Analyzing Workers Compensation Reform Impacts on Loss Development Patterns in NCCI Rate-Making

Frank A. Schmid

Director and Senior Economist

CAS Spring Meeting
June 19, 2007
Orlando, FL

Outline

- Loss Development as a Time Series Problem
- A Bayesian State-Space Model of Loss Development
- Analysis of the Impact of Regulatory Reform on the Run-Off
- Conclusion

Loss Development as a Time Series Problem

- Loss development can be modeled as a time series problem
- Once loss development is cast into a time series framework, the statistical technique of state-space modeling can be applied
- State-space models are flexible (by allowing for time-variation of parameters) and accommodating (to regulatory details)

Loss Development as a Time Series Problem

- There are three dimensions of time in a loss triangle

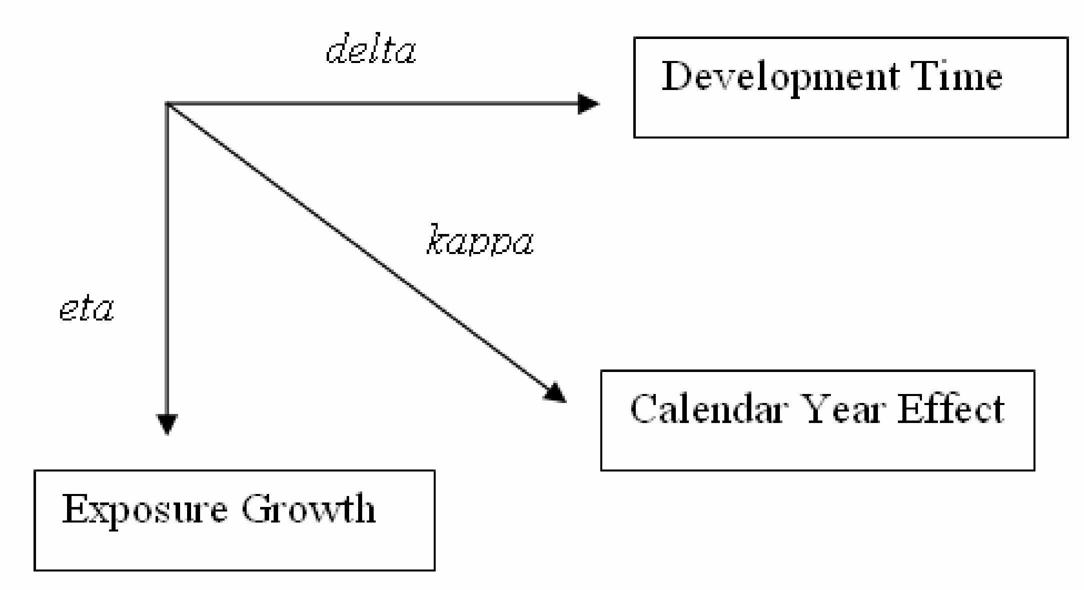
  ✓ Exposure (policy or accident) year time (exposure growth)

  ✓ Calendar time (calendar year effect)

  ✓ Development time (run-off)

Loss Development as a Time Series Problem

- The model is written in terms of (logarithmic) growth rates of incremental payments—these growth rates are allowed to be time-varying



A Bayesian State Space Model of Loss Development

- The model is Bayesian
  - A (posterior) parameter estimate is the result of a prior that is taken to the data
    - All prior distributions are conjugate, that is, they are from the same family as the posterior distribution
    - Expert priors are used for the calendar year effect—to be discussed below

A Bayesian State Space Model of Loss Development

- The model is estimated using the Metropolis-Hastings algorithm
  - The technique is also known as MCMC (Markov-chain Monte-Carlo simulation)
  - We use WinBUGS 1.4 and OpenBUGS 2.2.0 (the latter within the R package BRUGS)
    - Currently, we stay clear of OpenBUGS 3.0

A Bayesian State Space Model of Loss Development

- The model fits to the logarithm of incremental payments
  - Negative incremental payments are coded as missing values
  - In Bayesian models, missing values are treated as parameters that need to be estimated

A Bayesian State Space Model of Loss Development

- There is a stochastic add-up constraint in the model
  - This constraint ensures that for every development year, the sum of estimated incremental payments lines up with the observed cumulative payments
    - This technique, which is known as the cusum (cumulative sum) chart technique, is critical for interpolation when there are negative incremental payments

A Bayesian State Space Model of Loss Development

- The estimated (logarithmic) rates of growth
  - *eta*—rate of exposure growth (inclusive of calendar year effect); varies by exposure year
  - *kappa*—calendar year effect; varies by every cell in the triangle
  - *delta*—run-off rate, adjusted for the calendar year effect; varies by development year
    - *delta* is the growth rate of “real” incremental payments, that is, the growth rate of the amount of services provided

A Bayesian State Space Model of Loss Development

- The calendar year effect (*kappa*)
  - An expert prior is used for the calendar year effect
    - Rate of CPI Medical Care inflation ("M-CPI") for medical claims
    - Average weekly wage (QCEW), CPI, or fixed rate for escalating indemnity claims, depending the regulatory stipulation
    - Zero for non-escalating indemnity claims

A Bayesian State Space Model of Loss Development

- The calendar year effect (*kappa*), *cont'd.*
  - The model allows the fraction of escalating indemnity claims in the total to vary across development years
    - The calendar year effect varies by cell, not just by diagonal

A Bayesian State Space Model of Loss Development

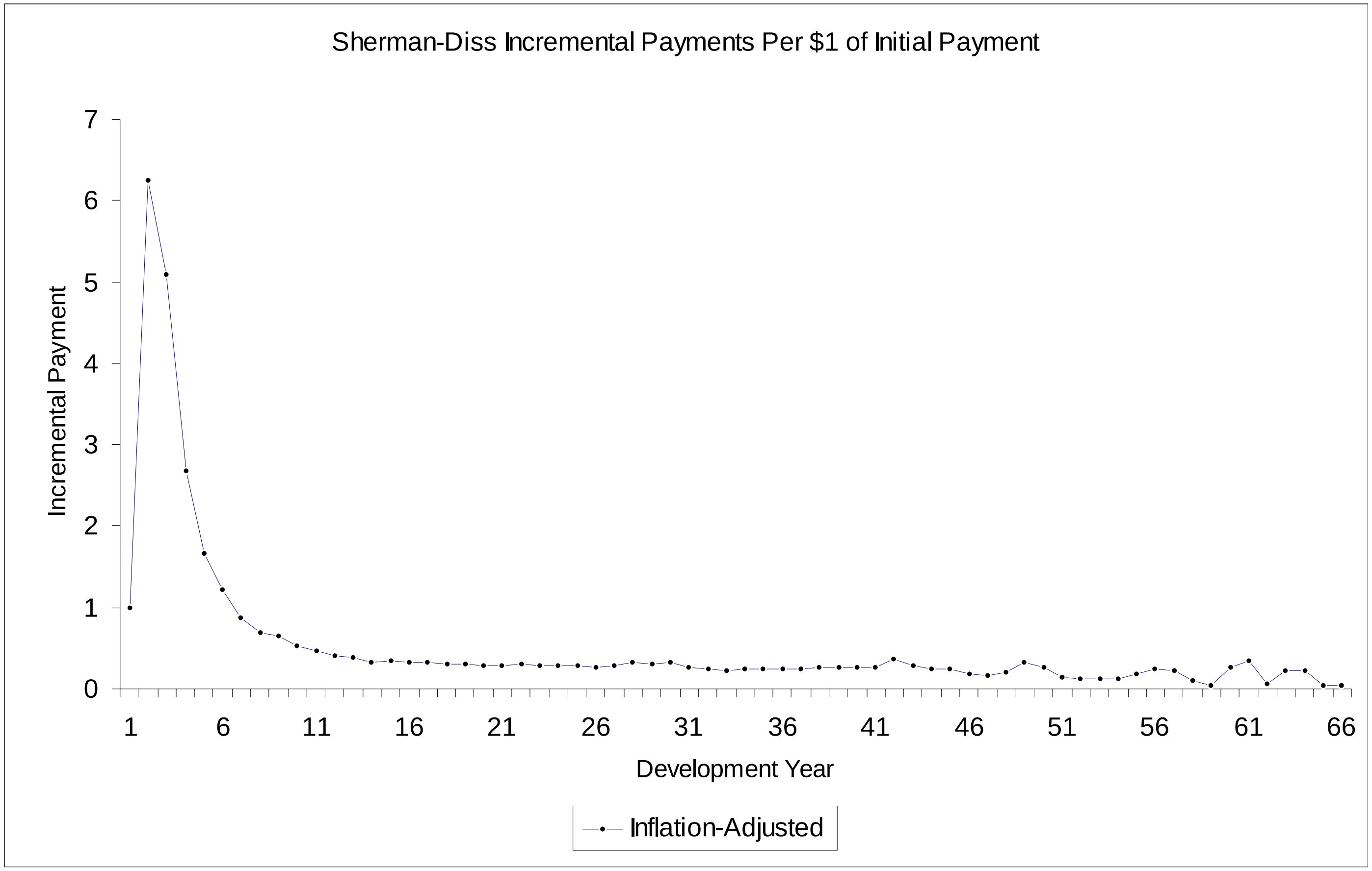
- The calendar year effect (*kappa*), *cont'd.*
  - The inflation rate pertinent to workers compensation (WC) claims is known up to a constant
    - WC Infl. Rate = *kappa* + constant + error term
  - For instance, if the WC-pertinent rate of medical inflation differs systematically to M-CPI inflation, then this difference (the "constant") feeds into the run-off rate (*delta*)

- The calendar year effect (*kappa*), cont'd.
  - Because any systematic difference between the WC-pertinent rate of inflation and the official rate of inflation feeds into the run-off rate (*delta*), it is this official rate of inflation (e.g., the M-CPI) that is relevant when projecting payments into the future
  - It is known that rates of inflation are close to random walks, which implies that the best forecast for any future rate of inflation is the current rate

A Bayesian State Space Model of Loss Development

- The run-off rate (*delta*)
  - We assume a stationary rate of run-off for the unobserved development years
  - This assumption is based on the Sherman/Diss study which shows a smooth decline of the inflation-adjusted incremental payments
  - The projected rate of run-off is at least as high as the rate of mortality (as posted on www.ssa.gov)

A Bayesian State Space Model of Loss Development



Analysis of the Impact of Regulatory Reform on the Run-Off

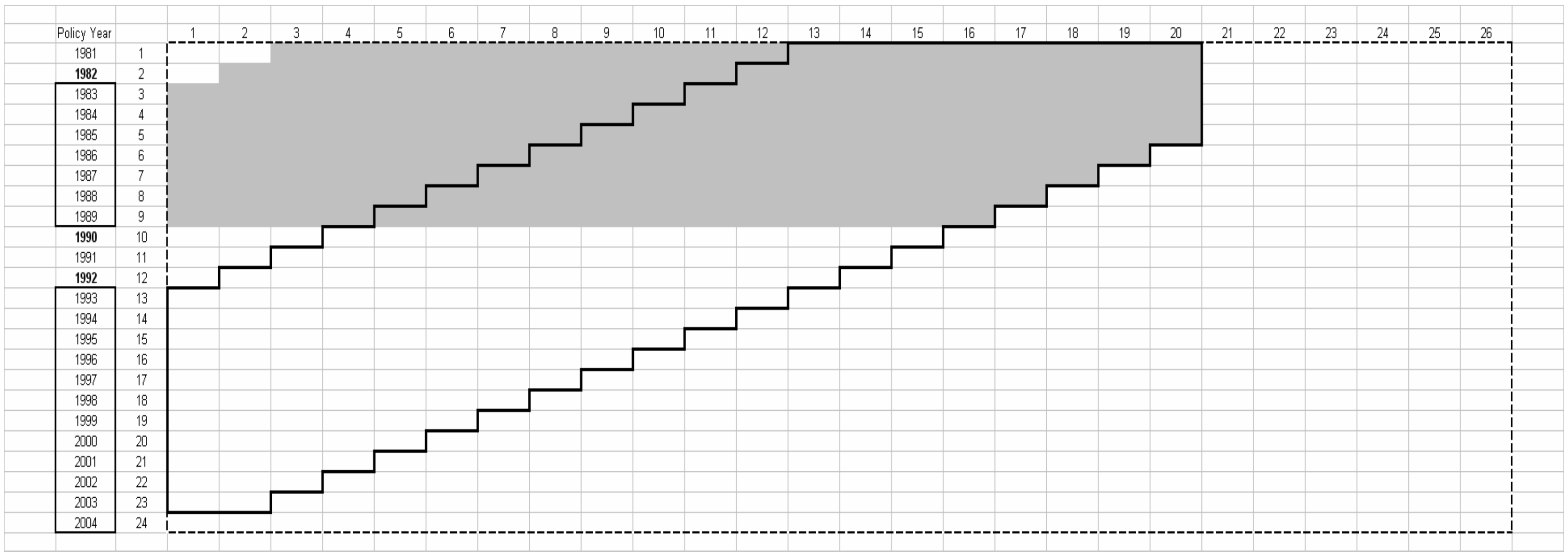
- Reforms in an unidentified state
  - There was a major reform in 1982
  - There was a cluster of reforms comprising the years 1990 and 1992
    - ➢ Limitation of the duration of temporary total (TT) claims to 52 weeks
    - ➢ Closer scrutiny regarding the continued eligibility of indemnity benefits

Analysis of the Impact of Regulatory Reform on the Run-Off

- Definition of pre-reform and post-reform periods
  - Pre-reform: 1983-1989
  - Post-reform: 1993-2004
    - 2004 is the final observed policy year
- Hypothesized reform impact
  - Limitation of the duration of TT claims and closer scrutiny of eligibility causes indemnity claims to close faster
  - The faster closing of indemnity claims may also accelerate the run-off of medical payments

Analysis of the Impact of Regulatory Reform on the Run-Off

- Pre-reform and post-reform models

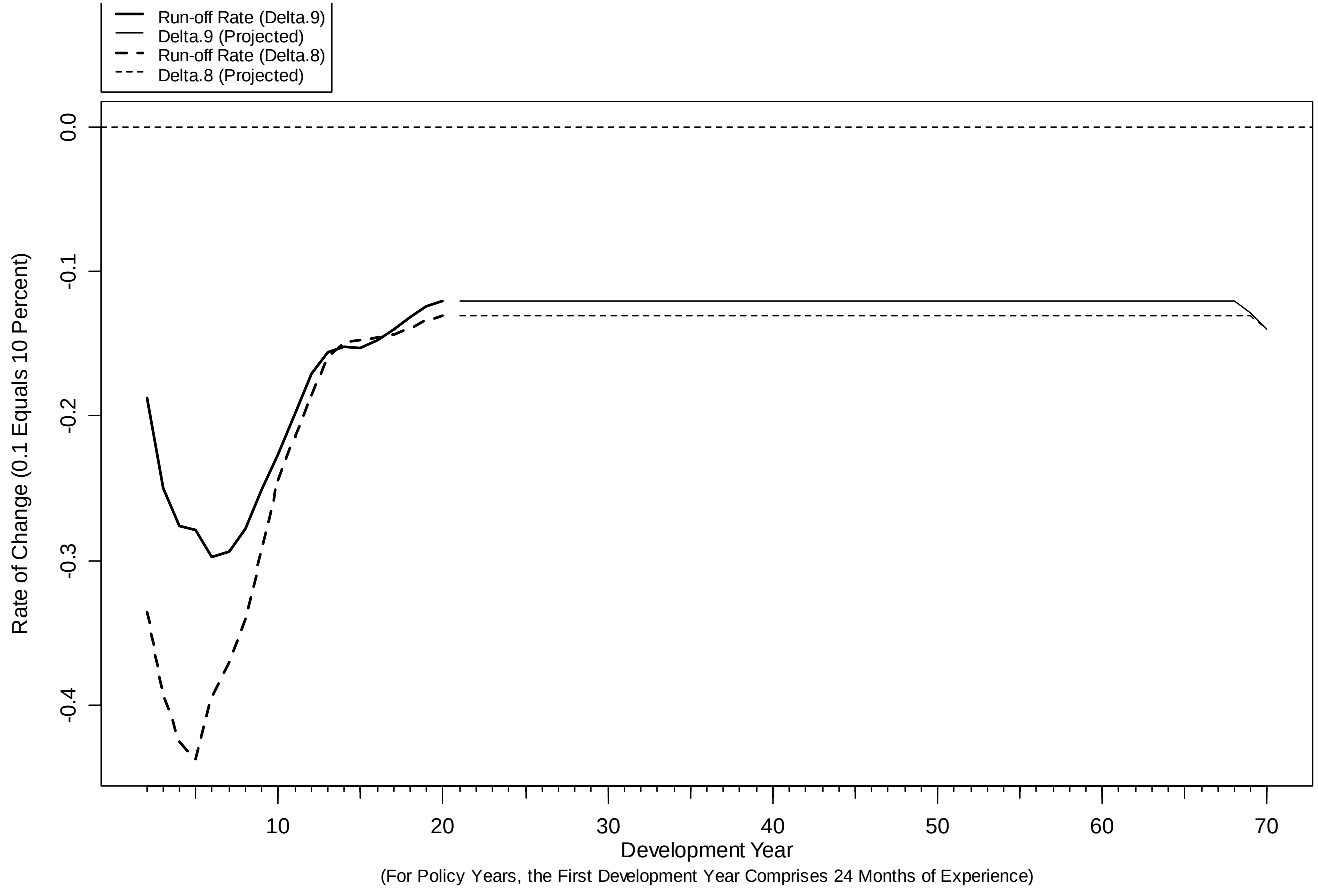


Analysis of the Impact of Regulatory Reform on the Run-Off

- In the post-reform model, only for the first development year do all observations originate from the post-reform period
  - Pre-reform observations phase in as time progresses on the development year axis
    - The cusum chart constraint also applies to the pre-reform policy years (although these policy years phase out post-reform run-off rates) as time progresses on the development year axis

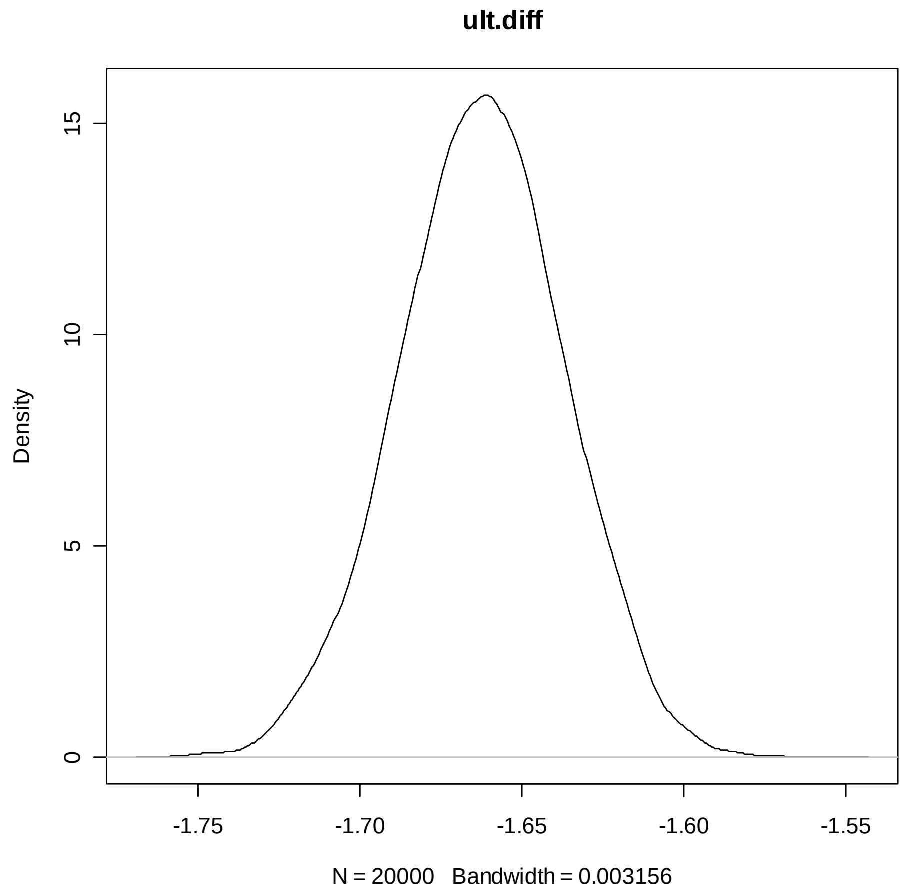
Analysis of the Impact of Regulatory Reform on the Run-Off

– Indemnity ("9": pre-reform; "8": post-reform)



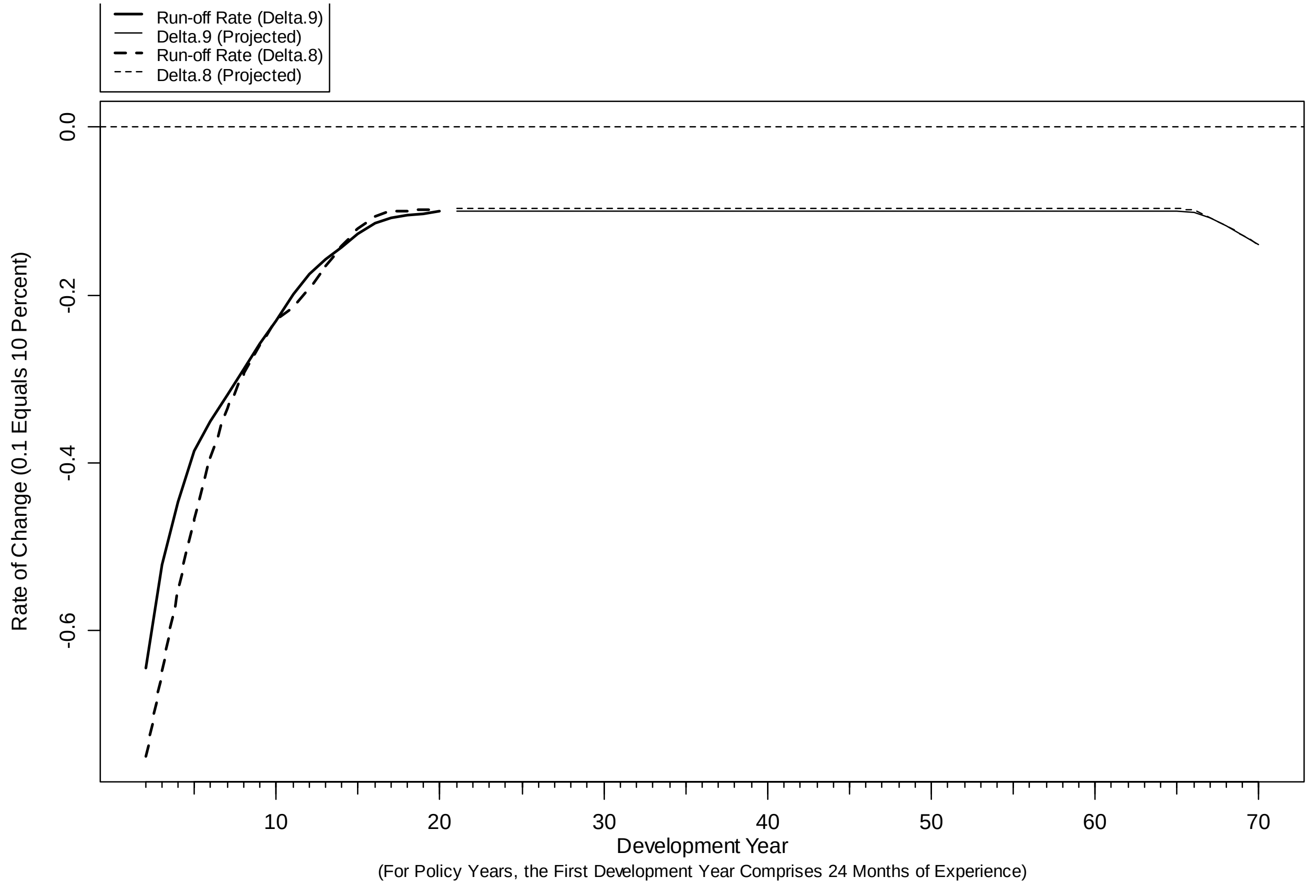
Analysis of the Impact of Regulatory Reform on the Run-Off

– Indemnity: Difference in ultimate loss per $1 of initial payment



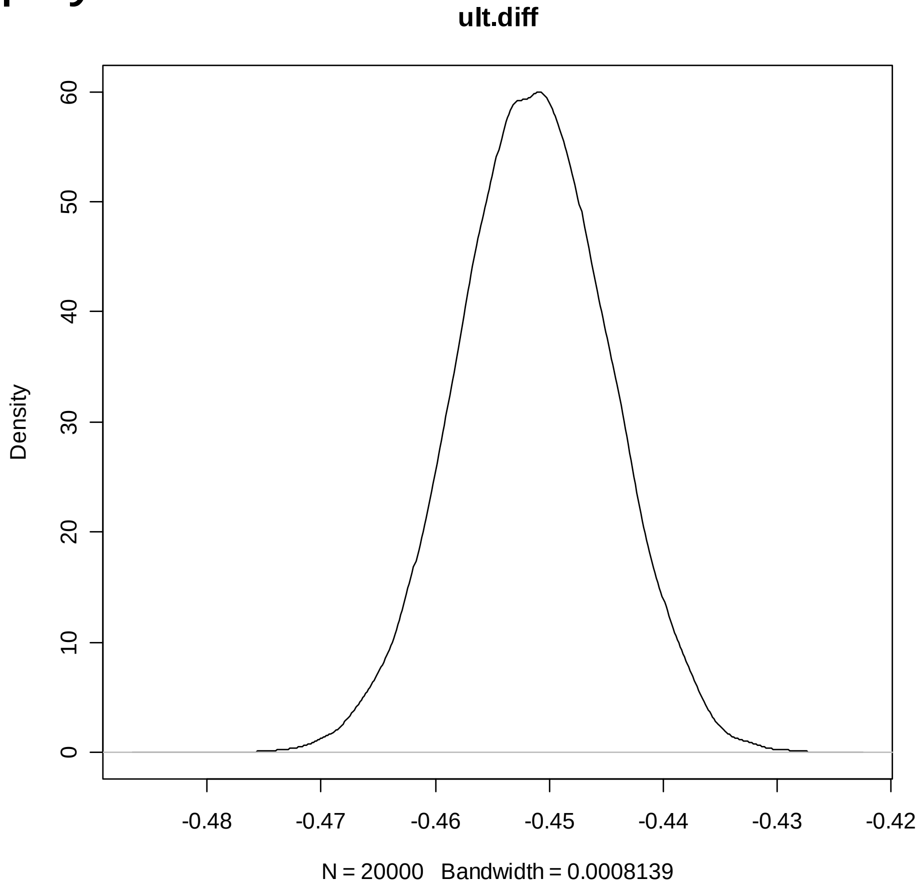
Analysis of the Impact of Regulatory Reform on the Run-Off

– Medical (“9”: pre-reform; “8”: post-reform)



Analysis of the Impact of Regulatory Reform on the Run-Off

– Medical: Difference in ultimate loss per $1 of initial payment



Conclusion

- New statistical techniques have become available in recent years that allow the estimation of statistical models that were once thought as too complex to solve
- Using such new statistical techniques, NCCI has designed a framework that models the processes that drive loss development
- The model has been developed for tail factor estimation but may also find use in…
  - …reserving
  - …legislative and regulatory analysis