

Example P&C Actuarial Analysis

Industry General Liability Trends

Illustrated using the Barnett-Zehnwirth PTF method inside the Bedford Actuarial Stochastic Reserving (BASR) software.



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This is meant to be an exploratory example of using the Barnett-Zehnwirth method, as presented in their 2000 paper "Best Estimates for Reserves", inside the BASR software using 2025 P&C Industry Schedule P data for the Other Liability - Occurrence line of business. While there is no industry data source specifically for commercial general liability, OL-Occ is a frequently used reasonable proxy. In this example, I have also used US GDP as a proxy for an industry wide GL exposure index.

For additional details on the specifics of this method, refer to the overview in my previous LinkedIn article titled "Are We Properly Modeling Calendar Year Effects?" or the original Barnett-Zehnwirth paper referenced above.

You can explore this model and others, including GLM models using the same structure, in the free demo of the software at bedfordactuarial.com/basr.

This presentation is not meant to be a complete actuarial analysis but rather an informational demonstration of the usefulness and output of this model, including observed trends in the sample data, and does not constitute an actuarial opinion.

Pay attention to the shape of the residuals in the graphs by parameter and in the triangular heatmap as we add parameter selections.

[illegible]

We want to select parameters where there is a statistically significant change, which can be visually indicated by a change in slope of the LOWESS residual curve and verified with the statistical diagnostics. After an initial DY 1 parameter, DY 4 is the next obvious choice.



Data Source

Schedule P

User Data

Company
P&C Industry

Line of business
OL-Occ

Valuation
2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood

3.30

77.66 prev

Automated Wizard

79.77

BIC

1.41

-107.22 prev

Automated Wizard

-119.46

AICc

-2.38

-123.86 prev

Automated Wizard

-134.54

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Load Wizard Selections

Clear All Selections

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, AY_2018, AY_2023

Wizard

All

Clear

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%	-22.7%
± SE	—	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
t-stat	—	-20.14	—	—	—	—	—	—	—	—	—
p-value	—	<.001	—	—	—	—	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2018, CY_2021, CY_2023

Wizard

All

Clear

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2018, AY_2023

Wizard

All

Clear

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Clear Exclusions

The DY curve is now much flatter, though the slope still appears to change at DY 2.



Data Source

Schedule P

User Data

Company
P&C Industry

Line of business
OL-Occ

Valuation
2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

Exposure Adjustment

Aggregation Models

Future AY Projection

Methods Used

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap (Simplified GLM)

MCMC (Meyers Bayesian)

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood

22.20

3.30 prev

Automated Wizard

79.77

BIC

-32.37

1.41 prev

Automated Wizard

-119.46

AICc

-37.92

-2.38 prev

Automated Wizard

-134.54

Automated Wizard selection:

DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

1

2

3

4

5

6

7

8

9

10

Tail

Incr. Decay	—	-10.2%	-10.2%	-10.2%	-30.2%	-30.2%	-30.2%	-30.2%	-30.2%	-30.2%	-30.2%
± SE	—	±2.0%	±2.0%	±2.0%	±1.4%	±1.4%	±1.4%	±1.4%	±1.4%	±1.4%	±1.4%
t-stat	—	-4.88	—	—	-6.79	—	—	—	—	—	—
p-value	—	<.001	—	—	<.001	—	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2018, CY_2021, CY_2023

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2018, AY_2023

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Clear Exclusions

AY

DY

We will revisit final DY selections later, but it now seems we have picked up most of the signal. Notice the pattern in the heatmap triangle now. Let's pick our first CY trend now.



Data Source

Schedule P

User Data

Company
P&C Industry

Line of business
OL-Occ

Valuation
2025 Sch P

P&C Industry / OL-Occ 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood24.4122.20 prevAutomated Wizard79.77

BIC-32.79-32.37 prevAutomated Wizard-119.46

AICc-40.02-37.92 prevAutomated Wizard-134.54

Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

Wizard Selection CriterionLRT (p<0.05)

Historical Trend IndexNone

Max Development Period15

AY ParameterizationTrends

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4

Wizard

All

Clear

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	-0.4%	-15.2%	-15.2%	-29.2%	-29.2%	-29.2%	-29.2%	-29.2%	-29.2%	-29.2%
± SE	—	±5.3%	±3.0%	±3.0%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%
t-stat	—	-0.07	-2.08	—	-3.54	—	—	—	—	—	—
p-value	—	0.94	0.04	—	<.001	—	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2018, CY_2021, CY_2023

Wizard

All

Clear

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2018, AY_2023

Wizard

All

Clear

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Clear Exclusions

Eyeballing the smoothed regression line there is clearly a break at CY 2021 but looking more closely at the individual residuals and knowing the pandemic affected several years we can see there is a clear drop from CY 2019 to 2020.

[illegible]

Next, let's select the more obvious CY 2021 parameter. Know that the parameter breakpoint selections here affect trends after the given point (e.g., a parameter at CY 2021 affects the CY 2022 trend, and all periods until the next breakpoint is selected).

Data |
 Barnett-Zehnwirth (Lognormal PTF) |
 GLM Models | ODP Bootstrap | MCMC | Deterministic | Bornhuetter-Ferguson | Frequency x Severity | Final Summary

Data Source

Schedule P ☐ User Data ☐

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016–2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Diagnostic Dashboard

Log-Likelihood ⊕
39.31
43.49 prev
Automated Wizard
79.77

BIC ⊕
-54.58
-66.94 prev
Automated Wizard
-119.46

AICc ⊕
-64.87
-75.75 prev
Automated Wizard
-134.54

Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Residuals vs DY
Wizard selection: DY_1, DY_2, DY_4

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay ⊕	—	-1.2%	-16.9%	-16.9%	-31.5%	-31.5%	-31.5%	-31.5%	-31.5%	-31.5%	-31.5%
± SE ⊕	—	±5.5%	±2.3%	±2.3%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
t-stat ⊕	—	-0.22	-2.33	—	-5.20	—	—	—	—	—	—
p-value ⊕	—	0.83	0.02	—	<.001	—	—	—	—	—	—

Residuals vs AY
Wizard selection: AY_2018, AY_2023

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend ⊕	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE ⊕	—	—	—	—	—	—	—	—	—	—
t-stat ⊕	—	—	—	—	—	—	—	—	—	—
p-value ⊕	—	—	—	—	—	—	—	—	—	—

Residuals vs CY
Wizard selection: CY_2018, CY_2021, CY_2023

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend ⊕	—	-2.0%	-2.0%	-2.0%	+6.9%	+6.9%	+6.9%	+6.9%	+6.9%	+6.9%	+6.9%
± SE ⊕	—	±3.5%	±3.5%	±3.5%	±1.1%	±1.1%	±1.1%	±1.1%	±1.1%	±1.1%	±1.1%
t-stat ⊕	—	-0.57	—	—	2.14	—	—	—	—	—	—
p-value ⊕	—	0.57	—	—	0.04	—	—	—	—	—	—

Residual Heatmap
Click a cell to exclude / restore it from the fit.

The AY 2024-25 observations are much lower than our model currently predicts- there could be many reasons for this you would want to explore in a full analysis. While I don't necessarily want to leverage this into my final ultimate selection, I will allow a parameter to pick this up in this example.

[illegible]

There is a pretty obvious AY breakpoint at AY 2018 we can now select.



Data Source

☒ Schedule P ☐ User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data Barnett-Zehnwirth (Lognormal PTF) GLM Models ODP Bootstrap MCMC Deterministic Bornhuetter-Ferguson Frequency x Severity Final Summary

Paid Loss Reported Loss MPTF Copula

Diagnostic Dashboard

Log-Likelihood

70.10

52.66 prev

Automated Wizard

79.77

BIC

-108.13

-77.28 prev

Automated Wizard

-119.46

AICc

-121.06

-88.94 prev

Automated Wizard

-134.54

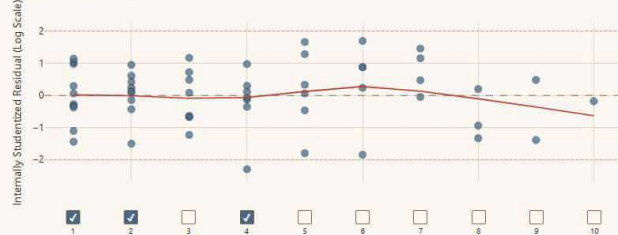
Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

Residuals vs DY

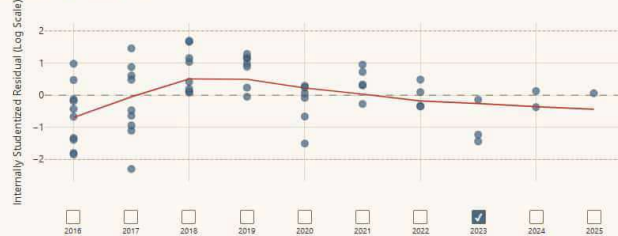
Wizard selection: DY_1, DY_2, DY_4



DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	-6.5%	-17.9%	-17.9%	-31.7%	-31.7%	-31.7%	-31.7%	-31.7%	-31.7%	-31.7%
± SE	—	±2.3%	±1.1%	±1.1%	±0.7%	±0.7%	±0.7%	±0.7%	±0.7%	±0.7%	±0.7%
t-stat	—	-2.78	-4.22	—	-8.58	—	—	—	—	—	—
p-value	—	0.008	<.001	—	<.001	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2018, AY_2023



AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-17.6%	-17.6%
± SE	—	—	—	—	—	—	—	—	±2.3%	±2.3%
t-stat	—	—	—	—	—	—	—	—	-6.82	—
p-value	—	—	—	—	—	—	—	—	<.001	—

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Residuals vs CY

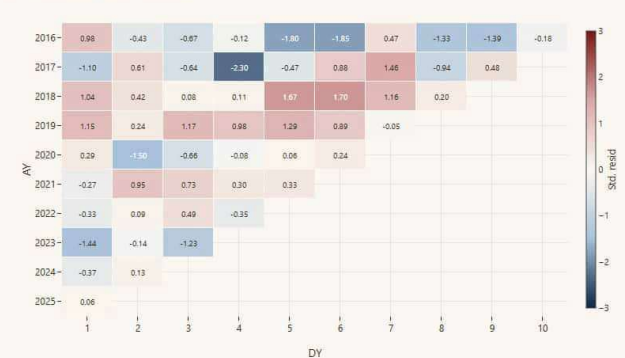
Wizard selection: CY_2018, CY_2021, CY_2023



CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	+6.0%	+6.0%	+6.0%	-2.6%	-2.6%	+10.9%	+10.9%	+10.9%	+10.9%	+10.9%
± SE	—	±1.6%	±1.6%	±1.6%	±1.3%	±1.3%	±0.8%	±0.8%	±0.8%	±0.8%	±0.8%
t-stat	—	3.74	—	—	-3.39	—	7.25	—	—	—	—
p-value	—	<.001	—	—	0.001	—	<.001	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.



There is quite a bit of downward pressure on the AY parameters and there are some rather large residuals in the AY 2017 column. The downward AY trend is partially explained by using unadjusted GDP in the exposure index.



Data Source

☒ Schedule P ☐ User Data

Company ⊙
P&C Industry ⌵

Line of business
OL-Occ ⌵

Valuation ⊙
2025 Sch P ⌵
P&C Industry / OL-Occ, 2025 Sch P, AY 2016–2025.

Options

☒ Exposure Adjustment ⊙

☒ Aggregation Models ⊙

☐ Future AY Projection ⊙

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency × Severity

Project

Save Project

Load Project

Data Barnett-Zehnwirth (Lognormal PTF) GLM Models ODP Bootstrap MCMC Deterministic Bornhuetter-Ferguson Frequency × Severity Final Summary

Paid Loss **Reported Loss** MPTF Copula

Diagnostic Dashboard ?
Log-Likelihood ⊙
75.08
70.10 prev
Automated Wizard
79.77

BIC ⊙
-114.09
-108.13 prev
Automated Wizard
-119.46

AICc ⊙
-128.15
-121.06 prev
Automated Wizard
-134.54

Wizard Selection Criterion ⊙
LRT (p<0.05) ⌵

Historical Trend Index ⊙
None ⌵

Max Development Period ⊙
15

AY Parameterization ⊙
Trends ⌵

Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

Residuals vs DY ⊙
Wizard selection: DY_1, DY_2, DY_4

Wizard

All

Clear

DY	1	2	3	4	5	6	7	8	9	10	Tail
Inc. Decay ⊙	—	-11.8%	-23.0%	-23.0%	-36.1%	-36.1%	-36.1%	-36.1%	-36.1%	-36.1%	-36.1%
± SE ⊙	—	±2.2%	±1.7%	±1.7%	±1.2%	±1.2%	±1.2%	±1.2%	±1.2%	±1.2%	±1.2%
t-stat ⊙	—	-5.12	-4.56	—	-8.31	—	—	—	—	—	—
p-value ⊙	—	<.001	<.001	—	<.001	—	—	—	—	—	—

Residuals vs CY ⊙
Wizard selection: CY_2018, CY_2021, CY_2023

Wizard

All

Clear

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend ⊙	—	+9.2%	+9.2%	+9.2%	+3.9%	+3.9%	+19.9%	+19.9%	+19.9%	+19.9%	+19.9%
± SE ⊙	—	±1.7%	±1.7%	±1.7%	±2.3%	±2.3%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%
t-stat ⊙	—	5.54	—	—	-1.87	—	7.37	—	—	—	—
p-value ⊙	—	<.001	—	—	0.07	—	<.001	—	—	—	—

Residuals vs AY ⊙
Wizard selection: AY_2018, AY_2023

Wizard

All

Clear

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend ⊙	—	0.0%	0.0%	-8.2%	-8.2%	-8.2%	-8.2%	-8.2%	-22.0%	-22.0%
± SE ⊙	—	—	—	±1.9%	±1.9%	±1.9%	±1.9%	±1.9%	±2.2%	±2.2%
t-stat ⊙	—	—	—	-4.18	—	—	—	—	-6.39	—
p-value ⊙	—	—	—	<.001	—	—	—	—	<.001	—

Residual Heatmap ⊙
Click a cell to exclude / restore it from the fit.

Clear Exclusions

Picking an AY 2017 breakpoint relieved some of that pressure and reduced the residuals. We now have a first pass in each direction. Moving back to CY, there is a pretty clear breakpoint at CY 2022 now.



Data Source

☒ Schedule P ☐ User Data

Company ⌵
P&C Industry

Line of business ⌵
OL-Occ

Valuation ⌵
2025 Sch P

P&C Industry / OL-Occ: 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment ⌵

☒ Aggregation Models ⌵

☐ Future AY Projection ⌵

Methods Used

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Project

Save Project

Load Project

DataBarnett-Zehnwirth (Lognormal PTF)GLM ModelsODP BootstrapMCMCDeterministicBornhuetter-FergusonFrequency x SeverityFinal Summary

Paid LossReported LossMPFPCopula

Diagnostic Dashboard ⓘ
Log-Likelihood ⓘ
76.65
75.08 prev
Automated Wizard

BIC ⓘ
-113.22
-114.09 prev
Automated Wizard

AICc ⓘ
-128.30
-128.15 prev
Automated Wizard

Wizard Selection Criterion ⓘ
LRT (p<0.05) ⌵

Max Development Period ⓘ
15

Historical Trend Index ⓘ
None

AY Parameterization ⓘ
Trends

Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

Residuals vs DY
Wizard selection: DY_1, DY_2, DY_4

Wizard

All

Clear

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay ⓘ	—	-8.0%	-19.7%	-19.7%	-33.3%	-33.3%	-33.3%	-33.3%	-33.3%	-33.3%	-33.3%
± SE ⓘ	—	±3.3%	±2.8%	±2.8%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%
t-stat ⓘ	—	-2.34	-4.67	—	-8.45	—	—	—	—	—	—
p-value ⓘ	—	0.02	<.001	—	<.001	—	—	—	—	—	—

Residuals vs CY
Wizard selection: CY_2018, CY_2021, CY_2023

Wizard

All

Clear

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend ⓘ	—	+4.9%	+4.9%	+4.9%	-0.9%	-0.9%	+15.0%	+15.0%	+15.0%	+15.0%	+15.0%
± SE ⓘ	—	±3.1%	±3.1%	±3.1%	±3.6%	±3.6%	±3.7%	±3.7%	±3.7%	±3.7%	±3.7%
t-stat ⓘ	—	1.67	—	—	-2.16	—	7.73	—	—	—	—
p-value ⓘ	—	0.17	—	—	0.04	—	<.001	—	—	—	—

Residuals vs AY
Wizard selection: AY_2018, AY_2023

Wizard

All

Clear

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend ⓘ	—	0.0%	+8.1%	-4.3%	-4.3%	-4.3%	-4.3%	-4.3%	-18.6%	-18.6%
± SE ⓘ	—	—	±5.4%	±3.1%	±3.1%	±3.1%	±3.1%	±3.1%	±3.1%	±3.1%
t-stat ⓘ	—	—	1.56	-3.88	—	—	—	—	-6.52	—
p-value ⓘ	—	—	0.13	<.001	—	—	—	—	<.001	—

Residual Heatmap
Click a cell to exclude / restore it from the fit.

Clear Exclusions

More subtle due to the smoothing of the regression line, the CY 2020 residuals look a little lower than CY 2019 and 2021, so let's test a breakpoint there.



Data Source

☒ Schedule P ☐ User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data Barnett-Zehnwirth (Lognormal PTF) GLM Models ODP Bootstrap MCMC Deterministic Bornhuetter-Ferguson Frequency x Severity Final Summary

Paid Loss Reported Loss MPTF Copula

Diagnostic Dashboard

Log-Likelihood

77.07

76.65 prev

Automated Wizard

79.77

Automated Wizard selection: DY_1, DY_2, DY_4, CY_2018, CY_2021, CY_2023, AY_2018, AY_2023

Load Wizard Selections

Clear All Selections

BIC

-110.07

-113.22 prev

Automated Wizard

-119.46

AICc

-126.01

-128.30 prev

Automated Wizard

-134.54

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

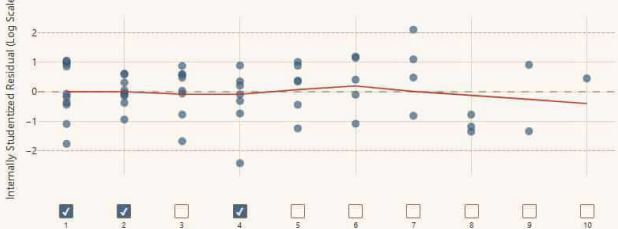
15

AY Parameterization

Trends

Residuals vs DY

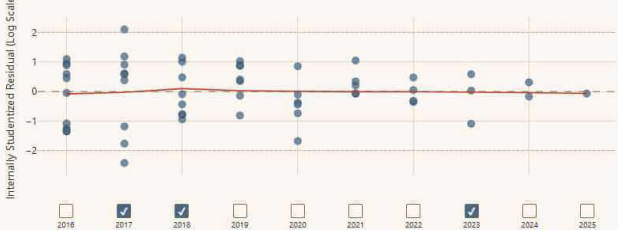
Wizard selection: DY_1, DY_2, DY_4



DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	-9.2%	-21.2%	-21.2%	-34.4%	-34.4%	-34.4%	-34.4%	-34.4%	-34.4%	-34.4%
± SE	—	±3.6%	±2.9%	±2.9%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%	±2.2%
t-stat	—	-2.48	-4.29	—	-6.56	—	—	—	—	—	—
p-value	—	0.02	<.001	—	<.001	—	—	—	—	—	—

Residuals vs AY

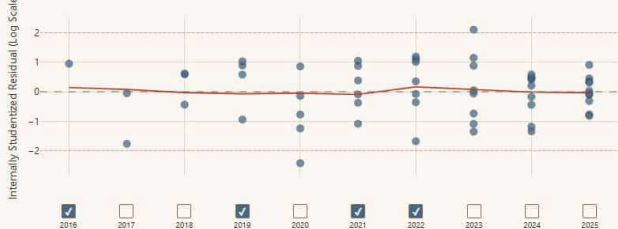
Wizard selection: AY_2018, AY_2023



AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	+7.3%	-6.6%	-6.6%	-6.6%	-6.6%	-6.6%	-18.4%	-18.4%
± SE	—	—	±5.7%	±3.2%	±3.2%	±3.2%	±3.2%	±3.2%	±3.4%	±3.4%
t-stat	—	—	1.32	-4.15	—	—	—	—	-4.47	—
p-value	—	—	0.19	<.001	—	—	—	—	<.001	—

Residuals vs CY

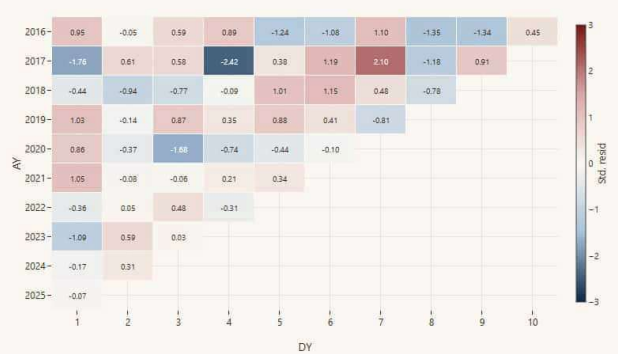
Wizard selection: CY_2018, CY_2021, CY_2023



CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	+6.1%	+6.1%	+6.1%	-0.5%	-0.5%	+27.1%	+14.7%	+14.7%	+14.7%	+14.7%
± SE	—	±3.5%	±3.5%	±3.5%	±3.9%	±3.9%	±5.7%	±4.0%	±4.0%	±4.0%	±4.0%
t-stat	—	1.81	—	—	-2.07	—	5.60	-2.68	—	—	—
p-value	—	0.08	—	—	0.04	—	<.001	0.01	—	—	—

Residual Heatmap

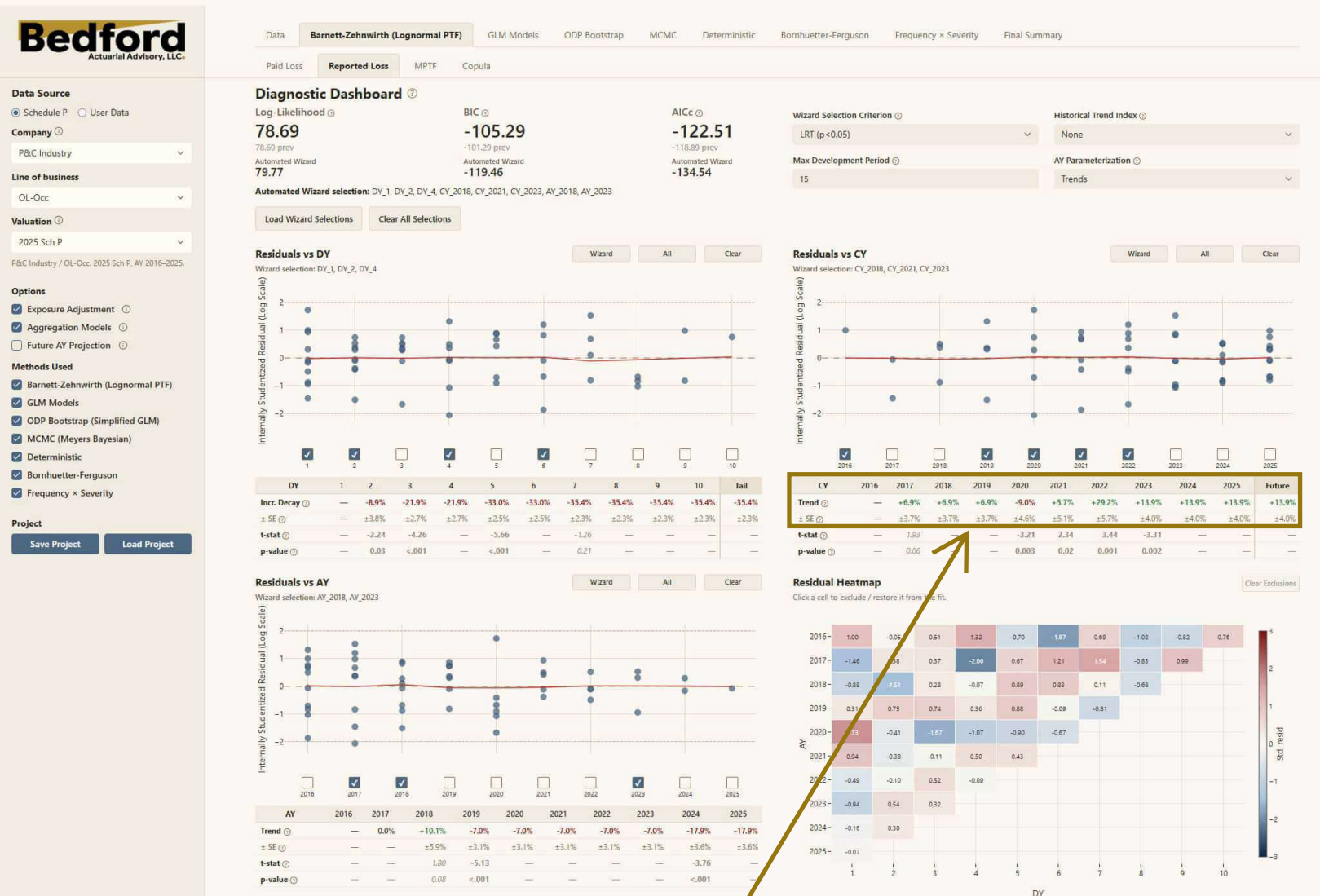
Click a cell to exclude / restore it from the fit.



The CY 2020 parameter was statistically significant and makes sense given the trends during the pandemic. Returning for a final look at the DY direction, there looks to be a breakpoint at DY 6.

[illegible]

Our residuals now look pretty good and we have a model that makes sense. We can test alternative selections, but I landed here as the final reported loss model fit.



You can see our final modeled CY trends in the reported loss data here

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Data Source

☒ Schedule P ☐ User Data

Company ⓘ

P&C Industry ▼

Line of business

OL-Occ ▼

Valuation ⓘ

2025 Sch P ▼

P&C Industry / OL-Occ. 2025 Sch P, AY 2026-2025.

Options

☒ Exposure Adjustment ⓘ

☒ Aggregation Models ⓘ

☐ Future AY Projection ⓘ

Methods Used

☒ Barnett-Zehrwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency × Severity

Project

Save Project Load Project

Future CY / DY Assumptions

Override the projected trend in future calendar years (CY) or development years past the observed triangle (DY tail). Each panel shows the trend **Mean** and its **Standard Error** (the estimation precision from the fit). Both default to the fitted values and are editable; overriding the trend freezes it past the boundary and applies the **Standard Error** you supply.

Model-implied DY tail decay: $-35.40\% \pm 2.34\%$ per DY

- Model Decomposition

Tan cells : projected expected incrementals. **Implied Tail Factor** = Ultimate / Cumulative projection at last triangle age

AY	Ultimate ①	Case Reserves ②	IBNR ③	Unpaid ④
2016	20,297,693	761,726	825,697	1,587,423
2017	22,229,389	1,203,637	1,416,669	2,620,306
2018	27,300,031	1,711,187	2,649,597	4,360,784
2019	29,835,371	2,270,324	4,093,318	6,363,642
2020	29,124,896	2,800,512	5,966,104	8,766,616
2021	35,367,173	4,014,601	9,648,659	13,663,260
2022	41,179,146	5,929,960	15,232,394	21,162,354
2023	46,138,055	7,392,284	23,131,554	30,523,838
2024	44,892,053	6,632,734	29,209,053	35,841,787
2025	43,200,115	4,207,956	35,705,343	39,913,299
Total	339,564,370	36,924,921	127,878,386	164,803,307

Now with our model fully parameterized we can simulate the range of outcomes.



Data Source

☒ Schedule P ☐ User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project Load Project

Data	Barnett-Zehnwirth (Lognormal PTF)	GLM Models	ODP Bootstrap	MCMC	Deterministic	Bornhuetter-Ferguson	Frequency x Severity	Final Summary
Paid Loss	Reported Loss	MPTF	Copula					

IBNR Projection

Empirical percentiles from the parametric Monte Carlo simulation (MVN draw on β' covariance + family-appropriate process noise).

AY	IBNR	SE	50th %ile	75th %ile	90th %ile	95th %ile	99th %ile	99.5th %ile
2016	825,697	124,270	812,661	901,990	987,328	1,038,729	1,157,559	1,211,705
2017	1,416,669	182,019	1,400,621	1,529,024	1,650,295	1,729,029	1,892,370	1,958,537
2018	2,649,597	351,653	2,613,120	2,859,320	3,098,215	3,256,341	3,590,520	3,709,554
2019	4,093,318	524,983	4,040,283	4,420,698	4,771,008	5,004,773	5,501,138	5,721,222
2020	5,966,104	751,038	5,892,396	6,412,276	6,947,949	7,269,479	7,942,190	8,231,498
2021	9,648,659	1,163,279	9,564,626	10,407,824	11,163,059	11,656,426	12,788,913	13,114,889
2022	15,232,394	1,872,655	15,068,800	16,381,830	17,682,553	18,541,905	20,457,319	21,142,223
2023	23,131,554	2,881,556	22,923,270	24,902,127	26,829,779	28,109,408	31,007,445	32,232,803
2024	29,209,053	3,776,783	28,891,603	31,491,109	34,057,707	35,812,399	39,769,605	41,397,611
2025	35,705,343	5,091,626	35,275,359	38,768,791	42,491,288	44,680,543	49,913,574	51,601,093
Total	127,878,386	15,821,358	126,482,985	137,443,213	148,474,103	155,502,252	171,350,316	177,944,783

Calendar-Year Unpaid (future payment diagonals)

CY	Mean	SE	50th %ile	75th %ile	90th %ile	95th %ile	99.5th %ile
2026	32,839,282	1,854,020	32,795,926	34,036,102	35,265,770	36,000,237	37,757,801
2027	26,392,597	2,276,985	26,286,661	27,864,267	29,380,644	30,257,761	32,807,584
2028	20,316,427	2,418,953	20,152,672	21,817,687	23,434,863	24,556,650	27,454,480
2029	14,800,414	2,250,636	14,646,564	16,220,726	17,733,873	18,778,306	21,458,923
2030	10,697,197	1,969,224	10,482,981	11,916,307	13,195,352	14,191,237	16,711,161
2031	7,540,440	1,665,178	7,345,064	8,524,865	9,766,283	10,444,428	13,015,130
2032	5,283,570	1,352,218	5,124,307	6,083,511	7,059,908	7,763,021	9,875,877
2033	3,648,809	1,065,366	3,491,662	4,234,567	5,053,926	5,621,753	7,330,608
2034	2,491,787	817,873	2,359,696	2,947,120	3,560,278	3,991,252	5,462,208
2035	1,659,521	606,152	1,561,319	1,984,759	2,454,025	2,803,703	3,883,598
2036	1,069,095	429,213	992,032	1,297,543	1,629,955	1,881,596	2,632,112
2037	641,644	283,247	585,836	780,335	1,015,609	1,178,854	1,667,698
2038	337,580	161,837	304,112	414,214	553,243	647,505	954,893
2039	134,188	70,566	118,067	164,785	225,344	269,800	422,224
Total	127,852,552	15,821,358	126,482,985	137,443,213	148,474,103	155,502,252	177,944,783

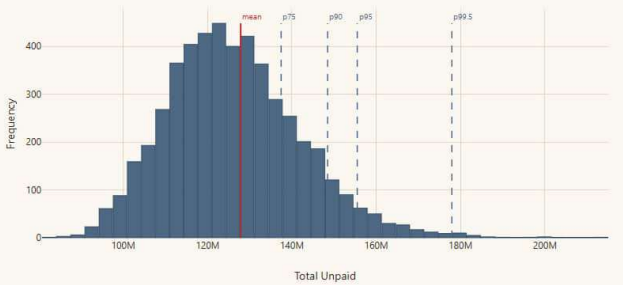
One-Year Reserve Risk (CDR)

How much this method's reserve estimate is expected to move after one more calendar year of experience — the Solvency II / ORSA one-year reserve-risk input. The no-refit Merz-Wüthrich CDR equals next year's simulated diagonal, recentered to zero.

AY	Expected Next-Year Reported Development	CDR SD	0.5%	50%	99.5%
2016	284,281	40,010	-86,774	—	116,891
2017	459,164	58,183	-128,698	—	169,579
2018	821,203	101,355	-226,292	—	286,620
2019	1,234,232	142,357	-325,576	—	399,261
2020	1,767,046	201,911	-442,009	—	572,505
2021	2,815,662	217,776	-505,153	—	606,559
2022	4,291,394	323,535	-772,949	—	892,519
2023	6,359,995	490,577	-1,145,879	—	1,378,809
2024	7,031,015	539,598	-1,338,909	—	1,494,279
2025	7,775,290	680,779	-1,542,003	—	1,855,480
Total	32,839,282	1,854,020	-4,543,870	-43,356	4,918,519

Monte Carlo Iterations 5000 Seed (0 = Random) 11 Run Monte Carlo Simulation

Total IBNR distribution (5,000 sims)

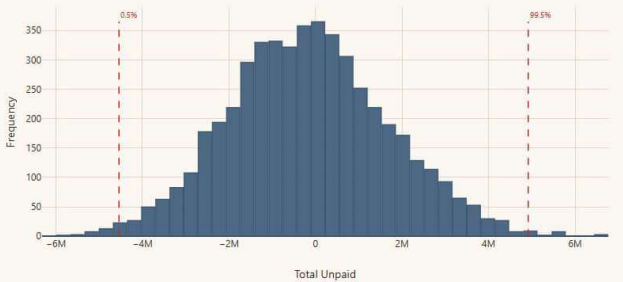


Tail Value at Risk (total unpaid)

VaR = the percentile of the total. TVaR = the average outcome at or beyond it (the expected severity of the upper tail).

Level	VaR	TVaR
75%	137,443,213	148,826,791
90%	148,474,103	158,440,948
95%	155,502,252	165,357,286
97.5%	162,508,203	172,049,417
99%	171,350,316	180,552,763
99.5%	177,944,783	186,308,788

One-Year CDR distribution (5,000 sims)



Now for comparison, let's fit our paid loss model.

Bedford

Actuarial Advisory, LLC.

Data Source

Schedule P

User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Wizard

All

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DY 2 is the next obvious choice.

Bedford
Actuarial Advisory, LLC.

Barnett-Zehnwirth (Lognormal PTF)

Data	Barnett-Zehnwirth (Lognormal PTF)	GLM Models	ODP Bootstrap	MCMC	Deterministic	Bornhuetter-Ferguson	Frequency x Severity	Final Summary
Paid Loss	Reported Loss	MPTF	Copula					

Diagnostic Dashboard

Log-Likelihood -**-30.81**
78.33 prev
Automated Wizard

BIC -**69.64**
-108.57 prev
Automated Wizard

AICC -**65.86**
-125.23 prev
Automated Wizard

Automated Wizard selection: DY_1, DY_2, DY_4, DY_7, CY_2021, CY_2022, AY_2022

Load Wizard Selections Clear All Selections

Wizard Selection Criterion

LRT ($p < 0.05$)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4, DY_7

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%	-2.7%
± SE	—	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%	±2.4%
t-stat	—	-1.12	—	—	—	—	—	—	—	—	—
p-value	—	0.27	—	—	—	—	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2021, CY_2022

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2022

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Options

- ☒ Exposure Adjustment
- ☒ Aggregation Models
- ☐ Future AY Projection

Methods Used

- ☒ Barnett-Zehnwirth (Lognormal PTF)
- ☒ GLM Models
- ☒ ODP Bootstrap (Simplified GLM)
- ☒ MCMC (Meiers Bayesian)
- ☒ Deterministic
- ☒ Bornhueter-Ferguson
- ☒ Frequency x Severity

Project

Save Project Load Project

Data Source

Schedule P User Data

Company: P&C Industry

Line of business: OL-Occ

Valuation: 2025 Sch P

P&C Industry / OL-Occ. 2025 Sch P, AY 2016–2025.

Now let's pick DY 4 as the residuals are clearly increasing before and decreasing after.

[illegible]

We'll revisit DY at the end but let's begin picking up the CY signal now.



Data Source

Schedule P

User Data

Company
P&C Industry

Line of business
OL-Occ

Valuation
2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood

21.63

3.95 prev

Automated Wizard

58.34

BIC

-27.23

4.10 prev

Automated Wizard

-84.63

AICc

-34.46

-1.46 prev

Automated Wizard

-97.55

Automated Wizard selection: DY_1, DY_2, DY_4, DY_7, CY_2021, CY_2022, AY_2022

Load Wizard Selections

Clear All Selections

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4, DY_7

Wizard

All

Clear

☒ 1

☒ 2

☐ 3

☒ 4

☐ 5

☐ 6

☐ 7

☐ 8

☐ 9

☐ 10

☐ Tail

Incr. Decay	—	+69.0%	+9.4%	+9.4%	-24.0%	-24.0%	-24.0%	-24.0%	-24.0%	-24.0%
± SE	—	±12.6%	±4.1%	±4.1%	±1.4%	±1.4%	±1.4%	±1.4%	±1.4%	±1.4%
t-stat	—	7.04	-4.35	—	-7.41	—	—	—	—	—
p-value	—	<.001	<.001	—	<.001	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2021, CY_2022

Wizard

All

Clear

☐ 2016

☐ 2017

☐ 2018

☐ 2019

☐ 2020

☐ 2021

☐ 2022

☐ 2023

☐ 2024

☐ 2025

☐ Future

Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2022

Wizard

All

Clear

☐ 2016

☐ 2017

☐ 2018

☐ 2019

☐ 2020

☐ 2021

☐ 2022

☐ 2023

☐ 2024

☐ 2025

Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Clear Exclusions

Picking CY 2019 or CY 2021 next makes sense.



Data Source

Schedule P

User Data

Company
P&C Industry

Line of business
OL-Occ

Valuation
2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood

46.58

21.63 prev

BIC

-73.12

-27.23 prev

AICc

-81.93

-34.46 prev

Automated Wizard

58.34

Automated Wizard

Automated Wizard selection:

DY_1, DY_2, DY_4, DY_7, CY_2021, CY_2022, AY_2022

Load Wizard Selections

Clear All Selections

Wizard Selection Criterion

LRT (p<0.05)

Historical Trend Index

None

Max Development Period

15

AY Parameterization

Trends

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4, DY_7

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	+65.5%	+5.5%	+5.5%	+5.5%	-25.5%	-25.5%	-25.5%	-25.5%	-25.5%	-25.5%	-25.5%
± SE	±6.5%	±2.2%	±2.2%	±2.2%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
t-stat	12.90	-8.46	—	-11.75	—	—	—	—	—	—	—
p-value	<.001	<.001	—	<.001	—	—	—	—	—	—	—

Residuals vs CY

Wizard selection: CY_2021, CY_2022

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend	—	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%
± SE	—	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%	±0.6%
t-stat	8.33	—	—	—	—	—	—	—	—	—	—
p-value	<.001	—	—	—	—	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2022

Wizard

All

Clear

Internally Studentized Residual (Log Scale)

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Residual Heatmap

Click a cell to exclude / restore it from the fit.

Clear Exclusions

Looking better. Now let's pick CY 2019.

[illegible]

Similar to the reported losses, we're seeing lower AY 2024-25 paid losses. While we would want to explore deeper before picking as our ultimate loss estimate, let's pick a breakpoint at AY 2024.

Bedford
Actuarial Advisory, LLC.

Data Source

Schedule P User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016–2025.

Options

☒ Exposure Adjustment

☒ Aggregation Models

☐ Future AY Projection

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency × Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency × Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Diagnostic Dashboard

Log-Likelihood

51.71

50.60 prev

Automated Wizard

58.34

BIC

-75.37

-77.15 prev

Automated Wizard

-84.63

AICc

-87.03

-87.44 prev

Automated Wizard

-97.55

Automated Wizard selection: DY_1, DY_2, DY_4, DY_7, CY_2021, CY_2022, AY_2022

Load Wizard Selections

Clear All Selections

Residuals vs DY

Wizard selection: DY_1, DY_2, DY_4, DY_7

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay	—	+64.6%	+6.0%	+6.0%	-25.7%	-25.7%	-25.7%	-25.7%	-25.7%	-25.7%	-25.7%
± SE	—	±6.0%	±2.1%	±2.1%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
t-stat	—	13.76	-8.99	—	-12.71	—	—	—	—	—	—
p-value	—	<.001	<.001	—	<.001	—	—	—	—	—	—

Residuals vs AY

Wizard selection: AY_2022

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	—	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
± SE	—	—	—	—	—	—	—	—	—	—
t-stat	—	—	—	—	—	—	—	—	—	—
p-value	—	—	—	—	—	—	—	—	—	—

Wizard Selection Criterion

LRT ($p < 0.05$)

Historical Trend Index

None

And let's flatten it out further by selecting an AY 2018 breakpoint.

[illegible]

Looking back at the DY table, we see a pretty obvious DY 6 breakpoint selection.

Data |
 Barnett-Zehnwirth (Lognormal PTF) |
 GLM Models | ODP Bootstrap | MCMC | Deterministic | Bornhuetter-Ferguson | Frequency x Severity | Final Summary

Data Source

☒ Schedule P ☐ User Data

Company Ⓞ

P&C Industry ▾

Line of business

OL-Occ ▾

Valuation Ⓞ

2025 Sch P ▾

P&C Industry / OL-Occ 2025 Sch P, AY 2016–2025.

Options

☒ Exposure Adjustment Ⓞ

☒ Aggregation Models Ⓞ

☐ Future AY Projection Ⓞ

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Project

Save Project Load Project

Diagnostic Dashboard ⓘ

Log-Likelihood Ⓞ
65.20
-64.47 prev
Automated Wizard
58.34

BIC Ⓞ
-94.34
-96.89 prev
Automated Wizard
-84.63

AICC Ⓞ
-108.40
-109.62 prev
Automated Wizard
-97.55

Automated Wizard selection: DY_1, DY_2, DY_4, DY_7, CY_2021, CY_2022, AY_2022

Load Wizard Selections Clear All Selections

Residuals vs DY

Wizard All Clear

Wizard selection: DY_1, DY_2, DY_4, DY_7

DY	1	2	3	4	5	6	7	8	9	10	Tail
Incr. Decay Ⓞ	—	+52.3%	+2.0%	+2.0%	-29.5%	-29.5%	-29.5%	-29.5%	-29.5%	-29.5%	-29.5%
± SE Ⓞ	—	±4.8%	±2.8%	±2.8%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%	±1.5%
t-stat Ⓞ	—	13.38	-10.50	—	-14.00	—	—	—	—	—	—
p-value Ⓞ	—	<.001	<.001	—	<.001	—	—	—	—	—	—

Residuals vs AY

Wizard All Clear

Wizard selection: AY_2022

AY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend Ⓞ	—	0.0%	0.0%	-5.0%	-5.0%	-5.0%	-5.0%	-5.0%	-17.4%	-17.4%
± SE Ⓞ	—	—	—	±2.3%	±2.3%	±2.3%	±2.3%	±2.3%	±2.9%	±2.9%
t-stat Ⓞ	—	—	—	-2.08	—	—	—	—	-4.18	—
p-value Ⓞ	—	—	—	0.04	—	—	—	—	<.001	—

Residuals vs CY

Wizard All Clear

Wizard selection: CY_2021, CY_2022

CY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Future
Trend Ⓞ	—	+12.6%	+12.6%	+12.6%	+1.4%	+1.4%	+15.2%	+15.2%	+15.2%	+15.2%	+15.2%
± SE Ⓞ	—	±2.3%	±2.3%	±2.3%	±2.8%	±2.8%	±2.7%	±2.7%	±2.7%	±2.7%	±2.7%
t-stat Ⓞ	—	5.71	—	—	-3.05	—	5.16	—	—	—	—
p-value Ⓞ	—	<.001	—	—	0.004	—	<.001	—	—	—	—

Residual Heatmap

Clear Exclusions

Click a cell to exclude / restore it from the fit.

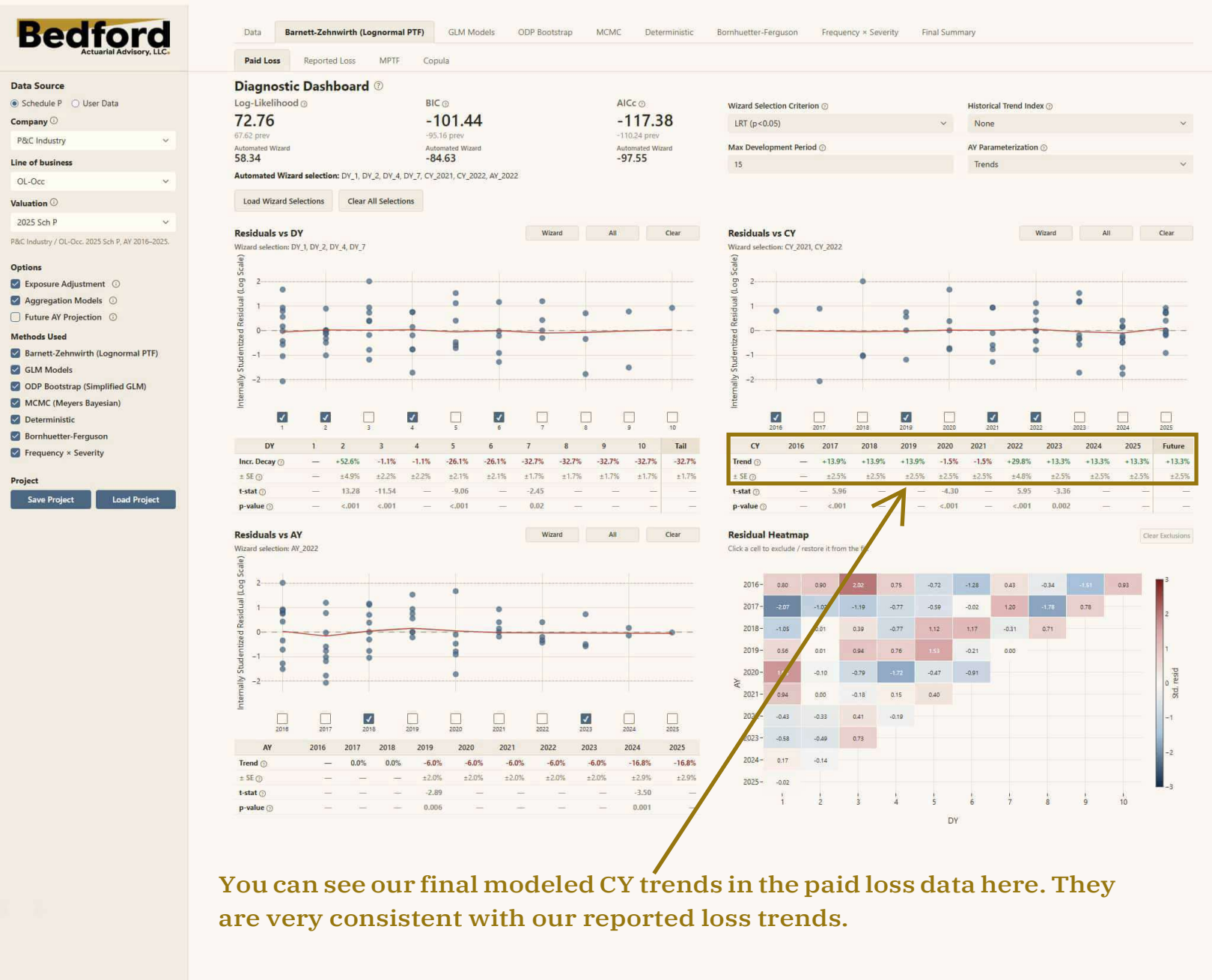
The LOWESS smoothing hides it slightly here but it appears the residual trends break at CY 2022 more so than CY 2023.

[illegible]

We can test alternative breakpoints, but this is where I landed as the best fit, finding the CY 2022 breakpoint did indeed fit better than CY 2023.

[illegible]

We can test alternative breakpoints, but this is where I landed as the best fit, finding the CY 2022 breakpoint did indeed fit better than CY 2023.



You can see our final modeled CY trends in the paid loss data here. They are very consistent with our reported loss trends.

Again, we'll carry forward the last DY decay factor and assumed CY trend will be at 13% before declining slowly to 6%.



Data Source

☒ Schedule P ☐ User Data

Company ⌵
P&C Industry

Line of business
OL-Occ

Valuation ⌵
2025 Sch P

P&C Industry / OL-Occ, 2025 Sch P, AY 2016-2025.

Options

☒ Exposure Adjustment ⌵

☒ Aggregation Models ⌵

☐ Future AY Projection ⌵

Methods Used

☒ Barnett-Zehnwirth (Lognormal PTF)

☒ GLM Models

☒ ODP Bootstrap (Simplified GLM)

☒ MCMC (Meyers Bayesian)

☒ Deterministic

☒ Bornhuetter-Ferguson

☒ Frequency x Severity

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency x Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Future CY / DY Assumptions

Override the projected trend in future calendar years (CY) or development years past the observed triangle (DY tail). Each panel shows the trend **Mean** and its **Standard Error** (the estimation precision from the fit). Both default to the fitted values and are editable; overriding the trend freezes it past the boundary and applies the Standard Error you supply.

Model-implied future CY trend: +13.34% ± 2.49% per CY

Future CY trend

Restore Defaults

Per-year mean (per yr) ☒ Vary by Year

2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
13%	12%	11%	10%	10%	9%	9%	8%	8%	7%	7%	6%	6%	6%

Standard Error (per yr)

2.49%

Model-implied DY tail decay: -32.68% ± 1.68% per DY

Future DY tail

Restore Defaults

Mean (per yr) ☐ Vary by Year

Standard Error (per yr)

-32.68%

1.68%

► Model Decomposition

Expected Incremental Triangle
Tan cells : projected expected incrementals. **Implied Tail Factor** = Ultimate / Cumulative projection at last triangle age.

AY	DY 1	DY 2	DY 3	DY 4	DY 5	DY 6	DY 7	DY 8	DY 9	DY 10	DY 11	DY 12	DY 13	DY 14	DY 15	Implied Tail Factor ⌵
2016	1,534,798	2,683,811	3,239,556	3,380,213	2,249,764	1,483,296	1,569,000	1,097,963	735,293	736,576	510,016	385,490	288,948	214,767	159,730	1.0833
2017	1,531,823	2,840,630	3,168,473	3,167,475	2,331,767	2,314,153	2,023,687	1,107,073	1,124,002	789,819	596,604	446,911	331,969	246,743	181,843	1.0884
2018	1,953,884	3,623,189	3,614,092	3,282,011	3,534,833	3,150,137	2,039,104	1,741,997	1,232,722	930,577	696,652	517,155	384,146	282,929	208,512	1.0832
2019	2,407,672	3,498,551	3,610,136	4,584,254	4,026,961	2,999,731	2,344,424	1,793,888	1,353,736	1,013,093	751,805	558,256	411,023	302,810	221,179	1.0812
2020	2,368,500	3,193,270	3,932,266	4,165,203	3,766,427	2,932,614	2,485,786	1,875,228	1,402,881	1,040,707	772,517	568,581	418,744	305,754	223,393	1.0843
2021	2,324,376	4,348,957	4,820,789	5,515,199	4,694,592	3,850,721	2,903,915	2,171,711	1,610,503	1,195,067	879,282	647,345	472,511	345,111	249,884	1.0776
2022	2,865,003	4,985,696	5,846,267	6,319,826	5,355,038	4,455,537	3,330,963	2,469,339	1,831,737	1,347,257	991,538	723,498	528,246	382,355	276,929	1.0748
2023	3,226,938	5,609,294	6,778,435	7,265,464	6,020,138	4,966,157	3,680,297	2,729,083	2,006,577	1,476,272	1,076,826	785,952	568,693	411,748	295,514	1.0717
2024	3,355,797	5,694,469	6,435,880	7,137,518	5,862,448	4,793,432	3,553,056	2,611,336	1,920,414	1,400,218	1,021,569	738,876	534,745	383,632	275,394	1.0691
2025	3,286,816	5,693,169	6,312,280	6,939,723	5,649,727	4,620,391	3,394,385	2,495,254	1,818,600	1,326,267	958,863	693,670	497,443	356,948	256,294	1.0665

AY	Ultimate ⌵	Case Reserves ⌵	IBNR ⌵	Unpaid ⌵
2016	20,269,221	761,726	797,225	1,558,951
2017	22,202,971	1,203,637	1,390,251	2,593,888
2018	27,191,940	1,711,187	2,541,506	4,252,693
2019	29,877,519	2,270,324	4,135,466	6,405,790
2020	29,451,871	2,800,512	6,293,079	9,093,591
2021	36,029,963	4,014,601	10,311,449	14,326,050
2022	41,709,230	5,929,960	15,762,478	21,692,438
2023	46,897,389	7,392,284	23,890,438	31,282,722
2024	45,718,786	6,632,734	30,035,786	36,668,520
2025	44,299,832	4,207,956	36,805,060	41,013,016
Total	343,648,722	36,924,921	131,962,738	168,887,659

Then run the simulation on our parameterized paid loss model.

Bedford

Actuarial Advisory, LLC.

Data Source

Schedule P

User Data

Company

P&C Industry

Line of business

OL-Occ

Valuation

2025 Sch P

P&C Industry / OL-Occ: 2025 Sch P, AY 2016–2025.

Options

Exposure Adjustment

Aggregation Models

Future AY Projection

Methods Used

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap (Simplified GLM)

MCMC (Meyers Bayesian)

Deterministic

Bornhuetter-Ferguson

Frequency × Severity

Project

Save Project

Load Project

Data

Barnett-Zehnwirth (Lognormal PTF)

GLM Models

ODP Bootstrap

MCMC

Deterministic

Bornhuetter-Ferguson

Frequency × Severity

Final Summary

Paid Loss

Reported Loss

MPTF

Copula

Unpaid Projection

Empirical percentiles from the parametric Monte Carlo simulation (MVN draw on β covariance + family-appropriate process noise).

AY	Unpaid	SE	50th %ile	75th %ile	90th %ile	95th %ile	99th %ile	99.5th %ile
2016	1,558,951	211,258	1,549,784	1,690,001	1,825,448	1,926,479	2,117,246	2,196,336
2017	2,593,888	308,055	2,573,180	2,785,159	2,981,907	3,129,440	3,415,251	3,511,367
2018	4,252,693	434,760	4,228,929	4,532,071	4,809,033	5,002,991	5,348,568	5,532,020
2019	6,405,790	591,122	6,375,866	6,778,830	7,186,751	7,430,764	7,950,718	8,104,883
2020	9,093,591	771,021	9,061,107	9,592,804	10,116,592	10,442,736	10,994,340	11,238,241
2021	14,326,050	1,153,603	14,285,447	15,099,455	15,852,174	16,299,100	17,134,837	17,444,304
2022	21,692,438	1,761,886	21,670,877	22,819,716	24,054,740	24,747,722	26,135,986	26,576,340
2023	31,282,722	2,656,042	31,195,081	33,024,285	34,767,808	35,883,638	38,046,549	38,860,294
2024	36,668,520	3,135,136	36,553,750	38,738,061	40,667,604	41,931,570	44,634,143	45,764,334
2025	41,013,016	4,058,118	40,730,507	43,610,900	46,281,233	47,909,957	51,425,114	52,490,545
Total	168,887,659	12,929,694	168,444,278	177,329,109	185,511,010	190,850,306	201,205,540	205,228,191

Calendar-Year Unpaid (future payment diagonals)

CY	Mean	SE	50th %ile	75th %ile	90th %ile	95th %ile	99.5th %ile
2026	35,397,768	1,517,250	35,346,681	36,378,635	37,400,310	37,994,762	39,496,636
2027	31,966,517	1,854,523	31,948,808	33,186,573	34,347,873	35,053,451	37,168,418
2028	27,105,472	2,032,999	27,018,073	28,451,261	29,711,519	30,526,826	32,785,585
2029	21,063,442	1,927,300	20,977,643	22,333,320	23,614,183	24,357,220	26,570,557
2030	16,050,036	1,764,289	15,995,464	17,217,604	18,363,097	19,100,163	20,942,649
2031	11,696,578	1,490,867	11,636,225	12,659,405	13,628,889	14,274,834	15,922,532
2032	8,463,322	1,237,617	8,386,667	9,281,084	10,101,060	10,615,209	12,043,874
2033	6,015,919	992,897	5,948,159	6,644,411	7,358,041	7,716,158	8,937,818
2034	4,224,916	792,064	4,164,617	4,722,896	5,278,037	5,653,180	6,601,809
2035	2,900,752	606,757	2,842,087	3,273,731	3,715,536	3,990,935	4,760,647
2036	1,918,665	444,810	1,875,474	2,190,087	2,509,577	2,723,868	3,289,940
2037	1,177,406	298,595	1,141,476	1,356,326	1,582,788	1,717,874	2,101,084
2038	632,615	175,473	608,990	733,164	865,795	957,268	1,212,809
2039	256,799	79,129	246,462	302,764	362,116	402,623	527,675
Total	168,870,206	12,929,694	168,444,278	177,329,109	185,511,010	190,850,306	205,228,191

One-Year Reserve Risk (CDR)

How much this method's reserve estimate is expected to move after one more calendar year of experience — the Solvency II / ORSA one-year reserve-risk input. The no-refit Merz-Wüthrich CDR equals next year's simulated diagonal, recentered to zero.

AY	Expected Next-Year Payment	CDR SD	0.5%	50%	99.5%
2016	510,601	70,664	-155,944	—	205,974
2017	788,851	98,387	-216,355	—	302,162
2018	1,232,332	142,925	-317,649	—	406,626
2019	1,796,792	201,775	-456,560	—	598,017
2020	2,487,601	279,141	-618,671	—	826,509
2021	3,840,490	432,131	-951,503	—	1,276,655
2022	5,358,997	375,475	-944,500	—	1,043,421
2023	7,271,428	519,933	-1,234,540	—	1,445,134
2024	6,425,824	445,084	-1,070,959	—	1,220,829
2025	5,684,851	479,137	-1,107,012	—	1,354,063
Total	35,397,768	1,517,250	-3,711,402	-51,087	4,098,868

One-Year CDR distribution (5,000 sims)

Monte Carlo Iterations: 5000
Seed (0 = Random): 11
Run Monte Carlo Simulation

Total Unpaid distribution (5,000 sims)

Tail Value at Risk (total unpaid)

VaR = the percentile of the total. TVaR = the average outcome at or beyond it (the expected severity of the upper tail).

Level	VaR	TVaR
75%	177,329,109	185,669,117
90%	185,511,010	192,590,614
95%	190,850,306	197,336,709
97.5%	196,132,456	201,408,485
99%	201,205,540	206,128,187
99.5%	205,228,191	208,986,369

Summary of model trend selections:

Paid Loss Data

CY	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	13.9%	13.9%	13.9%	-1.5%	-1.5%	29.8%	13.3%	13.3%	13.3%
± SE	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%	±4.8%	±2.5%	±2.5%	±2.5%

Reported Loss Data

CY	2017	2018	2019	2020	2021	2022	2023	2024	2025
Trend	6.9%	6.9%	6.9%	-9.0%	5.7%	29.2%	13.9%	13.9%	13.9%
± SE	±3.7%	±3.7%	±3.7%	±4.6%	±5.1%	±5.7%	±4.0%	±4.0%	±4.0%

Future Loss Trend Assumption

[illegible]

Summary of model estimates:

AY	Paid	Case Reserves	Reported	Paid BZ Ultimate	Reported BZ Ultimate	Implied Paid %	Implied Reported %
2016	18,710,270	761,726	19,471,996	20,269,221	20,297,693	92.3%	95.9%
2017	19,609,083	1,203,637	20,812,720	22,202,971	22,229,389	88.3%	93.6%
2018	22,939,247	1,711,187	24,650,434	27,191,940	27,300,031	84.4%	90.3%
2019	23,471,729	2,270,324	25,742,053	29,877,519	29,835,371	78.6%	86.3%
2020	20,358,280	2,800,512	23,158,792	29,451,871	29,124,896	69.1%	79.5%
2021	21,703,913	4,014,601	25,718,514	36,029,963	35,367,173	60.2%	72.7%
2022	20,016,792	5,929,960	25,946,752	41,709,230	41,179,146	48.0%	63.0%
2023	15,614,667	7,392,284	23,006,951	46,897,389	46,138,505	33.3%	49.9%
2024	9,050,266	6,632,734	15,683,000	45,718,786	44,892,053	19.8%	34.9%
2025	3,286,816	4,207,956	7,494,772	44,299,832	43,200,115	7.4%	17.3%
Total	174,761,063	36,924,921	211,685,984	343,648,722	339,564,370		

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Recall that we allowed a sharp downward AY trend parameter affecting AY 2024-25. That fit the data better, but the reason for lower initial loss levels needs to be fully explored before selecting this method, as parameterized, in those years. There are many other ways to handle this, but I wanted to keep this demonstration simple. Notice that the results are remarkably consistent, even in the heavily leveraged recent years.

Summary of model estimates:

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Summary of model outcome ranges:

Paid Barnett-Zehnwirth Ultimate Estimates							
AY	Ultimate	50th %ile	75th %ile	90th %ile	95th %ile	99th %ile	99.5th %ile
2016	20,269,221	20,260,054	20,400,271	20,535,718	20,636,749	20,827,516	20,906,606
2017	22,202,971	22,182,263	22,394,242	22,590,990	22,738,523	23,024,334	23,120,450
2018	27,191,940	27,168,176	27,471,318	27,748,280	27,942,238	28,287,815	28,471,267
2019	29,877,519	29,847,595	30,250,559	30,658,480	30,902,493	31,422,447	31,576,612
2020	29,451,871	29,419,387	29,951,084	30,474,872	30,801,016	31,352,620	31,596,521
2021	36,029,963	35,989,360	36,803,368	37,556,087	38,003,013	38,838,750	39,148,217
2022	41,709,230	41,687,669	42,836,508	44,071,532	44,764,514	46,152,778	46,593,132
2023	46,897,389	46,809,748	48,638,952	50,382,475	51,498,305	53,661,216	54,474,961
2024	45,718,786	45,604,016	47,788,327	49,717,870	50,981,836	53,684,409	54,814,600
2025	44,299,832	44,017,323	46,897,716	49,568,049	51,196,773	54,711,930	55,777,361
Total	343,648,722	343,205,341	352,090,172	360,272,073	365,611,369	375,966,603	379,989,254

Reported Barnett-Zehnwirth Ultimate Estimates							
AY	Ultimate	50th %ile	75th %ile	90th %ile	95th %ile	99th %ile	99.5th %ile
2016	20,297,693	20,284,657	20,373,986	20,459,324	20,510,725	20,629,555	20,683,701
2017	22,229,389	22,213,341	22,341,744	22,463,015	22,541,749	22,705,090	22,771,257
2018	27,300,031	27,263,554	27,509,754	27,748,649	27,906,775	28,240,954	28,359,988
2019	29,835,371	29,782,336	30,162,751	30,513,061	30,746,826	31,243,191	31,463,275
2020	29,124,896	29,051,188	29,571,068	30,106,741	30,428,271	31,100,982	31,390,290
2021	35,367,173	35,283,140	36,126,338	36,881,573	37,374,940	38,507,427	38,833,403
2022	41,179,146	41,015,552	42,328,582	43,629,305	44,488,657	46,404,071	47,088,975
2023	46,138,505	45,930,221	47,909,078	49,836,730	51,116,359	54,014,396	55,239,754
2024	44,892,053	44,574,603	47,174,109	49,740,707	51,495,399	55,452,605	57,080,611
2025	43,200,115	42,770,131	46,263,563	49,986,060	52,175,315	57,408,346	59,095,865
Total	339,564,370	338,168,969	349,129,197	360,160,087	367,188,236	383,036,300	389,630,767

The results are remarkably consistent.



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