# Measuring the Economic Drivers of Loss Development: Implications for Estimating Reserves

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## Today's Discussion

- The Challenge – handling changing trends in loss development
- Biases in traditional loss development during changing economic conditions
- An economic model of loss development
- Modeling "homogeneous" claim types to control for accident year considerations

# The Challenge –
# handling changing trends in loss development




## Changes in Trend Factors May Bias Traditional Triangle Development Factors

Chain ladder development factors used to develop recent accident payments are:

- biased by certain types of changes in the model factors,

and

- unbiased by other types of changes.

## Changes That Do Not Cause a Bias in Development Factors

No impact on link factors:

- Any change in the accident year benefit index.

Impact on link factors same for historical and future development:

- Any constant trend in the calendar year benefit index.
- Any constant trend in the medical CPI.

Note: "Constant trend" means an exponential trend rate which is constant in both the experience period and the future.




## Changes That Do Cause a Bias in Development Factors

- Almost any change in the mix of claims by injury type. (i.e., a higher percentage of permanent total claims, which have a much longer payout) – an accident year effect
- A difference between the historical and future trends in calendar year benefit index. (i.e., a turning point in the calendar year benefit index)
- A difference between the historical and future economic inflation rate - especially medical prices and the average weekly wage

# Hypothetical Examples for Testing Bias Sensitivity




# Hypothetical Example #1 – No Bias 5% AY Trend

Incremental Payments

| | Months of Evaluation---> | | | | | | |
|---|---|---|---|---|---|---|---|
| AY | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
| 1 | **200** | 200 | 150 | 150 | 100 | 100 | 100 |
| 2 | **210** | 210 | 158 | 158 | 105 | 105 | *105* |
| 3 | **221** | 221 | 165 | 165 | 110 | *110* | *110* |
| 4 | **232** | 232 | 174 | 174 | *116* | *116* | *116* |
| 5 | **243** | 243 | 182 | *182* | *122* | *122* | *122* |
| 6 | **255** | 255 | *191* | *191* | *128* | *128* | *128* |
| 7 | **268** | *268* | *201* | *201* | *134* | *134* | *134* |

# Hypothetical Example #1 – No Bias
# 5% AY Trend
(continued)

## Link Factors

| AY | Interval of Development---> 12 to 24 | 24 to 36 | 36 to 48 | 48 to 60 | 60 to 72 | 72 to 84 |
|---|---|---|---|---|---|---|
| 1 | **2.00** | 1.38 | 1.27 | 1.14 | 1.13 | 1.11 |
| 2 | **2.00** | 1.38 | 1.27 | 1.14 | 1.13 | *1.11* |
| 3 | **2.00** | 1.38 | 1.27 | 1.14 | *1.13* | *1.11* |
| 4 | **2.00** | 1.38 | 1.27 | *1.14* | *1.13* | *1.11* |
| 5 | **2.00** | 1.38 | *1.27* | *1.14* | *1.13* | *1.11* |
| 6 | **2.00** | *1.38* | *1.27* | *1.14* | *1.13* | *1.11* |
| 7 | ***2.00*** | *1.38* | *1.27* | *1.14* | *1.13* | *1.11* |




# Hypothetical Example #2 – No Bias
# 5% CY Trend

## Incremental Payments

| AY | Months of Evaluation---> 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 1 | **200** | **210** | **165** | **174** | **122** | **128** | **134** |
| 2 | **210** | 221 | 174 | 182 | 128 | 134 | *141* |
| 3 | **221** | 232 | 182 | 191 | 134 | *141* | *148* |
| 4 | **232** | 243 | 191 | 201 | *141* | *148* | *155* |
| 5 | **243** | 255 | 201 | *211* | *148* | *155* | *163* |
| 6 | **255** | 268 | *211* | *222* | *155* | *163* | *171* |
| 7 | **268** | *281* | *222* | *233* | *163* | *171* | *180* |

# Hypothetical Example #2 – No Bias
# 5% CY Trend
(continued)

## Link Factors

| | Interval of Development---> | | | | | |
|---|---|---|---|---|---|---|
| AY | 12 to 24 | 24 to 36 | 36 to 48 | 48 to 60 | 60 to 72 | 72 to 84 |
| 1 | **2.05** | 1.40 | 1.30 | 1.16 | 1.15 | 1.13 |
| 2 | **2.05** | 1.40 | 1.30 | 1.16 | 1.15 | *1.13* |
| 3 | **2.05** | 1.40 | 1.30 | 1.16 | *1.15* | *1.13* |
| 4 | **2.05** | 1.40 | 1.30 | *1.16* | *1.15* | *1.13* |
| 5 | **2.05** | 1.40 | *1.30* | *1.16* | *1.15* | *1.13* |
| 6 | **2.05** | *1.40* | *1.30* | *1.16* | *1.15* | *1.13* |
| 7 | ***2.05*** | *1.40* | *1.30* | *1.16* | *1.15* | *1.13* |




# Hypothetical Example #3 - Biased Estimates
# 10% Historical CY Trend and 4% Future CY Trend

## Incremental Payments

| | Months of Evaluation---> | | | | | | |
|---|---|---|---|---|---|---|---|
| AY | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
| 1 | 200 | 220 | 182 | 200 | 146 | 161 | 177 |
| 2 | 220 | 242 | 200 | 220 | 161 | 177 | *184* |
| 3 | 242 | 266 | 220 | 242 | 177 | *184* | *192* |
| 4 | 266 | 293 | 242 | 266 | *184* | *192* | *199* |
| 5 | 293 | 322 | 266 | *276* | *192* | *199* | *207* |
| 6 | 322 | 354 | *276* | *287* | *199* | *207* | *216* |
| 7 | 354 | *368* | *287* | *299* | *207* | *216* | *224* |

## Hypothetical Example #3 - Biased Estimates
## 10% Historical CY Trend and 4% Future CY Trend
(continued)

Link Factors

| AY | Interval of Development---> 12 to 24 | 24 to 36 | 36 to 48 | 48 to 60 | 60 to 72 | 72 to 84 |
|---|---|---|---|---|---|---|
| 1 | 2.10 | 1.43 | 1.33 | 1.18 | 1.17 | **1.16** |
| 2 | 2.10 | 1.43 | 1.33 | 1.18 | **1.17** | ***1.15*** |
| 3 | 2.10 | 1.43 | 1.33 | **1.18** | ***1.16*** | ***1.14*** |
| 4 | 2.10 | 1.43 | **1.33** | ***1.17*** | ***1.15*** | ***1.14*** |
| 5 | 2.10 | **1.43** | ***1.31*** | ***1.17*** | ***1.15*** | ***1.13*** |
| 6 | **2.10** | ***1.41*** | ***1.30*** | ***1.16*** | ***1.14*** | ***1.13*** |
| 7 | ***2.04*** | ***1.40*** | ***1.30*** | ***1.16*** | ***1.14*** | ***1.13*** |




## Hypothetical Example #3 - Biased Estimates
## 10% Historical CY Trend and 4% Future CY Trend
(continued)

Cumulative Development Factors (Tail = 1.00)

| AY | Unbiased | Chain Ladder | Ultimate Loss % Difference | Reserve % Difference |
|---|---|---|---|---|
| 2 | 1.151 | 1.160 | 1% | 6% |
| 3 | 1.328 | 1.357 | 2% | 9% |
| 4 | 1.539 | 1.605 | 4% | 12% |
| 5 | 1.993 | 2.138 | 7% | 15% |
| 6 | 2.753 | 3.061 | 11% | 18% |
| 7 | 5.521 | 6.429 | 16% | 20% |

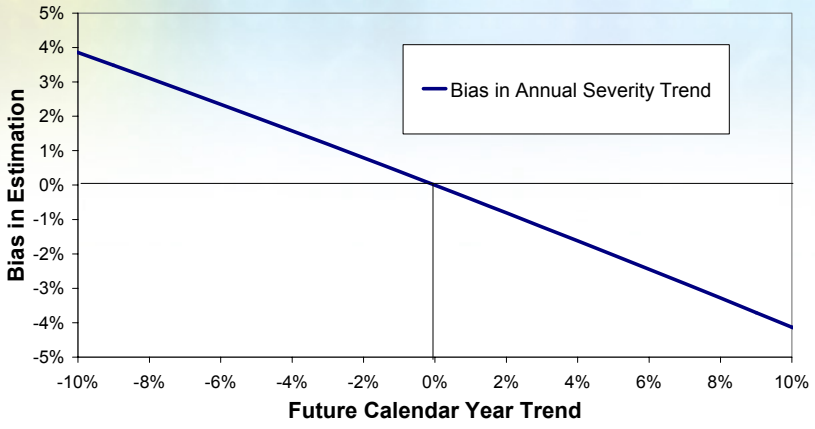
## Hypothetical Example #3 - Biased Estimates
## 10% Historical CY Trend and 4% Future CY Trend
(continued)

In this example, if the calendar year trend is entirely due to severity, then a severity trend estimate, using these development factors, across 6 years spanning the 7 accident years will be biased upward by a cumulative 16%, or about 2.5% per year.

A reserve portfolio using these development factors would tend to be biased upward about 15%.



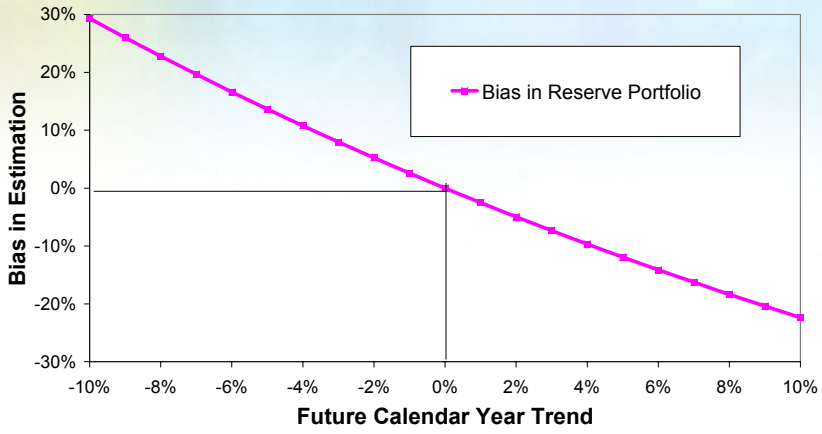

## Hypothetical Example #3a
### Severity Trend Estimation Bias Due to Changing Calendar Year Trend
**(historical CY trend = 0%)**



# Hypothetical Example #3a

## Reserve Portfolio Estimation Bias Due to Changing Calendar Year Trend

**(historical CY trend = 0%)**







# What Can Be Done ?

- Separate triangles by injury type and reconstruct accident years using appropriate weights by claim type.
- Estimate impact on historical development by factors such as medical CPI and the calendar year benefit index using paid loss triangles, and adjust estimates of future development factors based on forecasts of changes in future economic inflation and benefit levels.
- Particular attention given to economic time series as possible leading indicators of a material change in the calendar year factors.

# An Economic Model for Loss Development




## Model Assumptions

- Deterministic – process variance is not a central issue, and is not easy to model. For example, different variance structures have been formulated for triangular reserving (i.e., Mack, Stanard, Zehnwirth, etc.), no structure is generally accepted.
- Incremental payment triangles – case reserves not as directly connected to economic effects as actual payments, layout needs to allow for adjustment of various accident year and calendar year effects.
- Consideration of mix of injury type – development patterns vary by injury type and proportions of injury type can change over time. So there is a need to adjust for changes in the mix of injury types over accident years.
- Multiplicative Factors – Allows for direct application of economic indices, such as medical CPI, and is akin to methods already explored in the actuarial literature (i.e., Butsic, McClenahan, Zehnwirth, etc.)

## Shifting Analysis to Paid Losses

- It is closer to actual experience.
- The relationship between the dependant variables and the economic drivers is more direct.

but

- There is more random volatility in the data.




## Modeling Severity

Factors that Drive Severity
Common Sense and Theory

It is probably multiplicative

- base severity *
- price inflation *
- benefit inflation

Need to develop an explicit empirical model.

# A Basic Model – Incremental Paid Loss Severity

$$S_{a,c} = P_0 I^{\alpha}{}_c \beta_c^{calendar} \beta_a^{accident}$$

$S_{a,c}$ = Incremental Payment Severity in calendar year c from claims with accident year a

$P_0$ = a constant independent of accident year and calendar year

$I_c$ = economic inflation index for calendar year c

$\beta_c^{calendar}$ = benefit level index for calendar year c

$\beta_a^{accident}$ = benefit level index for accident year a

This Class of Model May Be Estimated in Log Linear Form Using Linear Regression.




# Controlling for claim type to eliminate accident year considerations

Accident Year Dimension Is Redundant
if Calendar and Development Period Inflation Effects
Are Properly Accounted For by Claim Type

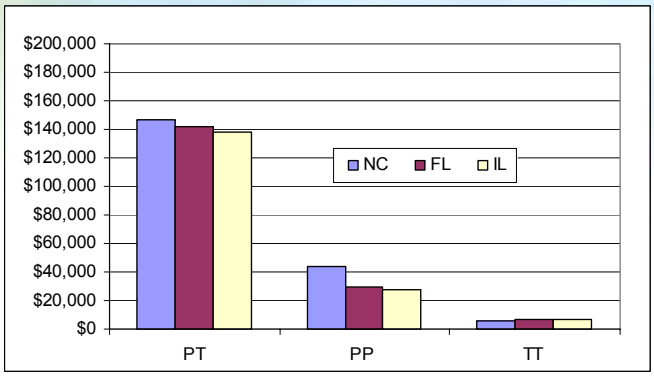
- It is well known that costs and payment patterns differ markedly between different claim types
- The impact of economic drivers such as wages and medical costs differs between claim types
- The impact of reforms typically differs materially between claim types

- A key objective is to identify “homogenous” categories of claims




Costs differ markedly between different claim types.

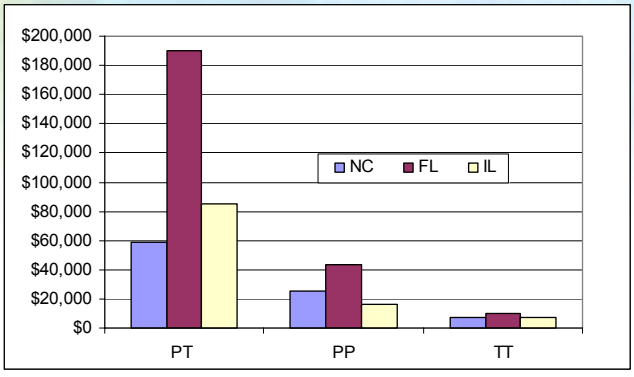
# Indemnity Severity by claim types similar in NC, FL, & IL PTs Much More Expensive







# Medical Severity by claim types FL more expensive – especially for PTs

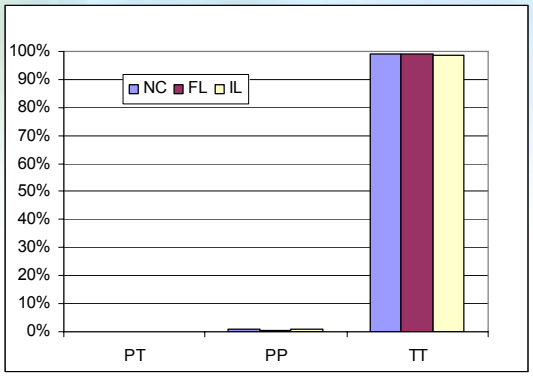


Claims Often Are Recognized as Being More Severe Sometime After First Report

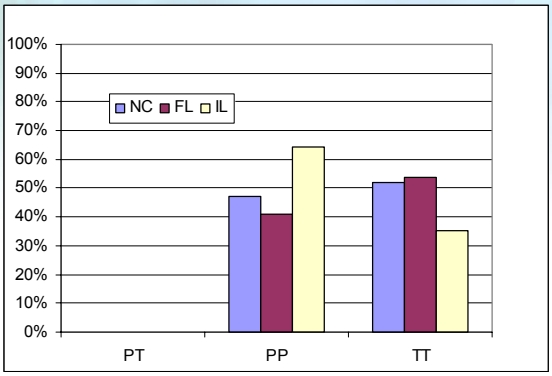
This Migration Pattern May Be Important




## TT Claims @ Final Report
## Where Did They Start? – as TTs



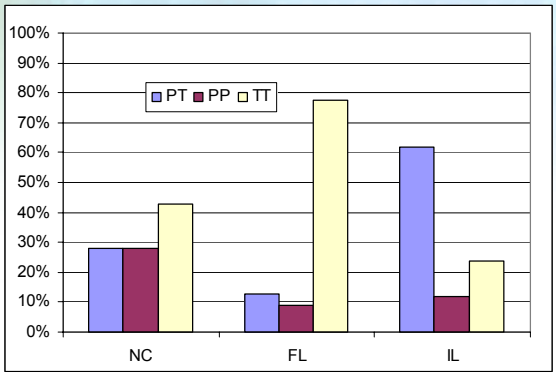
# PP Claims @ Final Report
# Where Did They Start? – Many as TTs







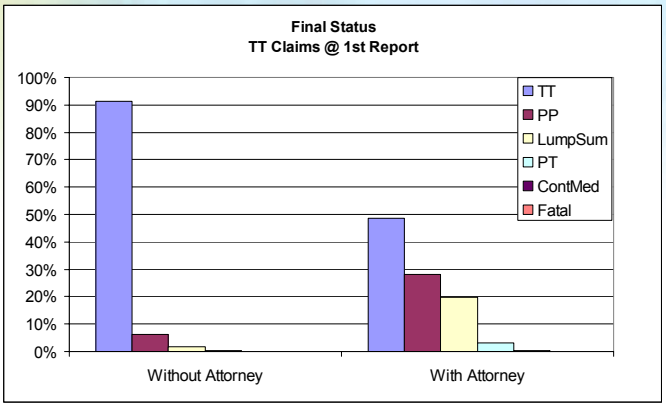
# PT Claims @ Final Report
# Where Did They Start? –
# TTs in FL, PTs in IL, Mixed in NC



Other Features Often Are Associated with Claims Migration or Shifts in Severity.




## Attorney Involvement Is Correlated with Migration in TT Claims

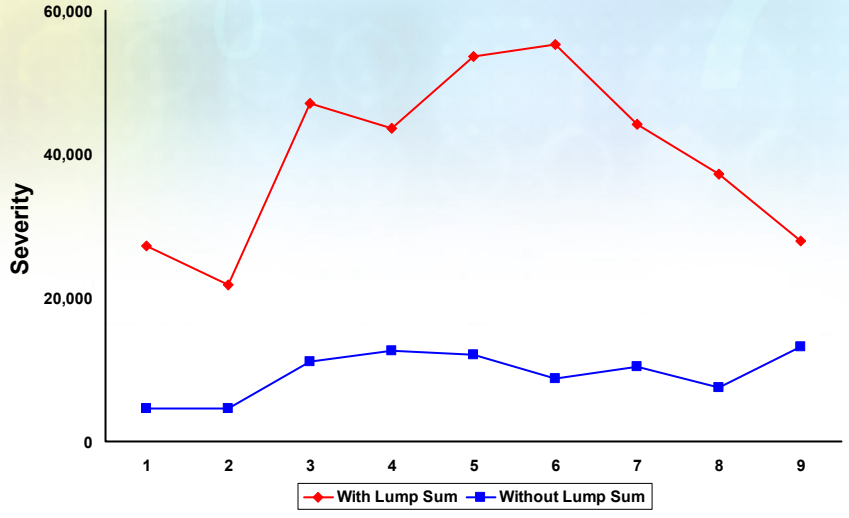


Claims with Lump Sum Payments Have an Impact on Paid Loss Severity.




## Analyzing Undeveloped Losses

Average Paid Loss Severity - Closed Claims with and without Lump Sum



# Developing Medical Losses

Accounting for WC Medical Price Inflation

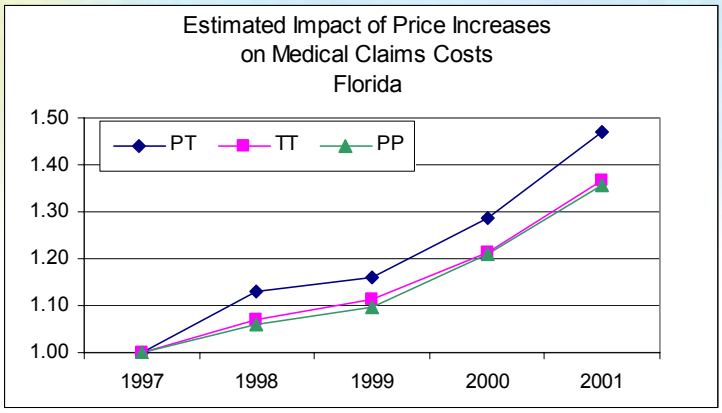
The Impact Differs by Claim Type

Service (Calendar) Year Analysis

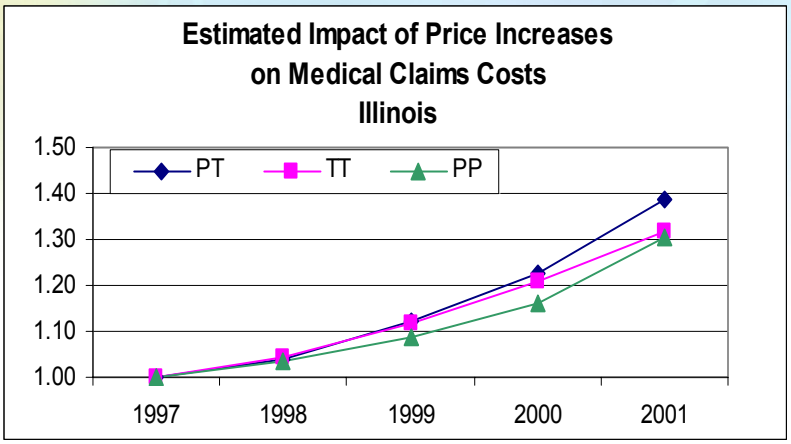
the diagonals in a standard incremental paid loss triangle




# Medical Price Inflation
# More Significant for PTs Claims in Florida



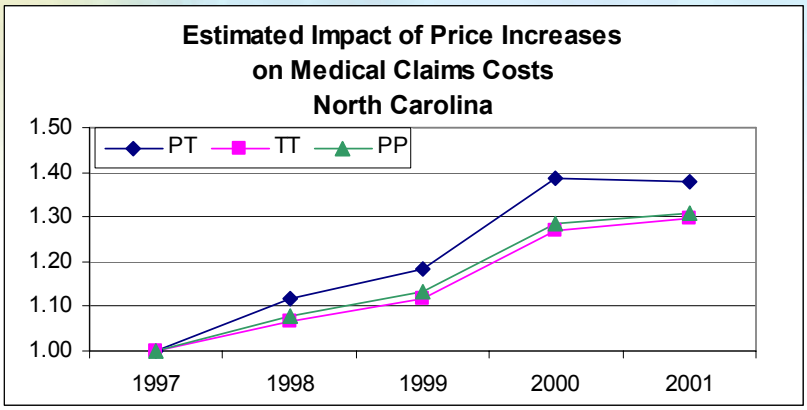
## Medical Price Inflation
## Less Pronounced for PT Claims in Illinois







## Medical Price Inflation
## More Significant for PT Claims in North Carolina



## The challenges in using econometric techniques to model loss development, reserving, and trending:

Working with appropriate claims data:

- Incremental paid losses
- By service year
- By homogeneous claim categories

Having the most appropriate measures of economic cost drivers:

- WC specific price indexes
- Changes in utilization to supplement the price impacts




Economic forecasting techniques currently are an effective and rigorous way:

- To predict changes in loss costs trends
  and
- To incorporate those changes systematically into reserve projections

Everything else relies on trend extrapolation.

Of course, the effectiveness of econometric forecasting depends on the accuracy of the forecasts of the explanatory variables.

Thanks for Your Interest

Questions and Comments