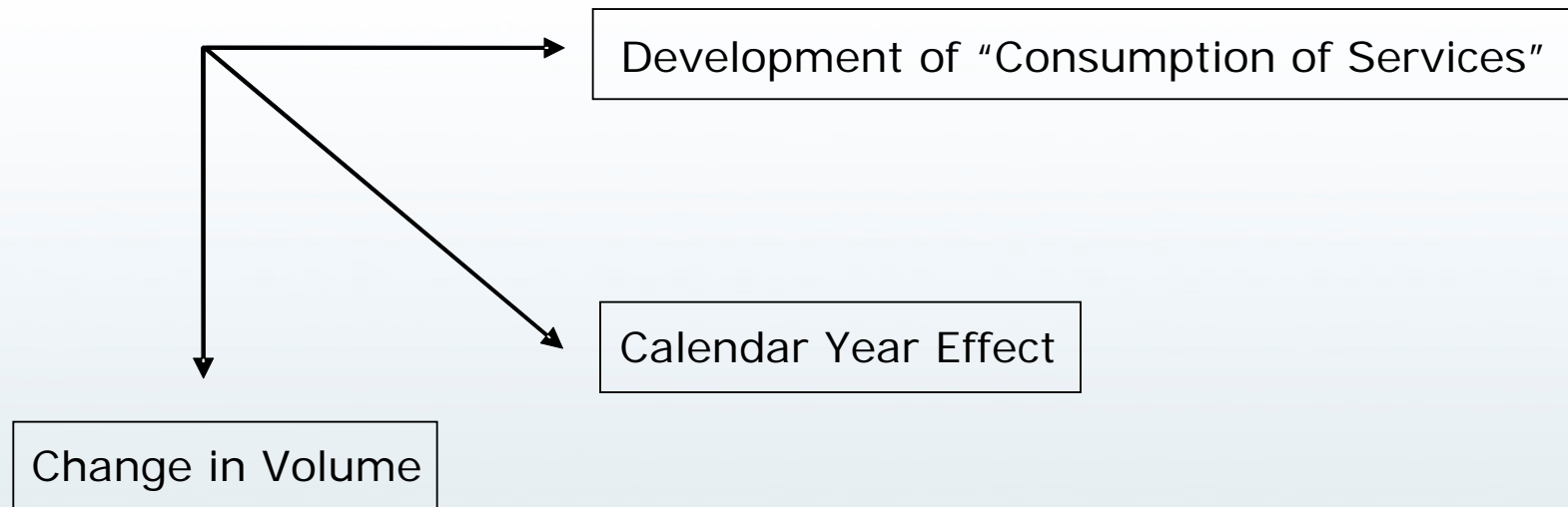
CAMAR
December 10, 2009
Philadelphia, PA

Prepared by Frank Schmid, Director and Senior Economist
Presented by John Robertson, Director and Senior Actuary
National Council on Compensation Insurance, Inc.

Large Indemnity and Medical Triangles

- Studying the payment pattern of workers compensation claims until closure requires triangles that comprise many decades of accident years—only very few such triangles are available for research purposes
- We present findings for a set of large indemnity and medical triangles
 - The SCF (State Compensation Fund) Arizona indemnity triangle comprises 74 years of development; the accident years range from 1930 through 2003. Due to a dearth of data for accident years 1930-1937, these eight years are excluded from the analysis, thus reducing the triangle to 66 development years
 - The SAIF Corporation (State Accident Insurance Fund Corporation, Oregon) triangle comprises the medical component of permanent disability claims; the accident years run from 1926 through 2005. Due to the sparseness of the data, the first nine accident years (1926-1934) are discarded, thus reducing the triangle to 71 development years

Triangle Dynamics

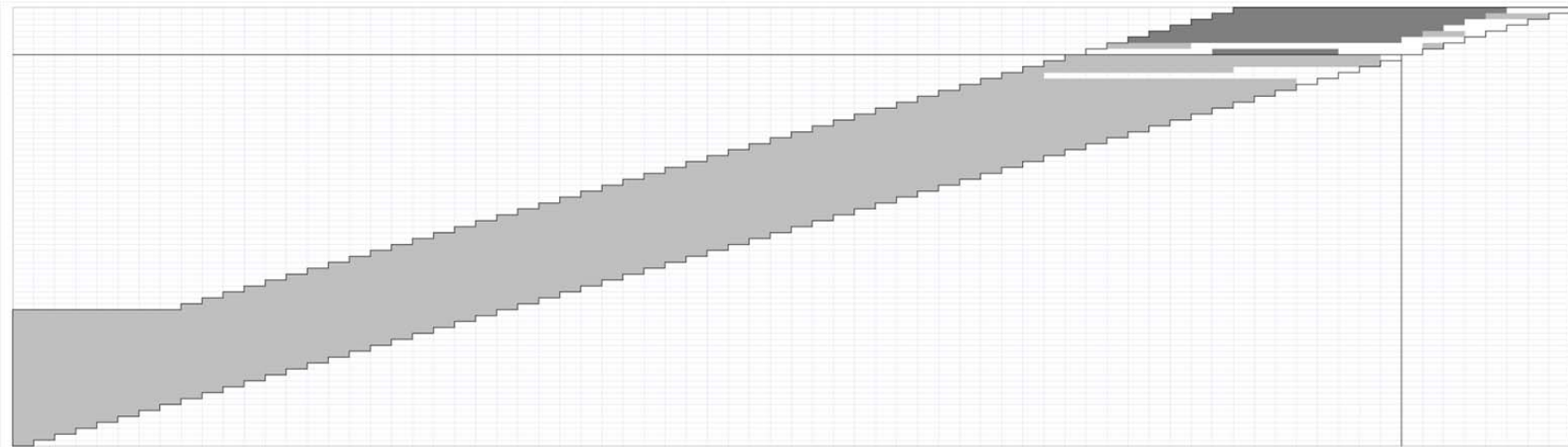


For this architecture of triangle analysis, see Glen Barnett and Ben Zehnwirth, "Best Estimates for Reserves," Casualty Actuarial Society Proceedings Vol. 37, No. 167, pp. 245-321, 2000, <http://www.casact.org/pubs/proceed/proceed00/00245.pdf>

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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The SCF Arizona Indemnity Triangle



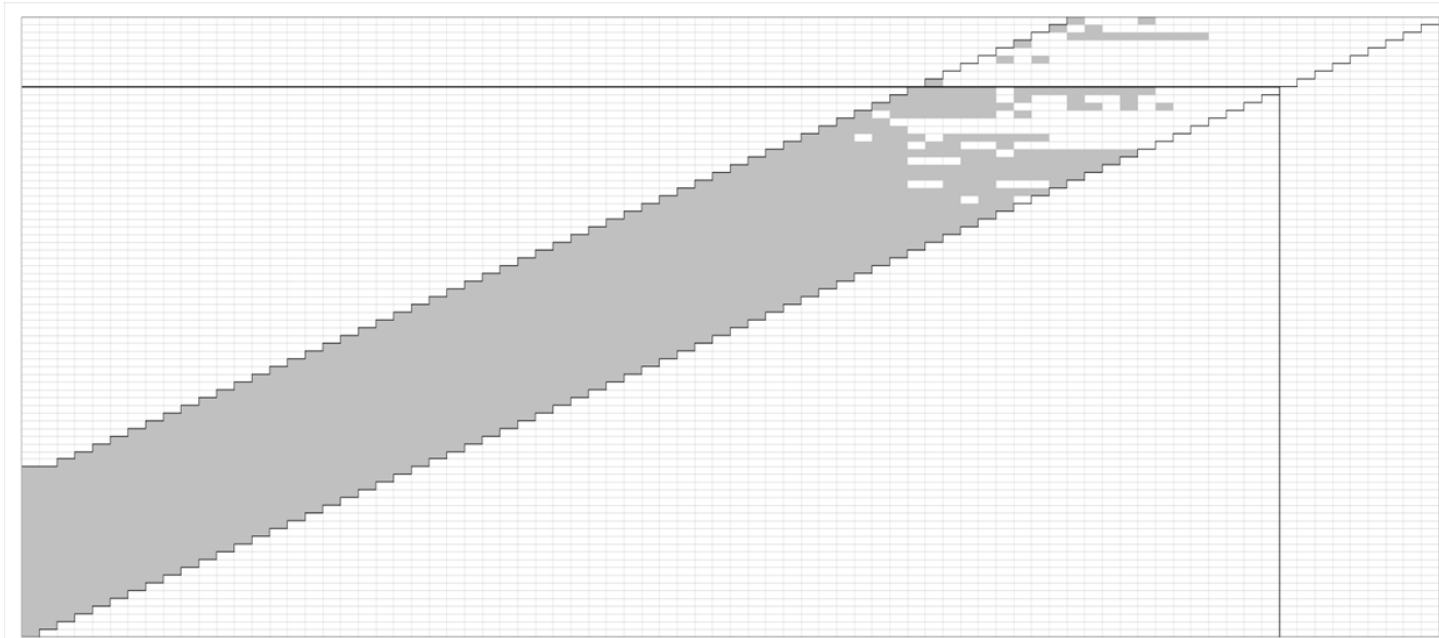
Positive incremental payments are shaded light gray, and incremental payments at zero amounts are left white; there are no negative incremental payments. For the cells shaded dark gray, no payment information is available. In the analysis, only the triangle within the rectangular box (accident years 1938-2003; 66 development years) is used.

Data source: Arizona State Compensation Fund

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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The SAI F Corporation PTD Medical Triangle



Incremental payments (of which some are negative) are shaded gray, and incremental payments at zero amounts are left white. In the analysis, only the triangle within the rectangular box (accident years 1935-2005; 71 development years) is used.

Data source: State Accident Insurance Fund Corporation, Oregon

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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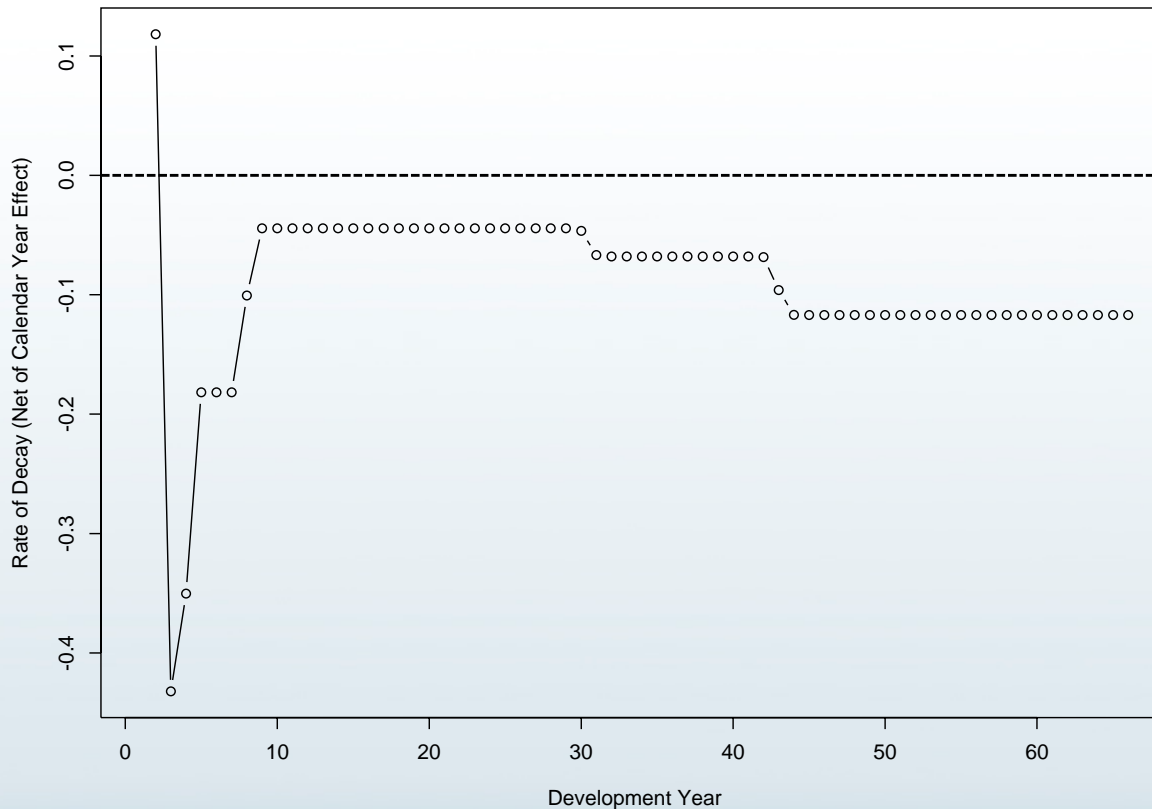
Main Features of the Statistical Model (1/2)

- The model is Bayesian and estimated using MCMC (Markov Chain Monte Carlo simulation)
- The model fits to the logarithmic incremental payments
- The model uses Reversible Jump MCMC for determining the optimal degree of smoothing of the path of the consumption of services (as measured by the exposure adjusted and calendar year effect adjusted logarithmic incremental payments)
 - Reversible Jump MCMC is a concept of Bayesian model averaging; this way, the estimation process accounts for model uncertainty
- The likelihood is a Student t distribution, which is implemented as a scale mixture of normal distributions. (The normalcy satisfies the conjugacy requirements of the Reversible Jump algorithm.)
 - The degrees of freedom of the Student t distribution are determined within the model. The lower the degrees of freedom are, the heavier the tails of the distribution are. By allowing for heavy tails, the model is robust to outliers

Main Features of the Statistical Model (2/2)

- Using a second-order random walk, the scale parameter of the Student t distribution is allowed to vary in development time (i.e., is allowed to vary by column)
- A Bernoulli distribution (the parameter of which varies on a Gompertz curve in development time) accounts for the variation in the probability of observing a payment in a given column
- Due to reforms in Oregon in mid-1990, the model allows for a structural break in the consumption path of medical services. (The interval 1990-1991 is chosen for the range of locations of the changepoint.)
- The calendar year effect is modeled as a normal distribution around an expert prior for the ratio of inflation (which is zero for indemnity, since there is no cost of living adjustment in Arizona, and equals the M-CPI rate of inflation for medical)
- For the medical triangle, future rates of inflation are simulated using an Ornstein-Uhlenbeck process that has been calibrated to annual data of the M-CPI rate of inflation—in an Ornstein-Uhlenbeck process, the rate of inflation reverts to its historical mean at the rate embodied in the history of available data

Development of Indemnity Consumption

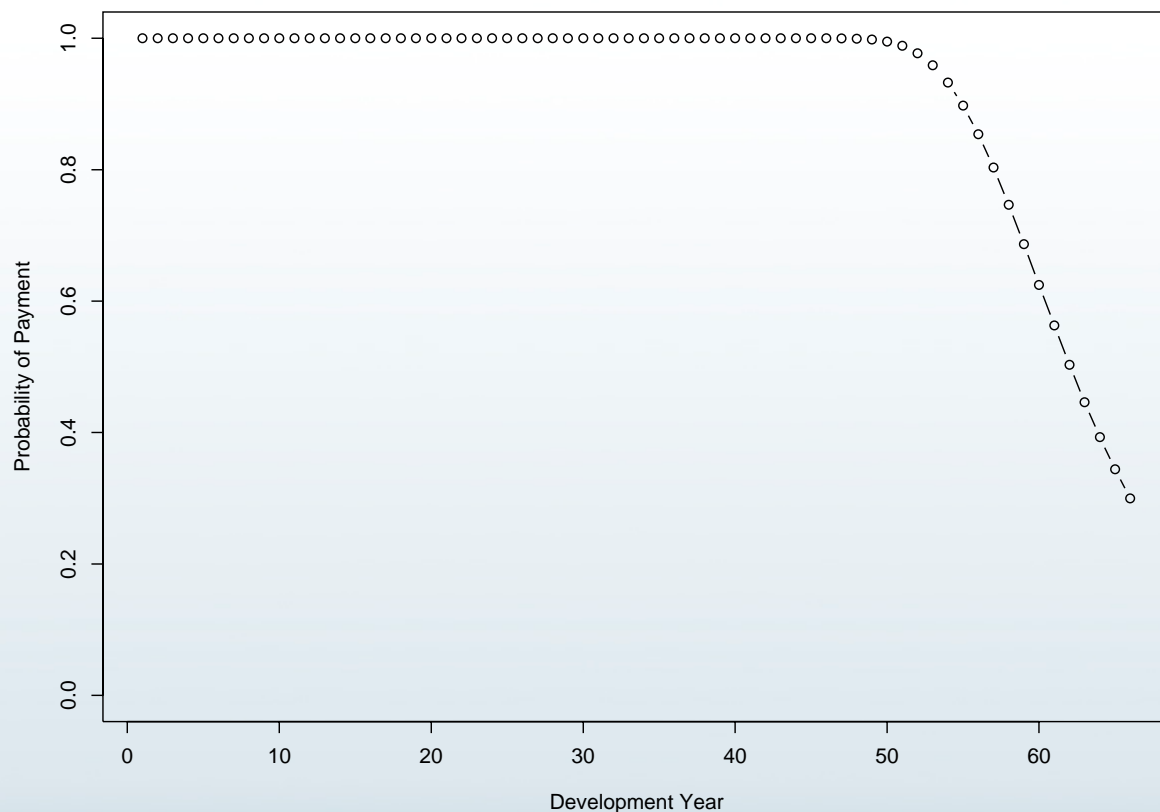


- The chart displays the rate of change in the consumption (per development year) of indemnity benefits
- Consumption is defined as indemnity payments, adjusted for calendar year effects
- (Generally, the calendar year effect includes cost of living adjustments; here, no cost of living adjustments apply)
- The decline of consumption quickens, following the rate of mortality of the cohort of injured claimants

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Probability of Observing an Indemnity Payment

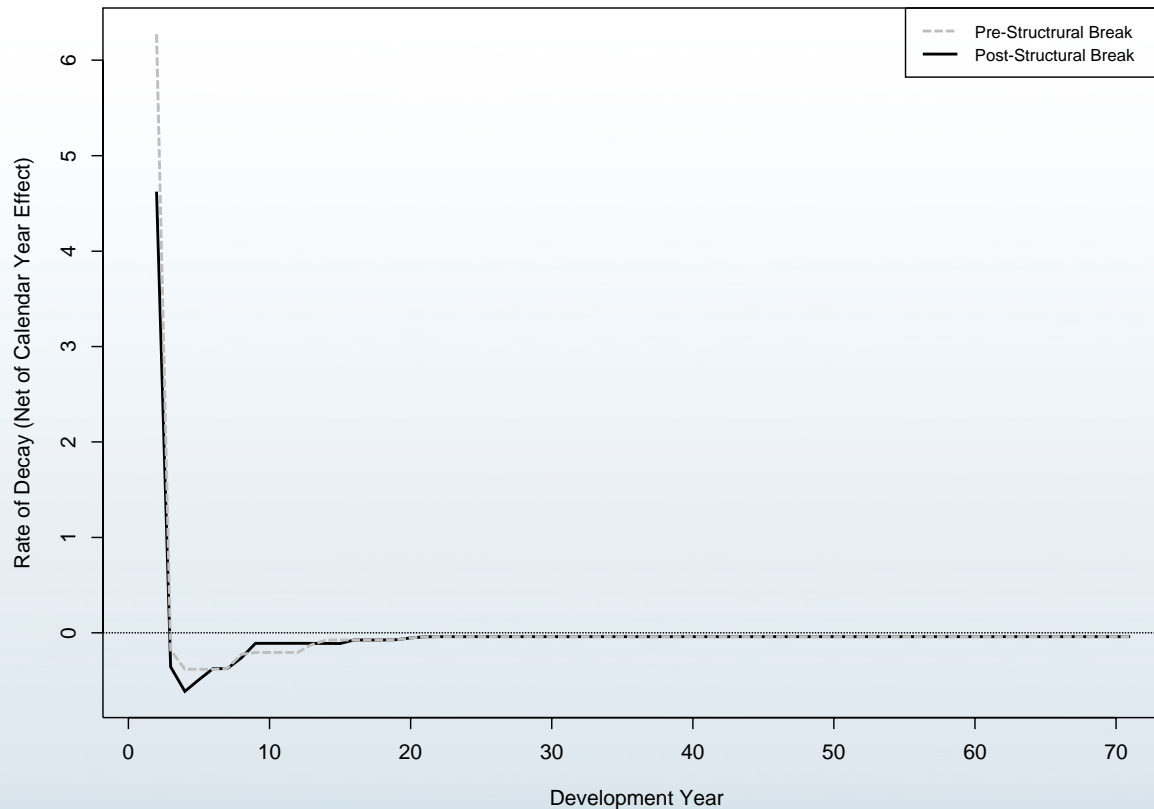


- The chart displays the probability of observing a nonzero incremental payment
- The trajectory of this probability is estimated using a Gompertz curve
- The trajectory is treated as uniform across accident years (although increased exposure may increase the probability of observing a payment, all else equal)
- Assuming that longevity improves with exposure years, the trajectory has to be shifted to the right when simulating ultimate losses

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Development of Medical Consumption (1/2)

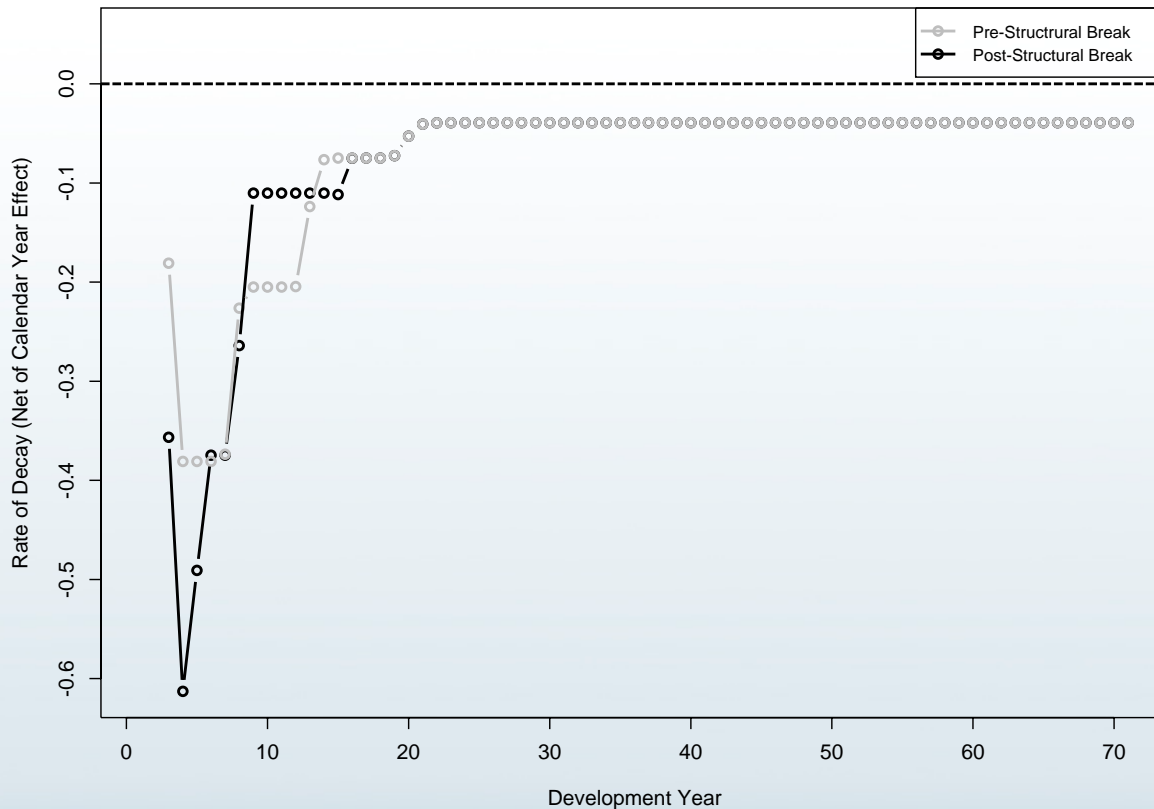


- The chart displays the rate of change in the consumption (per development year) of medical benefits
- Consumption (per development year) is defined as incremental medical payments adjusted for calendar year effects (which include inflation)
- There is a structural break in consumption, which is related to cost containment reforms in Oregon in 1990

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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Development of Medical Consumption (2/2)

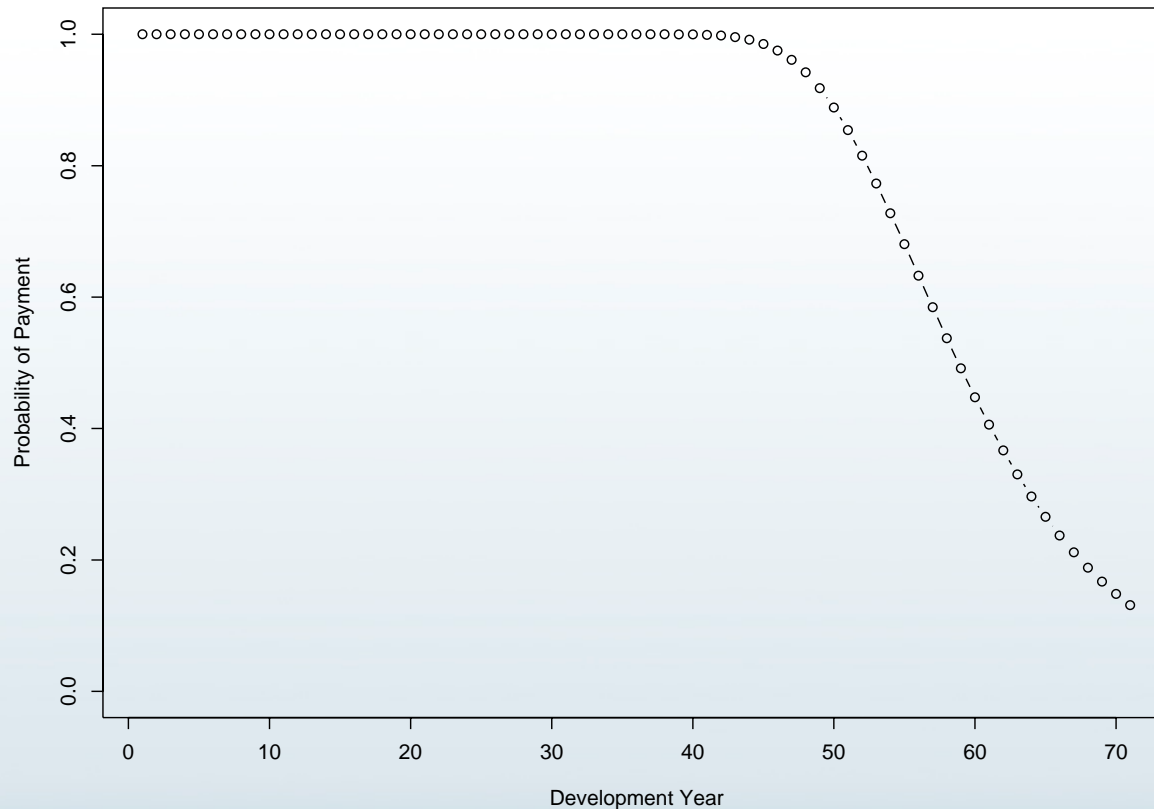


- The chart details the rate of change in the consumption of medical benefits by starting with the 24 month to 36 month development factor
- The rate of decline of consumption stabilizes around development year 20, which implies that from then on, increases in mortality are offset by increases in consumption of medical services on the part of the survivors
- The cost containment reform of 1990 has led to an accelerated run-off during the first couple of development years

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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Probability of Observing a Medical Payment



- The chart displays the probability of observing a nonzero incremental payment
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- The trajectory is treated as uniform across accident years (although increased exposure may increase the probability of observing a payment, all else equal)
- Assuming that longevity improves with exposure years, the trajectory has to be shifted to the right when simulating ultimate losses

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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Simulating Medical Losses

- The rate of decay in the consumption of medical services assumes a stationary (negative) value after about 20 development years
 - This implies that as the cohort of claimants of a given exposure year ages, increases in mortality are offset by increases in consumption of medical services on the part of the survivors
 - Further, a stationary rate of decay of medical consumption allows for straightforward simulation of ultimate losses
 - Future rates of medical inflation may be simulated using an Ornstein-Uhlenbeck process that has been calibrated to the rate of M-CPI inflation
 - Note that any systematic difference between the (logarithmic) rate of M-CPI inflation and the actual and unobservable (logarithmic) rate of inflation for medical workers compensation services factors into the (logarithmic) rate of decay of consumption of medical services
 - Legislative reforms, such as the 1990 cost containment reforms in Oregon, may accelerate the decay in the consumption of medical services

Discussion (1/2)

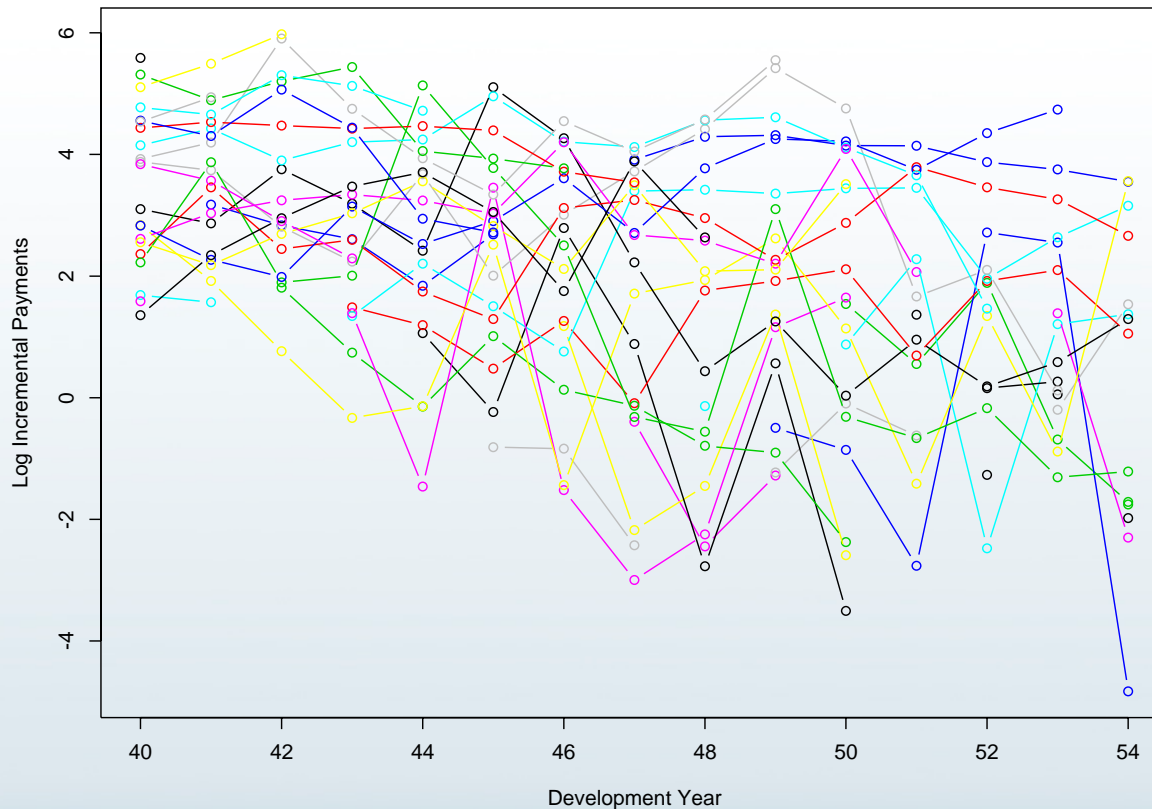
- The finding of a stationary rate of decay of medical consumption (after about 20 development years) differs from earlier findings by Sherman and Diss (*), who discover a bulge in incremental payments between development years 40 and 52, approximately
 - Note that Sherman and Diss analyzed the same triangle, except that their accident years run through 2002 (instead of 2005), and they do not discard accident years 1926-1934 (which comprise a total of 16 payments)
- Sherman and Diss (*) posit that such bulge in payments is due to “added costs of caring for the elderly”
 - An alternative explanation for the bulge in payments is a spike in volume caused by accident year 1945 and, to a lesser degree, accident year 1946—these payments start in development years 41 (accident year 1945) and 40
 - For instance, the volume of payments (summed up within the window of observed development years) in 1945 (1946) is 17.4 (6.5) times as high as in 1944, and 11.4 (4.2) times as high as in 1947

(*) Sherman, Richard E., and Gordon F. Diss, “Estimating the Workers’ Compensation Tail,” 2006, <http://www.richardsherman.com/img/PCASPaperFinal.pdf>

Source: Schmid, Frank A. (2009) “The Workers Compensation Tail Revisited,” first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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Discussion (2/2)



- The chart displays the observed logarithmic payments for the bracket of development years for which Sherman and Diss (*), pp. 8-9, postulate a bulge in incremental payments—the chart shows the raw data for all accident years, devoid of any statistical modeling
- Clearly, there is no indication of a bulge in incremental payments
- (Note that lower lines tend to be lines that start farther to the right because they are associated with earlier accident years; these lines tend to be lower because volume was lower in earlier accident years)

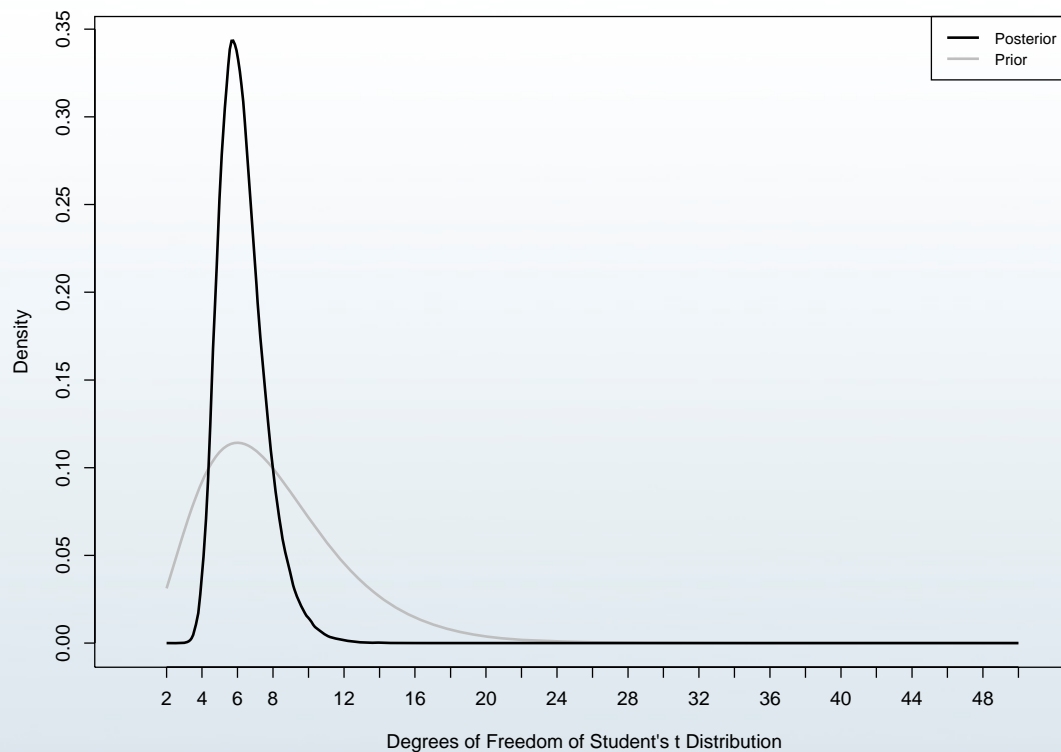
(*) Sherman, Richard E., and Gordon F. Diss, "Estimating the Workers' Compensation Tail," 2006, <http://www.richardsherman.com/img/PCASPaperFinal.pdf>

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Appendix

Degrees of Freedom of Student's t : Indemnity



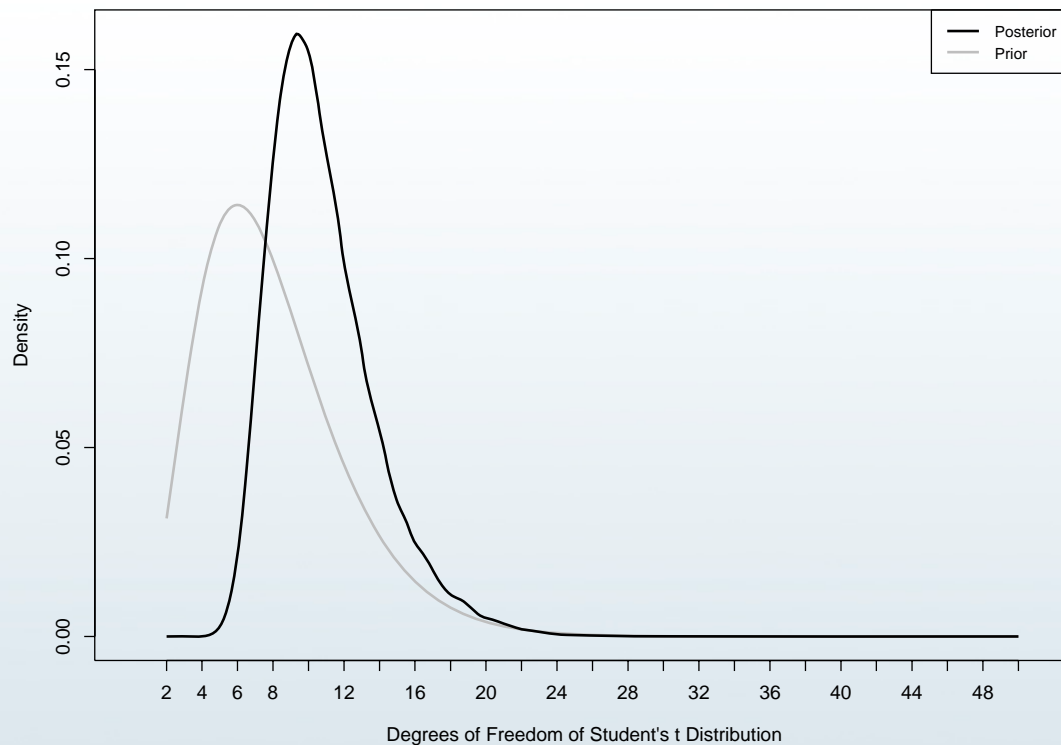
- The chart displays the prior distribution and a kernel density estimate of the posterior distribution of the degrees of freedom
- The estimated degrees of freedom indicate that incremental indemnity payments have heavy tails

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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Appendix

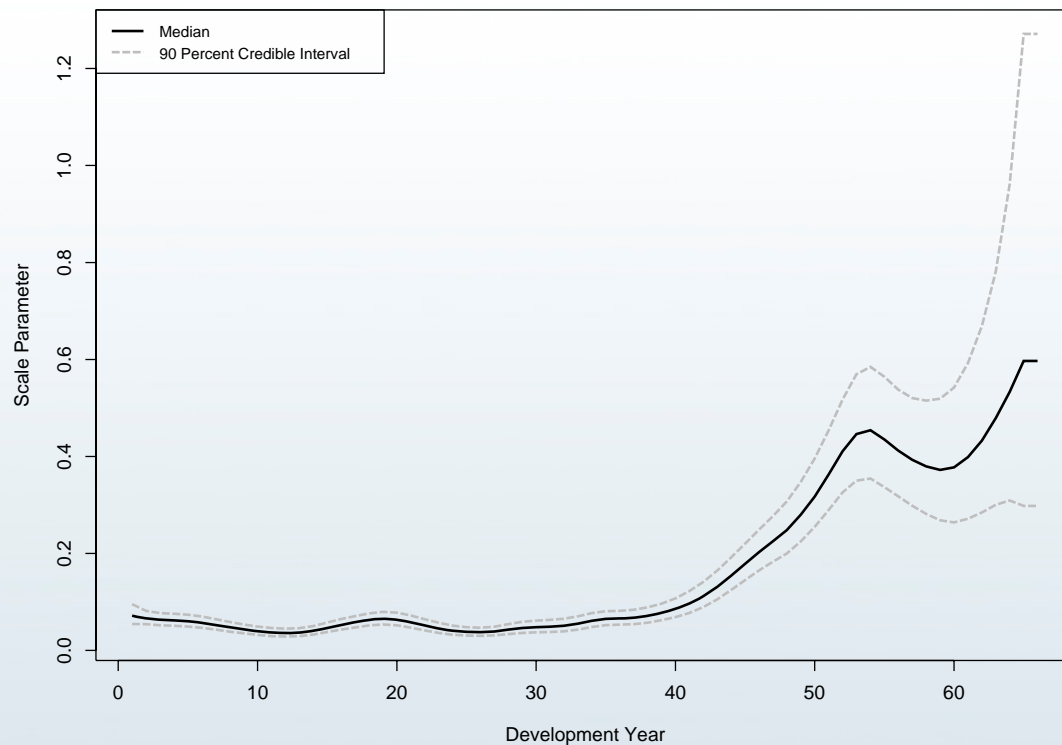
Degrees of Freedom of Student's t : Medical



- The chart displays the prior distribution and a kernel density estimate of the posterior distribution of the degrees of freedom
- The estimated degrees of freedom indicate that incremental medical payments have heavy tails

Appendix

Scale Parameter of Student's t : Indemnity



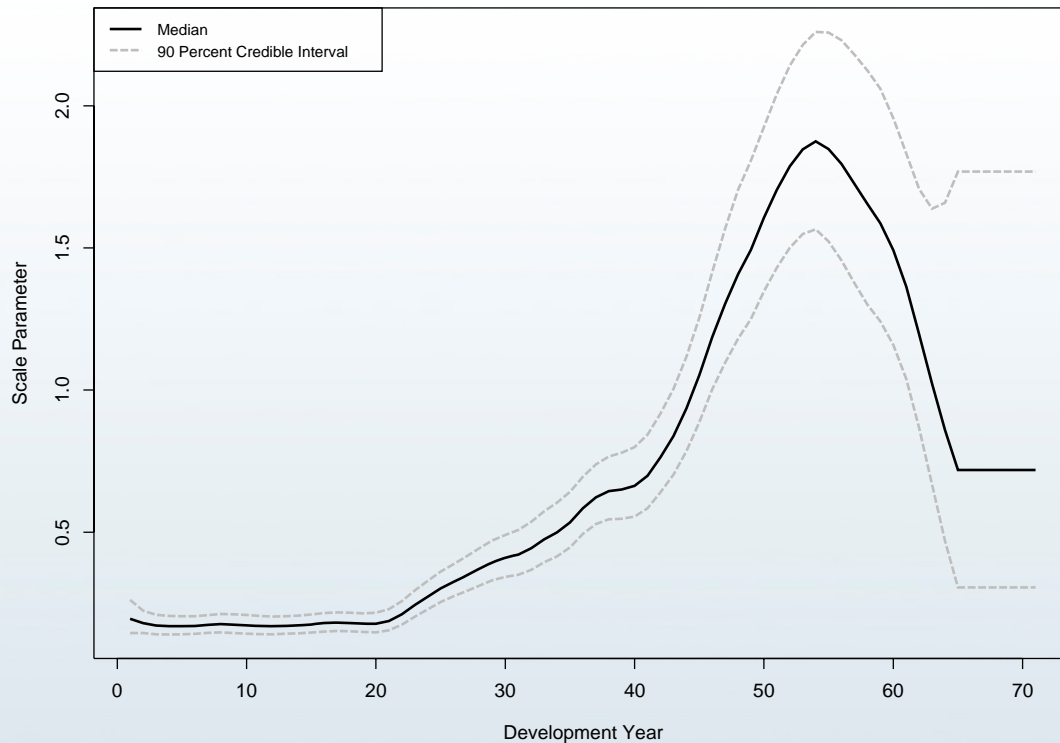
- The chart displays the scale parameter of the Student t distribution
- The (log of the square of the) scale parameter was smoothed using a second-order random walk with an inverse gamma(5,0.5) prior for the innovation variance
- The dashed lines indicate 90 percent credible intervals—these intervals are reflective of the degree of smoothing

Source: Schmid, Frank A. (2009) "The Workers Compensation Tail Revisited," first draft: January 8, 2009; last revised: September 25, 2009, <https://www.ncci.com/documents/CASJournal-Schmid.pdf>

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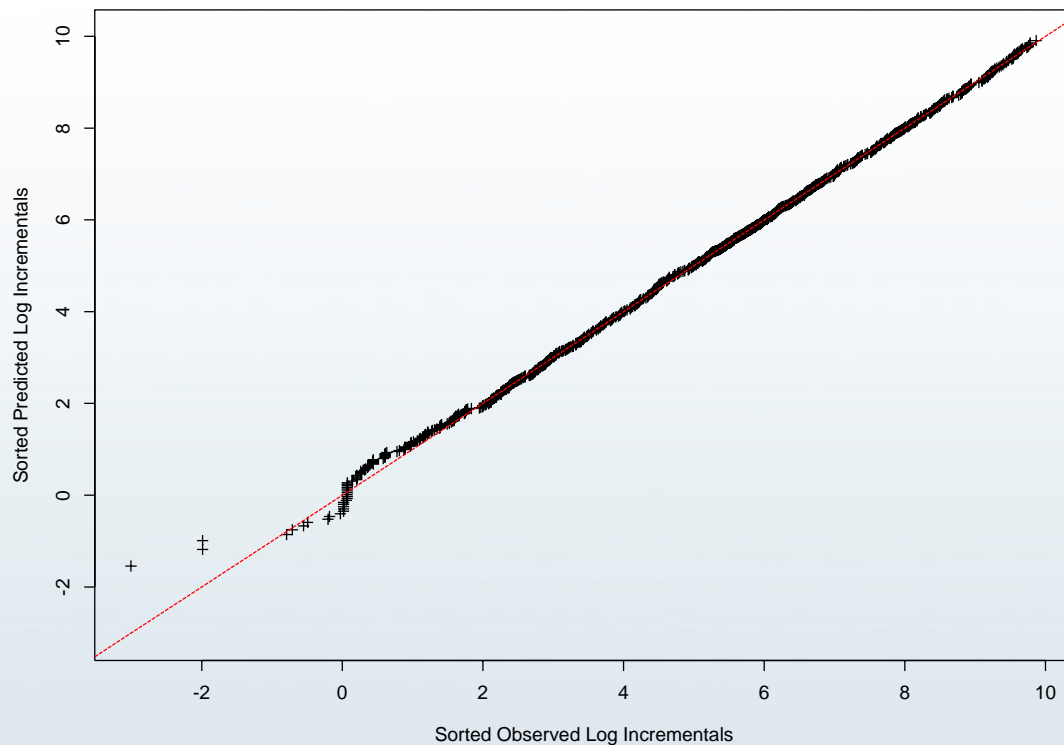
Scale Parameter of Student's t : Medical



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Appendix

Generic QQ Plot



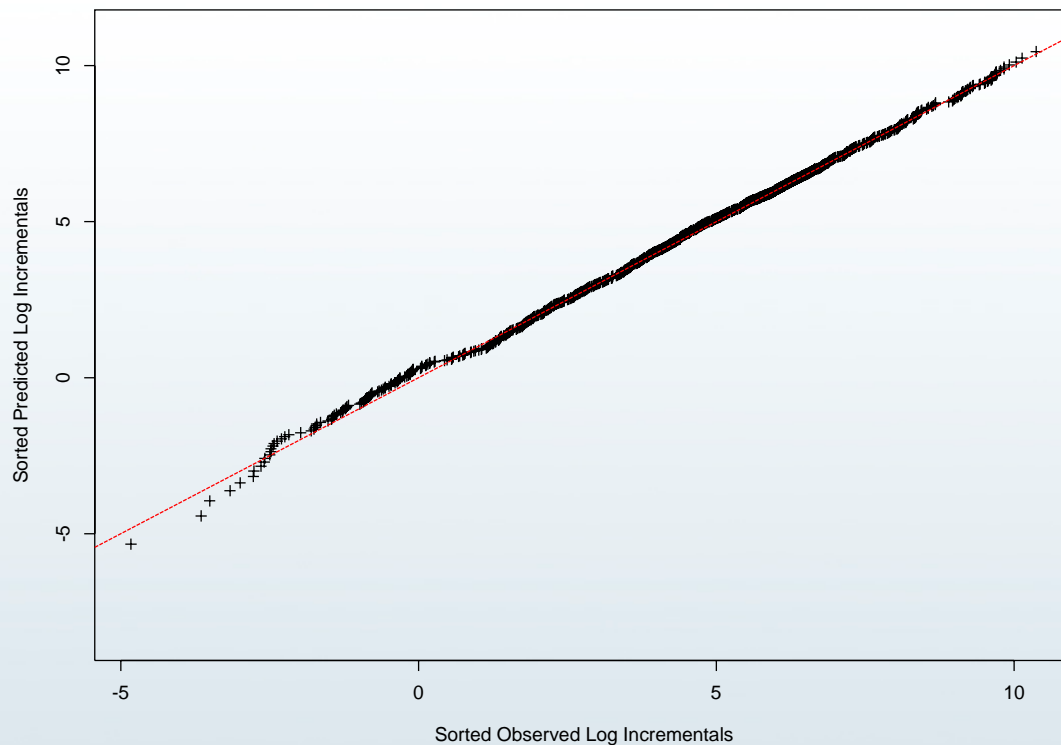
- The chart plots the observed logarithmic payments against the estimated quantiles of the predicted logarithmic incremental payments; this is to gauge the ability of the model to replicate the empirical distribution
- At each draw from the posterior, the predicted values were sorted; the chart displays the medians of these sorted values (or, equivalently, estimates of quantiles), which were plotted against the sorted observed values
- The chart indicates that the heavy tails and the skewness of the empirical distributions have been well replicated

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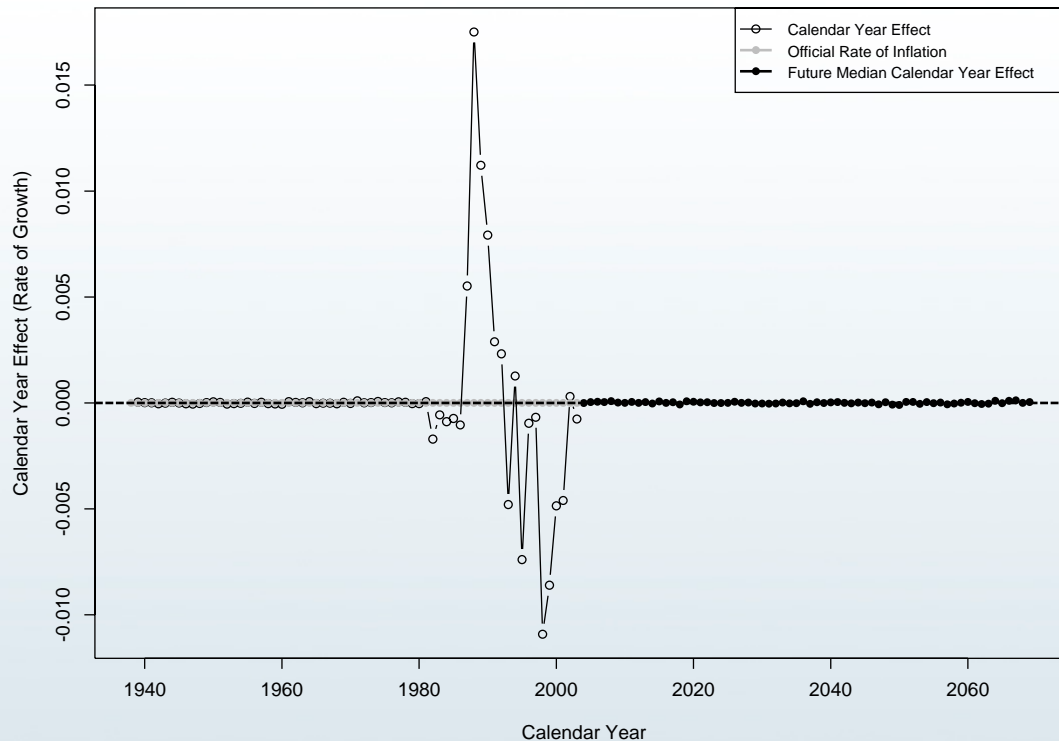
- The chart plots the observed logarithmic payments against the estimated quantiles of the predicated logarithmic incremental payments; this is to gauge the ability of the model to replicate the empirical distribution
- At each draw from the posterior, the predicted values were sorted; the chart displays the medians of these sorted values (or, equivalently, estimates of quantiles), which were plotted against the sorted observed values
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Appendix

Calendar Year Effect: Indemnity



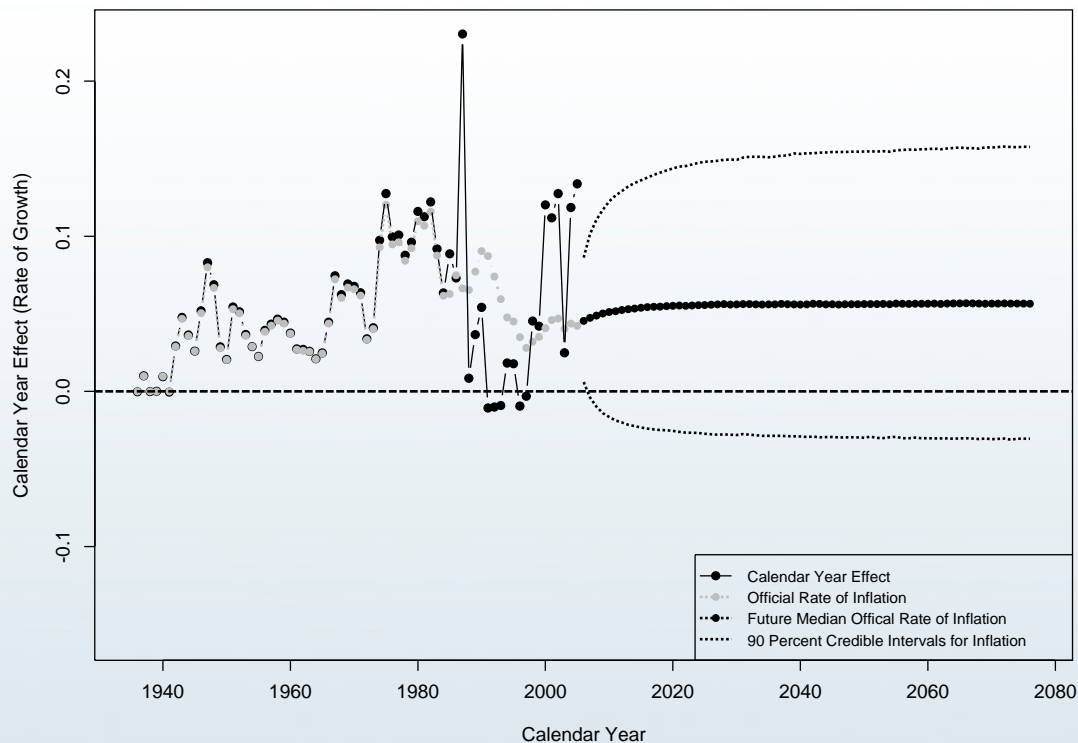
- The chart displays the calendar year effect
- Arizona has no cost of living adjustment for indemnity claims
- The first 43 diagonals of the SCF Arizona triangle are not populated (and another 7 diagonals are populated only in the first couple of development years)—thus, in the early calendar years, the means of the posteriors for the calendar year effects equal the expert priors (net of sampling errors)

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Appendix

Calendar Year Effect: Medical



- The chart displays the calendar year effect, inclusive of the simulated future rates of inflation
- The first 49 diagonals of the SAIF Corporation triangle are not populated (and the first populated diagonal has only one incremental payment)—thus, in the early calendar years, the means of the posteriors for the calendar year effect equal the expert priors (net of sampling errors)

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