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2025

Addressing Social Inflation

definition, drivers and mitigation strategies

Actuarial Seminar MFF UK,
May 23, 2025
Mgr. Valeriya Plotnikova

About Price Forbes Re

Price Forbes Re is a global specialist risk strategy and reinsurance broker.

- We bring a fresh perspective to help our clients understand their business within the complex and evolving risk landscape.
- We combine reinsurance broking, capital solutions and strategic advisory underpinned by insight driven analytics to deliver tailor made solutions for our clients.

One global team

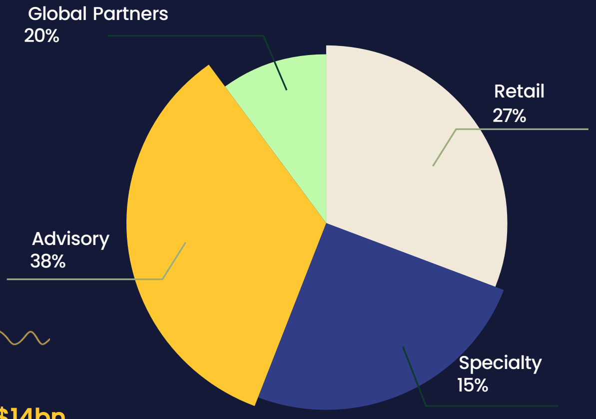
100+	3
Professionals working in agile teams	Strategic hubs: London, Bermuda and the US

Price Forbes Re Analytics and Advisory

The capabilities of our team covers several disciplines including **Actuarial, Data Science, Portfolio Management, Cat Modelling and Credit Advisory** services with an average of 10 years' experience gained at both broking and carrier organisations.

Part of the Ardonagh Group

>$18bn+	12,000+
Gross Written Premium	Employees
250+	**30+**
Offices Worldwide	Territories



Group valued at **$14bn**

The Ardonagh Group

A UK-based, private equity-backed insurance distribution platform offering a wide range of insurance products and services across the UK, Ireland, and international markets. Founded in 2017, it has grown rapidly through acquisitions, including its largest deal with PSC Insurance Group in 2024.

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Introduction to Social Inflation

Defining social inflation

Social inflation refers to the increasing severity of liability claims beyond what can be explained by economic factors, driven by societal trends.

The **'social'** part of the term reflects changing social as well as legal norms and beliefs regarding who should bear the responsibility for absorbing the risk of injury or loss as well as the entitlement to compensation[1].

Defining social inflation

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The **'social'** part of the term reflects changing social as well as legal norms and beliefs regarding who should bear the responsibility for absorbing the risk of injury or loss as well as the entitlement to compensation[1].

As a concept, it dates to at least **1959** when, in an actuarial journal, **F.S. Perryman** asked whether rising loss costs and claim frequencies in automobile insurance could be attributed "to reasons which are not economic but social?"

Perryman, F. S. Discussion of Compulsory Automobile Insurance in Europe, in Proceedings of the Casualty Actuarial Society, vol. 46, 1959

Types of inflation

Economic inflation	Super-imposed inflation	Social inflation
A sustained **increase** in the **price level of goods and services**.	**Additional inflation** specific to certain sectors, **beyond general economic inflation**, often due to regulatory changes or increased costs.	A part of super-imposed inflation: a rising insurance claim costs due to **societal and cultural shifts.**
Price levels are measured based on the **price of a typical basket of goods and services.**[2]	Arises from the impact of **trends** such as: • Regulatory changes • Increased litigation costs • Technological advancements • Sector-specific cost increases • Supply chain disruptions	**Arises from the impact of societal trends** such as:[2] • Changing social attitudes • A rising willingness to resolve conflict via the legal system

New regulations can increase compliance and operational costs for specific sectors.

Regulatory changes

Rising legal fees and more frequent lawsuits drive up costs in industries like insurance and healthcare.

Increased litigation costs

The need for advanced technologies, such as cybersecurity, leads to higher operational expenses.

Technological advancements

Certain industries face unique cost pressures, such as higher raw material prices in manufacturing.

Sector-specific cost increases

Interruptions in supply chains lead to higher costs for materials and goods.

Supply chain disruptions

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Drivers of Social Inflation

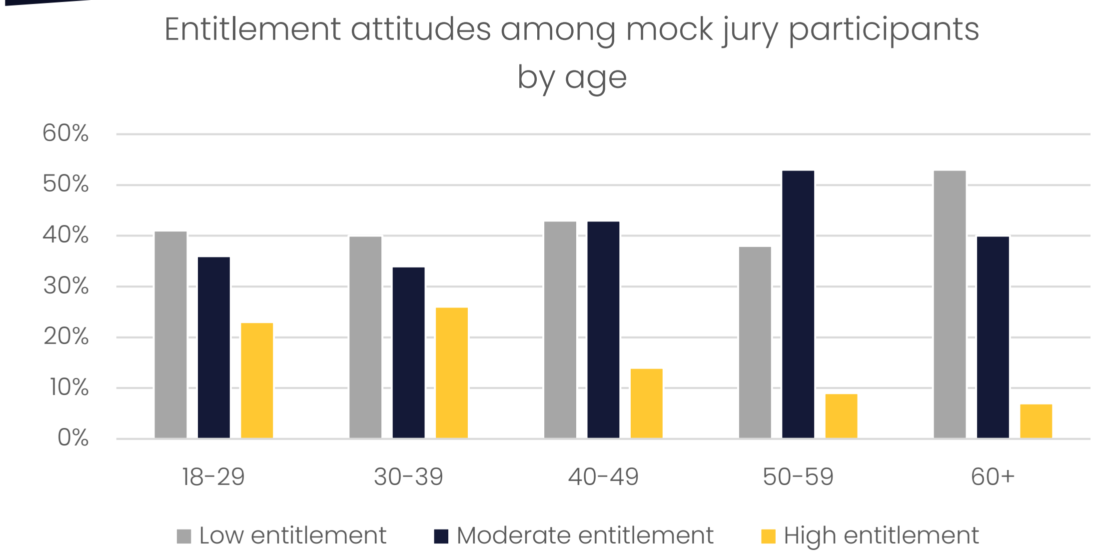
The following information on the drivers[3] of social inflation and mitigation strategies[4] is primarily based on the context of the United States.

While these insights may not be directly applicable to the Czech Republic, we believe it is valuable to be aware of these concepts to better understand potential trends and strategies in managing social inflation risks.

Drivers of social inflation – part 1

Rising public expectations for compensation amounts

Research on entitlement attitudes and jury behaviour provides indirect evidence that entitlement attitudes may indeed be increasing throughout the general population.



Source: Gary Giewat, Damage Awards: Jurors' Sense of Entitlement as a Predictor, The Jury Expert, May 30, 2011 (accessed April 27, 2020).

Drivers of social inflation – part 1

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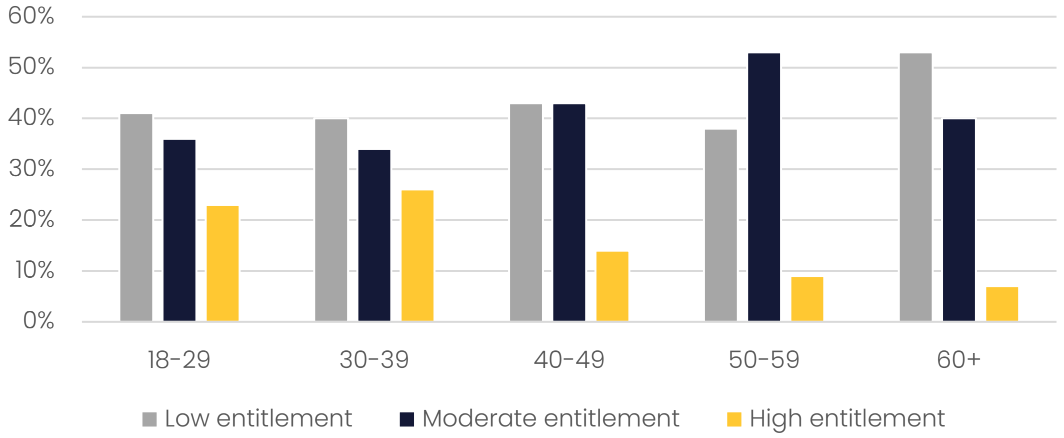
Entitlement attitudes among mock jury participants by age



Source: Gary Giewat, Damage Awards: Jurors' Sense of Entitlement as a Predictor, The Jury Expert, May 30, 2011 (accessed April 27, 2020).

Class action lawsuits

Multiple plaintiffs joining together to seek compensation from a single defendant.

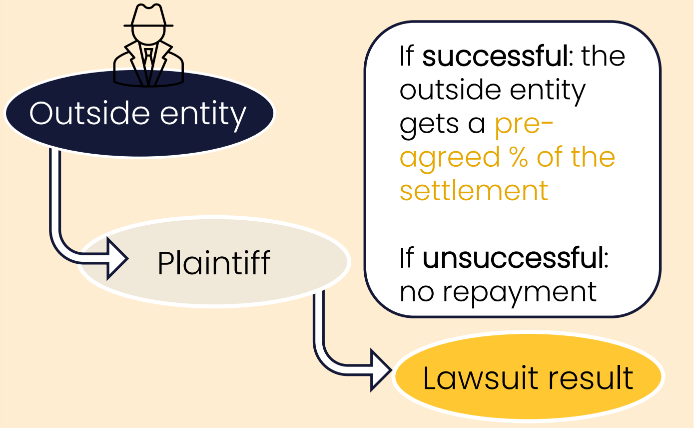
Total U.S. corporate legal spending on class action lawsuits (billion $)

Source: 2019 Carlton Fields Class Action Survey, Carlton Fields, April 16, 2019, www.classactionsurvey.com (accessed May 26, 2020).

Drivers of social inflation – part 2

Third-party litigation financing[5]

Definition:



Settlement dynamics:

Limited funds

↓

Early settlement, or abandonment of the case, hence **lower settlement amount**

- More funds
- Hire better legal teams
- Can afford to be patient

↓

Extended settlement, hence **larger settlement amount**

Drivers of social inflation – part 2

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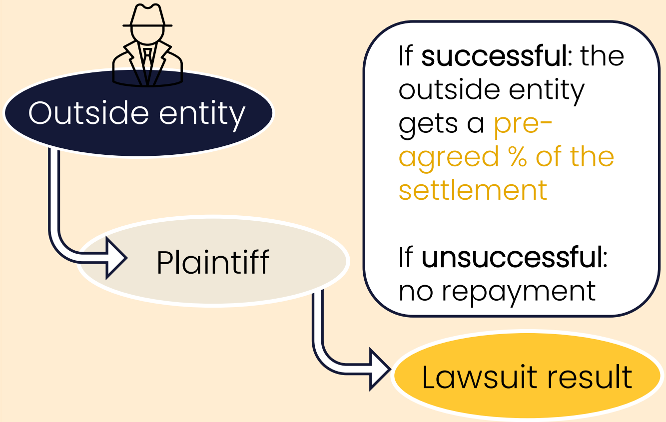

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Nuclear verdicts[6]

Definition:

Extremely large jury awards (often exceeding $10 million)

Include **strong emotional and punitive elements**, far surpassing actual economic losses.

➢ **Perception of deep pockets**: defendants, especially corporations, insurance companies and healthcare providers, are seen as having deep pockets and deserving punishment.

Interesting statistics:

Median	$21m in 2020 and **$44m** in 2023
Average	$89m 2013-2022
Medical malpractice	Number of nuclear verdicts over $25m: 4 in 2014 and **17** in 2018
Commercial auto insurance	Against **trucking firms.** Average $2.3m in 2012 and **$22.3m** in 2019

Drivers of social inflation – part 2

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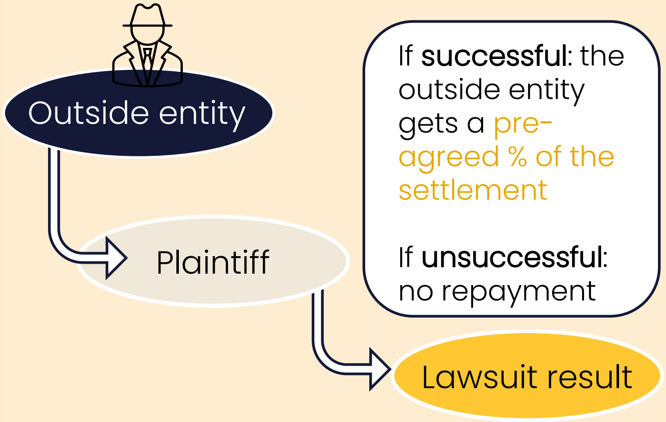

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Tort reforms rollbacks[7]

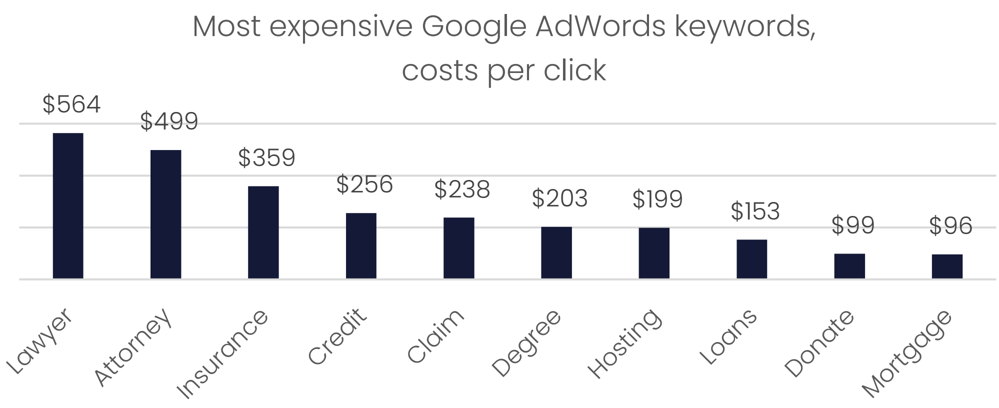
Tort reforms:

- **Legislative changes to reduce litigation costs** and make the civil justice system more predictable.
- <u>Common reform:</u> cap on non-economic damages (e.g., pain and suffering).

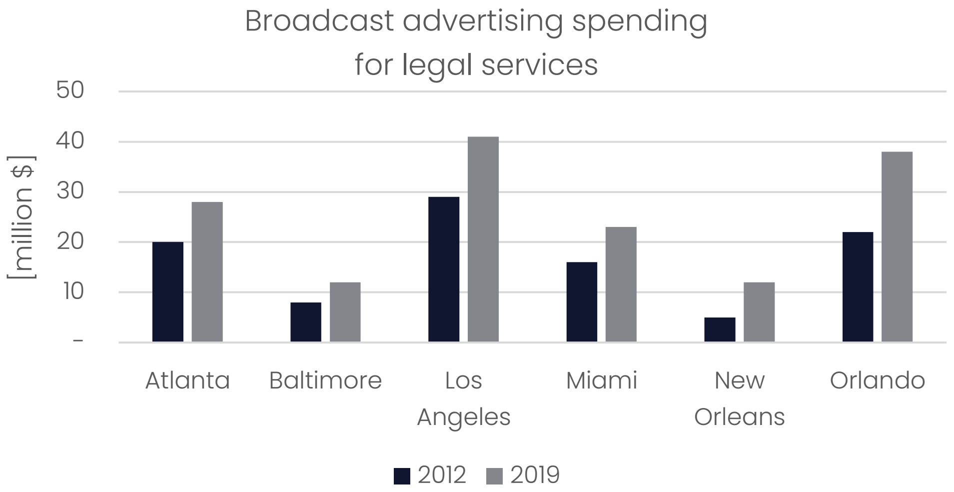
Rollbacks:

- **Some** state supreme **courts** have **overturned these caps**, allowing for higher non-economic damage awards.

Drivers of social inflation – part 3



Source: Sam Carr, "The Most Expensive AdWords Keywords," PPC Protect, Dec. 30, 2019, ppcprotect.com/mostexpensive-adwords-keyword



Source: Kantar Media

Future social inflation drivers

- **The United States** is projected to remain the **epicentre of social inflation** due to its **distinct legal and cultural dynamics**.
- However, countries like Australia, Canada, the UK, and **parts of Europe** also show potential liability claims growth driven by third-party litigation funding and expanded collective redress.[8]

	US	Australia	UK	Canada	Netherlands	France	Germany	Japan
Claims penetration (ratio of liability claims to a country's GDP)	H	M	H	M	L	M	M	L
Income inequality (is measured using standardized Gini coefficients from the SWIID)	H	M	M	M	L	M	M	M
Third-party litigation funding	H	H	H	M	H	M	M	L
Contingency fees (payment arrangement where a lawyer is only paid a % of the settlement if the case is won)	H	M	M	H	L	L	L	L
Collective redness	H	H	H	H	H	M	M	L
Case law (collection of past court decisions that judges use to help decide new cases with similar facts)	H	H	H	H	L	L	L	L
Jury based (group of citizens decides the outcome of a legal case instead of a judge making the decision alone)	H	L	L	L	L	L	L	L

High risk | Medium risk | Low risk

Source: Swiss Re Institute

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Which industries are most affected?

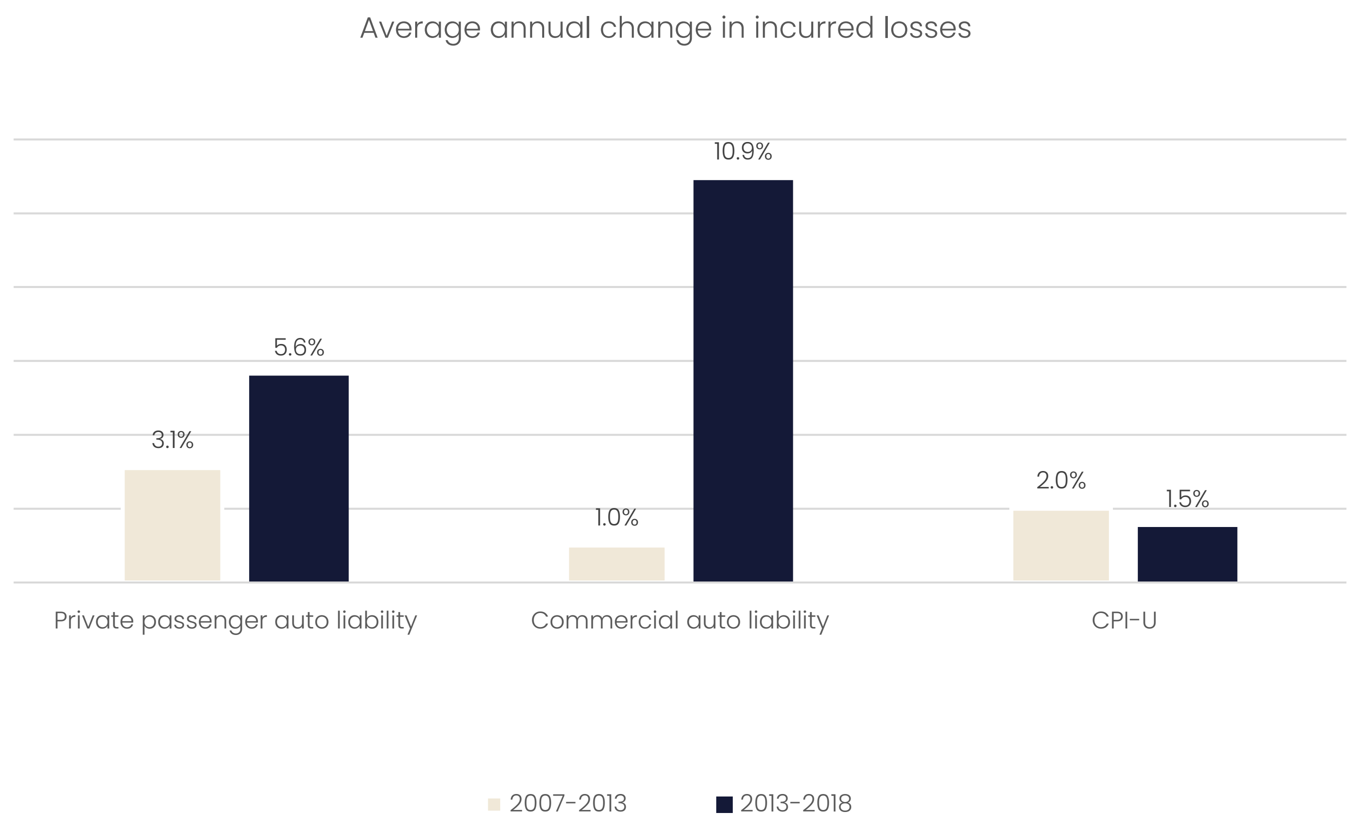
Social inflation mostly affects **casualty and property insurance**

Examples:

Commercial Auto Insurance[9]	**Trucking**: high accident rates and the perception of negligence in trucking companies contribute to increased claims costs.
General Liability Insurance[9]	**Product liability**: consumer goods and medical devices are frequent targets for class-action lawsuits, attracting TPLF firms and expanding the plaintiff pool through targeted advertising.
Financial and Professional Liability Insurance[9]	**Intellectual property & trade secrets**: litigation is increasingly used to reveal defendants' proprietary information, making companies with valuable intellectual property particularly vulnerable.
Marine and Energy Liability[10]	**Energy offshore liability:** notable example of social inflation impacting climate change litigation.

Which industries are most affected?

While social inflation has mainly impacted **commercial liability lines**, it is now beginning to affect **personal liability lines** as well.[1]



Source: The Institutes Risk & Insurance Knowledge Group "Social Inflation: Evidence and Impact on Property-Casualty Insurance"

Mitigation of risks coming from the social inflation

Counteract negative sentiment

- **Corporate Social Responsibility** (CSR): a business model for social accountability.
- Implement CSR **initiatives**: charitable giving, eco-friendly practices, good labour policies.

Examine the jury

- Gather information on **jurors**' media **habits** and **biases**.
- **Tailor defence strategies** to combat social inflation.

Third-party litigation financing

- Advocate for transparency and **disclosure**.

Nuclear verdicts

- Plan for **worst-case scenarios** and have a response plan.

Other strategies

- **Raise awareness of social inflation's impact** on insurance costs.
- Aim for **early settlements** to avoid jury verdict uncertainty.
- Embrace court measures to **speed up litigation**.

Czech experience with social inflation

The New Civil Code: changes in **damage compensation**

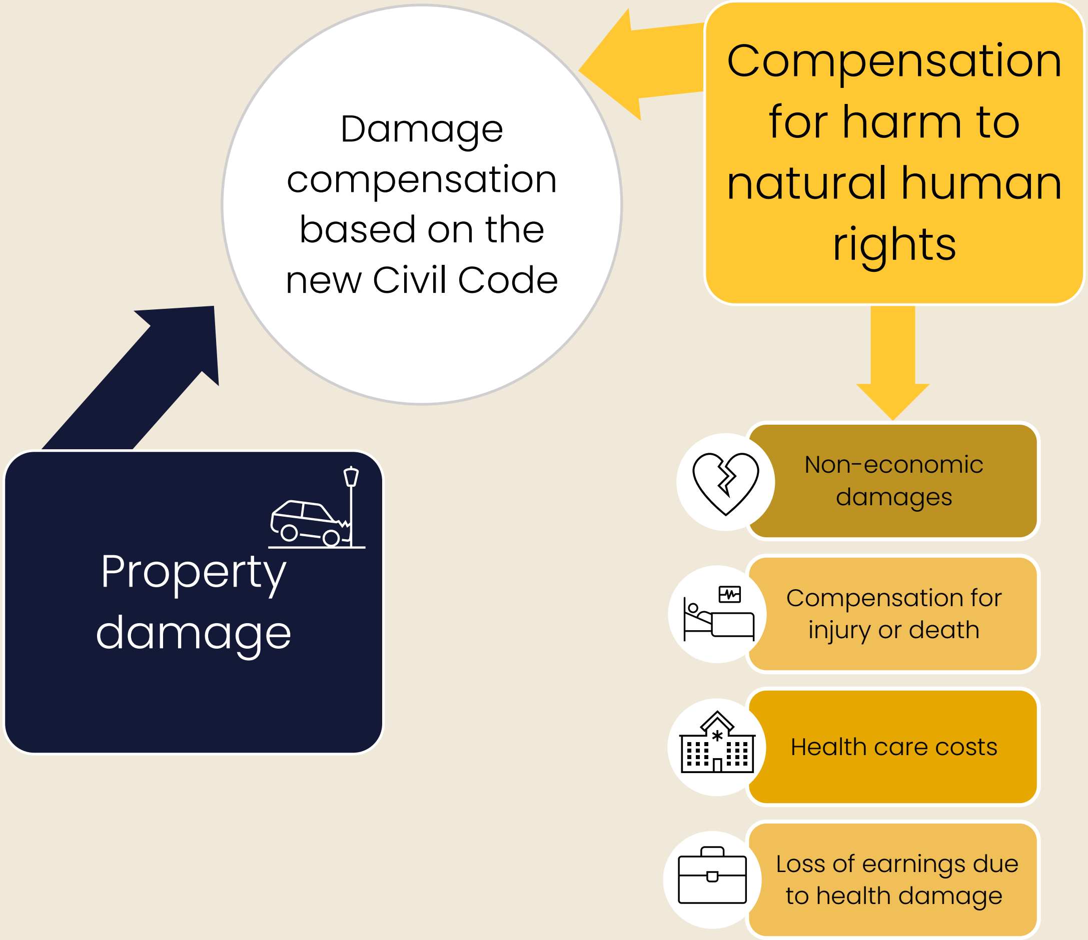
(Nový Občanský Zákoník VII: odpovědnost za škodu, způsob a rozsah náhrady újmy)

Effective Date: **January 1, 2014**

The new Civil Code redefines **damage** to include both the reduction of assets and the increase of debts. This change ensures that **individuals responsible for causing harm**:[11]

- Must **compensate the injured party**, either by restoring their original financial state or by paying monetary compensation.
- Are now also **liable for debts incurred by the injured party** as a direct result of their wrongful actions

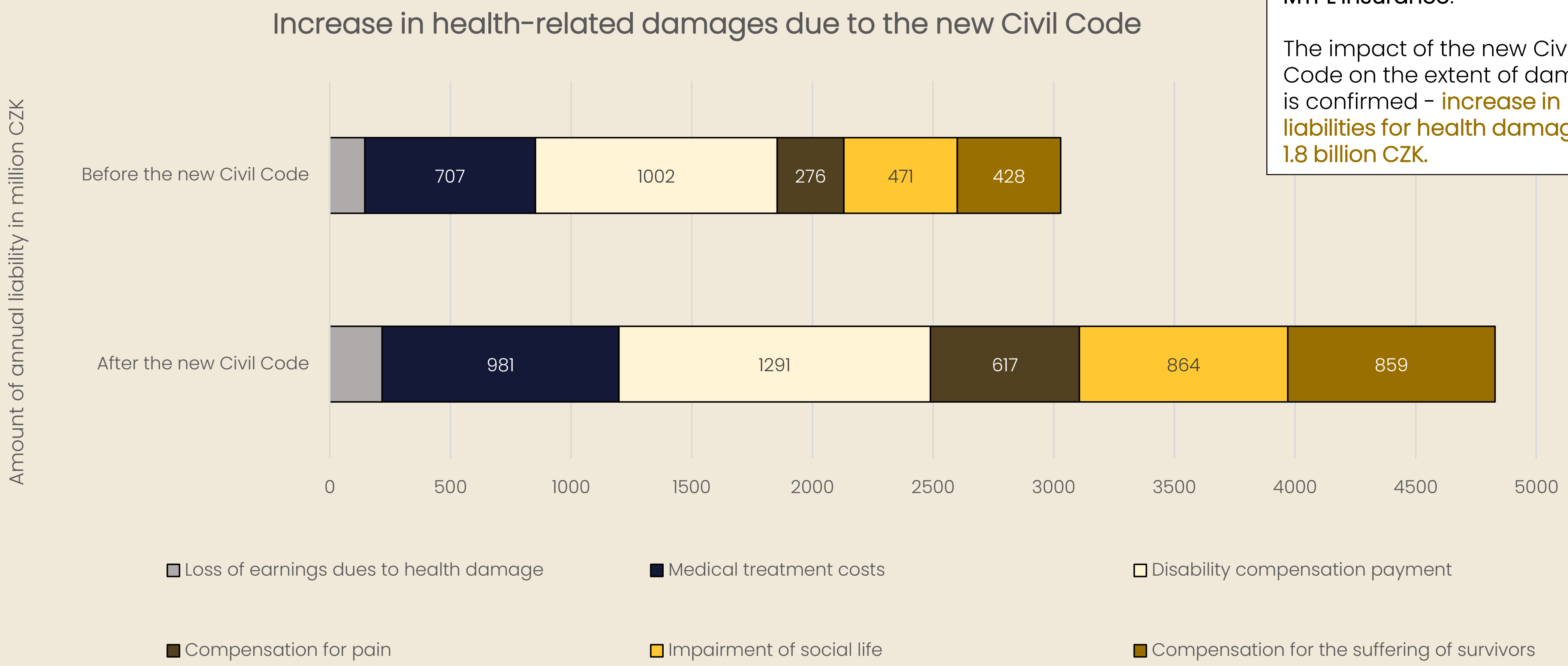
Previously, courts often did not recognize debt obligations caused by a wrongdoer as compensable damage.



Czech experience with social inflation

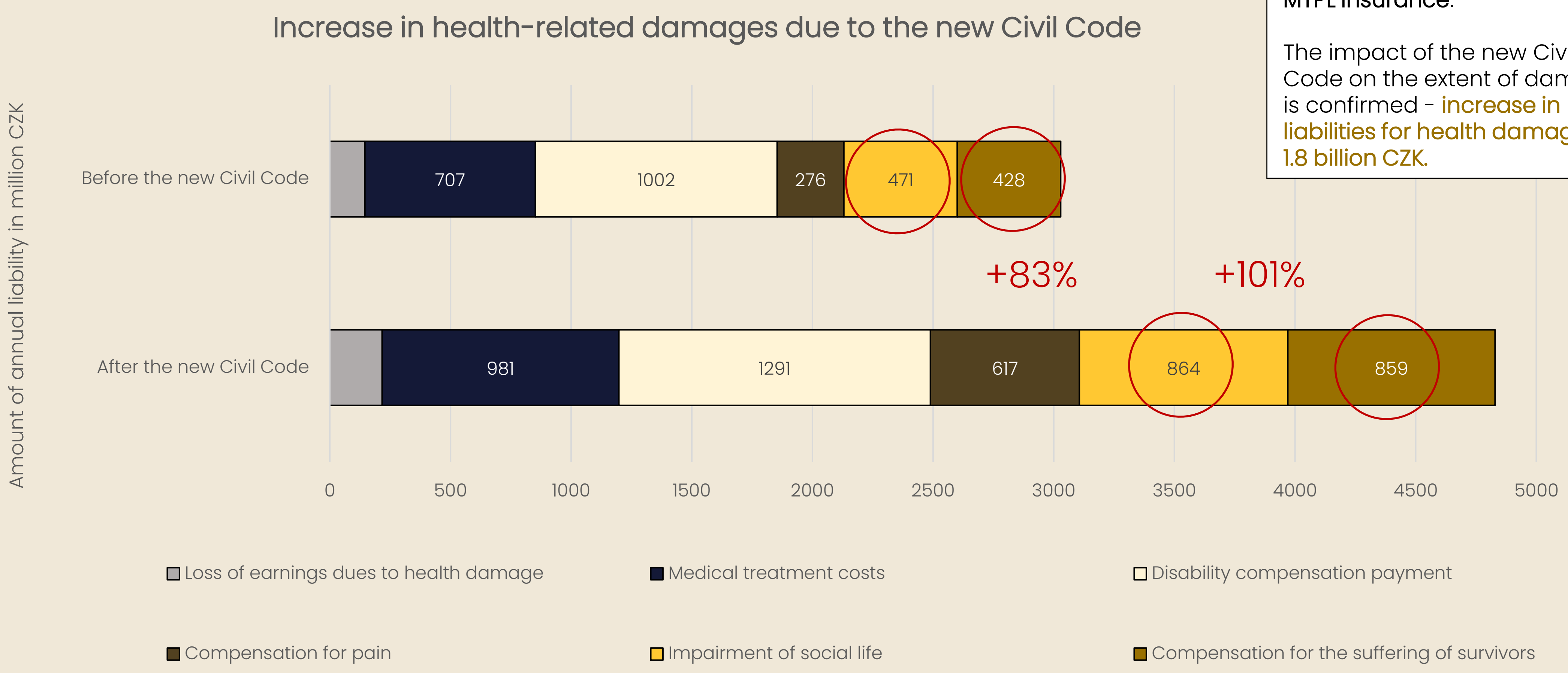
Damages covered by insurance companies **under compulsory MTPL insurance**.

The impact of the new Civil Code on the extent of damages is confirmed - increase in liabilities for health damages by 1.8 billion CZK.



Source: ČKP a ČAP Povinné ručení 2017, Tisková konference, Mgr. Jan Matoušek, RNDr. Petr Jedlička, Ph.D., 10. října 2017
https://www.ckp.cz/images/clanky/cz/tiskove_centrum/prezentace_ckp/2017/TK-POV-2017_superfin.pdf

Czech experience with social inflation



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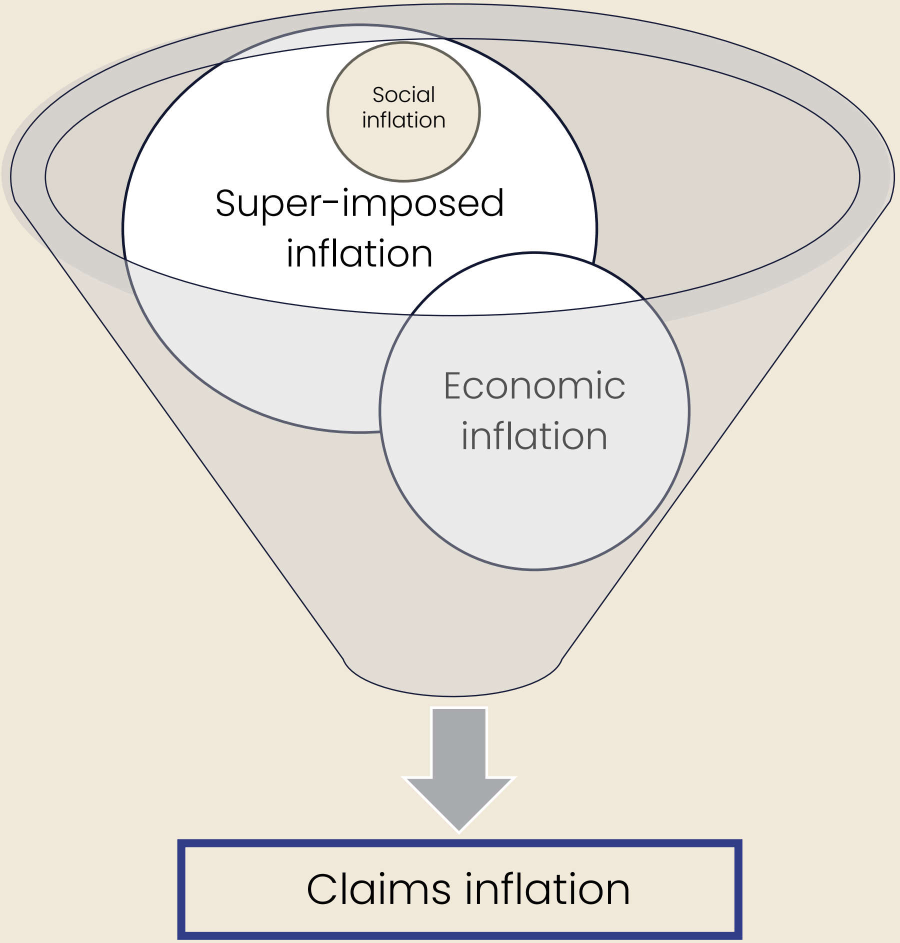
Defining claims inflation

While calculating **social inflation presents challenges**, our primary focus remains on understanding the overall impact of total inflation.



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Reserving Methodologies to Account for Claims Inflation

Implicit and explicit allowances for claims inflation in reserving

	Implicit allowances	Explicit allowances
Definition	Implicit allowances for claims inflation are made **indirectly, without** specifically **identifying** or **quantifying the inflation component**.	Explicit allowances for claims inflation involve **direct identification** and **quantification of the inflation component** in the reserving process.
Consideration	Suitable when it is assumed that **past inflation** rates will **remain constant** and **match future inflation** rates.[13]	Suitable when **past inflation** rates are **variable** and **future inflation** is expected to **differ.**[13]
Benefits	• Simplicity: straightforward and **easy to implement**. • Consistency: **ensures uniformity** in reserving practices. • Data efficiency: requires **less detailed inflation data**.	• Accuracy: provides **precise estimates** by directly accounting **for inflation**. • Flexibility: **adapts to changing** inflation rates and **economic conditions**. • Transparency: **offers clear visibility** into the impact of inflation on reserve estimates.
Drawbacks	• Assumption risk: relies on the continuation of past trends, which may **not always be accurate**. • Precision limitations: may not adequately account for future inflation changes, leading to potential under- or over-reserving. • Adaptability issues: struggles to adjust to **sudden economic shifts**.	• Complexity: more intricate and **requires detailed inflation data**. • Data intensive: needs comprehensive historical and projected inflation data. • Resource demands: **implementation** can be resource-intensive, requiring **more time and expertise**.

Break – 10 minutes

Notation for claims triangle

- The data in claims triangle are categorised by **accident year** $i \in \{0, \dots, I\}$ and **development year** $j \in \{0, \dots, J\}$
- We assume the most recent accident year equals the last development year[14] $\boldsymbol{I = J}$
- **Incremental data** $\boldsymbol{X_{i,j}}$ … claim amount in accident year i made in year $i + j$
- **Cumulative data** $\boldsymbol{C_{i,j}}$ for accident year i after j development years:

$$C_{i,j} = \sum_{k=0}^{j} X_{i,k}$$

- **Incremental development triangle**

$$D_I = \{X_{i,j} : i + j \leq I, 0 \leq j \leq J\}$$

- **Cumulative development triangle**

$$D_I = \{C_{i,j} : i + j \leq I, 0 \leq j \leq J\}$$

Implicit Allowances for Claims Inflation

In this discussion, we will focus on the most used methods: the Standard Chain Ladder and Bornhuetter-Ferguson.

Standard Chain Ladder method model assumptions

- Cumulative claims $\boldsymbol{C_{i,j}}$ **of different accident years** $\boldsymbol{i}$ **are independent**,[14] i.e.

$$\{C_{i,0}, \dots, C_{i,J}\} \text{ and } \{C_{k,0}, \dots, C_{k,J}\} \text{ are independent for } k \neq i.$$

- The **exist development factors** $\boldsymbol{f_0, \dots, f_{J-1} > 0}$ such that for all accident years $0 \leq i \leq I$ and all development years $0 \leq j \leq J$ we have

$$\mathrm{E}\left[C_{i,j} \middle| C_{i,0}, \dots, C_{i,j-1}\right] = f_{j-1} * C_{i,j-1}.$$

Then the expected value of aggregate loss for given accident year $1 \leq i \leq I$, conditional on the history known at the end of year:

$$\mathrm{E}\left[C_{i,J} \middle| D_I\right] = \mathrm{E}\left[C_{i,J} \middle| C_{i,I-i}\right] = C_{i,I-i} * f_{I-i} * \cdots * f_{J-1}.$$

- There **exist parameters** $\boldsymbol{\sigma_0^2, \dots, \sigma_{J-1}^2 > 0}$ such that for all accident years $0 \leq i \leq I$ and all development years $0 \leq j \leq J$ we have

$$\mathrm{Var}\left[C_{i,j} \middle| C_{i,0}, \dots, C_{i,j-1}\right] = \sigma_{j-1}^2 * C_{i,j-1}.$$

The last assumption is essential for derivation of an expression for the MSE of Chain-Ladder estimate:

$$\mathrm{mse}\left(\hat{C}_{i,j} - C_{i,j}\right) = \mathrm{E}\left[\left(\hat{C}_{i,j} - C_{i,j}\right)^2 \middle| D_I\right]$$

Standard Chain Ladder method

Paid/incurred cumulative claims triangle

$C_{0,0}$	$C_{0,1}$	$C_{0,2}$	$C_{0,3}$	$C_{0,4}$
$C_{1,0}$	$C_{1,1}$	$C_{1,2}$	$C_{1,3}$	
$C_{2,0}$	$C_{2,1}$	$C_{2,2}$		
$C_{3,0}$	$C_{3,1}$			
$C_{4,0}$				

Calculate estimates $\hat{f}_j$ of development factors

$$\hat{f}_j = \frac{\sum_{i=0}^{I-j-1} C_{i,j+1}}{\sum_{i=0}^{I-j-1} C_{i,j}}$$

$$\boxed{\hat{C}_{i,j} = C_{i,I-i} * \hat{f}_{I-i} * \cdots * \hat{f}_{j-1}}$$

Projected best estimate losses

			$\hat{C}_{1,4} = C_{1,3} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2 * \hat{f}_3$
		$\hat{C}_{2,3} = C_{2,2} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2$	$\hat{C}_{2,4} = C_{2,2} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2 * \hat{f}_3$
	$\hat{C}_{3,2} = C_{3,1} * \hat{f}_0 * \hat{f}_1$	$\hat{C}_{3,3} = C_{3,1} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2$	$\hat{C}_{3,4} = C_{3,1} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2 * \hat{f}_3$
$\hat{C}_{4,1} = C_{4,0} * \hat{f}_0$	$\hat{C}_{4,2} = C_{4,0} * \hat{f}_0 * \hat{f}_1$	$\hat{C}_{4,3} = C_{4,0} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2$	$\hat{C}_{4,4} = C_{4,0} * \hat{f}_0 * \hat{f}_1 * \hat{f}_2 * \hat{f}_3$

Bornhuetter-Ferguson method model assumptions

- Cumulative claims $\boldsymbol{C_{i,j}}$ **of different accident years** $\boldsymbol{i}$ **are independent**,[14] i.e.

$$\{C_{i,0}, \dots, C_{i,J}\} \text{ and } \{C_{k,0}, \dots, C_{k,J}\} \text{ are independent for } k \neq i.$$

- The **exist parameters** $\boldsymbol{\mu_0, \dots, \mu_I > 0}$ and a **pattern** $\boldsymbol{\beta_0, \dots, \beta_J > 0}$ with $\beta_J = 1$ such that for all accident years $0 \leq i \leq I$ and all development years $0 \leq j \leq J$ we have

$$\mathrm{E}C_{i,J} = \beta_j * \mu_i.$$

Then the expected value of aggregate loss for given accident year $1 \leq i \leq I$, conditional on the history known at the end of year:

$$\mathrm{E}\left[C_{i,J} \middle| D_I\right] = C_{i,I-i} + (1 - \beta_{I-i}) * \mu_i.$$

Bornhuetter-Ferguson method

Paid/incurred cumulative claims triangle

$C_{0,0}$	$C_{0,1}$	$C_{0,2}$	$C_{0,3}$	$C_{0,4}$
$C_{1,0}$	$C_{1,1}$	$C_{1,2}$	$C_{1,3}$	
$C_{2,0}$	$C_{2,1}$	$C_{2,2}$		
$C_{3,0}$	$C_{3,1}$			
$C_{4,0}$				

- Estimates of development factors:

$$\hat{f}_j = \frac{\sum_{i=0}^{I-j-1} C_{i,j+1}}{\sum_{i=0}^{I-j-1} C_{i,j}}$$

- Estimates of $\beta_0, \dots, \beta_J$:

$$\hat{\beta}_j = \frac{1}{\prod_{k=j}^{J-1} \hat{f}_k}$$

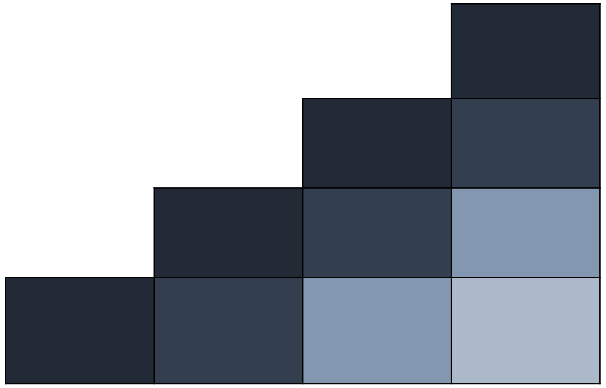
- Estimates of $\mu_0, \dots, \mu_I$:

$$\hat{\mu}_i = \text{ELR} * \text{Earned Premium}_i,$$

where ELR is a priori estimate of the loss ratio (ratio of ultimate losses to earned premiums).

$$\boxed{\hat{C}_{i,j} = C_{i,j} + \left(1 - \hat{\beta}_j\right) * \hat{\mu}_i}$$

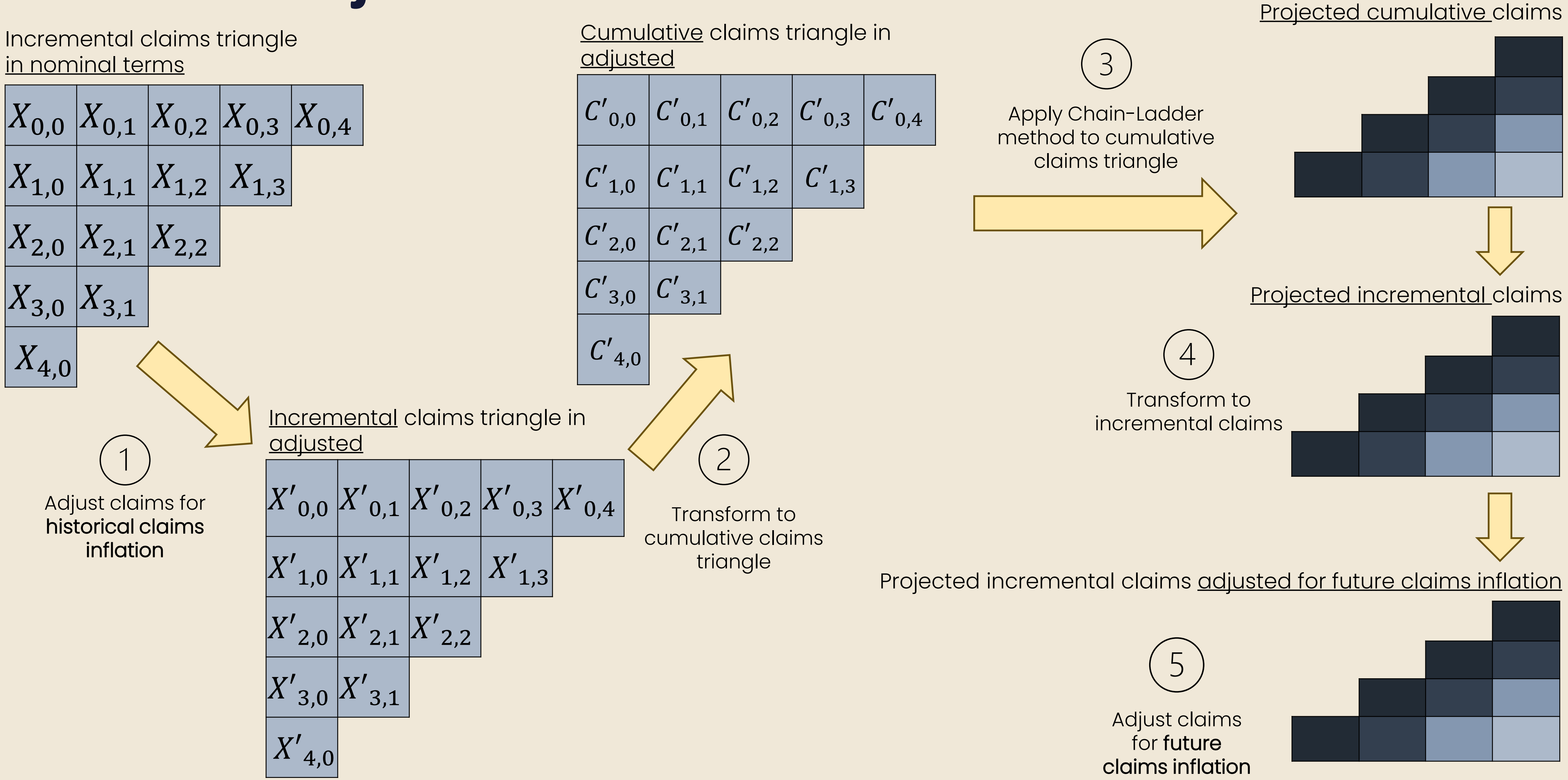
Projected best estimate losses



Explicit Allowances for Claims Inflation

There are numerous approaches for explicitly accounting for claims inflation. In this discussion, we will focus on the most used method, the Inflation Adjusted Chain Ladder, as well as one additional approach that we find particularly interesting - Probabilistic Trend Family model.

Inflation-adjusted Chain Ladder method



Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Historical inflation

Year	Inflation rate
2016	-1.5%
2017	1.3%
2018	4.6%
2019	3.8%

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Historical inflation

Year	Inflation rate
2016	-1.5%
2017	1.3%
2018	4.6%
2019	3.8%

Inflation matrix

	0	1	2	3	4
2016	(1-1.5%)*(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+4.6%)*(1+3.8%)	1+3.8%	1
2017	(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+4.6%)*(1+3.8%)	1+3.8%	1	
2018	(1+4.6%)*(1+3.8%)	1+3.8%	1		
2019	1+3.8%	1			
2020	1				

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Historical inflation

Year	Inflation rate
2016	-1.5%
2017	1.3%
2018	4.6%
2019	3.8%

Inflation matrix

	0	1	2	3	4
2016	(1-1.5%)*(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+4.6%)*(1+3.8%)	1+3.8%	1
2017	(1+1.3%)*(1+4.6%)*(1+3.8%)	(1+4.6%)*(1+3.8%)	1+3.8%	1	
2018	(1+4.6%)*(1+3.8%)	1+3.8%	1		
2019	1+3.8%	1			
2020	1				

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	0	1	2	3	4
2016	1.08336	1.09986	1.08575	1.03800	1
2017	1.09986	1.08575	1.03800	1	
2018	1.08575	1.03800	1		
2019	1.03800	1			
2020	1				

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Inflation matrix

	0	1	2	3	4
2016	1.08336	1.09986	1.08575	1.03800	1
2017	1.09986	1.08575	1.03800	1	
2018	1.08575	1.03800	1		
2019	1.03800	1			
2020	1				

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Inflation matrix

	0	1	2	3	4
2016	1.08336	1.09986	1.08575	1.03800	1
2017	1.09986	1.08575	1.03800	1	
2018	1.08575	1.03800	1		
2019	1.03800	1			
2020	1				

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle
adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle
adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Cumulative claims triangle
adjusted

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	
2018	584,773	1,498,886	2,572,019		
2019	646,754	1,628,068			
2020	647,098				

Inflation-adjusted Chain Ladder method

Incremental claims triangle <u>in nominal terms</u>

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle <u>adjusted</u>

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Cumulative claims triangle <u>adjusted</u>

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	
2018	584,773	1,498,886	2,572,019		
2019	646,754	1,628,068			
2020	647,098				

Development factors

2.6306

Inflation-adjusted Chain Ladder method

Incremental claims triangle
<u>in nominal terms</u>

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle
<u>adjusted</u>

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Cumulative claims triangle
<u>adjusted</u>

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	
2018	584,773	1,498,886	2,572,019		
2019	646,754	1,628,068			
2020	647,098				

Development factors

2.6306
1.7424

Inflation-adjusted Chain Ladder method

Incremental claims triangle
in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle
adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Cumulative claims triangle
adjusted

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	
2018	584,773	1,498,886	2,572,019		
2019	646,754	1,628,068			
2020	647,098				

Development factors

2.6306
1.7424
1.4330
1.0002

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Cumulative claims triangle adjusted

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	
2018	584,773	1,498,886	2,572,019		
2019	646,754	1,628,068			
2020	647,098				

Development factors

2.6306
1.7424
1.4330
1.0002

			3,436,913 * 1.002
		2,572,019 * 1.4330	2,572,019 * 1.4330 * 1.002
	1,628,068 * 1.7424	1,628,068 * 1.7424 * 1.4330	1,628,068 * 1.7424 * 1.4330 * 1.002
647,098 * 2.6306	647,098 * 2.6306 * 1.7424	647,098 * 2.6306 * 1.7424 * 1.4330	647,098 * 2.6306 * 1.7424 * 1.4330 * 1.002

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed cumulative claims

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	3,437,770
2018	584,773	1,498,886	2,572,019	3,685,949	3,686,869
2019	646,754	1,628,068	2,836,801	4,065,408	4,066,423
2020	647,098	1,792,290	2,966,128	4,250,746	4,251,807

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed cumulative claims

	0	1	2	3	4
2016	486,214	1,326,494	2,347,296	3,365,951	3,366,791
2017	497,869	1,375,060	2,399,674	3,436,913	3,437,770
2018	584,773	1,498,886	2,572,019	3,685,949	3,686,869
2019	646,754	1,628,068	2,836,801	4,065,408	4,066,423
2020	647,098	1,792,290	2,966,128	4,250,746	4,251,807

Transform to incremental claims

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Adjust claims for future inflation

Future inflation

Year	Inflation rate
2021	5.1%
2022	13.8%
2023	10.4%
2024	5.6%

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Adjust claims for future inflation

Future inflation

Year	Inflation rate
2021	5.1%
2022	13.8%
2023	10.4%
2024	5.6%

Inflation matrix

	0	1	2	3	4
2016					1
2017				1	1+5.1%
2018			1	1+5.1%	(1+5.1%)*(1+13.8%)
2019		1	1+5.1%	(1+5.1%)*(1+13.8%)	(1+5.1%)*(1+13.8%)*(1+10.4%)
2020	1	1+5.1%	(1+5.1%)*(1+13.8%)	(1+5.1%)*(1+13.8%)*(1+10.4%)	(1+5.1%)*(1+13.8%)*(1+10.4%)*(1+5.6%)

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Adjust claims for future inflation

Future inflation

Year	Inflation rate
2021	5.1%
2022	13.8%
2023	10.4%
2024	5.6%

Inflation matrix

	0	1	2	3	4
2016					1
2017				1	1+5.1%
2018			1	1+5.1%	(1+5.1%)*(1+13.8%)
2019		1	1+5.1%	(1+5.1%)*(1+13.8%)	(1+5.1%)*(1+13.8%)*(1+10.4%)
2020	1	1+5.1%	(1+5.1%)*(1+13.8%)	(1+5.1%)*(1+13.8%)*(1+10.4%)	(1+5.1%)*(1+13.8%)*(1+10.4%)*(1+5.6%)

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	0	1	2	3	4
2016					1
2017				1	1.0510
2018			1	1.0510	1.1960
2019		1	1.0510	1.1960	1.3204
2020	1	1.0510	1.1960	1.3204	1.3943

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Adjust claims for future inflation

	0	1	2	3	4
2016					1
2017				1	1.0510
2018			1	1.0510	1.1960
2019		1	1.0510	1.1960	1.3204
2020	1	1.0510	1.1960	1.3204	1.3943

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
2020	647,097	1,055,192	1,263,838	1,284,618	1,060

Adjust claims for future inflation

	0	1	2	3	4
2016					1
2017				1	1.0510
2018			1	1.0510	1.1960
2019		1	1.0510	1.1960	1.3204
2020	1	1.0510	1.1960	1.3204	1.3943

Developed incremental claims adjusted for future inflation

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	901
2018	584,773	914,112	1,073,133	1,170,741	1,100
2019	646,754	981,314	1,270,379	1,469,461	1,340
2020	647,097	1,109,008	1,511,598	1,696,243	1,479

Inflation-adjusted Chain Ladder method

Incremental claims triangle in nominal terms

	0	1	2	3	4
2016	448,800	763,986	940,183	981,363	840
2017	452,665	807,914	987,104	1,037,238	
2018	538,590	880,648	1,073,133		
2019	623,078	981,314			
2020	647,098				

Adjust claims for historical inflation

Incremental claims triangle adjusted

	0	1	2	3	4
2016	486,214	840,280	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,614	1,037,238	
2018	584,773	914,113	1,073,133		
2019	646,754	981,314			
2020	647,098				

Apply Chain-Ladder method to CUMULATIVE claims triangle

Developed incremental claims

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	857
2018	584,773	914,112	1,073,133	1,113,930	919
2019	646,754	981,314	1,208,733	1,228,607	1,014
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Adjust claims for future inflation

Developed incremental claims adjusted for future inflation

	0	1	2	3	4
2016	486,214	840,279	1,020,802	1,018,655	840
2017	497,869	877,191	1,024,613	1,037,238	901
2018	584,773	914,112	1,073,133	1,170,741	1,100
2019	646,754	981,314	1,270,379	1,469,461	1,340
2020	647,097	1,109,008	1,511,598	1,696,243	1,479

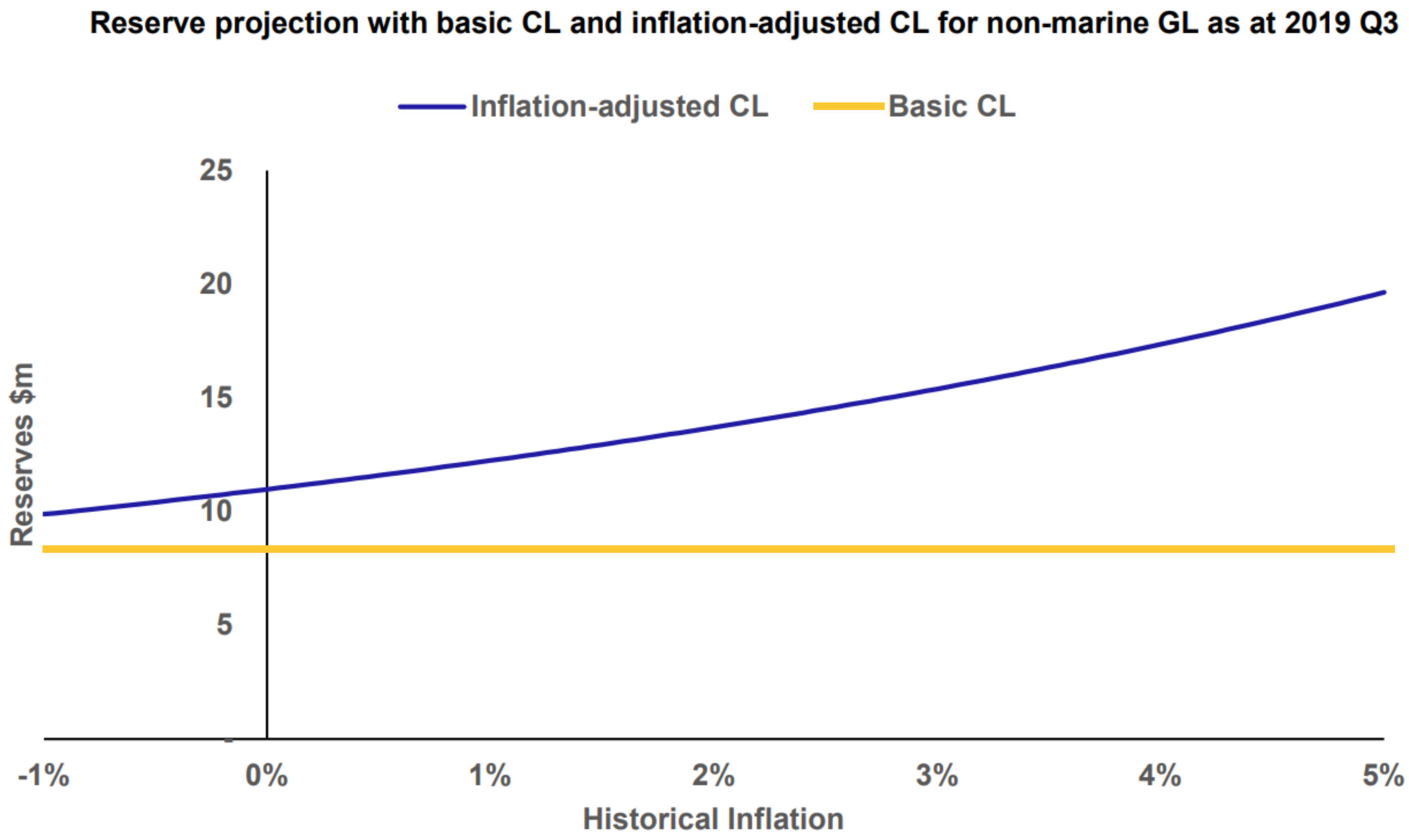
Historical inflation

Year	Inflation rate
2016	-1.5%
2017	1.3%
2018	4.6%
2019	3.8%

Future inflation

Year	Inflation rate
2021	5.1%
2022	13.8%
2023	10.4%
2024	5.6%

Inflation-adjusted and standard Chain Ladder method



Source: Martis, Stavros and Stewart, Emma (2020); Claims inflation trends within the Lloyd's and the London Market; GIRO conference

Probabilistic trend family model (PTF)

PTF is a model used in claims reserving that **captures trends** in **accident year, development year, and calendar year directions simultaneously.** [15]

It is particularly useful for forecasting and risk assessment in environments with **significant changes in external factors.**

Mathematical model

$$y_{i,j} = \alpha_i + \sum_{k=1}^{j} \beta_k + \sum_{t=1}^{i+j} \gamma_t + \varepsilon_{i,j}$$

Notation	Meaning
i	Accident year
j	Development year
$t = i + j$	Calendar year
$y_{i,j}$	**Natural logarithm of the incremental paid data** in accident year i and at development year j
α_i coefficient	Trend for accident year i
β_j coefficient	Trend for development year j
γ_t coefficient	Trend for calendar year t
$\varepsilon_{i,j}$	Zero-mean normally distributed random error with variance σ^2 (can be constant or varying)

Probabilistic trend family model (PTF)

On a **logarithmic scale** the distribution for each **incremental claim** amounts $x_{i,j}$ is **normal**:

$$\log(x_{i,j}) =: y_{i,j} \sim \mathcal{N}(\mu_{i,j}, \sigma^2),$$

where the **means** of the normal distributions are related by the "**trends**" described by the member:

$$\mu_{i,j} = \alpha_i + \sum_{k=1}^{j} \beta_k + \sum_{t=1}^{i+j} \gamma_t \,.$$

The **incremental claim** amounts $x_{i,j}$ therefore follow a **lognormal distribution:**

$$x_{i,j} \sim \mathrm{LN}\left(\tilde{\mu}_{i,j}, \tilde{\sigma}^2\right),$$

where

$$\tilde{\mu}_{i,j} = e^{\mu_{i,j}+\frac{\sigma^2}{2}},$$

$$\tilde{\sigma}^2 = \tilde{\mu}_{i,j} * (e^{\sigma^2} - 1).$$

Mathematical model

$$y_{i,j} = \alpha_i + \sum_{k=1}^{j} \beta_k + \sum_{t=1}^{i+j} \gamma_t + \varepsilon_{i,j}$$

Notation	Meaning
i	Accident year
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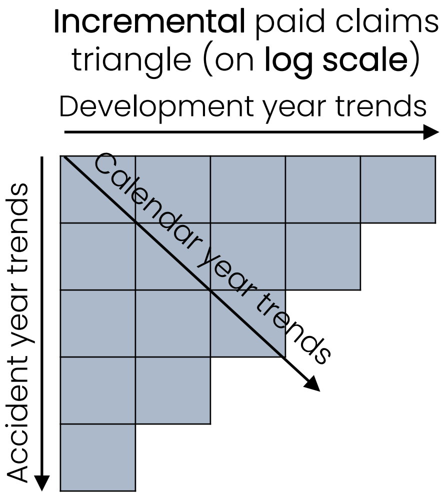
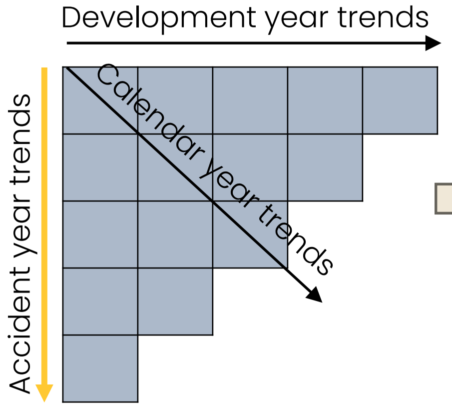
Accident, development and calendar year trends in PTF model



Accident, development and calendar year trends in PTF model

Incremental paid claims triangle (on **log scale**)



Accident year (AY) trends:

α_0	α_0	α_0	α_0	α_0
α_1	α_1	α_1	α_1	
α_2	α_2	α_2		
α_3	α_3			
α_4				

Definition: trends capturing the impact of events or conditions specific to the year in which claims occur.

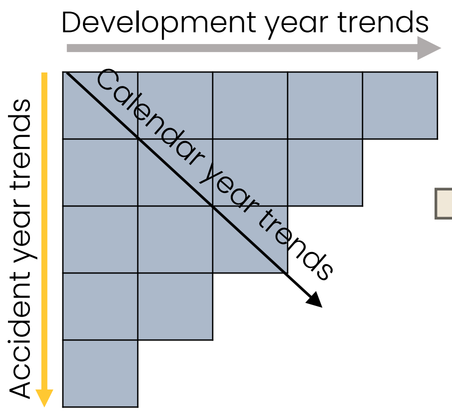
Examples:[16]

- Changes in underwriting practices.
- Economic conditions.
- Regulatory changes.

Importance: helps understand how the environment at the time of the accident influences claims development.

Accident, development and calendar year trends in PTF model

Incremental paid claims triangle (on log scale)



Accident year (AY) trends:

α_0	α_0	α_0	α_0	α_0
α_1	α_1	α_1	α_1	
α_2	α_2	α_2		
α_3	α_3			
α_4				

Definition: trends capturing the impact of events or conditions specific to the year in which claims occur.

Examples:[16]

- Changes in underwriting practices.
- Economic conditions.
- Regulatory changes.

Importance: helps understand how the environment at the time of the accident influences claims development.

Development year (DY) trends:

	β_1	β_2	β_3	β_4
	β_1	β_2	β_3	
	β_1	β_2		
	β_1			

Definition: trends accounting for how claims evolve over time.

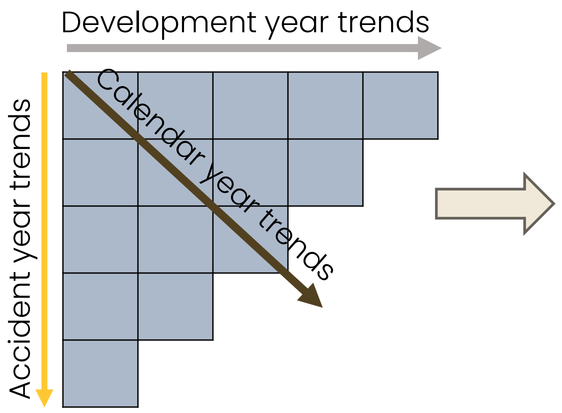
Examples:[16]

- Time taken for claims to be reported, settled, or paid.
- Changes in legal processes.

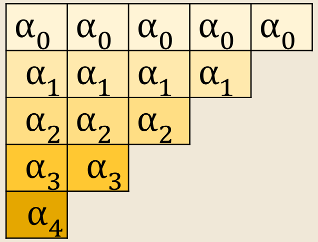
Importance: models the progression of claims from inception to final settlement.

Accident, development and calendar year trends in PTF model

Incremental paid claims triangle (on **log scale**)



Accident year (AY) trends:



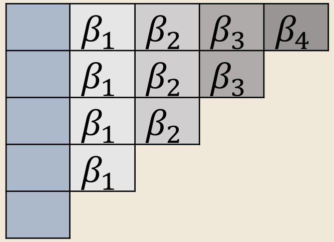
Definition: trends capturing the impact of events or conditions specific to the year in which claims occur.

Examples:[16]

- Changes in underwriting practices.
- Economic conditions.
- Regulatory changes.

Importance: helps understand how the environment at the time of the accident influences claims development.

Development year (DY) trends:



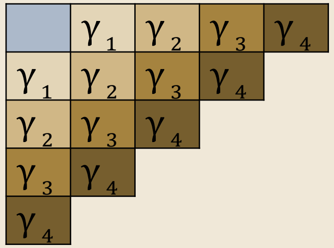
Definition: trends accounting for how claims evolve over time.

Examples:[16]

- Time taken for claims to be reported, settled, or paid.
- Changes in legal processes.

Importance: models the progression of claims from inception to final settlement.

Calendar year (CY) trends:



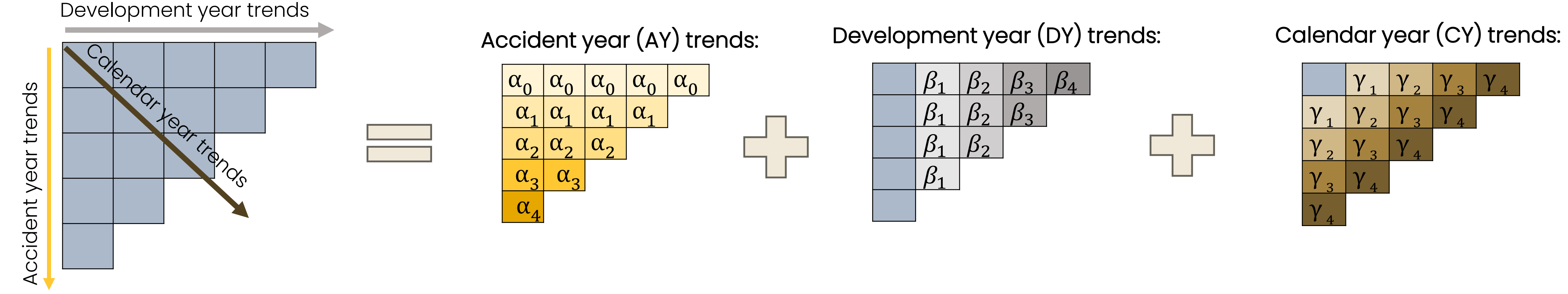
Definition: trends considering external factors affecting claims payments across different calendar years.

Examples:[16]

- Economic inflation.
- Changes in legal environments.
- Shifts in social attitudes towards claims.

Importance: impacts all claims regardless of accident or development year.

Accident, development and calendar year trends in PTF model



α_0	$\alpha_0+\beta_1+\gamma_1$	$\alpha_0+\beta_1+\beta_2+\gamma_1+\gamma_2$	$\alpha_0+\beta_1+\beta_2+\beta_3+\gamma_1+\gamma_2+\gamma_3$	$\alpha_0+\beta_1+\beta_2+\beta_3+\beta_4+\gamma_1+\gamma_2+\gamma_3+\gamma_4$
$\alpha_1+\gamma_1$	$\alpha_1+\beta_1+\gamma_1+\gamma_2$	$\alpha_1+\beta_1+\beta_2+\gamma_1+\gamma_2+\gamma_3$	$\alpha_1+\beta_1+\beta_2+\beta_3+\gamma_1+\gamma_2+\gamma_3+\gamma_4$	
$\alpha_2+\gamma_1+\gamma_2$	$\alpha_2+\beta_1+\gamma_1+\gamma_2+\gamma_3$	$\alpha_2+\beta_1+\beta_2+\gamma_1+\gamma_2+\gamma_3+\gamma_4$		
$\alpha_3+\gamma_1+\gamma_2+\gamma_3$	$\alpha_3+\beta_1+\gamma_1+\gamma_2+\gamma_3+\gamma_4$			
$\alpha_4+\gamma_1+\gamma_2+\gamma_3+\gamma_4$				

Simple example of PTF model

To demonstrate how to estimate parameters in a model from the PTF, we created a **simple example** with clearly **identifiable calendar year trends**

Log-transformed incremental claims triangle

	0	1	2	3
2018	10	10.2	10.4	11
2019	10.2	10.4	11	
2020	10.4	11		
2021	11			

Simple example of PTF model

Log-transformed incremental claims triangle

	0	1	2	3
2018	10	10.2	10.4	11
2019	10.2	10.4	11	
2020	10.4	11		
2021	11			

Calendar year trends

	0	1	2	3
2018		+0.2		
2019	+0.2			
2020				
2021				

Simple example of PTF model

Log-transformed incremental claims triangle

	0	1	2	3
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Calendar year trends

	0	1	2	3
2018		+0.2		
2019	+0.2			
2020				
2021				

	0	1	2	3
2018			+0.2	
2019		+0.2		
2020	+0.2			
2021				

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	0	1	2	3
2018	10	10.2	10.4	11
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2020	10.4	11		
2021	11			

Calendar year trends

	0	1	2	3
2018		+0.2		
2019	+0.2			
2020				
2021				

	0	1	2	3
2018			+0.2	
2019		+0.2		
2020	+0.2			
2021				

	0	1	2	3
2018				+0.6
2019			+0.6	
2020		+0.6		
2021	+0.6			

Simple example of PTF model

Log-transformed incremental claims triangle

	0	1	2	3
2018	10	10.2	10.4	11
2019	10.2	10.4	11	
2020	10.4	11		
2021	11			

Calendar year trends

	0	1	2	3
2018		+0.2		
2019	+0.2			
2020				
2021				

	0	1	2	3
2018			+0.2	
2019		+0.2		
2020	+0.2			
2021				

	0	1	2	3
2018				+0.6
2019			+0.6	
2020		+0.6		
2021	+0.6			

Log-transformed incremental claims triangle in **form of PTF model**

	0	1	2	3
2018	$10 = \alpha$	$10.2 = \alpha + \gamma_1$	$10.4 = \alpha + \gamma_1 + \gamma_1$	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$
2019	$10.2 = \alpha + \gamma_1$	$10.4 = \alpha + \gamma_1 + \gamma_1$	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$	
2020	$10.4 = \alpha + \gamma_1 + \gamma_1$	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$		
2021	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$			

Simple example of PTF model

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2021	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$			

Linear regression problem

Development year	Response variable	Regression matrix		
0	10	1	0	0
0	10.2	1	1	0
0	10.4	1	2	0
0	11	1	2	1
1	10.2	1	1	0
1	10.4	1	2	0
1	11	1	2	1
2	10.4	1	2	0
2	11	1	2	1
3	11	1	2	1
	$=: \boldsymbol{y}$	$=: \boldsymbol{X}$		

Regression coefficients
α
γ_1
γ_2

$=: \boldsymbol{\beta}$

Simple example of PTF model

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	0	1	2	3
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2020	$10.4 = \alpha + \gamma_1 + \gamma_1$	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$		
2021	$11 = \alpha + \gamma_1 + \gamma_1 + \gamma_2$			

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Development year	Response variable	Regression matrix		
0	10	1	0	0
0	10.2	1	1	0
0	10.4	1	2	0
0	11	1	2	1
1	10.2	1	1	0
1	10.4	1	2	0
1	11	1	2	1
2	10.4	1	2	0
2	11	1	2	1
3	11	1	2	1
	$=: \boldsymbol{y}$	$=: \boldsymbol{X}$		

Regression coefficients
α
γ_1
γ_2

$=: \boldsymbol{\beta}$

Linear regression model:

$$\boldsymbol{y} = \boldsymbol{X} * \boldsymbol{\beta} + \boldsymbol{\varepsilon},$$

where $\boldsymbol{\varepsilon}$ is vector of errors (i.i.d. random variables with zero mean and constant variance).

Regression coefficients are calculated using **Ordinary Least Squares** method:

$$\widehat{\boldsymbol{\beta}} = (\boldsymbol{X}^T * \boldsymbol{X})^{-1} * \boldsymbol{X}^T * \mathbf{y}$$

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$$\widehat{\boldsymbol{\beta}} = (\hat{\alpha}, \hat{\gamma}_1, \hat{\gamma}_2)^T = (10, 0.2, 0.6)^T$$

PTF model: best practices in modelling

Negative increments

Possible ways to handle **negative incremental paid losses**, which **cannot be log transformed**:[17]

- Zero out negative values, treating them as 0 after log-transforming the rest.
- Replace the value with $-\log(-q(w,d))$ instead of $\log(q(w,d))$.
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Trends selection

Methods to determine **AY, DY and CY trends coefficients**:[15]

- **By inspection**:
  1. Fit the data with a basic model (assuming only one trend in each direction)
  2. Plot residuals against DY, AY and CY indices and identify trends through these plots.

  This method can vary based on the analyst's interpretation.

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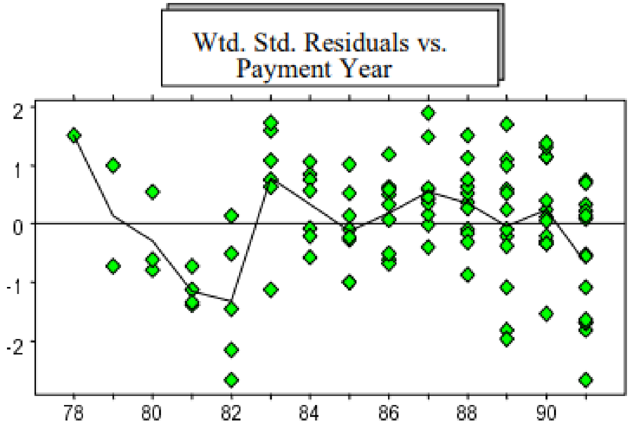
Plot of standardized residuals against calendar years for the **basic PTF model**.

Estimated calendar year trend parameter is **0.1563**



Source: “Best Estimates for Reserves”, May 17, 1998, by Glen Barnett and Ben Zehnwirth

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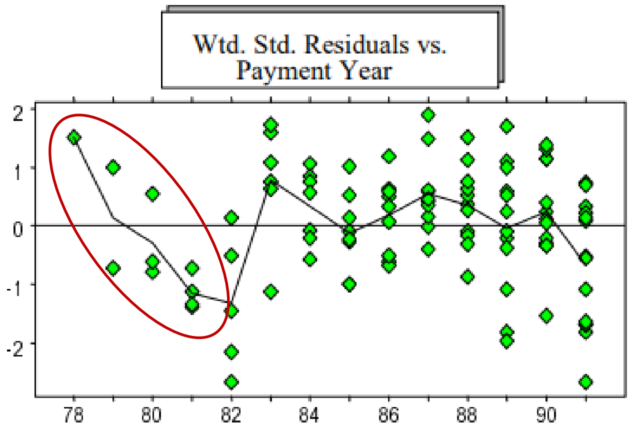

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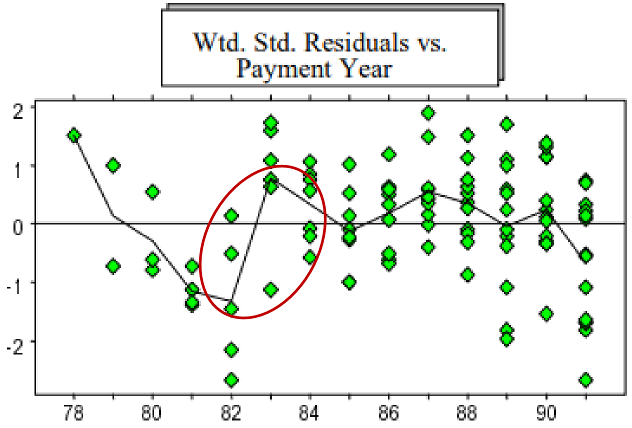

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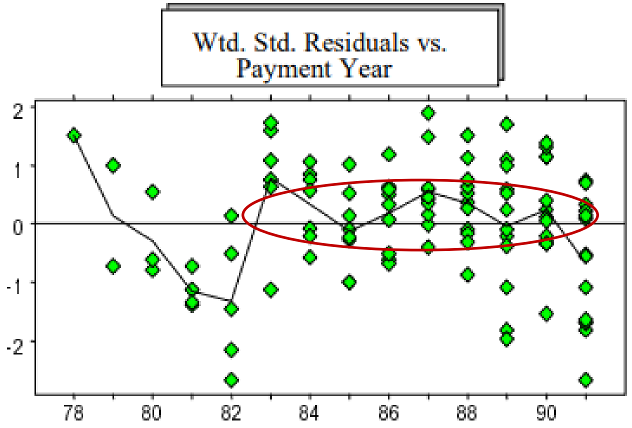

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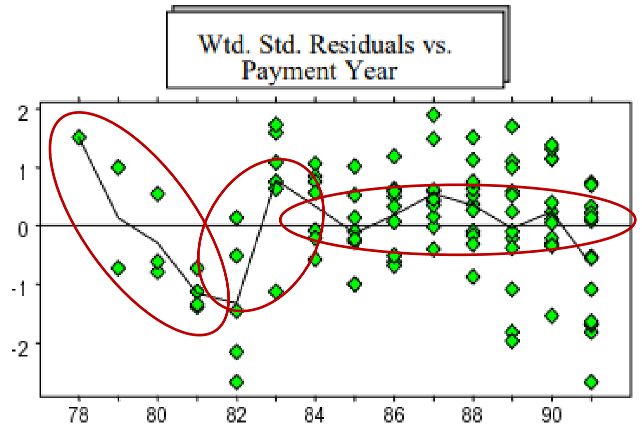
Methods to determine **AY, DY and CY trends coefficients**:[15]

- **By inspection**:
  1. Fit the data with a basic model (assuming only one trend in each direction)
  2. Plot residuals against DY, AY and CY indices and identify trends through these plots.

  This method can vary based on the analyst's interpretation.

Plot of standardized residuals against calendar years for the **basic PTF model.**

Estimated calendar year trend parameter is **0.1563**



Source: "Best Estimates for Reserves", May 17, 1998, by Glen Barnett and Ben Zehnwirth

PTF model: best practices in modelling

Negative increments

Possible ways to handle **negative incremental paid losses**, which **cannot be log transformed**:[17]

- Zero out negative values, treating them as 0 after log-transforming the rest.
- Replace the value with $-\log(-q(w,d))$ instead of $\log(q(w,d))$.
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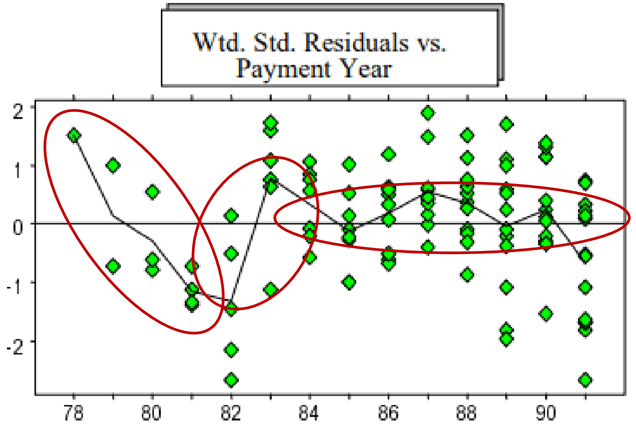
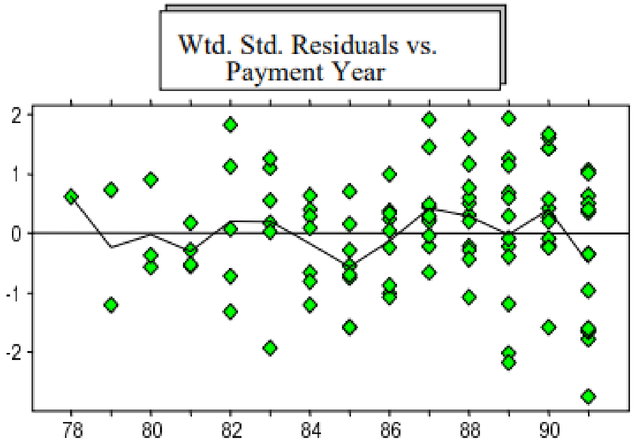


Plot of standardized residuals against calendar years for the **PTF model with three calendar year trends**.



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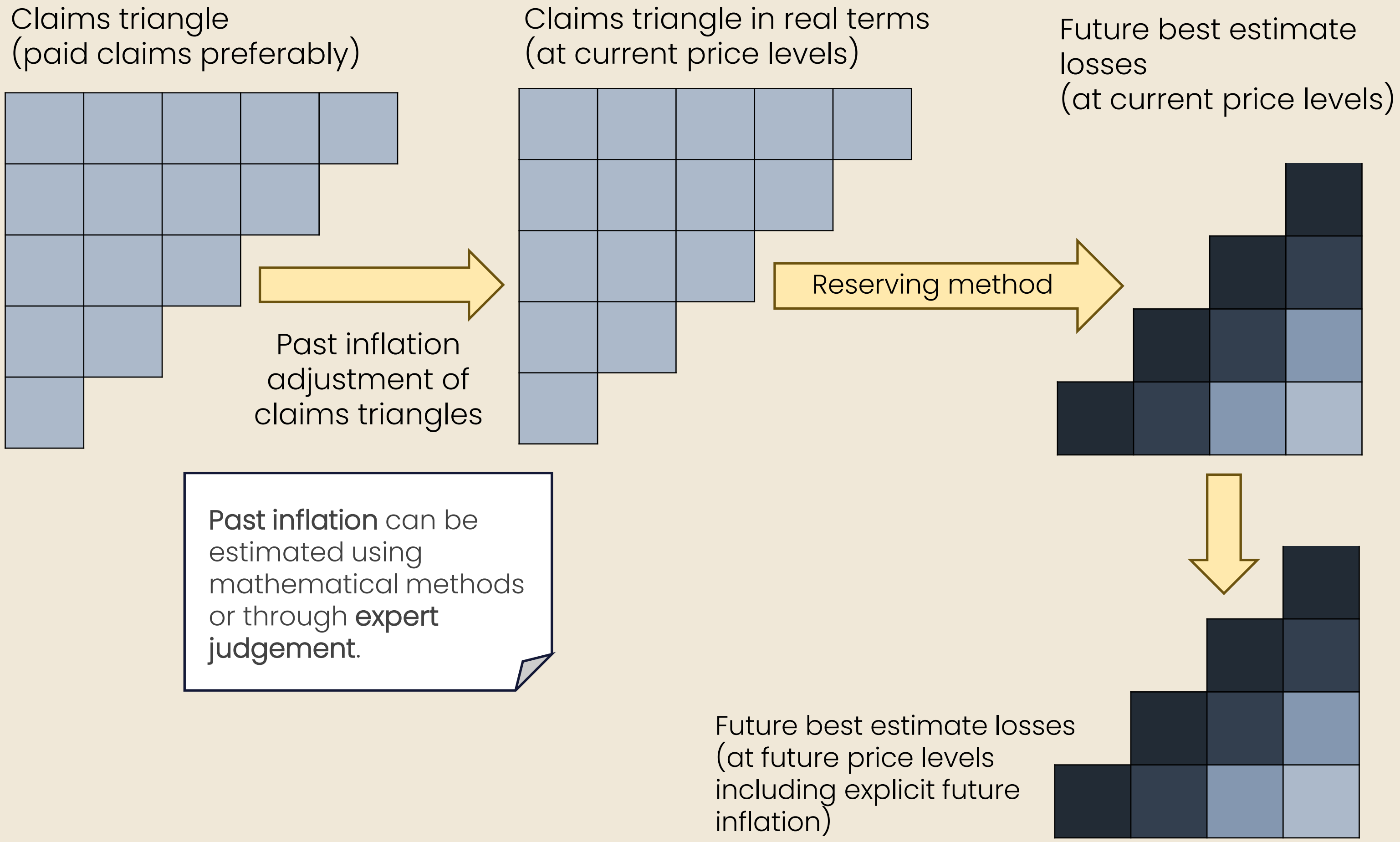
Projecting CY trends

To **estimate ultimate losses**, we need to project **future CY trends**, which may not be observable in current data.

- If **calendar year trend** has been **stable in the more recent years**:[15]
  - e.g. if the estimate of calendar year trend in the most recent years is $\hat{\gamma} \pm \mathrm{s.e.}(\hat{\gamma})$, then we assume for the future a **mean trend of** $\hat{\gamma}$ with a **standard deviation of trend** $\mathrm{s.e.}(\hat{\gamma})$.
- If **calendar year trend** has been **unstable in the more recent years**:
  - analysing other data types and using any relevant **business knowledge** (though this can be complex as some trends may overlap with development and accident year trends).

Accounting for claims inflation explicitly – general approach



Past inflation can be estimated using mathematical methods or through **expert judgement**.

Calibrated expected future claims Inflation:

Option 1: deterministic

Weighting of the economic inflation drivers must be performed and **adjusted** by other factors (e.g. **social inflation**) to estimate future expected claims inflation per insurance business.

This process uses public information (e.g. **breakdown of overall CPI projections**) in combination with **expert judgement.**

Option 2: stochastic

Future claims inflation can be modelled as a function of **inflation projections from an Economic Scenario Generator**, allowing it to be stochastic rather than deterministic.

Source: "Reserve Methodologies to Account for Inflation", September 20, 2022, by Ashley Wohler, FCAS, MAAA Jon Sappington, FCAS, MAAA

Lloyd's guidance on managing claims inflation

LLOYD'S

Reserving Expectations of Syndicates

*"We expect syndicates to **explicitly consider economic and excess inflation** (including social inflation) in their reserving process **when setting best estimate reserves.** This is particularly important when historical data is unlikely to be representative of the future and traditional reserving techniques do not address this.*

*Where syndicates are not making an explicit additional allowance in their best estimate reserves for inflation, they must be able to **explain why their approach is appropriate** and how they have gained sufficient comfort that their reserves are adequate."*

LLOYD'S

Best practice

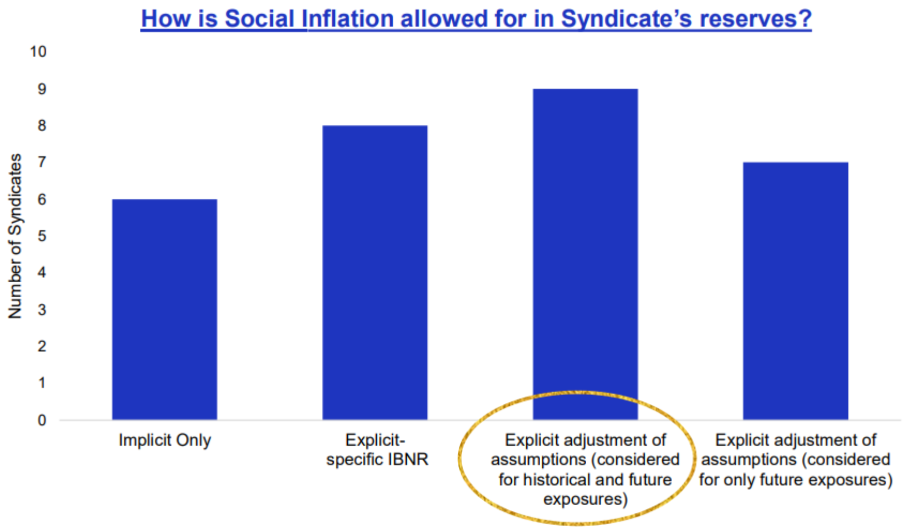
Best estimate reserve inputs

The best approaches have explicit consideration for inflation such as:

Generalised linear models

Inflation-adjusted chain ladder

Source: Lloyd's Market Association. (2022). *LMA Townhall: Inflation NED slides.*



Source: Lloyd's Reserving Thematic Review 2022

price forbes re

2025

Reinsurance Products that Address Claims Inflation

The most common risk management measure taken is **purchasing reinsurance cover** for classes specifically exposed to social inflation or claims inflation in general.

Considerations in Reinsurance Agreements

Reinsurance Contract Exclusions:

Social inflation has led to several exclusions in reinsurance contracts.

Some common exclusions include

- **nuclear verdicts**
- **TPLF**
- **class action lawsuits**
- **attorney-driven claims inflation**.

It is crucial for insurance companies to **carefully review reinsurance agreements** for such exclusions before finalizing any deals.

Considerations in Reinsurance Agreements

Social inflation and different types of reinsurance agreements:

In *proportional reinsurance*, the insurer and reinsurer **share** premiums and losses, **including the effects of social inflation**. This provides the insurer with **proportional protection** against rising claims costs.

Non-proportional reinsurance, however, only covers **losses above a set threshold**, potentially leaving the insurer **more exposed to inflation-driven increases**:

- To manage this, reinsurers may use **additional tools**—such as indexation clauses that adjust limits based on inflation indices—to maintain the real value of coverage.

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Reinsurance tools for hedging against social inflation risk:

Adverse development covers (ADC) and loss portfolio transfers (LPT) are two possible tools used to hedge against claims inflation.

While non-proportional reinsurance protects against large, unexpected losses,

- **ADC** provides additional protection by **capping liabilities from worsening claims over time,**
- **LPT** provides additional protection by **transfers existing and future claim liabilities to the reinsurer.**

Together, they help insurers manage both **immediate high-severity risks and long-term reserve** uncertainties, offering a more comprehensive risk management approach.

Indexation clause

What is it?

- Definition: IC in a reinsurance contract is a contractual provision that **adjusts** the **retention** and **limit** amounts based on a **specified inflation index.** [18]

- Purpose: to **maintain the real value** of the **reinsurance coverage over time** by accounting for inflation.

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How does it work ?

- Redistributes inflation-related increases by adjusting retention and limit amounts based on an inflation index.

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Example scenario:

XoL treaty **$20m xs. $5m** for motor liability, established in **2010**.

Inflation reached **25% by 2020** (base 1 in 2010 to 1.25 in 2020).

A loss **settled** at **$15m in 2020**.

Calculation:

Real value of the loss in 2010 terms:

$15m / 1.25 = $12m

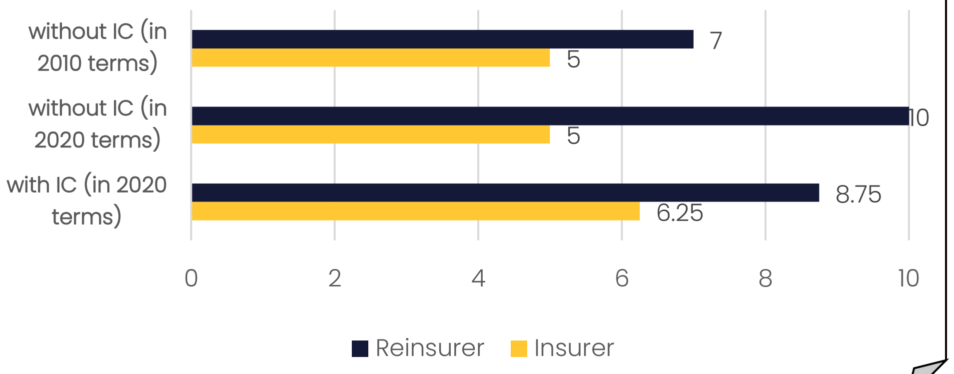
Adjusted retention:

$5m * 1.25 = $6.25m

Adjusted limit:

$20m * 1.25 = $25m

Distribution of loss



Adverse development cover

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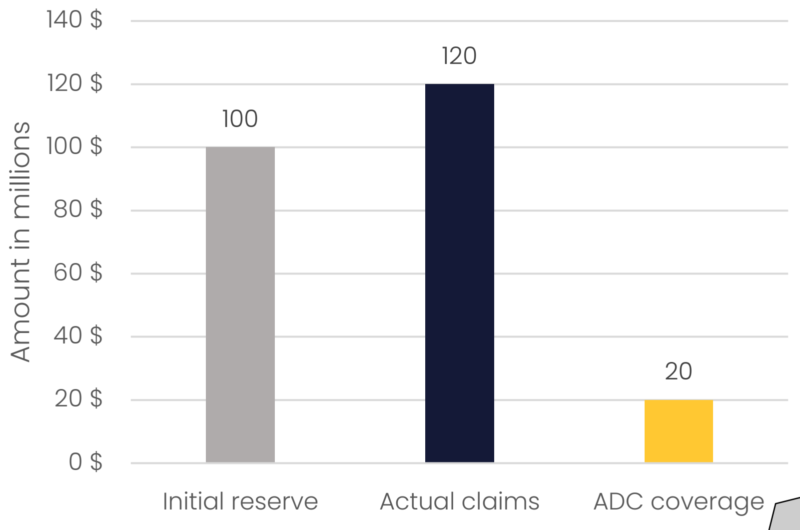
How does it work?

- ADC activates when **actual claims exceed the insurer's reserved amount, covering the excess.**
- This helps maintain financial stability and manage reserve risk effectively.

Example scenario:



Loss Portfolio Transfer

What is it?

Definition: LPT is a reinsurance agreement where an insurer **transfers existing claim liabilities** and related **reserves to a reinsurer.**[20]

Purpose: **provides** insurers with **capital relief** by transferring existing claim liabilities to a reinsurer, helping manage claims inflation and stabilizing the insurer's financial position.

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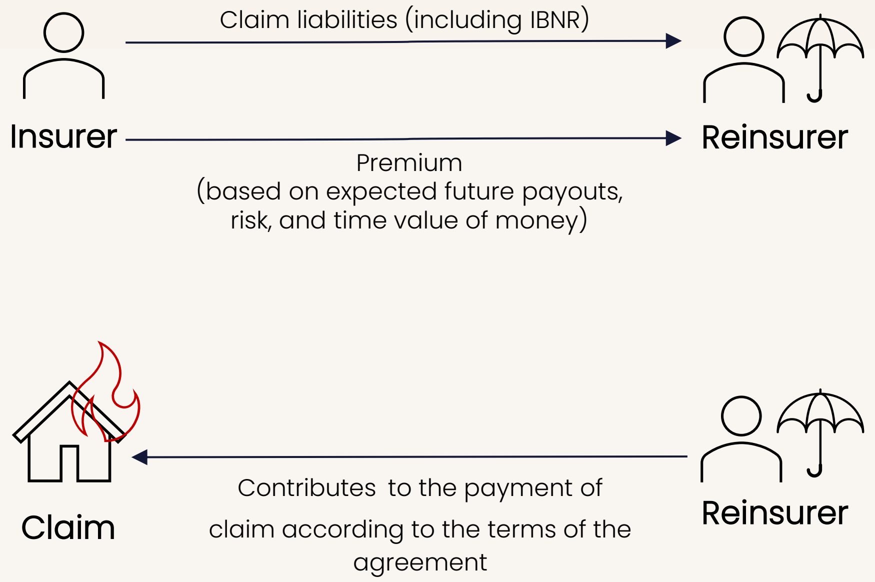

Thank you for your attention

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