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Major Conundrums and Possible Solutions in DeFi Insurance

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ABSTRACT

This paper empirically explores the early development of insurance projects in the decentralised finance (DeFi) industry, which is based on disruptive technologies like blockchain and smart contracts. A brief history of DeFi is narrated, stressing four risks of DeFi (volatility risk, cyberattack risk, liquidity risk, and regulation risk) and its co-evolution with traditional finance. Then, first-hand evidence is collected from informed industrial practitioners by two semi-structured focus group discussions. Consensuses are reached on why the DeFi insurance market is underdeveloped and incomplete (the liquidity conundrum, the actuarial conundrum, the verification conundrum, the scale conundrum, the yield conundrum, the exploitation conundrum, the cybersecurity conundrum, and the regulation conundrum) and how the next generation of DeFi insurance can address these conundrums. Further evidence is obtained to quantify the importance of conundrums using the Analytic Hierarchy Process (AHP). Building on the qualitative and quantitative findings, a prototypical model of DeFi insurance is proposed.

1 | Introduction

Blockchain technology harnessed with smart contracts has been transforming the finance sector (Hairudin et al. 2022) by providing trustless solutions such as initial coin offerings (Bai and Zhang 2025) and decentralised exchanges (Aspris et al. 2021). However, the exuberant hype of decentralised finance (DeFi) is intertwined with excessive risks of cryptoassets, including both fungible tokens (cryptocurrencies) and non-fungible tokens (NFTs) (see Appendix S1 in Supporting Information for a brief history of DeFi). One well-known risk of holding cryptoassets is price volatility (Ghosh et al. 2023). For example, Bitcoin and Ethereum fell by 27.3% and 38.1% in May/2022 respectively, after the collapse of another DeFi project, Terra Luna (the price of which has plummeted by 99.9%). Another notorious risk of holding cryptoassets is cyberattack. Around $3.7 billion was lost from crypto platforms due to hacks and scams in 2022 alone (Chainalysis 2024). To mitigate the high risks of holding cryptoassets, an obvious prescription is resorting to insurance in the same vein as hedging against losses by traditional finance (TradFi) insurance. Unfortunately, almost all TradFi firms in the world are reluctant to underwrite insurance policies for cryptoassets—TradFi companies and regulators do not even acknowledge cryptoassets as financial assets (ESMA 2023). As a result, the DeFi ecosystem is forced to develop its own insurance projects (DeFi insurance) to meet the native need for risk sharing and loss mitigation with the help of smart contracts.

Despite the genuine demand, the development of DeFi insurance lagged far behind the entire crypto market. As shown in Figure 1, the total value locked (TVL) of DeFi insurance projects only accounts for 0.15% of DeFi segments. In contrast, the total assets of TradFi insurance companies account for 8.6% of TradFi assets (Statista 2023). This disparity suggests that the development of DeFi insurance is unbalanced, and the market gap is worth billions of dollars.

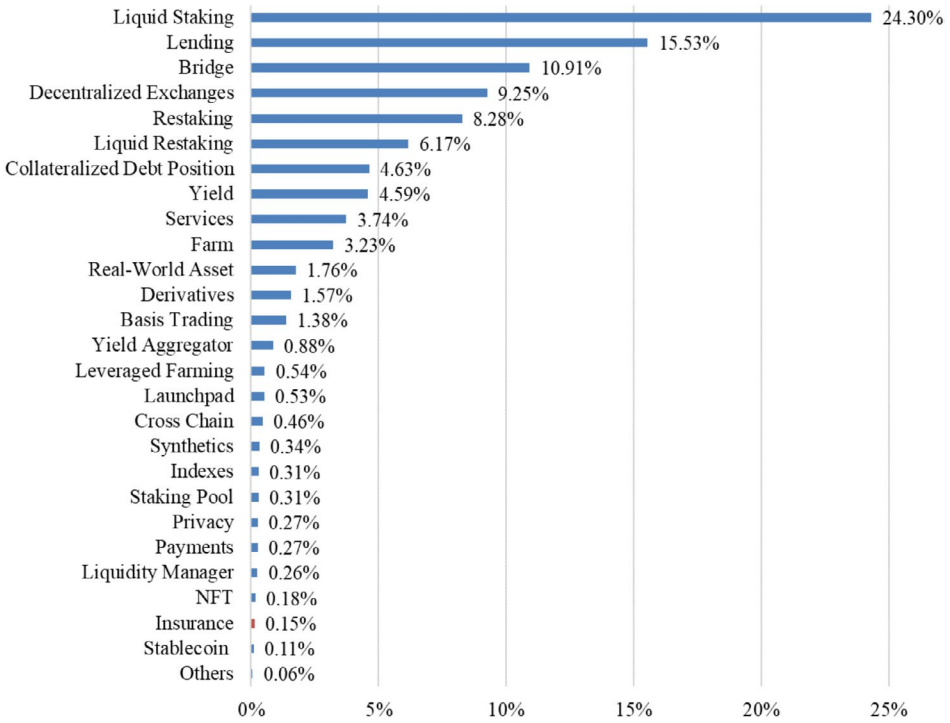

FIGURE 1 | Market shares of different DeFi segments in 2024.
Source: DeFi Llama (https://defillama.com/categories). The total value locked in DeFi was estimated to be $234 billion on 31 May 2024. [Colour figure can be viewed at wileyonlinelibrary.com]

DeFi insurance is a classic example of an *incomplete market* in economics. There is a vast literature on incomplete market in the TradFi insurance context, but it mostly discusses the effects of incomplete market on the pricing of insurance policies. Under the complete market assumption, insurance can be priced using the Black-Scholes model (Grosen and Jørgensen 2002). Nevertheless, when the market does not have a complete set of Arrow-Debreu securities, the underlying assumption of the Black-Scholes model no longer holds. In this case, market gaps between the supply and demand sides lead to insufficient price information as some risks are not priced (Eberlein et al. 2014). In addition, a higher degree of exogenous shocks also makes the applicability of the classical insurance pricing model questionable. Investors either have simple solutions for hedging strategies (local risk-minimisation) or a control over total costs and risks (mean–variance hedging). Specifically, Moore and Young (2003) consider cases where the source of incompleteness arises from mortality risk. Consiglio and De Giovanni (2010) model the surrender option as a path-dependent European option while introducing the incompleteness through additional risk factors. A key variable in pricing is the expected rate of return or cost of capital. Albrecher et al. (2022) discuss the cost-of-capital rate for an insurance company under an incomplete market as an equilibrium in the triangle structure of policyholders, shareholders, and regulators. Bauer and Zanjani (2021) derive the rate in multi-periods based on classical actuarial premium principles.

The traditional wisdom in economics usually attributes the main cause of incomplete market to transaction costs (Ibragimov et al. 2009). However, the development of smart contracts is supposed to reduce those costs, potentially fostering a complete market as evidenced by recent studies in DeFi insurance (Mahmoud et al. 2018; Sheth and Subramanian 2020) and TradFi insurance (Dominguez Anguiano and Parte 2023; Yadav et al. 2023). Moreover, peer-to-peer risk-sharing mechanisms in DeFi insurance could address the incomplete market present in TradFi insurance for specific risks like flood (Vannucci et al. 2021; Feng et al. 2023) and customised insurance needs (Norta et al. 2019). These innovations significantly reduce transaction costs compared to premiums in centralised models (Abdikerimova and Feng 2022).

Despite its theoretical potential, the market for DeFi insurance remains practically underdeveloped. Current research often focuses on hurdles related to DeFi in general (Amponsah et al. 2021; Dominguez Anguiano and Parte 2023). Regulatory challenges and technological risks are regarded as common issues in DeFi products and services (Sheth and Subramanian 2020; Manda et al. 2024; McGurk and Reichenbach 2024). Nevertheless, an in-depth analysis of this substantial market gap in DeFi insurance is still missing. There must be some hidden barriers stopping DeFi insurance from developing to its potential, which in turn hampers the healthy growth of the DeFi ecosystem in general. To better understand this market gap, we aim to investigate the following research questions (RQs):

RQ1. *What are the major conundrums that hinder the growth of DeFi insurance?*

RQ2. *How to solve these conundrums to foster a balanced growth of DeFi insurance?*

To answer these RQs, it is more appropriate to employ focus group discussions among professional practitioners in the

DeFi industry to analyze and synthesise the grand challenges in the industry. First-hand evidence from these informants provides more informative insights as other forms of empirical evidence and theoretical literature are yet to accumulate. Engaging practitioners from DeFi insurance projects ensures that the information is up-to-date and directly relevant to the RQs, avoiding limitations of secondary data (Cao et al. 2020; Dominguez Anguiano and Parte 2023). Through two rounds of semi-structured focus group discussions, eight major conundrums are identified and potential solutions are proposed. To supplement the qualitative method, a follow-up survey was conducted to provide further empirical evidence using a quantitative method—Analytic Hierarchy Process (AHP). This method is well-established and widely used in decision science and operational research. Combining the qualitative and quantitative methods makes the paper a mixed-method study.

This paper is one of the first attempts embarking on DeFi insurance, a sector expected to be multi-billion. It contributes to the literature in three ways (see Appendix B in Supporting Information for a more detailed literature review on DeFi). Theoretically, we emphasise the importance of insurance in the DeFi ecosystem for hedging against various risks. Existing research has focused on cross-asset, spillover-based hedging strategies to mitigate price volatility risk, relying on statistical connectedness among cryptoassets (Gunay et al. 2023; Assaf et al. 2024) and TradFi assets (Yousaf et al. 2022; Annamalaisamy and Vepur Jayaraman 2023). However, the role of insurance in financial markets for risk management is largely overlooked in the DeFi literature. We develop a conceptual framework of the DeFi market microstructure, based on which major conundrums and potential solutions are identified for DeFi insurance. To our knowledge, this is the first framework of its kind in the DeFi insurance literature, laying a foundation for future research.

Empirically, we carefully design a qualitative, exploratory method. It provides early evidence in the nascent insurance industry when other forms of evidence, like secondary data and literature, are still developing. Prior qualitative research in DeFi has largely relied on authors' experiences and conceptualisation (e.g., Catalini et al. 2022; Berger and Boot 2024) or secondary documents like media reports and articles (e.g., Cao et al. 2020; Dominguez Anguiano and Parte 2023). In contrast, our study overcomes the challenge of finding DeFi practitioners, thereby supplementing the understanding of DeFi insurance and the broader DeFi ecosystem with first-hand evidence.

Practically, we synthesise a prototypical model of future DeFi insurance projects based on the consensus of DeFi practitioners. While designing DeFi insurance solutions is not new, existing solutions often propose technical schemes without reflecting the business logic of insurance (e.g., Qi et al. 2020; Huang et al. 2022). Our prototype model, which combines on-chain and off-chain business connections, as well as tokenomics and business models, offers valuable insights for insurers, policyholders, investors, and regulators in both DeFi and TradFi.

Following the introduction, Section 2 compares the chosen empirical methods with other alternatives. The empirical findings on the conundrums and solutions are synthesised in Section 3, following which Section 4 quantifies the importance of the conundrums and develops a prototype of the future generation of DeFi insurance. Section 5 concludes.

2 | Method

Given the nature of the RQs, an exploratory approach is employed. Specifically, semi-structured focus group discussions combine interviews with group interactions (Morgan 1996; Rabiee 2004), offering advantages over other alternative data collection methods when little prior information is available to researchers (Xing et al. 2021). First, it is not viable to apply document-based literature surveys such as systematic literature reviews (Liu et al. 2023; Zhang et al. 2024; Zhou et al. 2025) and bibliographic analyses (Tandon et al. 2021) to answer our RQs because the existing literature on DeFi insurance is scanty. Academic research usually lags behind business practice, and DeFi is a nascent industry that effectively started in 2015. Second, statistical surveys and questionnaires are not appropriate because they are structured a priori based on adequate knowledge from previous literature. Again, the 'adequate knowledge' does not exist in this area of research. Another reason is that the opinions of the general public are usually non-informative on emerging industries. DeFi insurance has not been fully developed yet (even the entire DeFi market has not), so information is more likely to be extracted from the opinions of professional practitioners than from unselected respondents. Furthermore, interactions among the participants can bring constructive synergy from diverse experiences and perspectives (Sumarwan et al. 2021; Balzarova et al. 2022). Therefore, individual interviews (without multilateral interactions) are less effective. In recent exploratory research on DeFi and FinTech, focus group discussions have been actively used (e.g., Dekkers et al. 2020; Grassi et al. 2022).

To summarise, the advantages of focus group discussions in our research context include the semi-structured contents to allow for flexibility, the selected expertise to enhance informativeness, and the multilateral interactions to inspire novelties. The key to ensuring the validity and effectiveness of focus group discussions is to form the focus group with an appropriate level of diversity, so that the opinions of different perspectives can be fully mixed and combined to generate comprehensive, creative insights (Morgan 1996; Krueger 2014). In contrast, homogeneous groups tend to be dominated by a single viewpoint, resulting in less balanced discussions and generalisability (Calder 1977; Nyumba et al. 2018).

We target practitioners and academics knowledgeable in DeFi insurance. We initially identified participants from our professional networks following Wang et al. (2019) and Wiersema and Mors (2023). A snowball sampling was then used—initial participants suggest other experts from their networks, as in Biernacki and Waldorf (1981). This approach expands our outreach to participants with diverse backgrounds, including DeFi insurance entrepreneurs, DeFi market-makers (e.g., liquidity providers, stakers, miners), blockchain technicians, TradFi insurance professionals, venture capital investors, academic researchers, consultants, and media commentators. The diversity in industry backgrounds ensures comprehensive insights from various DeFi market segments.

Diversity also extends to the participants' educational background (undergraduate, master, PhD), age group (26–55), experience level (junior manager, senior manager, executive) and country of origin (United States, United Kingdom, Australia, Dubai, Singapore and China). Participants with diverse backgrounds can mitigate subjective biases and capture a broad spectrum of perspectives (Wiersema and Mors 2023). Literature suggests that an effective focus group size is 9–28 participants, considering efficiency, resources, and time constraints (Baharmand et al. 2021; Misra et al. 2023; Moradlou et al. 2023). Table 1 gives a brief description of the 20 discussants in the focus group meetings.

Following Grassi et al. (2022), the focus group held two meetings for the two RQs. Prior to each meeting, all discussants were informed about the topics and objectives. The goal of the first meeting was to summarise possible conundrums in DeFi insurance (RQ1). The focus group discussion was held online using Microsoft Teams for about 120 min in August 2023. All discussants joined in the discussion and interacted with each other, led by the moderator and the observer (i.e., the authors). The goal of the second meeting was to discuss potential solutions to the identified conundrums (RQ2). The meeting was held 1 week after the first meeting, and it lasted about 180 min with a good level of interactions and brainstorming discussions. The same discussants joined the second focus group. Specifically, the entrepreneurs of DeFi insurance explained their business plans attempting to solve some of the conundrums. Other existing cases are also discussed by other informants. In addition to the discussions, six participants provided secondary documents, including white papers on their DeFi insurance projects and websites for reference. The insights from the two semi-structured focus group discussions and these secondary documents are used as input data for analysis in the next two sections.

Apart from the qualitative method, we also conducted a follow-up survey in December 2023. Analytic Hierarchy Process (AHP) is used to quantitatively assess the relative importance of various conundrums. This method is well established in decision science and operational research for systematically evaluating the priority of criteria and alternatives using a small sample of experts (Sharma et al. 2021). Details of the method, procedures and participants description are provided in Appendix E in Supporting Information. We contacted all participants from the focus group, and 70% (14/20) agreed to participate. We added six additional participants from our professional networks to balance the number of practitioners and academics, so that we can identify discrepancies in opinions between these two groups. The insights from the follow-up survey are detailed in the discussion section.

TABLE 1 | Focus group discussants description.

Sector	(%)	Occupation	(%)
DeFi insurance	25%	Entrepreneur	20%
DeFi other segments	20%	Operations manager	15%
TradFi insurance	15%	Liquidity provider	10%
TradFi other segments	10%	Miner	10%
Venture Capital	10%	Actuarial analyst	5%
Academic	10%	Blockchain technician	10%
Consulting	5%	Investor	15%
Media	5%	Researcher	15%
Education	**(%)**	**Position**	**(%)**
UG	55%	Junior	20%
PG	25%	Senior	60%
PhD	20%	Executive	20%
Age	**(%)**	**Region**	**(%)**
< 30	35%	Dubai	25%
30–40	45%	United States	20%
40–50	15%	China	20%
> 50	5%	United Kingdom	15%
		Australia	10%
		Singapore	10%

3 | Results

As shown in Figure 1, DeFi projects concentrated in liquid staking (staking assets to provide market liquidity) and lending (e.g., peer-to-peer lending, liquidity pool lending, flash loan). The unbalanced growth of DeFi insurance is a puzzle to both academic researchers and blockchain practitioners. This section analyses and synthesises the opinions of the two semi-structured discussions. In addition to the two RQs, the focus group also reached a consensus on the DeFi insurance market structure and the market gaps of the DeFi industry in general. These insights provided a helpful big picture to position the conundrums and identify corresponding solutions. To better present the answers to the RQs, the next subsection summarises the conceptual framework (Figures 2 and 3) based on the focus group discussions.

3.1 | The Big Picture

Discussants with different backgrounds tend to take diverse perspectives and use distinctive jargon, so the moderator suggested forming a unified framework to navigate the discussion. The focus group therefore first discussed and agreed on the market structure of DeFi insurance (Figure 2). This framework was constantly referred to in later discussions to identify conundrums and to propose solutions.

In the core of a DeFi insurance project lie the supply side (developers) and demand side (users). In the meantime, market participants like liquidity providers (LPs) and stakers fuel the project with adequate liquidity (i.e., funds) so that insurance users (insurees) can be compensated. They are essentially **market makers**. On the contrary, market participants like hackers and arbitrageurs attack projects with malicious trading to take advantage of the security loopholes or business

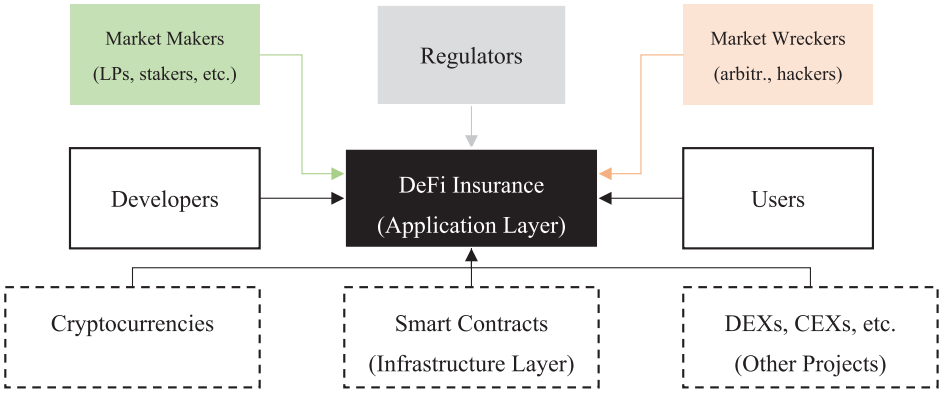

FIGURE 2 | The market participants and market structure of DeFi insurance. Created by the authors. LPs = liquidity providers, arbitr. = arbitrageurs, DEXs = decentralised exchanges, CEXs = centralised exchanges. [Colour figure can be viewed at wileyonlinelibrary.com]

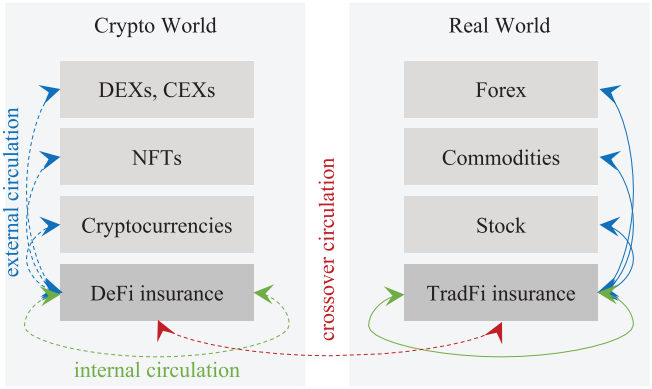

FIGURE 3 | The market gaps of the DeFi industry. [Colour figure can be viewed at wileyonlinelibrary.com]

logic. They are essentially **market wreckers**. In addition to the market participants, regulators of financial markets keep a close eye on DeFi development given its high risks and impact on financial stability. Other blockchain-based projects (e.g., DEXs, CEXs, oracles, decentralised courts, etc.), smart contract-empowered networks (e.g., Ethereum), and cryptocurrencies (e.g., stablecoins) provide ecological support to (or barrier against) DeFi insurance projects. This market structure was useful to organise and understand the identified conundrums facing DeFi insurance.

During the discussion on the DeFi insurance market structure, the discussants frequently digressed outside DeFi insurance and talked about the DeFi industry in general. The discussion was navigated back on track by the moderator, but as a by-product, three market gaps seem to attract most discussants' attention. This consensus deepens the understanding of the proposed solutions because good solutions must fill the gaps not only within a DeFi segment but also throughout the entire industry. So, we report the market gaps in the DeFi industry, which are believed to shed light on the next generation of DeFi projects, especially DeFi insurance.

The foundation for the crypto ecosystem is an efficient circulation of value and information. A circular economy model in the crypto world or the metaverse is similar to the real world: internal circulation (analogous to corporate operation/governance) and external circulation (analogous to national trade/finance). In addition, there is crossover circulation between the crypto and real worlds (analogous to international trade/finance) as shown in Figure 3.

The first gap exists in the **crossover circulation** of value and information between the crypto world and the real world. There has been some progress bridging the two worlds already. For example, stablecoins connect cryptocurrencies and fiat currencies (analogous to Forex markets connecting different fiat currencies in the real world). DeFi reserve currencies link cryptoassets with real-world financial assets (analogous to mutual funds protecting wealth against inflation). In contrast, DeFi insurance and TradFi insurance have the weakest link compared to other segments. On the one hand, DeFi players cannot go to a traditional insurance company to insure their cryptoassets, like cryptocurrencies and NFTs. On the other hand, traditional insurance needs (e.g., health, vehicle, pension, war, catastrophe) can rarely be insured in existing DeFi insurance products. Future DeFi projects, especially DeFi insurance projects, are expected to fill this crossover gap between the two worlds.

The second gap lies among DeFi projects in the **external circulation** of value and information within the crypto world. The evolving DeFi ecosystem results in many interdependent projects (analogous to various financial products in the real world). For example, cryptocurrencies and NFTs need to be traded, so DEXs are invented. However, only very few tokens (e.g., Bitcoin and ETH) can be insured in DeFi insurance. It is especially difficult to find insurers willing to provide insurance for the most insurable high-risk projects due to a lack of data and excessive risks. Let alone the availability of customised insurance for different needs. Future DeFi projects are expected to strengthen the connections among projects within the DeFi ecosystem, and DeFi insurance seems to be the key missing component of the infrastructure.

The third is the gap between the supply of and demand for liquidity in the **internal circulation** of value and information within each DeFi project. All financial products need a big enough pool to exploit the Law of Large Numbers. Lack of liquidity makes it

difficult to bootstrap the project from scratch while providing low-cost, wide-coverage insurance. It is a common issue for all DeFi products, but it poses a thornier challenge for insurance, which heavily relies on actuarial stability.

The three identified market gaps can be interpreted as an incomplete market in economics. In this case, the First Fundamental Theorem of Welfare Economics no longer holds. It leads to imperfectly smoothed consumption (Kraft et al. 2020), suboptimal equilibrium (Geanakoplos and Polemarchakis 1986), and wealth inequality (Fiaschi and Marsili 2012). A common explanation of incomplete markets is transaction costs (Nell et al. 2009). However, smart contracts are supposed to work at substantially lower transaction costs than TradFi. The reasons for an undeveloped DeFi insurance market must be found elsewhere. The first focus group concluded with eight major conundrums in Subsection 3.2.

3.2 | The Conundrums of DeFi Insurance

A thematic analysis is conducted based on the first focus group discussion. The eight identified conundrums I–VIII are summarised below using the market structure in Figure 2. Discussants referred to DeFi jargon, products, and events. To facilitate understanding, a DeFi glossary and product list are compiled in Appendix C and Appendix D in Supporting Information for readers in need.

I. **The Liquidity Conundrum**. The most prominent conundrum facing DeFi insurance, or the entire DeFi industry indeed, is liquidity. This is mainly from the perspective of developers (but also involving market makers and other market participants). In the earlier stage of DeFi development (so-called DeFi 1.0), liquidity was mainly provided by liquidity miners, who constantly switch among different projects to reap the highest yield. Consequently, a particular DeFi project is not able to maintain its liquidity unless a higher yield is offered to compete for liquidity. For example, blue-chip DeFi protocols (e.g., Curve, Sushi) typically offer around 2%–15% annual percentage yield (APY) on various cryptoassets, while other riskier protocols may have eye-popping yields. The highest APY in DeFi history was 393,197% APY by DAOGO in Mar/2022. This 'liquidity war' inevitably leads to Ponzi's game, and backward induction may collapse the project even faster. It poses a challenge for developers to design a liquidity-retaining mechanism to support the project in the long run.

II. **The Actuarial Conundrum**. This conundrum is also from the perspective of developers. The actuarial analysts in the focus group raised that, compared to TradFi insurance, the insured perils (cryptoassets) in DeFi lack a stationary, independent distribution, so the associated risks are very difficult to quantify. For example, the famous digital art '*Everydays: The First 5000 Days*' was traded at $69.3 million in 2021, making it the most expensive NFT sold to single owners. However, the trading history was not long enough to constitute a reliable, continuous estimate of the price distribution. Without a reliable pricing model, insurance policy cannot be underwritten.

III. **The Verification Conundrum**. A unique difficulty in DeFi insurance relative to TradFi insurance is claim verification. Losses in the real world can be verified by centralised insurers and centralised governments at mild information costs. However, in the crypto world, the anonymity feature of digital wallets makes it difficult, sometimes impossible, to verify the validity of claims. For example, if a policyholder claims that his or her NFT is hacked, it is almost impossible to distinguish between a genuine theft and an insurance fraud, since the policyholder can simply create another digital wallet and transfer the cryptoassets without being identified. What is worse, this type of insurance fraud has almost no legal consequences due to the absence of regulation. Therefore, DeFi insurance projects without Know-Your-Customer (KYC) procedures are confined by asymmetric information.

IV. **The Scale Conundrum**. This is a conundrum from the perspective of users. The focus group emphasised two possible reasons for the small scale of DeFi insurance. On the one hand, there is an economy of scales in the insurance industry (both DeFi and TradFi). For the Law of Large Numbers to work, it requires a large enough pool to obtain the benefits of risk pooling (Huggenberger and Albrecht 2022). If the liquidity pool is not large enough, then even fewer users will use the insurance simply because the industry is too small to satisfy the insurance need. The total market value of DeFi insurance was about $353 million in 2023, while the market capitalisation of NFTs in the art segment alone was already $1182 million (Statista 2023). It is impossible for a small fund pool to insure against a big cryptoasset (a big fish in a small pond!). So, if the pool is not large enough, then it will stay small and will never bootstrap itself to a large pool. The dominant strategy of all users is to not participate unless the pool is big enough. It is a Nash equilibrium of a coordination game (Kets et al. 2022). The 'bad' Nash equilibrium (both non-participate) and the 'good' Nash equilibrium (both participate) are shown in the following simple coordination game. If there is no external force, the DeFi insurance market will always be stuck in the bad Nash equilibrium.

		Player 2	
		Non-participate	Participate
Player 1	Non-participate	**(1, 1)**	(0, −1)
	Participate	(−1, 0)	**(2, 2)**

On the other hand, the risk preferences of DeFi users or crypto markets are extremely high. The largest group of the crypto community is young males (18–29 years old) with high technological enthusiasm. These people are well known for their high-risk tolerance and risk-loving attitude to investment. Therefore, they are in the crypto market for high-risk high return, rather than for low risk stable return. Therefore, the intrinsic demand for insurance may be limited in the first place, which traps the DeFi insurance market in the 'bad' Nash equilibrium.

V. **The Yield Conundrum**. This conundrum reflects the perspective of market makers such as LPs and stakers. The DeFi market cannot work without market makers, particularly LPs, to provide liquidity. However, they also caused serious liquidity problems in the DeFi 1.0 era because they always seek the highest APY (like hot money in the international financial market) as mentioned in the liquidity conundrum. Once a higher yield appears in alternative projects, crypto investors are motivated to withdraw their funds from existing projects. This leads to a quick drainage of old liquidity pools. That is why in DeFi 2.0, there is always a fund reserve or depository to control the mobility of funds and to lock the liquidity in the same project. For DeFi insurance, investors must choose their roles between LPs and stakers. If you choose to be an LP, then your fund is locked up in the liquidity pool for a shorter period, and the APY is lower. If you choose to be a staker, then your fund is locked up in the stake pool for a longer period, but the APY is higher together with some governance power. Some DeFi insurance protocols also provide a third choice of being 'bonders' to buy bonds from the fund repository or 'vault' with fixed APYs (e.g., Olympus). Moreover, they also need to compare APYs between DeFi insurance projects and other DeFi projects (e.g., DEXs and DeFi lending). All these choices involve sophisticated information, which takes time for crypto investors to digest. This conundrum is inter-related to other conundrums such as the liquidity conundrum and the scale conundrum.

VI. **The Exploitation Conundrum**. There are two types of market wreckers. The mild ones are arbitrageurs, who exploit business logic errors to earn risk-free profit. For example, in Oct 2020, an arbitrageur took advantage of an arbitrage opportunity on the Harvest Finance DeFi platform using a flash loan to manipulate the liquidity pool prices. The $50 million flash loan generated $24 million profit in minutes. Another famous example was the '51% attack' on Ethereum Classic in 2020. These exploitations, although unethical, are valid manoeuvres following the rules. Therefore, they can improve the robustness of the business logic if the project under attack survives the temporary loss. The economist in the focus group raised a possible paradox in DeFi insurance. The arbitrageur can use a flash loan to buy in a large sum of a particular cryptocurrency to push its price up while buying a cryptocurrency insurance against a high price at the same time. This portfolio can form a risk-free arbitrage opportunity. The attack is similar to a historical event when France sent a warship to New York harbour in Aug 1971 to bring back its gold from the New York Federal Reserve Bank, which led to the breakdown of the Bretton Woods system. Obviously, most DeFi insurance protocols are not robust against this kind of self-fulfilling arbitrage.

VII. **The Cybersecurity Conundrum**. The other type of market wreckers is hackers, who are more brutal in illegitimate crypto theft. The most popular method is the infiltration of crypto exchange security systems. CEXs often act as custodians and hold the private keys on behalf of the users who purchase and trade cryptocurrencies on the exchange. This custodial structure has advantages such as speed of transactions, customer support and insurance verification, just like the stock exchange in the real financial system. However, this centralised control is against the spirit of DeFi and is susceptible to cyberattacks. Around $3.7 billion was lost due to hacks and scams in 2022 alone.

VIII. **The Regulation Conundrum**. This conundrum is from the perspective of regulators. Most countries do not have formal legislation on DeFi because it is not limited within sovereign borders by nature, and it is practically difficult to regulate DeFi activities. It was pointed out by a discussant that the taxation authority in the UK has added a new section on DeFi to its cryptoasset manual, but the regulation only applies to money laundering and terrorist financing (HMRC 2021). The slow pace of legislation cannot catch up with the fast evolution of DeFi, but the lack of regulation does limit further growth of DeFi insurance.

The eight major conundrums identified by the first focus group discussion cover all stakeholders in the DeFi insurance market (Figure 2), but they are not an exhaustive list of challenges to DeFi insurance. Other minor issues were also raised, but the group regarded them as of different levels of importance. For example, the institutional investors (e.g., venture capital) pointed out that they were usually not interested in supporting long-term projects like DeFi insurance because they were seeking short-term profits. Another technical conundrum discussed was the scalability issue in smart contracts-powered blockchains, but it was deemed a temporary technical issue since layer-2 blockchain scaling solutions have been fast developing.

Moreover, some of the eight major conundrums are not only limited to DeFi insurance, but are also pertinent to DeFi in general. For example, the liquidity conundrum (I), the exploitation conundrum (VI), the cybersecurity conundrum (VII), and the regulation conundrum (VIII) are common issues for all DeFi projects. Nevertheless, these conundrums impose greater difficulties on insurance than on other DeFi applications, leading to unbalanced development.

3.3 | The Solutions to the Conundrums

RQ2 was addressed by the second focus group meeting. The same discussants participated and proposed possible solutions to the eight major conundrums identified in the first meeting. The moderator started the discussion by summarising the eight conundrums. The discussion was carried out conundrum by conundrum to maintain the focus. No particular order of speech was followed by discussants. The following summarises the views of the focus group on the eight conundrums.

I. **The Liquidity Conundrum**. The focus group unanimously agreed that a revolutionary solution is needed to resolve the liquidity conundrum. The lessons learned from the past few years about DeFi have proved that unlimited token issuance was a wrong incentive mechanism. One emerging possibility is the so-called DeFi 2.0 solution, in which a fund reserve or 'vault' is established apart from the liquidity pool to back the liquidity need. This solution was initially developed by other DeFi segments like Olympus (a reserve currency project) and can be applied to DeFi insurance projects. By various incentive designs, the vault in DeFi 2.0 can stabilise the liquidity provision in DeFi insurance projects. It adopts an anchored token issuance mechanism, which greatly reduces the capabilities of the founding team to control and manipulate the token price, gives back users the high degree of autonomy that they deserve, and makes full use of DAO governance.

II. **The Actuarial Conundrum**. Noting that insurance is essentially a contingent claim in uncertain states, the risk premium pricing model is similar to that of financial derivatives. The actuarial analyst in the TradFi insurance industry commented that they usually used Monte Carlo methods to simulate and estimate the actuarially fair premium of the insured assets with limited information. As more and more price records become available, a continuous-time pricing model such as Black-Scholes formula can also be applied. The insurance premium S_t is thus regarded as a financial derivative in pricing:

$$S_T = S_t e^{\left(\mu - \frac{\sigma^2}{2}\right)(T-t)+\sigma\epsilon\sqrt{T-t}}, \text{where } \frac{dS_t}{S_t} = \mu dt + \sigma dW_t \quad (1)$$

In Equation (1), μ is the risk-free rate, σ is the standard deviation of the return of the underlying cryptoasset, $T-t$ is the time to maturity and W_t follows a Brownian motion. The key determinant for S_T is $\epsilon \sim N(0,1)$ which can be obtained by sampling ϵ and simulate the price path of the underlying cryptoasset. The actuarial analyst from the DeFi insurance industry responded that the most popular method in existing DeFi insurance was indeed Monte Carlo methods. But if one can use averaging (or indexing) to construct a composite peril to insure, then the distribution can potentially be stabilised and smoothed, so conventional approaches like Black-Scholes formula can be applied as well. For example, it can be done by either averaging over the same series of NFTs or averaging over units of the same NFT (e.g., *The Merge* was sold as 312,686 units to 28,893 collectors at the total price of $91.8 million).

III. **The Verification Conundrum**. The focus group did not come to a consensus to solve the verification conundrum, but the discussants agreed on two types of verification in the insurance context. The first type is claims against (continuous) value fluctuations. Publicly available data such as trading prices and floor prices of cryptocurrencies, NFTs and even financial assets in the real world can be used in the verification process with the help of blockchain oracles. The DeFi ecosystem has already developed various oracle protocols (e.g., Chainlink) that can feed real-time market information on-chain, so smart contracts can be programmed to automate verification and compensation. The second type is claims against (discrete) event incidents. Unfortunately, there is no ready-to-use DeFi solution to directly verify case-specific claims on cyberattack, healthcare, accident, disaster, and so forth. One imperfect but practical solution is through DAO votes either within or outside the insurance project. A media discussant mentioned the first decentralised court Kleros, which is used by businesses in crypto and the real world for arbitration. When a dispute or a claim arises, the protocol randomly selects a panel of jurors and sends back a decision. It relies on game theoretical incentives to have jurors rule cases correctly in a decentralised way. This equilibrium is known as the 'Schelling point', where jurors tend to tell the truth by default in the absence of communication (Schelling 1960). However, jurors may not know the truth themselves, so the judgements may simply reflect common sense.

IV. **The Scale Conundrum**. Unlike TradFi insurance, the capital used in DeFi insurance cannot expand with external forces because all insurance purchases are voluntary rather than compulsory, like vehicle insurance or national insurance in TradFi. But the focus group agreed that there is an intrinsic demand for DeFi insurance for LPs, stakers, miners, and NFT investors. As the users in crypto markets grow, the insurance demand will grow more than proportionately because the risk preferences of the new entrants tend to be lower than those of the incumbents. Market penetration needs time. DeFi insurance projects must wait for the users to grow naturally with the crypto ecosystem. Before that, DeFi insurance projects must bootstrap themselves with a diverse business model to support the growth. A DeFi insurance entrepreneur in the focus group proposed a comprehensive insurance model called NICE (N = NFTs, I = Investment, C = Cryptocurrencies, E = Events). It not only covers spot markets (N and C) but also future markets (I and E).

V. **The Yield Conundrum**. This conundrum affects DeFi insurance more than other DeFi projects because the APY in insurance tends to be lower due to its lower risk. To attract investors, insurance projects need to be creative in providing different types of yield-generating mechanisms for different risk preferences and investment needs. For example, one discussant (a DeFi insurance entrepreneur) summarised three

alternative ways of reaping yield: (i) bonders: buy bonds to earn fixed interest from the 'vault', (ii) fund providers: pledge funds to earn insurance premium shares from the insurance fund pool, and (iii) stakers: stake tokens to earn rebasing bonuses from the stake pool. The APY of stakers tends to be higher than LPs and bonders, so it encourages them to stay in the project longer. The fundamental logic to ensure the feasibility of yield generation is the sustained growth of insurance premiums. It is not a Ponzis game as long as the intrinsic growth of the demand for insurance can support the increase in token issuance and yield repayment.

VI. **The Exploitation Conundrum**. The business logic error can largely be avoided if it is peer-reviewed by entrepreneurs, investors, researchers, technicians and rating institutes. The key is to design a project such that the monetary aspect and the business aspect do not systematically diverge. This is similar to the relationship between the money market and the real market in monetary economics. If the growth of tokens/money exceed that of business/GDP, then there will be inflation. As the Nobel Laureate Milton Friedman said, 'inflation is always and everywhere a monetary phenomenon'. The trending DeFi 2.0 is exactly one such tokenomic model, which resembles the Bretton Woods system in monetary history, according to the researcher discussant.

VII. **The Cybersecurity Conundrum**. A blockchain technician suggested that the codes should be checked both internally and externally before publication to mitigate this conundrum. Other suggestions include DAO votes to create a fork to undo the hackers' attacks. However, discussants all agreed that cybersecurity risks can only be mitigated rather than removed. DeFi insurance is exactly one of such mitigating solutions to cybersecurity risks, and reinsurance may be needed to insure the DeFi insurance per se. After all, a decentralised, market-based solution to the cybersecurity conundrum is possible, and it is regarded as the infrastructure of DeFi without which the ecosystem is not complete.

VIII. **The Regulation Conundrum**. As DeFi grows, regulations applied to TradFi are expected to be adapted to impose similar restrictions on DeFi counterparts, but when, how, and to what extent remain uncertain. A researcher discussant pointed out that regulations have so far focused on financial aspects like cryptocurrency use (e.g., money laundry) while ignoring the technological risks. It is advisable for policymakers and legislators to establish a technology assurance regulatory environment. It should be 'embedded regulation' integrated into the technological structures underlying DeFi. This way, the regulation targets the process rather than the outcome of the problem. In terms of implementation, it is suggested to use a 'regulatory sandbox' to provide novel support as well as guidance.

To summarise, there is no master key to all conundrums, but the discussion points to several common themes. First, a healthy DeFi insurance project must have a coherent design of its tokenomic model and business model. An unbalanced design of the two can hamper the growth or even lead to the bankruptcy of a DeFi insurance project. Second, a sustainable DeFi insurance project must have a supporting environment from other DeFi projects, TradFi experiences, and regulatory legislations. Without an adequate ecosystem, no DeFi projects can sustain. Third, all solutions boil down to technology. The rises and falls of DeFi seem to be due to the irrationality of market participants and the evilness of market wreckers, but underneath all these scenes lie the immaturity of the technology. The innovation of technologies (blockchain and smart contracts) is the ultimate driver of the growth of the market. Internal moderation, external evaluation and embedded regulation can help in this process.

4 | Discussion

The answers to the two RQs are qualitative in nature. To further enhance the findings, additional quantitative evidence is collected to measure the importance of conundrums, and a prototypical model is proposed to synthesise the potential solutions. These extensions lead to theoretical refinement and practical advancement.

4.1 | Quantifying the Importance of Conundrums

The conceptual framework (Figure 2) demonstrates how conundrums involve different stakeholders. Conundrums I, II and III mainly concern the supply side (developers), while conundrum IV involves the demand side (users). In addition, there are three types of profit-seekers: conundrum V is related to 'yield farmers' (e.g., liquidity providers and stakers), Conundrum VI is related to arbitrageurs/speculators, and conundrum VII is related to hackers. Finally, Conundrum VIII pertains to regulators. In the focus group discussions, liquidity and regulation conundrums are the most prominent challenges concerning most stakeholders.

However, prominence does not necessarily imply importance. To strictly quantify the relative importance of conundrums, we quantitatively extend the qualitative answers to RQ1 by utilising the Analytic Hierarchy Process (AHP) method. AHP is a well-established Multi-Criteria Decision-Making method initially developed in Decision Science and widely used in management (Ho and Ma 2018) and economics/finance (Lin and Tang 2009) to systematically evaluate the priority of criteria and alternatives. Details of the method can be found in Appendix E in Supporting Information. We simply report and discuss the results of AHP in this subsection.

As shown in Table 2, liquidity and regulation turn out to be the two most important challenges facing the DeFi insurance industry. Nevertheless, there are gaps between practitioners' and academics' emphases. Practitioners are more concerned about liquidity, yield and scale, which are more market-oriented

issues facing entrepreneurs. In contrast, academic researchers worry more about regulatory uncertainties and conformation, and they contribute less informative opinions on practical challenges (almost the same importance across I to IV).

The quantitative evidence provided by AHP directs the emphasis on the prototypical model in the next subsection. A successful DeFi insurance product should prioritise liquidity provision design, yield mechanism incentive and market scale expansion. Regulation compliance should always be part of the product design if DeFi insurance goes beyond crypto markets (the crossover circulation as shown in Figure 3). Other conundrums such as arbitrages and cyberattacks are less important because these issues can be naturally mitigated if the product design per se is coherent and robust.

4.2 | A Prototypical Model of DeFi Insurance

The identified conundrums are both challenges and opportunities to DeFi entrepreneurs. Building on the qualitative evidence in Section 3 (RQ1 and RQ2) and quantitative evidence in

TABLE 2 | Relative importance (priority eigenvector) of conundrums based on AHP.

Conundrums	Overall	Practitioners	Academics
I. The Liquidity Conundrum.	**0.1664**	**0.2104**	**0.1279**
II. The Actuarial Conundrum.	0.0868	0.0487	0.1193
III. The Verification Conundrum.	0.1403	0.1497	0.1247
IV. The Scale Conundrum.	0.1383	**0.1595**	0.1202
V. The Yield Conundrum.	**0.1478**	**0.1736**	**0.1288**
VI. The Exploitation Conundrum.	0.0714	0.0511	0.0909
VII. The Cybersecurity Conundrum.	0.0998	0.0928	0.1059
VIII. The Regulation Conundrum.	**0.1492**	0.1142	**0.1823**
Consistency Ratio	0.0686 < **0.1**	0.0740 < **0.1**	0.0665 < **0.1**

Note: The priority eigenvector is calculated based on the pairwise comparison matrix between all conundrums in terms of relative importance at a scale of 1–9. The consistency ratios should be smaller than 0.1 to ensure the validity of responses (Sharma et al. 2021). Data were collected in December 2023 from a follow-up survey involving 14 original focus group members and 6 additional participants, evenly split between practitioners and academics. Matlab code is available on request.

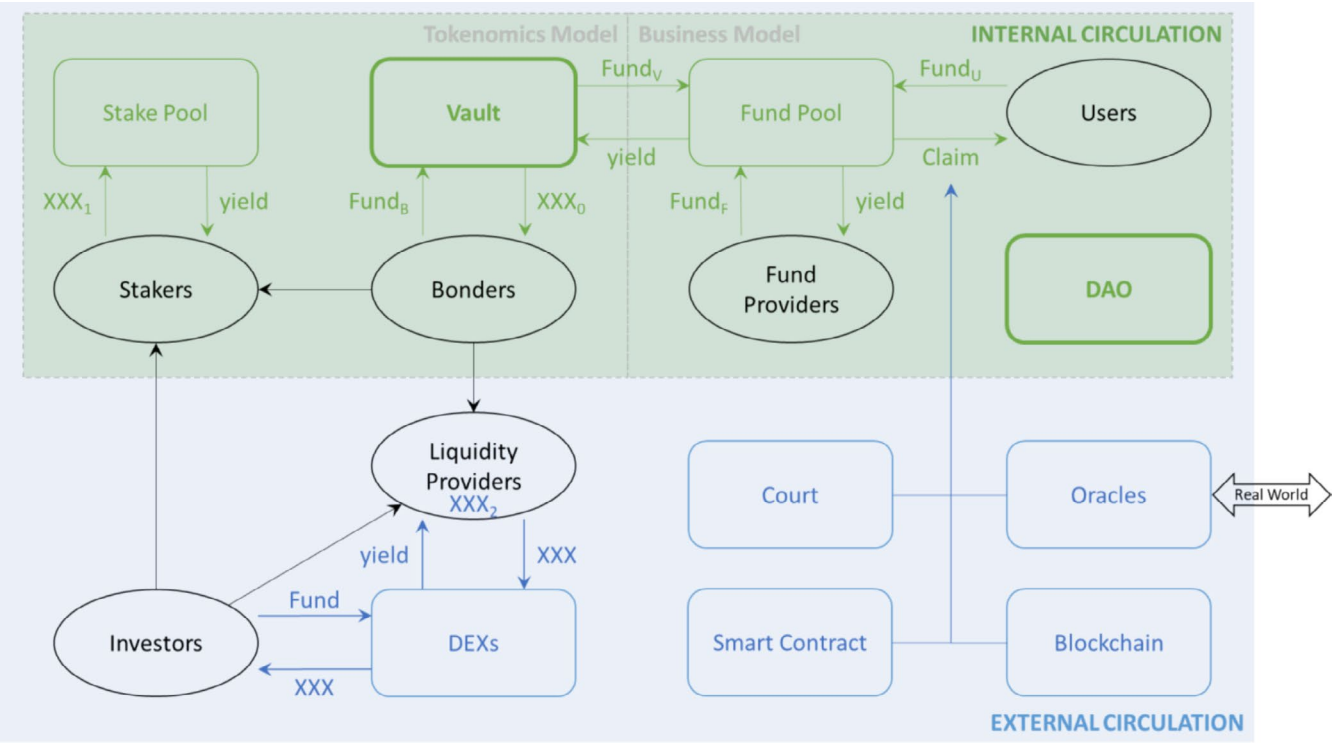

FIGURE 4 | The prototype model of future DeFi insurance.
Source: Created by the authors. Circles = market participants, green rectangles = internal mechanisms, blue rectangles = external projects, *XXX* = the native token. [Colour figure can be viewed at wileyonlinelibrary.com]

Subsection 4.1, this subsection proposes a prototypical model of DeFi insurance (Figure 4). The model addresses the conundrums of DeFi insurance by improving the circulation of value and information flows. It features a 'vault' to anchor the tokenomic model, a fund pool to provide liquidity for the business model, and a DAO mechanism to enhance inclusive governance.

Instead of the old DeFi 1.0 tokenomics that incentivises liquidity provision by constantly issuing new tokens, the prototype DeFi 2.0 insurance model uses a 'vault' to issue 'bonds' to acquire primitive funds $Fund_B$ from bonders in exchange of XXX_0 (the native token) at a discount of the market price. The discount motivates investors to purchase tokens from the vault rather than from external DEXs. The vault then uses $Fund_B$ to support the liquidity need in the insurance products on the platform. Analogously, the vault acts like a 'central bank' to provide initial liquidity to the economy. Furthermore, the vault is governed by the protocol such that the token is always backed (not pegged) by one US dollar, so the token can also serve as reserve crypto assets. The intrinsic growth of token value is supported by the insurance business model.

Backed by the vault, the tokenomics incentivises token holders to stay in the project by two alternative ways of reaping required yields. One is to attract funds ($Fund_F$) in the insurance **Fund Pool**, which distributes the insurance premia after deducting the claims to fund providers (FPs) according to their shares in the fund pool. These FPs in DeFi insurance are effectively the counterparts of LPs in DEXs. Apart from FPs, users (insurance policyholders) pay $Fund_U$ to the fund pool at the actuarially calculated insurance premia, and the vault can also act as a particular FP to provide adequate liquidity ($Fund_V$) in the fund pool to bootstrap the growth of the insurance project. Normally the funds ($Fund_U$, $Fund_F$, $Fund_V$) should be able to cover all claims, but black swan events do happen so the yield to a FP can be higher or lower than the fixed yield of bonders. The other way of earning yield is to stake tokens (XXX_1) in the **Stake Pool**, which grants DAO voting power as well as rebasing returns to stakers. In addition to the two internal incentives, token holders can also choose to be LPs in external DEXs to earn liquidity mining yield by pledging their tokens in the liquidity pool (XXX_2). This role links the internal and external circulation of fund flows. Eventually, the yields received by bonders, stakers, FPs, and LPs will balance thanks to arbitrage and competition (no arbitrage condition), and the market clearing condition holds: $XXX_0 = XXX_1 + XXX_2$.

The above tokenomic model (the left half of the *internal circulation* in Figure 4) is supported by the business model of insurance (the right half of the *internal circulation* in Figure 4). There can be a comprehensive range of insurance products covering both cryptoassets and TradFi assets. According to the current practice, insurance of NFTs, investments, and cryptocurrencies belongs to 'value insurance' which protects against volatility risks. Insurance of events can be further distinguished between 'security insurance' which protects against cyberattack risks, and 'wealth insurance' which protects against rare disaster risks like earthquakes, tsunamis, pandemics and so forth.

In addition, the DAO mechanism can ensure the orderly operation and democratic governance of the project, so that the platform is extendable to multiple directions in DeFi applications. Internal affairs such as dividend policies and claim verifications can be determined in DAO too. An external court can be resorted to if disputes on claims arise. Therefore, this business model enhances the internal and external circulation of value and information as well as the connections with real-world assets and events. It fills the three market gaps of the DeFi ecosystem and mitigates the major conundrums of DeFi insurance. It is an innovation, not a repackaging of the old DeFi 1.0 model.

5 | Conclusion

Using semi-structured focus group discussions and a follow-up survey, this paper collected first-hand evidence from informed practitioners in the DeFi industry and academic researchers. It provides a timely summary of the nascent insurance industry based on disruptive technologies like blockchain and smart contracts. There are three consensuses reached. First, three market gaps restrain the full potential of the DeFi industry in the circulation of value and information internally and externally as well as between DeFi and TradFi. Second, eight major conundrums impose barriers to the DeFi insurance and lead to its unbalanced growth (RQ1). Third, possible solutions or at least principles of solutions are proposed to address the major conundrums (RQ2). Based on these solutions, the paper synthesises a prototypical model of the next generation of DeFi insurance, which is featured with a vault-anchored tokenomic model, a comprehensive business model and a DAO governance.

The early evidence discovered in this paper provides informative implications and guidance for a wide audience. First, for DeFi insurance entrepreneurs, the market gaps and conundrums inform them of what core features should be developed in product design, and the prototypical model gives them a blueprint and benchmark of the next generation of DeFi insurance. Second, for TradFi insurance providers, new features of DeFi insurance may pose competitive advantages against TradFi, so it informs strategic reactions for TradFi to develop similar features to cope with these threats. Third, for regulators, regulations should catch up with the development of DeFi insurance and DeFi in general. Nevertheless, regulations are usually lagging behind practice, so the early evidence provided in this paper offers forward-looking, proactive regulatory and legislative insights. Fourth, for researchers, media coverage and academic research in DeFi have been explosive in the last decade for its appealing ideology of decentralisation. DeFi may never replace TradFi, but DeFi solutions will exist and co-evolve with TradFi in the foreseeable future. This paper serves as an example of a mixed-method approach to investigate emerging evidence in a nascent industry.

One limitation of this study is that the findings were based on opinions rather than behaviours. Therefore, the study is more a forward-looking preview than a backward-looking review. As time goes by, more DeFi insurance projects are expected to be launched, both successful and unsuccessful ones. It will provide better databases (cross-sectional and panel data) on the actual behaviours, based on which a more retrospective, quantitative research can be done.

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Ethics Statement

The School Research Ethics Committee (Approval No. 2297), Cardiff Business School, Cardiff University, UK.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.