Looking through the Rear-View Mirror: Back-Testing Loss Reserve Methods

CAS Loss Reserve Seminar

Adam Troyer
September 6, 2018

Agenda

- The problem
- The solution?
- R package: `reservetestr`
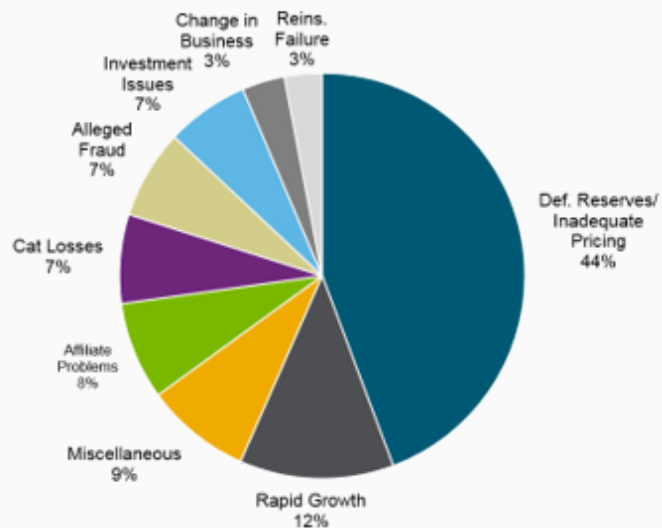- The results
- The future

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Links

R package: https://github.com/problemofpoints/reservetestr

Presentation: https://reservetestr.netlify.com/

The problem

Reserve risk is material…

Primary Causes of U.S. P/C Impairments (1968 – 2013)

Cause of Impairment (1968 – 2013)	
Deficient Loss Reserves/Inadequate Pricing	44.3%
Rapid Growth	12.3%
Miscellaneous	8.4%
Affiliate Problems	7.8%
Catastrophe Losses	7.1%
Alleged Fraud	7.1%
Investment Issues (Overstated Assets)	6.6%
Significant Change in Business	3.4%
Reinsurance Failure	3.0%

Change in Business 3%
Reins. Failure 3%
Investment Issues 7%
Alleged Fraud 7%
Cat Losses 7%
Def. Reserves/ Inadequate Pricing 44%
Affiliate Problems 8%
Miscellaneous 9%
Rapid Growth 12%

Source: A. M. Best Impairment Study 2014
* A. M. Best defines impairment as any type of restrictive regulatory action

Reserve risk is material…

Largest US P&C Industry Events

$ in Billions

Event	Nominal Loss	
Asbestos Losses	~85.0	
Environmental Losses	~42.0	
Hurricane Katrina	41.1	
AY 2000 Development*	22.0	
AY 1999 Development*	19.3	
September 11th	18.8	
Hurricane Sandy	18.8	
Hurricane Andrew	15.5	
Northridge Earthquake	12.5	
Hurricane Ike	12.5	
AY 1998 Development*	12.1	
AY 2001 Development*	10.5	

Source: A.M. Best, ISO PCS, NAIC Annual Statements
*Due to Schedule P limitations, these figures represent 10 years of development

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...but it's hard to estimate!

Insurance Model Risk Characteristics Checklist

Reserve Risk
Catastrophe Risk

Risk Process — Physical ← → Behavioral

Model of Process — Structural ← → Statistical

Parameter Stability — Stable ← → Unstable

And some don't appreciate that...

S&P faults actuaries on insurer liabilities

Joanne Wojcik

11/20/2003 12:00:00 AM

<   **SHARE**

Actuaries aren't doing a good job of assessing insurers' future liabilities, forcing rating agencies to doubt the veracity of company statements and to rely more on their own analysis, according to Standard & Poor's Corp.

Reserve additions by U.S. property/casualty insurers for 2003 will likely surpass the $22 billion total for all lines of business in 2002, which exceeded the $11.6 billion reserve boost necessary in 2001, forecasts a new report by S&P analysts.

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The solution?

Main stochastic methods used
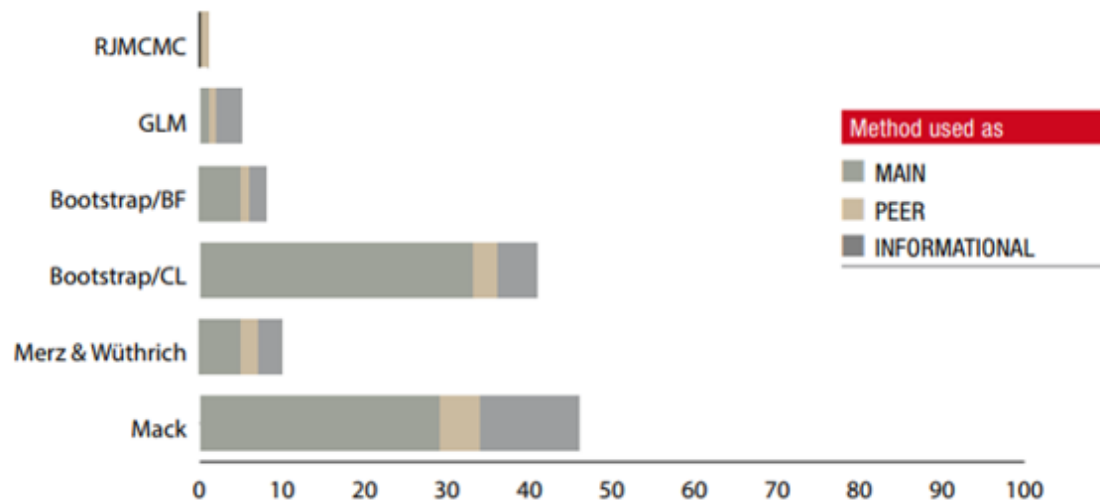
Mack-derived analytical methods are slightly behind the algorithmic Bootstrap methods, the other methods following far behind. On average a little more than one out of two insurers on two use a stochastic method (either being Bootstrap or Mack-derived).

LOSS RESERVING DATA PULLED FROM NAIC SCHEDULE P

Glenn G. Meyers, PhD, FCAS

Peng Shi, PhD, ASA

Posted: 2011

**Please direct all comments to Glenn Meyers at ggmeyers@metrocast.net**

1. **Purpose**

   Our goal is to prepare a clean and nice data set of loss triangles that could be used for claims reserving studies. The data includes major personal and commercial lines of business from U.S. property casualty insurers. The claims data comes from Schedule P – Analysis of Losses and Loss Expenses in the National Association of Insurance Commissioners (NAIC) database.

   We have obtained permission from the NAIC to make this data available to all interested researchers on the CAS website.
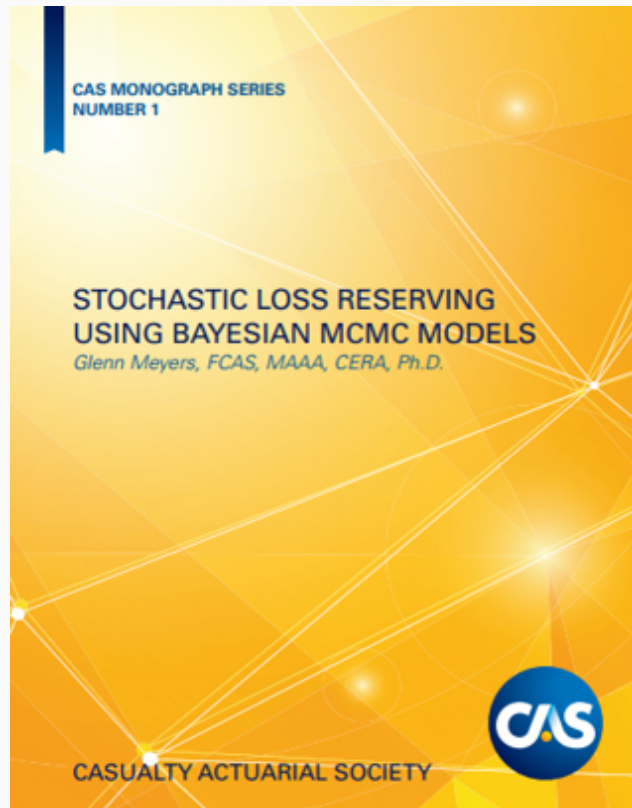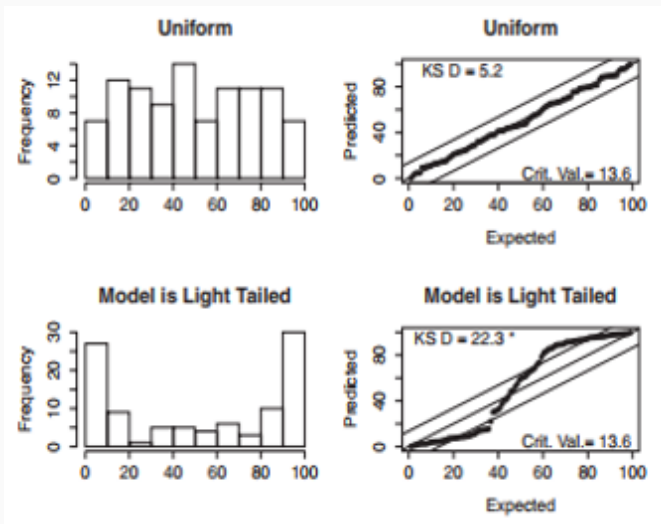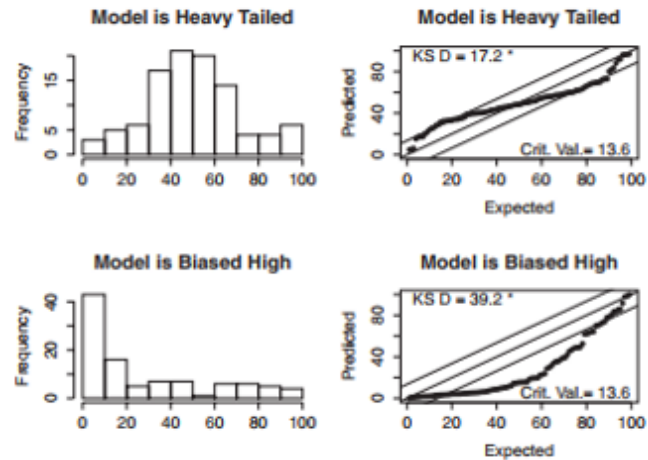
# Back-testing methodology

Back-testing methodology

8. Summary and Conclusions

The central thrust of this monograph is twofold.

- It implements the idea of large-scale retrospective testing of stochastic loss reserve models on real data. The goal is not to comment on the reserves of individual insurers. Instead the goal is to test the predictive accuracy of specific models.
- As shortcomings in existing models are identified, it demonstrates that Bayesian MCMC models can be developed to overcome some of these shortcomings.

R package: reservetestr

Me trying to replicate results
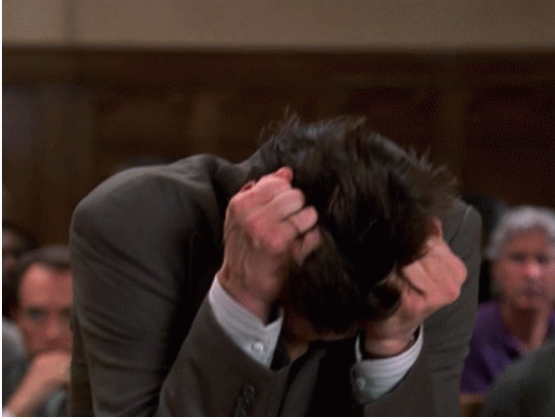
So build an R package!

- `reservetestr` package
  - Work in progress
  - https://github.com/problemofpoints/reservetestr

Example: "training data"

```
cas_loss_reserve_db %>%
  get_meyers_subset() %>%
  filter(line == "ppauto" & group_id == 388) %>%
  pluck("train_tri_set", 1, "paid")
```

```
##       dev_lag
## acc_yr    1     2     3     4     5     6     7     8     9    10
##   1988 13440 35680 48703 56319 61018 61119 63049 63556 63744 63835
##   1989 18757 44166 57578 66264 65600 67721 75369 76713 77007    NA
##   1990 19834 42225 56347 63194 67112 69459 74267 79208    NA    NA
##   1991 16230 38045 46055 53983 60638 62917 71074    NA    NA    NA
##   1992 14629 22427 33873 43339 53168 60413    NA    NA    NA    NA
##   1993 24597 51373 68484 80253 92192    NA    NA    NA    NA    NA
##   1994 31723 59733 77398 94395    NA    NA    NA    NA    NA    NA
##   1995 37397 71133 94294    NA    NA    NA    NA    NA    NA    NA
##   1996 53670 98628    NA    NA    NA    NA    NA    NA    NA    NA
##   1997 52837    NA    NA    NA    NA    NA    NA    NA    NA    NA
## attr(,"class")
## [1] "triangle" "matrix"
## attr(,"exposure")
##  [1]  83473  91800  95877  99256  96170 139038 152174 167833 180523 164717
```

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Example: "testing data"

```
cas_loss_reserve_db %>%
  get_meyers_subset() %>%
  filter(line == "ppauto" & group_id == 388) %>%
  pluck("test_tri_set", 1, "paid")
```

```
##        dev_lag
## acc_yr     2      3      4      5      6      7      8      9     10
##   1988    NA     NA     NA     NA     NA     NA     NA     NA  63835
##   1989    NA     NA     NA     NA     NA     NA     NA     NA  77029
##   1990    NA     NA     NA     NA     NA     NA     NA  79250  79308
##   1991    NA     NA     NA     NA     NA     NA  71885  72560  72579
##   1992    NA     NA     NA     NA     NA  61452  62363  62464  62458
##   1993    NA     NA     NA     NA  94939  97226  97536  97654  97787
##   1994    NA     NA     NA 101008 104557 107399 108067 108476 110038
##   1995    NA     NA 103996 107948 109478 110401 111051 111108 111598
##   1996    NA 112473 123070 129739 131549 132682 133137 133426 133522
##   1997 77758  95357 104789 109025 111835 112467 113000 113086 113371
## attr(,"class")
## [1] "triangle" "matrix"
```

Example: Commercial Auto

Now we can run the Mack method on our triangle training data and back-test its accuracy. We use the implementation of the Mack method in the `ChainLadder` package, `MackChainLadder`, applied to the `comauto` line of business.

```
cas_db_subset ← cas_loss_reserve_db %>%
  get_meyers_subset()

mack_paid_results ← run_single_backtest(cas_db_subset,
                                        testr_MackChainLadder,
                                        lines_to_include = "comauto",
                                        loss_type_to_backtest = "paid",
                                        method_label = "mack_paid")
```

Example: Commercial Auto - output

```
glimpse(mack_paid_results)

## Observations: 47
## Variables: 11
## $ line              <chr> "comauto", "comauto", "comauto", "comauto", ...
## $ group_id          <dbl> 353, 388, 620, 833, 1066, 1090, 1538, 1767, ...
## $ company           <chr> "Celina Mut Grp", "Federal Ins Co Grp", "Emp...
## $ method            <chr> "mack_paid", "mack_paid", "mack_paid", "mack...
## $ actual_ultimate   <dbl> 40000, 745997, 388485, 24613, 63022, 21354, ...
## $ actual_unpaid     <dbl> 7399, 189270, 89855, 2959, 5269, 3474, 16640...
## $ mean_ultimate_est <dbl> 39177.438, 714600.238, 398408.978, 25350.326...
## $ mean_unpaid_est   <dbl> 6576.4378, 157873.2378, 99778.9781, 3696.325...
## $ stddev_est        <dbl> 1442.5094, 46454.1901, 9466.1578, 836.7769, ...
## $ cv_unpaid_est     <dbl> 0.21934510, 0.29424994, 0.09487126, 0.226380...
## $ implied_pctl      <dbl> 0.7200268344, 0.7563488511, 0.1468789988, 0....
```

Example: Commercial Auto - results

```
create_pp_plot(mack_paid_results, by_line = TRUE)
```
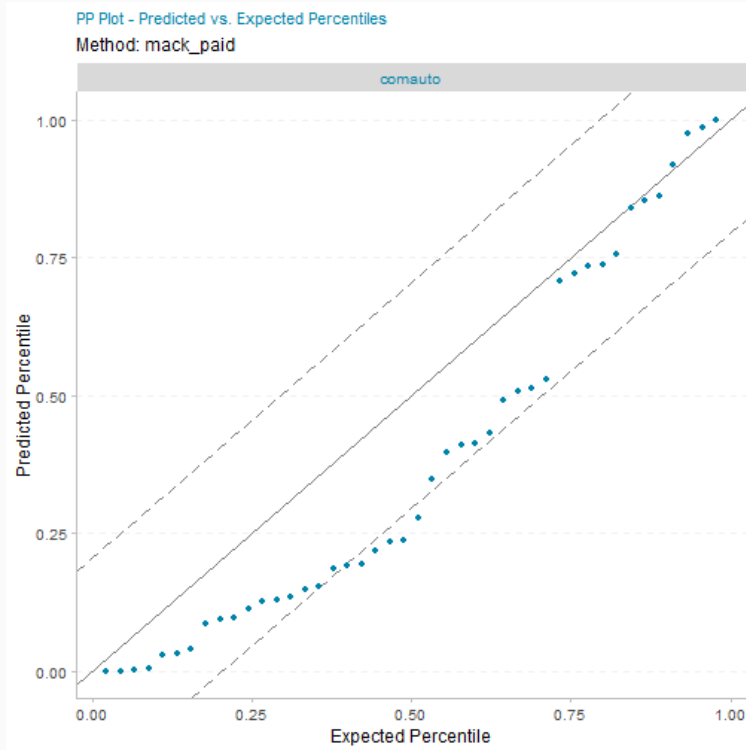
The competition

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  - MackChainLadder
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- Show results from Meyers's Changing Settlement Rate (CSR) method

The competition

- Test several methods on both paid and case-incurred triangles
- All methods from the `ChainLadder` package for now
  - MackChainLadder
  - BootChainLadder
  - ClarkCapeCod
- Show results from Meyers's Changing Settlement Rate (CSR) method
- Declare winners?

Mack - Paid

```
create_pp_plot(mack_paid_results_all, by_line = TRUE)
```
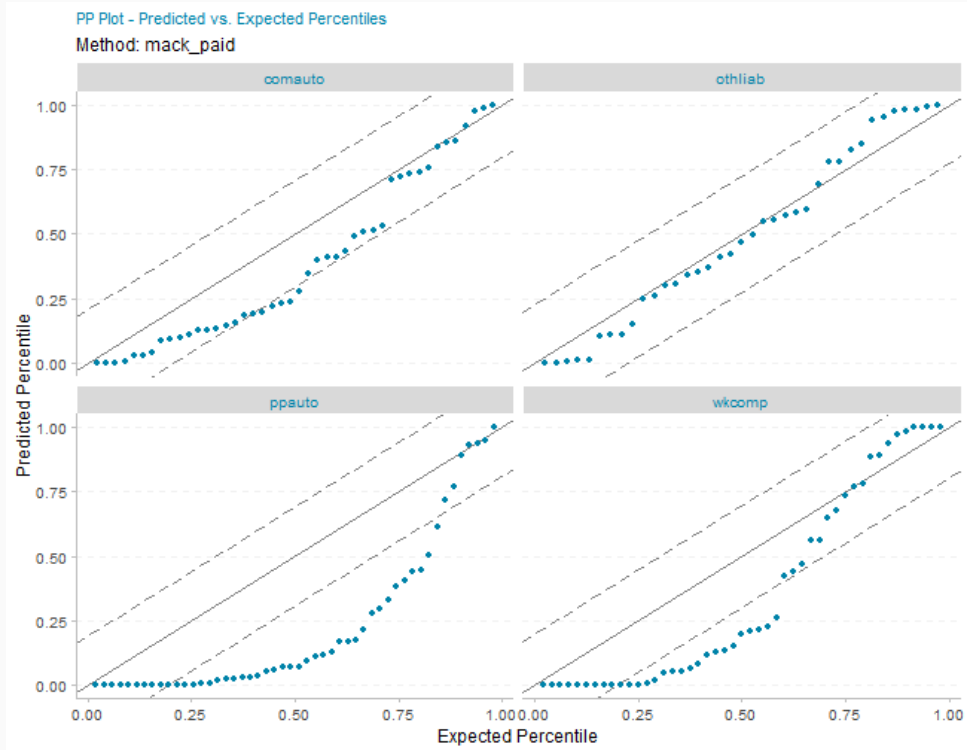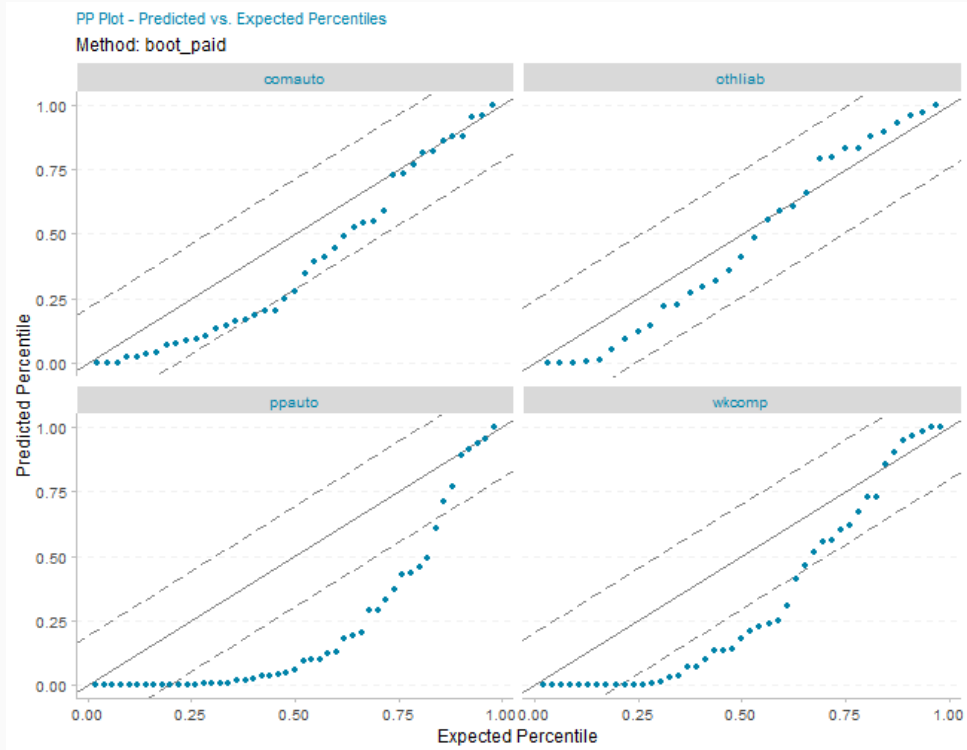
Mack - Case-Incurred

```
create_pp_plot(mack_case_results_all, by_line = TRUE)
```
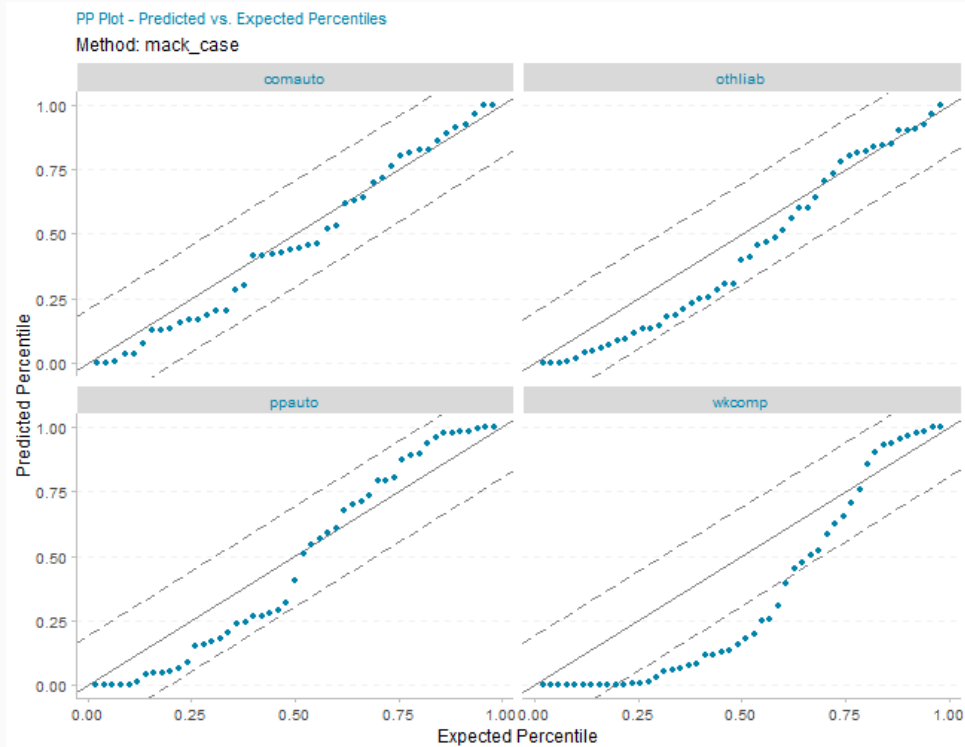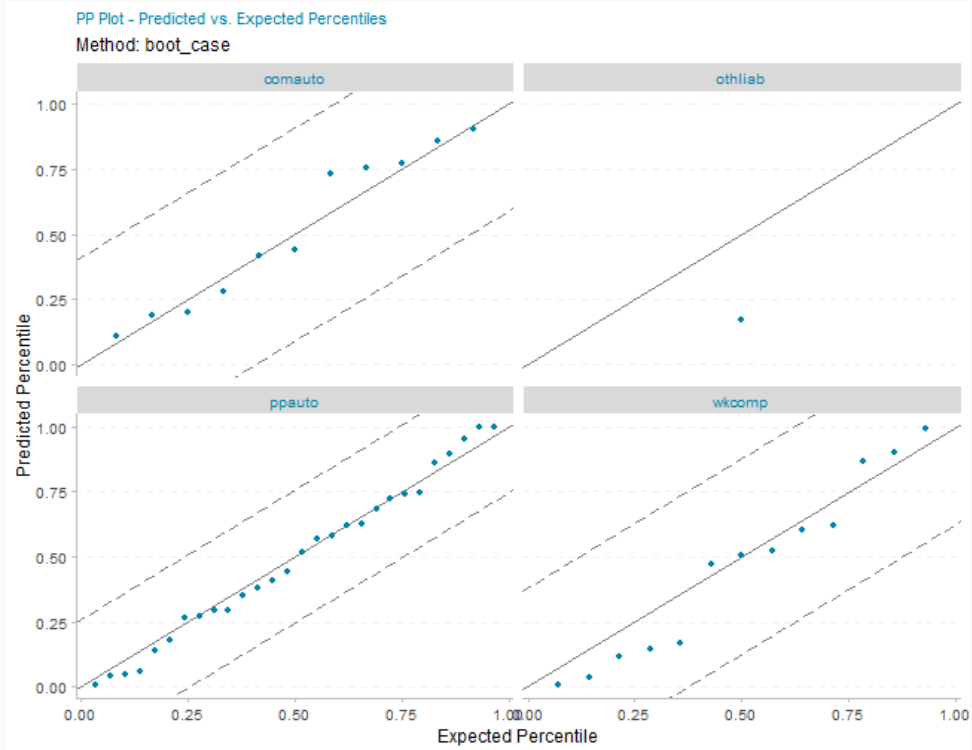
ODP Bootstrap - Paid

```
create_pp_plot(boot_paid_results_all, by_line = TRUE)
```
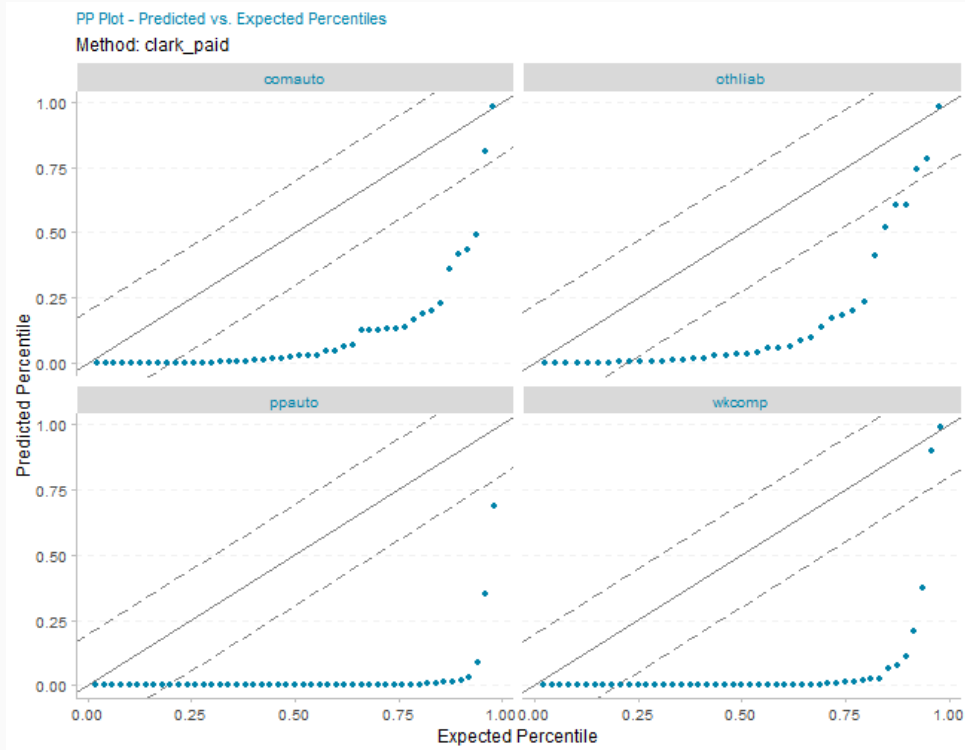
ODP Bootstrap - Case-Incurred

```
create_pp_plot(boot_case_results_all, by_line = TRUE)
```
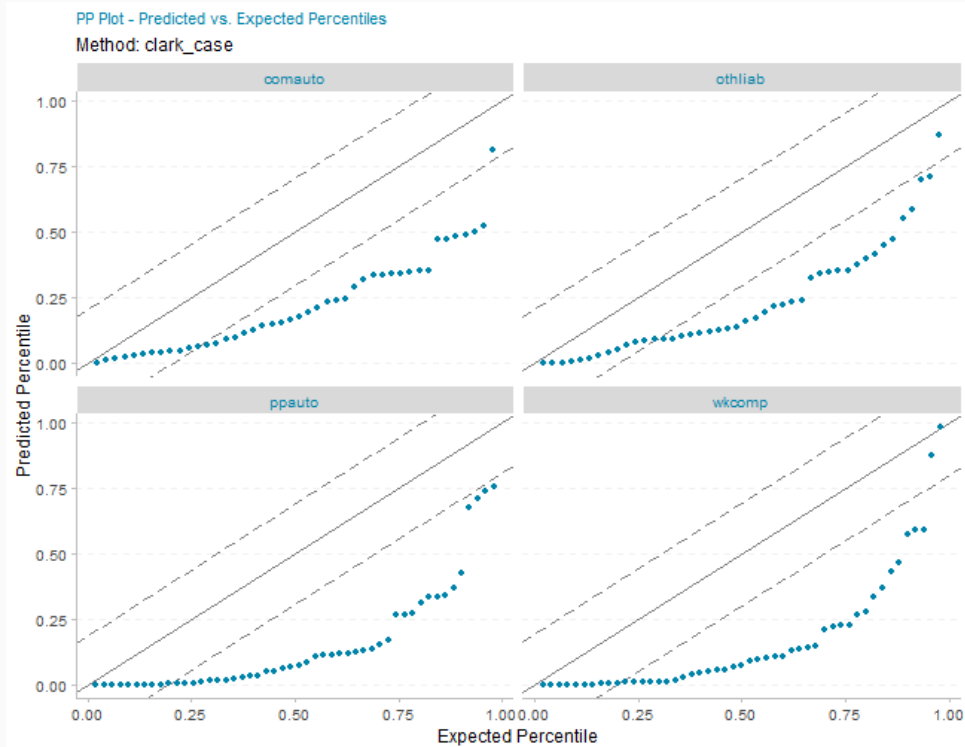
Clark Cape Cod - Paid

```
create_pp_plot(clark_paid_results_all, by_line = TRUE)
```
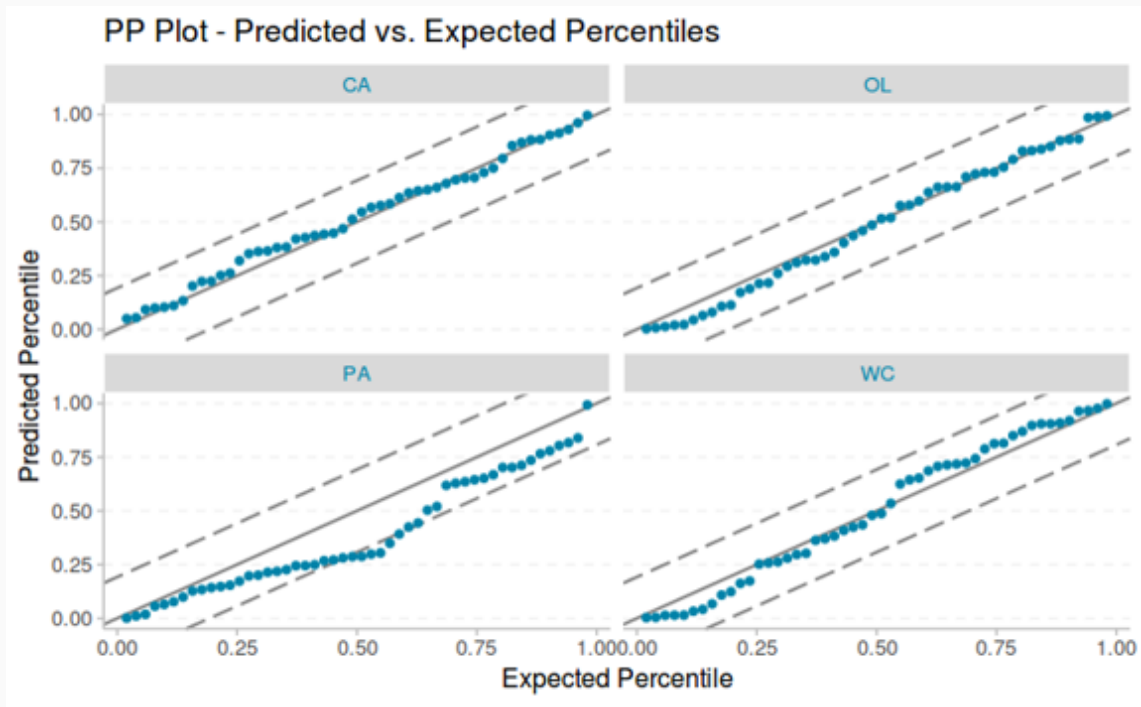
Clark Cape Cod - Case-Incurred

```
create_pp_plot(clark_case_results_all, by_line = TRUE)
```

PP Plot - Predicted vs. Expected Percentiles

The future

reservetestr enhancements

- Add error metrics for deterministic methods
- Create an object structure using S3 class system
- Add more error handling
- Add `testr_` functions for the other methods in `ChainLadder`
- Add ability to test several methods at once

Contact

- adam.troyer@aonbenfield.com