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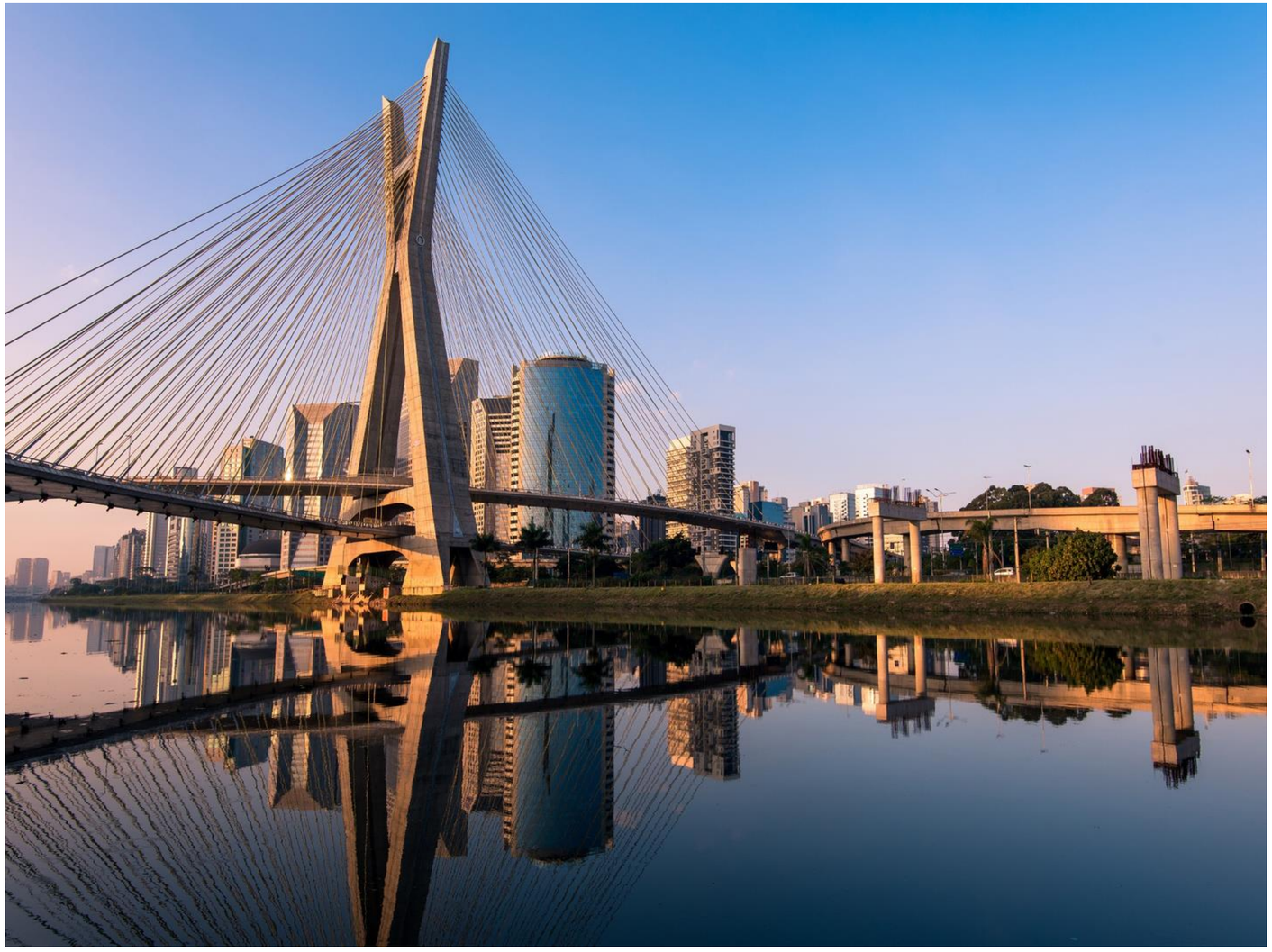

THE IMPACT OF CLIMATE CHANGE ON PRICING MODELING FOR INSURANCE IN BRAZIL: AN ANALYSIS

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CONTEXT AND MOTIVATION

Why this study matters?

- Brazil was historically seen as a low-catastrophe country

Climate change is shifting this reality:

"Many of these occurrences are now classified as catastrophic, despite Brazil's historical reputation as a non-catastrophic region."

- Major socioeconomic impacts (property, agriculture, infrastructure)
- Insurance sector is on the front line of risk management

OBJECTIVE AND RESEARCH QUESTIONS

Main Objective:

Analyze how Brazilian insurers are adapting pricing models to climate-related risks

Research Questions:

How to price extreme events with limited local historical data?

How to adapt international models to Brazilian reality?

How to reduce the protection gap while ensuring solvency?

STRUCTURE OF THE STUDY

Section 1: Climate risks and impacts in Brazil

Section 2: Fundamentals of insurance pricing

Section 3: Brazilian market strategies

Section 4: International models and their relevance

Section 5: Future directions and recommendations

CLIMATE RISKS AND IMPACTS IN BRAZIL

Section 1

São Paulo 2025

CLIMATE RISKS IN BRAZIL

Recent examples of extreme events:

- Droughts (2019–2020): R$13.4 billion in agricultural losses
- Floods (2024 in Rio Grande do Sul):

“The largest claim event in the country’s history, with estimated losses up to R$88.9 billion.”

Impact sectors:

Agriculture (6% of GDP)
Energy (hydropower = 33% of matrix)
Food security

THE INSURANCE PROTECTION GAP

- **Key issue:**

In Brazil, up to 93% of catastrophe-related losses are uninsured (SUSEP, 2024)

Cultural and economic reasons limit insurance penetration

“Even in countries with developed markets, like the U.S., the protection gap can reach 65% (e.g., Hurricane Katrina).”

BRAZILIAN MARKET ADAPTATIONS

- Mitigating financial impact
- Stabilizing local economies after disasters
- Supporting long-term resilience
- Requires **accurate risk pricing** and **sustainable reserves**

FUNDAMENTALS OF INSURANCE PRICING

Section 2

TRADITIONAL INSURANCE PRICING

Actuarial Foundations:

- Premium = Frequency × Severity
- Pure Premium + Expenses + Profit + Contingency
- Credibility theory and historical loss experience

“Traditional pricing assumes that historical patterns reflect future risks – a key limitation under climate change.”

CHALLENGS OF TRADITIONAL MODELING

- Climate change creates **non-stationary risks**
- Historical data may no longer be reliable
- Uncertainty in estimating frequency and severity
- Pressure on solvency and fair pricing

“How much credibility can we give to past data when extreme events are increasing?”

BRAZILIAN MARKET STRATEGIES

Section 3

BRAZILIAN MARKET ADAPTATIONS

Observed strategies include:

- Increased use of catastrophic and parametric insurance
- Regional initiatives like UIIF (Urban Infrastructure Insurance Facility)
- Government subsidies for agriculture

“The lack of an insurance culture significantly exacerbates this situation.”

PARAMETRIC INSURANCE: AN OPPORTUNITY

Definition:

Trigger-based payout model (e.g., rainfall exceeds threshold)

Advantages:

Fast response and simpler claim process

Suitable for public-private programs

Limitations in Brazil:

Only one current provider

Issues with data accuracy and trigger calibration

CASE STUDY: RIO GRANDE DO SUL FLOOD (2024)

- Over R$13 billion in total estimated damages
- R$6 billion in reported claims (around $1bi)
- Only **a fraction of losses insured**
- Reinforces urgency of pricing reform

"This event could surpass COVID-19 in terms of indemnity cost (CNSEG, 2024)."

INTERNATIONAL MODEL AND THEIR RELEVANCE

Section 4

LESSONS FROM INTERNATIONAL MODELS

Post-Katrina (1992): catastrophe modeling became essential in the U.S.

Cat models: Helpful for frequency, but not always for severity (Dietz & Niehörster, 2020)

Climate Index Insurance: Used in 30+ countries

Actuaries Climate Index (ACI):

Aggregates temperature, precipitation, wind, sea levels

MACHINE LEARNING AND CLIMATE MODELING

- Improved predictive capacity from open data
- Use in pricing, reserving, and exposure analysis

Example:

“Adoption of ML is gaining traction due to multivariate modeling and predictive accuracy.” (Blier-Wong et al., 2021)

FUTURE DIRRECTIONS AND RECOMMENDATIONS

Section 5

WHAT COULD BRAZIL ADOPT?

- Create **a Brazilian Climate Risk Index**
- Encourage **parametric insurance** frameworks
- Improve **data sharing** across sectors
- Incentivize **public-private collaboration**

KEY RECOMMENDATIONS

- Leverage international experience, adapted to local context
- Use probabilistic models with **uncertainty loadings**
- Expand actuarial education focused on climate risk
- Foster regulatory frameworks for resilience

LIMITATIONS AND FUTURE RESEARCHS

- Lack of long historical data
- Emerging models still under development

Future research:

- Cross-country comparative pricing strategies
- Policy effectiveness in reducing protection gaps

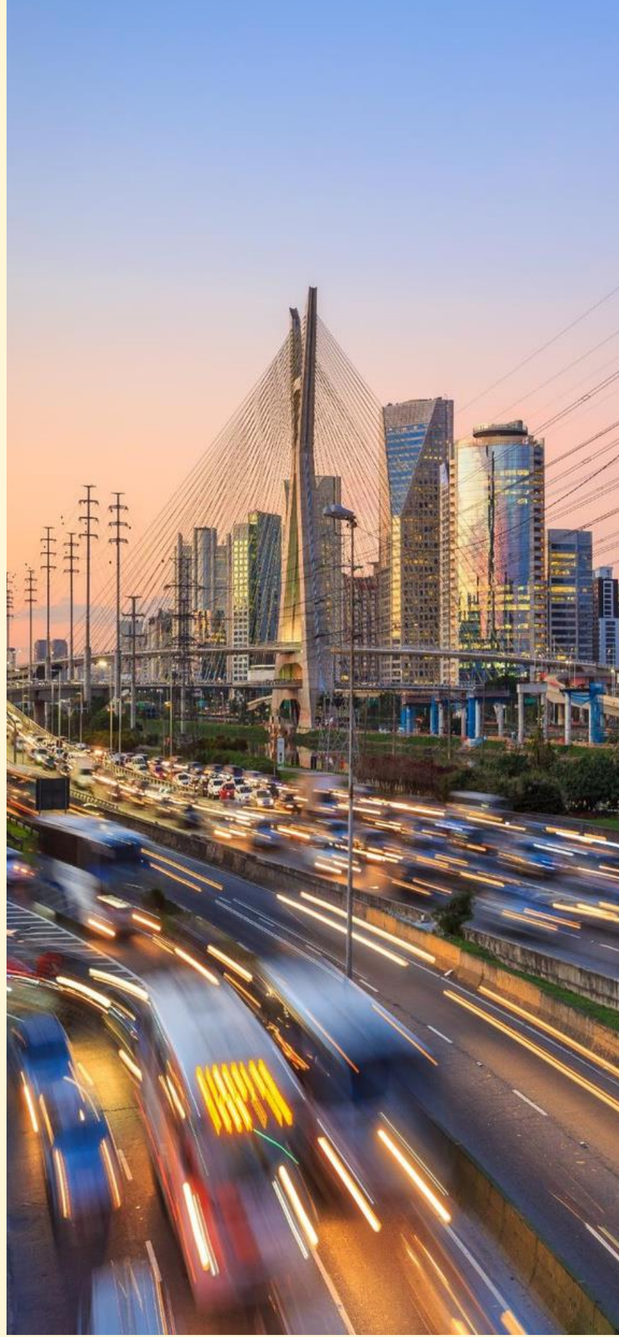
CONCLUSION

- Climate change is reshaping the Brazilian insurance landscape
- Traditional models must evolve to account for new risks
- Advanced modeling, collaboration, and innovation are essential

"A proactive and data-driven approach is vital to ensure long-term market sustainability and societal resilience.”

Thank you! Obrigado!

Questions?



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