



Basis risk in parametric insurance: challenges and mitigation strategies

Content

Introduction	2
Key takeaways	3
1. What is parametric insurance?	4
2. What is the value proposition of parametric insurance?	4
3. Market overview	6
4. Basis risk	8
5. Examples of basis risk in parametric insurance	9
6. Selective case studies	10
7. Approaches to addressing basis risk in parametric insurance	12
8. Designing and structuring parametric insurance is key	14
9. Conclusion	14
Authors/contacts	16

Introduction

Parametric insurance is quickly becoming a popular alternative to traditional insurance policies. Unlike traditional policies that require detailed assessments of losses, parametric insurance works by using predetermined, objective markers to determine payouts in the event of a specific triggering event, such as a natural disaster or other defined risk.

Parametric insurance can provide quick, transparent and customisable coverage for specific risks and exposures, allowing businesses and organisations to better manage their financial risk and protect their assets. In some cases, this type of cover can be more cost effective relative to a standard policy.

However, parametric insurance is also associated with a risk called basis risk which occurs when the pre-determined triggers used in parametric insurance products don't match the actual loss suffered by a business or organisation. In such cases, the payout may be less or more than what is needed. To mitigate the risk, it's essential to choose appropriate metrics that accurately capture the impact of the triggering event on the business or organisation. For example, a parametric insurance policy for crop damage may use a rainfall index as the trigger for payout. However, if the crops were damaged due to reasons other than lack of rainfall, the policyholder may not receive a payout, even though they experienced a loss. While basis risk is a concern, it can be mitigated through careful selection of the parameters and maintaining realistic expectations for the coverage provided by the policy.

This paper explores the benefits and risks associated with parametric insurance and how it can help individuals and businesses effectively manage their risk exposures. We'll also delve deeper into basis risk, share examples and actual case studies, and explore ways this risk can be mitigated.

Key takeaways



Parametric insurance is a non-traditional insurance cover that settles on a pre-agreed parameter or index

The payout depends on the occurrence of a pre-agreed triggering event (e.g. a weather event, cyber/terrorism attack, strike or epidemic/pandemic), regardless of the actual loss. There's no need for claims adjustment after the event occurs, unlike with a traditional, indemnity-based product.



Value proposition is centred on speedy claims payment, claims certainty and transparency, and bespoke solutions that can bridge gaps in conventional insurance policies. It acts as a complement to traditional insurance, not as a substitute for it

Parametric insurance makes sense when traditional insurance isn't accessible or affordable. When a trigger event occurs, there's little subjectivity as the claims payout is set on the pre-agreed index measurement being reached, rather than a loss being sustained. It also offers the opportunity for carriers to provide a structured, tailor-made solution that reflects an insured company's exposure and bridges any gaps in conventional insurance policies.



The market for parametric insurance is expected to more than double by 2031

The market for parametric insurance was estimated at approx. USD 12 billion Gross Written Premium (GWP) and is expected to grow to approximately USD 29 billion by 2031 (Allied Market Research), driven by advancements in sensor technology and satellite imagery, the growing natural catastrophe protection gap and the attractiveness of the product. The agriculture sector represents the largest share of premiums, while the construction segment shows the fastest growth. Geographically, North America accounted for the largest share, with APAC being the fastest growth region for parametric insurance.



One of the significant challenges associated with parametric insurance products is basis risk

Basis risk occurs when there's a mismatch between the coverage of the policy and the actual event that triggers payment, resulting in the policyholder receiving a lower payout than expected or no payout at all. This can be driven by a number of factors, including the limited availability of high-quality data that accurately predicts the occurrence of an insured event, the lack of an accurate and up-to-date index or trigger mechanism that accurately reflects the event, and/or the imposition of rigid terms within the policy.



Basis risk can be mitigated by enhancing data quality, monitoring and evaluating the parameters of the policy, diversifying insurance parameters or complimenting with traditional insurance covers

Reducing basis risk in parametric insurance typically involves improving the accuracy of models, refining index triggers, ensuring high-quality data and designing policies that align as closely as possible with the insured's true risk profile. Insurers often work with meteorologists, data scientists and other specialists to continuously refine their parameters and decrease basis risk. While no solution can completely eliminate basis risk, a multifaceted approach can significantly reduce it.

1. What is parametric insurance?

Parametric insurance is a type of insurance that includes predefined criteria which, when met, trigger a payment to policyholders. Parametric insurance guarantees payment based on the occurrence of pre-specified events (e.g. a weather event, cyber/terrorism attack, strike or epidemic/pandemic), regardless of actual loss. An independent third party determines the intensity

of the event and if the pre-agreed trigger has been reached, the claim is automatically paid without the need to go through a lengthy adjudication process as would be observed in a traditional, indemnity-based product requiring a detailed proof of loss and where outcome can be uncertain.¹

2. What is the value proposition of parametric insurance?

Compared to traditional indemnity insurance, parametric insurance offers the following key advantages:

Fast claims payments

Because there's no need for traditional claims investigations, payouts can be made quickly, often within days of a triggering event. This can be critically important in situations where funds are needed urgently, such as after a natural disaster.

Claims certainty and transparency

The policyholder has a clear understanding of the exact amount to be paid and under what conditions in advance, meaning that all ambiguity is removed. An independent source defines the mechanics of any payment, thus ensuring a truly unbiased method of assessing the policy. The promise of a seamless payout mechanism contrasts with the long, drawn-out claims adjudication process observed for traditional policies.

Simplicity

Because payouts are based on a predetermined metric, such as wind speed or earthquake magnitude, parametric insurance is straightforward and easy to understand.

Cost-efficient

Because payouts are based on a predetermined metric, parametric insurance can be more cost-effective than traditional insurance policies in certain situations.

Coverage for difficult-to-cover risks

Parametric insurance pushes the boundaries of traditional insurance by using data to offer alternative means for underwriting difficult-to-insure losses – unanticipated expenses, lost wages and revenue shortfall.

Bespoke solutions

In contrast to conventional insurance policies that tend to have standardised policy wording, parametric policies are tailor-made, allowing the policy holder to determine the parameters, terms, and conditions that align with the particular risk exposures they're looking to cover. The term of a parametric cover is also flexible – a policy can be effective for any period from a few months to several years.

Protecting revenue volatility

From an investor's perspective, parametric insurance can effectively reduce the volatility of a company's or a project's financial results, making them more willing to lend or invest in a company/project.

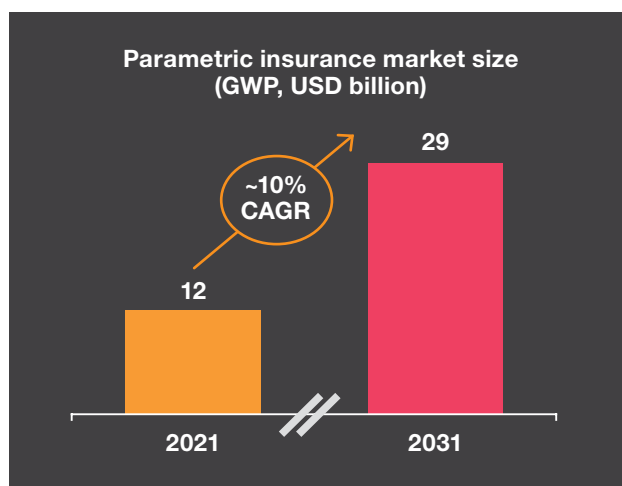
1 <https://www.pwc.ch/en/insights/fs/closing-the-gap-with-parametrics-insurance.html>



3. Market overview

Parametric products were initially developed to address the complexities and delays often associated with claims processing in conventional policies, particularly in response to large-scale natural disasters. By using a parametric trigger, such as the intensity of an earthquake or the speed of wind during a cyclone, payouts can be made swiftly and without the need for lengthy assessments of actual damages. Over the years, parametric insurance has evolved significantly, both in terms of complexity and application. Initially focused on natural disaster coverage, it's expanded to cater to a variety of risks, including agricultural yield shortfalls, travel delays and even specific business disruptions. The evolution has been driven by advancements in technology and data analytics, allowing for more precise measurement and modelling of risks.

The parametric insurance market generated approx. USD 12 billion in GWP in 2021 and is projected to reach approx. USD 29 billion by 2031,² growing at a CAGR of approx. 10% from 2022 to 2031. The agriculture sector represents the largest share of premiums, while the construction segment shows the fastest growth.



Source: Allied Market Research

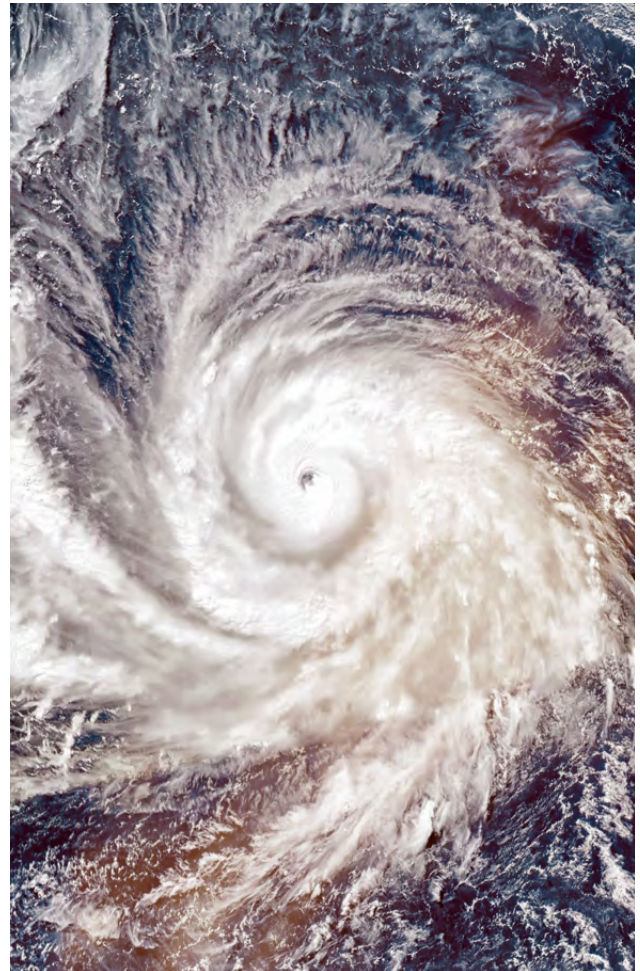
Geographically, North America accounted for the largest share, with APAC being the fastest growth region for parametrics.

The growth of the parametric insurance market has been driven by the following dynamics:

- **Advancements in sensor technology and satellite imagery:** Hazard modelling is benefiting from more accurate measurements by weather stations and satellite-captured data. Startups worldwide are providing data collection and analysis tools powered by artificial intelligence (AI), machine learning, computer vision and other powerful technologies. These technologies enable insurers to analyse vast amounts of environmental data, improving the accuracy of parametric triggers. IoT devices are also playing a critical role, especially in agricultural parametric insurance, by providing real-time data on soil moisture, temperature and other relevant parameters.
- **Growing NatCat protection gap:** The increased frequency and severity of natural disasters have led to increased demand for parametric insurance products, leading to increased demand for insurance coverage that can quickly provide funds for recovery and rebuilding efforts. According to Swiss Re, only USD 108 billion (~39%) of the USD 280 billion economic losses arising from natural catastrophes were insured in 2023. This means that millions of households and businesses face a large protection gap. With climate change, environmental devastation and ever more people concentrated in high-risk areas, impacts from natural catastrophes will continue to grow.
- **Need for financial protection against non-damage losses:** Many businesses and organisations face risks that aren't covered by conventional insurance policies, such as lost revenue due to business interruption or cancellations of events. Parametric insurance can provide financial protection against these kinds of losses.
- **Attractiveness of parametric insurance vs traditional indemnity-type products:** As noted earlier, parametric insurance offers speedy claims payments, certainty of claims payment (when a pre-defined threshold is triggered) and the ability to insure what has historically been uninsurable, while being able to structure products that meet the needs of the insured party.

2 Allied Market Research

-
- **Increased demand in emerging markets:** There's a noticeable increase in demand for parametric insurance in emerging markets. These markets, traditionally underserved by conventional insurance, find parametric insurance appealing due to its simplicity and the speed of payouts. This trend is also being fuelled by the increasing availability of regional weather and geological data, making it feasible to design effective parametric products for these areas.
 - **Innovation in product design:** Innovation is a key driver of growth in demand for parametric products. Insurers aren't only covering traditional risks like natural disasters but are also creating products for newer risks. For example, parametric policies covering solar irradiance levels support solar energy producers in managing the risk of inconsistent sunlight. Similarly, policies tailored for the travel industry, which compensate for delays due to specific weather conditions, are becoming popular. These innovations are driven by a deeper understanding of various business sectors and their unique risk profiles.
 - **Climate change adaptation:** As the effects of climate change become more pronounced, parametric insurance is increasingly viewed as a tool for adaptation. Governments and international organisations are looking at parametric solutions as part of broader strategies to increase resilience against climate-related risks. This is especially relevant for regions that are becoming increasingly vulnerable to extreme weather events due to climate change.
 - **Regulatory developments:** Regulators in various jurisdictions are starting to recognise the potential of parametric insurance and are adapting regulations to facilitate its growth. This includes creating frameworks that recognise the unique nature of parametric products and supporting innovation in this space.
-



4. Basis risk

One of the significant challenges associated with parametric insurance products is basis risk. Basis risk arises when the parametric index doesn't perfectly correlate with the actual loss experienced by the insured. This can result in the policyholder receiving a lower payout than expected or no payout at all, which can erode trust in parametric products. This is a key

risk for both insurers and insured parties, as it can significantly impact the effectiveness and reliability of parametric insurance products. This risk is inherent in parametric insurance due to the nature of its design – the payout is triggered by specific, measurable events, rather than the actual damage or loss experienced. Basis risk can arise as a result of several factors:



Index triggers

The use of an index (like rainfall levels, seismic activity or wind speed) to trigger insurance payouts means that if the index doesn't perfectly correlate with actual losses, basis risk occurs.



Temporal granularity

If the timeframe used by the index doesn't align well with the period of loss, this can contribute to basis risk. For example, seasonal variations can impact the relationship between the index and actual losses.



Data quality

Inaccurate or insufficient historical data can lead to a mismatch between the index and actual losses. For example, in regions with less developed infrastructure, data might be sparse, leading to indices that don't accurately represent local conditions. Also, historical data might not be a reliable predictor of future conditions due to climate change or some other evolving factor.



Policy structure

Deductibles, limits and the specific structure of the parametric product can affect how closely payouts match losses. The choices of deductibles, caps and limits can lead to significant basis risk if they don't align well with the actual risk profile and financial resilience of the insured. The exact wording and definitions within the policy can also lead to disputes about coverage.



Model accuracy

If the models used to predict losses based on the index aren't accurate, the payouts may not reflect the true damages. The complexity of natural phenomena makes modeling them inherently difficult. Small errors in models can lead to significant basis risk. Also, over time, models can become outdated as new research and data become available.



Non-physical triggers

For non-physical triggers, changes in the underlying metrics may not always correlate directly with the policyholder's losses. For example, currency fluctuations, political instability, and other economic variables can distort the correlation between the index and actual losses.



Geographical granularity

The index may not capture localised losses if the geographical area it covers is too large or not well aligned with the actual area of loss. For example, losses can be highly localised, such as hail damage or flooding. A parametric index covering a broader area may not capture this. In another example, disparities in infrastructure and building codes within the covered area can also lead to a mismatch between index readings and actual damage.

Legal and regulatory factors

Changes in regulations or legal interpretations can influence the execution and effectiveness of parametric insurance, introducing basis risk. New laws or interpretations of insurance contracts can change how policies are enforced, potentially leading to unexpected gaps in coverage. Cross-border insurance policies face additional complexity from differing legal systems, which can contribute to basis risk.



Market volatility

For parametric insurance linked to financial markets or commodities, market volatility can influence basis risk. For parametric insurance covers tied to commodities or other financial indicators, swings in these markets can lead to payouts that don't align with the insured's actual losses. External economic shocks can distort the relationship between the trigger index and the actual value of the loss.



5. Examples of basis risk in parametric insurance

There are many examples of basis risk in parametric insurance. In the agricultural sector, crop-index insurance products are commonly used to protect farmers against crop failures due to weather events such as drought and excessive rainfall. In designing a crop-index insurance policy, the insurer may use crop yield as an index. The insurer would require that the yield of crops falls below a pre-agreed index level to trigger a payout. However, yields might fall below this level because of insufficient rainfall, nutrient deficiencies or pests, and the farmer will not get any payout.

Another example is a parametric insurance policy designed to protect a coastal property owner against storm surge damage. The triggering parameter for this insurance is the category of hurricanes making landfall within a specified region. Basis risk can arise when the actual damage incurred by the property owner isn't solely determined by the hurricane category but is also influenced by factors like the angle of impact, the timing of high tide and the specific topography of the coastline. If the insurance policy relies solely on the hurricane category as the triggering factor, it may not fully capture the nuanced and location-specific risks associated with storm surge, introducing basis risk as the payout may not align accurately with the actual property damage.



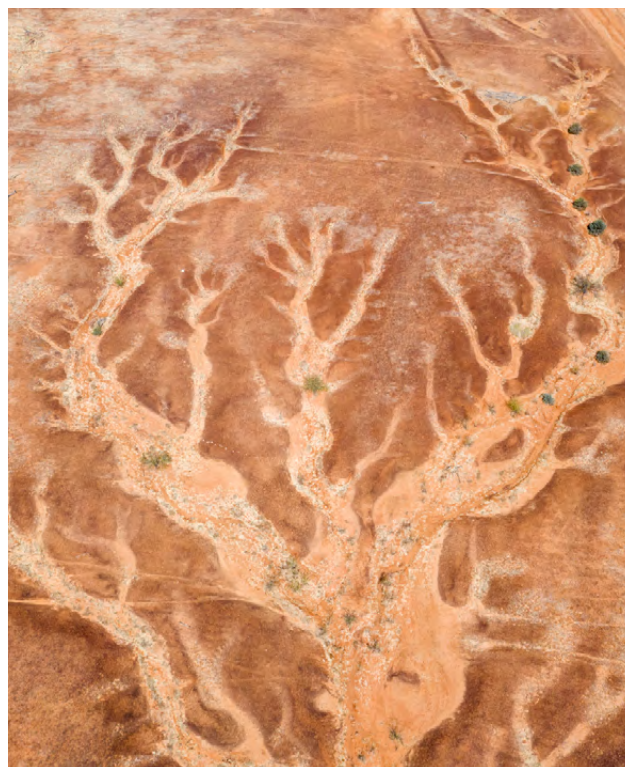
6. Selective case studies

Caribbean Catastrophe Risk Insurance Facility (CCRIF)

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) provides parametric insurance policies to Caribbean and Central American countries to help them manage financial risk associated with natural disasters.

In 2017, Hurricane Maria caused significant damage in Dominica, but the parametric insurance policies purchased by the country didn't provide adequate coverage due to the basis risk. The policies were triggered by wind-speed levels, but the true extent of the damage was caused by rainfall and flooding, which weren't covered by the policies.

To address this, CCRIF has developed a more comprehensive suite of parametric insurance products that cover a wider range of natural disasters, such as tropical cyclones, earthquakes, excess rainfall and drought. The organisation has also made efforts to educate policyholders about the limitations of parametric insurance and the importance of selecting appropriate metrics for their specific needs.



African Risk Capacity (ARC)

The African Risk Capacity (ARC) provides parametric insurance policies to member countries in Africa to help them manage financial risk associated with natural disasters such as drought, floods and tropical cyclones.

In 2019, Zambia experienced a severe drought which was a triggering event for ARC's parametric insurance policies. However, while the drought was severe, the amount of rainfall was just above the threshold needed to trigger a payout. This resulted in ARC not being able to provide sufficient financial assistance to support the affected populations.

ARC has addressed this by developing more comprehensive parametric insurance products that cover a wider range of natural disasters and underlying metrics. An example of this is a drought insurance policy which also includes vegetation health indices as triggers. This means that payouts are triggered not only by the amount of rainfall but also by the impact it has on the vegetation and crops.

2018 Bali volcanic eruption

A parametric insurance policy was purchased to protect Bali's Tourism industry from the financial impact of a volcanic eruption using metrics such as the distance of businesses from the volcano and the level of ashfall.

When the 2018 Bali volcanic eruption occurred, the ash didn't reach the predetermined levels required for the policy to pay out, even though the tourism industry sustained significant financial losses due to cancelled trips and closed businesses.



Hurricane Katrina

In 2005, Hurricane Katrina caused massive damage and losses in Louisiana and Mississippi. However, some parametric insurance policies that had been purchased to cover hurricane-related losses didn't payout, as the metrics used to trigger the policies didn't match the actual damage.



Wellington (NZ) earthquake, 2013

In 2012, the New Zealand Earthquake Commission (EQC) introduced a parametric insurance policy known as the 'Natural Disaster Cover' for residential properties. The trigger was based on the intensity of ground shaking, measured by seismographs. If the ground shaking exceeded a certain predefined threshold, policyholders would receive a payout, regardless of the actual damage to their property.

In August 2013, a magnitude 6.8 earthquake hit south of Wellington, New Zealand. While the ground shaking intensity met the parametric trigger criteria for some policyholders, the actual damage to structures varied. Some buildings that experienced intense ground shaking remained relatively undamaged, while others with lower ground shaking intensity suffered more severe damage. As a result, there was a mismatch between the trigger event and the actual losses incurred by property owners.

Wildfire events in California

Parametric insurance policies have been developed to cover losses related to wildfires in California, where drought conditions and high temperatures create favourable conditions for fires. However, the metrics used in some policies have been criticised for not capturing the impact of smoke and ash on businesses and homes, which can be significant even if a property isn't directly damaged by the fire.



7. Approaches to addressing basis risk in parametric insurance



Improved data collection and analysis

- **Enhancing data quality:** One of the most effective ways of addressing basis risk in parametric insurance is by using reliable data sources to infer the probable risk of triggering a payout. The deployment of high-resolution satellite imagery and IoT sensors can provide more accurate data, thereby refining the index and reducing basis risk. This helps to improve the accuracy of the payout and lowers the chances of basis risk occurrence.
- **Advanced analytics:** Employing sophisticated data analytics, including AI and machine learning algorithms, can help in better understanding the correlation between parametric triggers and actual losses. These technologies can analyse large datasets to refine trigger thresholds and reduce the likelihood of a mismatch.



Tailored policy design

- **Customisation of triggers:** Designing triggers that are closely aligned with the insured's specific risk exposure can significantly reduce basis risk. This involves understanding the unique aspects of the risk being insured and customising the parameters accordingly.
- **Layered triggers:** Parametric insurance providers can offer multiple or layered triggers to mitigate against basis risk. By offering multiple indices, providers can increase the likelihood of payouts and offer a wider range of benefits to policyholders. For instance, in crop-index insurance policies, insurers could utilise multiple crop parameters (e.g. yield, quality and price of the commodity) to minimise the effects of any single parameter. In another example, a drought insurance policy might consider not just rainfall levels, but also soil moisture and temperature readings to trigger payouts.
- **Developing dynamic parametric insurance products:** Another effective approach to addressing basis risk is by developing dynamic parametric insurance products. These products use live data, including satellite readings, to calculate payouts and adjust parameters continually. Adopting dynamic indices that can be updated with new data and risk modelling techniques to reflect the changing nature of risks can minimise basis risk. This approach ensures that payments reflect real-time conditions, reducing the likelihood of basis risk.
- **Combining insurance solutions:** Combining parametric insurance with traditional indemnity-based products can cover the gaps and reduce the overall basis risk.





Geographical and temporal alignment

- **Localised data points:** Using data sources that are geographically closer to the insured risk can reduce geographical mismatch. For example, utilising local weather stations for agricultural insurance rather than regional averages.
- **Temporal precision:** Ensuring that the timing of the triggers aligns as closely as possible with the period of risk (e.g. to reflect seasonality). This might involve analysing historical data to understand the most relevant time frames for specific risks.

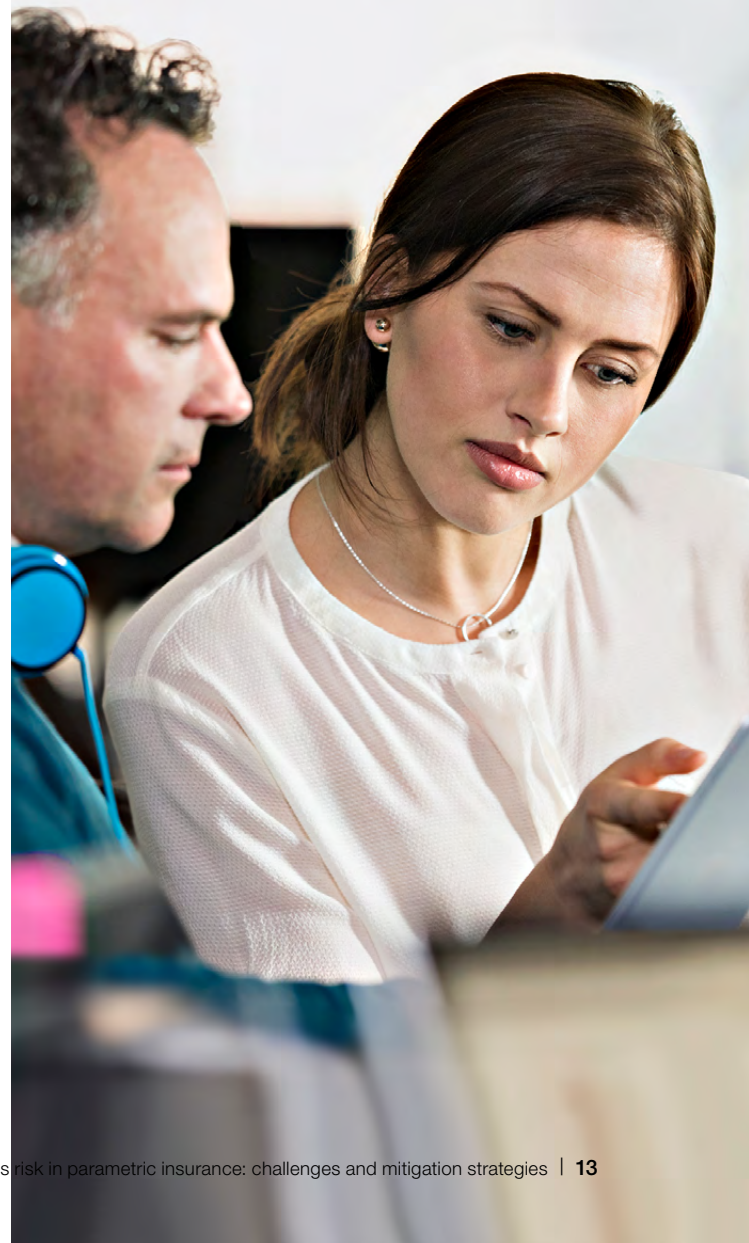


Enhanced modelling techniques

- **Complex event modelling:** Developing more sophisticated models that can account for a variety of factors influencing a risk event. For example, in earthquake insurance, considering not just the seismic activity but also local building codes and ground composition.
- **Continuous model refinement:** Regularly updating and refining models based on new data and past claim experiences to keep the triggers relevant and accurate.



Reducing basis risk in parametric insurance typically involves improving the accuracy of models, refining index triggers, ensuring high-quality data and designing policies that align as closely as possible with the insured's true risk profile. Insurers often work with meteorologists, data scientists and other specialists to continuously refine their parameters and decrease basis risk. While no solution can completely eliminate basis risk, a multifaceted approach can significantly reduce it.”



8. Designing and structuring parametric insurance is key

The design and structure of a parametric insurance policy are critical to ensure its success. Policies must accurately define the triggering event, establish the extent of coverage, design proper parameters and select appropriate data sources. The insured must also be confident that the policy pays in a timely and transparent manner. (Re)insurers ensure effective design

by writing and collecting relevant data sets or seeking pay-per-use models for data sources, collaborating with intermediaries to structure the right coverage level and customer needs, and regularly reviewing their trigger mechanisms. This ensures that the product is well-structured to manage high-frequency, low-value losses, such as natural disasters.



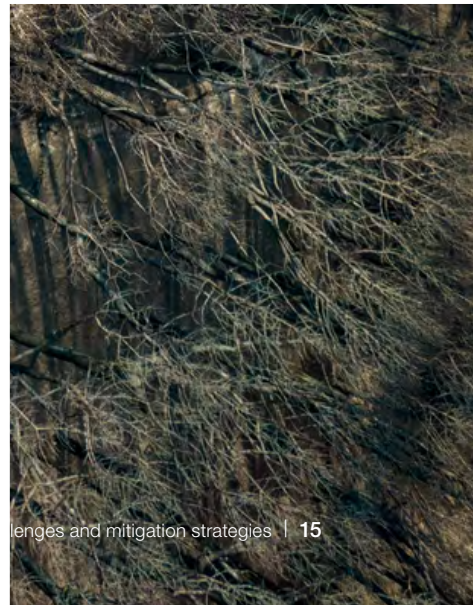
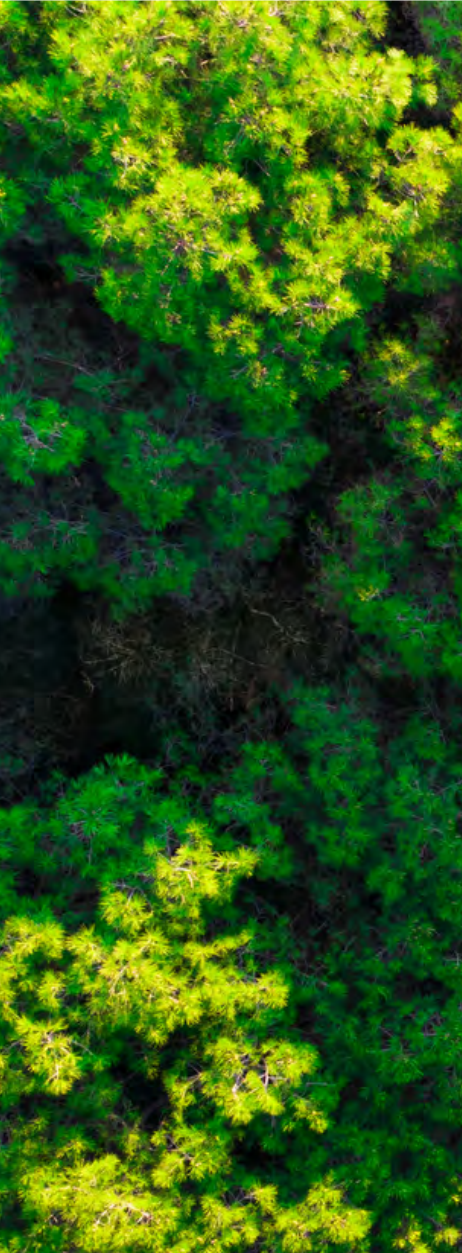
9. Conclusion

Parametric insurance has the potential to help individuals, businesses and governments manage catastrophic risk events. However, it's essential to recognise the potential for basis risk and develop appropriate mitigation strategies. Basis risk is a significant challenge associated with parametric insurance products. It can result in policyholders receiving lower payouts or no payments at all due to a mismatch between the event to be insured and the specific triggers that trigger payment.

Measures to reduce basis risk include improving data uptake and using advanced technology to analyse insurance parameters and data efficiently, regularly updating policy parameters and diversifying available

indices. Innovations such as dynamic parametric insurance could improve the accuracy of insurance coverage significantly. Addressing basis risk will promote risk transfer to insurance markets, which will result in more extensive coverage, better pricing, and reduction in losses after catastrophic events.

Parametric insurance continues to evolve, offering promising solutions for rapid disaster recovery financing. Although basis risk poses a challenge, its mitigation is possible through thoughtful design, leveraging technology and engaging with local contexts. As data quality improves and modelling becomes more sophisticated, the future of parametric insurance looks promising.



Authors

With our experienced global parametric advisory team, we have the capabilities and experience to help you design your parametric programme, whether for a specific area or end-to-end. Are you interested in an initial discussion to find out what we can do for you? Please contact any of the individuals named below.



Alex Viergutz
Director, Global Head of
Parametric Insurance Advisory
+41 58 792 29 98
alexander.viergutz@pwc.ch

Key regional contacts



Switzerland
Jörg Thews
Head of Insurance Switzerland
+41 58 792 26 35
thews.joerg@pwc.ch



Americas
Richard Mayock
Senior Partner Americas
+1 646-479-4856
richard.mayock@pwc.com



China
Delvin Cai
Lead Partner China
+86 131 4387 5175
delvin.d.cai@cn.pwc.com



Singapore
Winston Nesfield
Lead Partner Southeast Asia
+65 9159 1425
winston.nesfield@pwc.com



India
Joydeep Roy
Lead Partner India
+91 98216 11173
joydeep.k.roy@pwc.com



UK
Alex Bertolotti
UK Insurance Leader
+44 7525 299263
alex.bertolotti@pwc.com

PwC, Birchstrasse 160, 8050 Zurich, +41 58 792 44 00