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RESEARCH ARTICLE

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Communicating tokenomics and monetary policy: A comparative analysis of real and virtual economies

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Abstract

This article investigates the economic governance of blockchain-based virtual economies in the context of monetary policy. Focusing on tokenomics communication, we employ deductive and inductive approaches, applying real-world monetary policy metrics and text mining frameworks. Our comparative analysis reveals that the tokenomics communication in blockchain-based virtual economies primarily functions as a fundraising tool, lacking policy discussions, with divergences from real-world economies in policy goals and numerical targets. Furthermore, our research highlights similarities between blockchain-based virtual economies and early-stage low-income developing countries in communication dynamics.

KEYWORDS

blockchain, monetary policy communication, monetary policy frameworks, text mining, tokenomics, virtual economies

1 | INTRODUCTION

Over the last 5 years, two rapidly growing technological landscapes—virtual worlds and blockchain technology—have increasingly converged, creating blockchain-based virtual economies (BBVEs). On the one side, virtual worlds provide internet users the opportunity to spend their time online within a computer simulated environment through an avatar, shown through the rapid growth of Second Life in the 2000s (Nazir & Lui, 2016). On the other side, the recent technology of blockchain as a distributed ledger system enables developers to power the underlying economic structures of virtual worlds, seen for instance in the rise of play-to-earn gaming or metaverses (Vidal-Tomás, 2022). Even though relatively low engagement still nurtures scepticism regarding the prospects of BBVEs, their economies have been of significant interest to public and institutional investors, with the metaverses Sandbox and Decentraland both boasting market capitalizations of over a billion US$ in virtual tokens in 2022 (Mogaji et al., 2023). Numerous incentives exist for virtual world developers to leverage blockchain in the underlying economy: increased accessibility to fundraising vehicles (Conley, 2017; Malinova & Park, 2023) and a plethora of blockchain enabled tools through the utilization of smart contracts (Zheng et al., 2020) are the most prominent ones. At the intersection of both landscapes, we witness how BBVEs emerge as new approach to economic structures within virtual worlds.

In this regard, a commonly found narrative amongst BBVE developers stems from comparing these to real-world economic systems. Policymakers of the game Axie Infinity claim 'You can think of Axie as a nation with a real economy' (Axie Infinity, 2021b, p. 1). Similarly, Sandbox developers state 'We are aiming at replicating real-world economy systems...' (Sandbox, 2020, p. 30).

The Star Atlas whitepaper claims that its economy provides the '...opportunity for players to extract in-game virtual earnings into real-world income' (Star Atlas, 2021b, p. 19). Such statements paint BBVEs with a clear ambition to function just as their real-world counterparts, at times allowing for interaction and trade between both economies. In a similar vein, academic literature analysing virtual economies of the pre-blockchain era frequently draws on parallels between real-world economics and that of virtual worlds (Castronova, 2005; Nazir & Lui, 2016; Zhang & Shrestha, 2010).

In a comprehensive survey, Lee et al. (2021) already identify economic governance as a crucial issue for the development of the metaverse. While several dimensions of economic governance exist, the design of monetary policy is of crucial importance for macroeconomic developments related to output and inflation as well as for the functioning and stability of financial markets. Key features are the degree of monetary policy independence which often displays a negative relationship with inflation (Cukierman et al., 1992), and as well as the monetary policy strategy and monetary policy communication (Cobham, 2021). An inflation targeting strategy has been successfully adopted by several central banks and monetary policy communication is necessary to communicate monetary policy aims and affect expectations about inflation and the future path of monetary policy (Coibion et al., 2022).

Against this background, our article analyses the economic governance of BBVEs by answering the following question: How are the structures, mechanisms, and policies of blockchain-based economies communicated? It thus investigates the ways developers communicate the so-called tokenomics (Freni et al., 2022; Mougayar, 2017). By focusing on the communication of monetary policy, we align our research with a mature field of economic literature, providing an established benchmark to our research. Hence, we can validate the claim that BBVEs resemble real-world economies, shedding light on their credibility and potential impact. Lastly, the way BBVEs communicate their monetary policies within a competitive environment may offer insights applicable to newly established real-world entities such as charter cities and special economic zones.

We combine both a deductive and an inductive approach by applying, first, the real-world monetary policy framework metric introduced by Unsal et al. (2022) to the BBVEs, and, secondly, the text mining frameworks introduced by Benchimol et al. (2022) and Benoit et al. (2018). To our knowledge, this article presents the first application of these frameworks to the communication of tokenomics. Furthermore, we present the first comparison of the tokenomics communication of BBVEs to that of real-world economies with different stages of development, including advanced economies, emerging markets, and low-income developing countries.

Our comparative analysis reveals that the tokenomics communication in BBVEs primarily functions as a fundraising tool, lacking policy discussions, with notable divergences from real-world economies in policy goals and numerical targets. Furthermore, our research highlights similarities between BBVEs and early-stage low-income developing countries in communication dynamics. Our study is complementary to recent work by Vidal-Tomás (2023). He analyses 196 metaverse fungible tokens and argues—based on comprehensive econometric analyses—that these tokens fail to function as unit of account and medium of exchange or store of value due in part to explosive dynamics and negative market performance. Based on our findings, we argue that deficiencies in economic governance, in particular with respect to tokenomics communication, could be one potential reason for why these tokens are failing to serve as reliable currencies.

The remainder of this article is structured as follows: The theory section provides the conceptual background to analyse monetary policy in BBVEs. The methods section reflects on the empirical design of our study. The results section displays the main findings. Finally, a discussion of the main results is followed by a conclusion that outlines avenues for further research.

2 | THEORY

2.1 | Monetary policy in real-world economies

Our main point of reference for analysing tokenomics in a systematic manner are frameworks of monetary policy that stem from academic studies analysing real-world economies. A monetary policy framework should define all the structures needed for the development, communication, and execution of monetary policy (Cobham, 2021), providing clarity and a reference point to policy-makers and transparency to stakeholders (Unsal et al., 2022). Monetary policy frameworks vary greatly between countries or economic zones, depending on legal frameworks, regulations, and governmental policy (Cobham, 2021).

This paper builds on the monetary policy framework of the International Monetary Fund (IMF) (Unsal et al., 2022) that characterizes monetary policy multidimensionally by three main pillars: 'Independence and Accountability', 'Policy and Operational Strategy', and 'Communications' (IAPOC). 'Independence and Accountability' largely refers to the legal foundations regulating

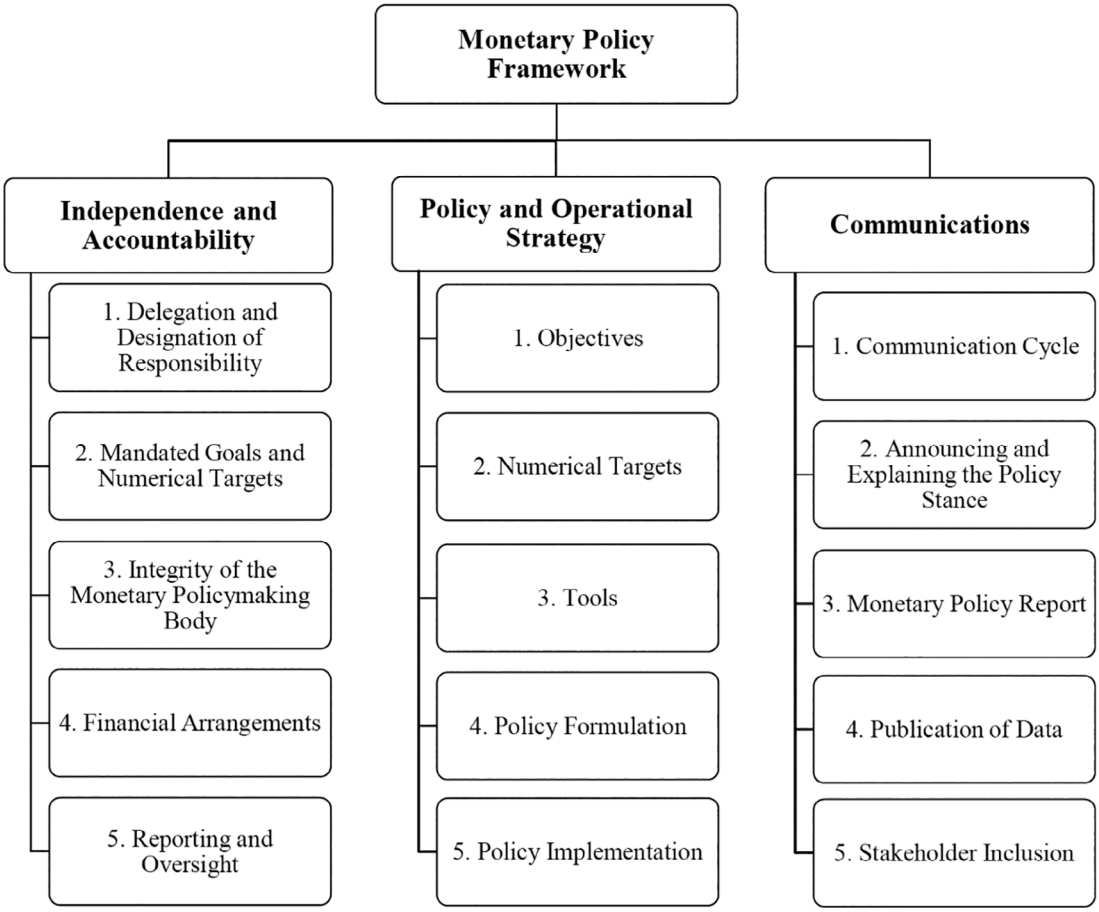

FIGURE 1 The pillars and sub-pillars of the IMFs monetary policy framework (Unsal et al., 2022).

policy-making institutions, usually central banks, and defines their legal capacity to pursue policy goals, such as numerical targets. Also, it encompasses the degree of their operational independence and accountability (Berger et al., 2001; Friedman, 1990; Goodfriend, 2007). The pillar 'Policy and Operational Strategy' defines strategies for policy implementation and also transparency requirements regarding policy tools and instruments, such as interest rates (Unsal et al., 2022). 'Communications,' finally, encompasses how information regarding policy actions, current monetary stance, and rationale regarding policy decisions is communicated to the public.

As displayed in Figure 1, the pillars of the IAPOC framework are further divided into sub-pillars. However, some features are inherently connected across sub-pillars. Policy formation, for example, falls within the scope of 'Policy and Operational Strategy,' yet the 'Communications 'sub-pillar defines how these policies are worded, justified, and presented. This interconnection underlines the holistic approach needed when looking at the IAPOC index as a complete description for monetary policy frameworks. For this reason, our empirical design comprises a comparative assessment of the extent to which the tokenomics of BBVEs exhibit the main premises of monetary policies that underlie all three pillars.

The importance of communication is now widely recognized by central banks and scholars (Blinder et al., 2008). Since the beginning of the 1990s—especially following the 2008 financial crisis (Hayo & Neuenkirch, 2015)—central banks have increased the frequency and transparency of their communication (Geraats, 2006), acknowledging the increase in monetary policy effectiveness it entails (Benchimol et al., 2020; Blinder et al., 2008). In line with this development, interest in academia has turned towards empirical measures of central bank communication. Quantitative measures build on text data mining (Benchimol et al., 2022) or investigate the relationship of communication on high-frequency financial market data (Gertler & Horvath, 2018). Unsal et al. (2022) use a more manual methodology to apply the IAPOC framework. They define their metric by a set of criteria, in which countries or economic zones are subjected to 225 questions across the three pillars, and use information based on governing laws as well as website-based material and publications.[1] With respect to the communication pillar, the assessment applies a principle-based and axiomatic approach, where a series of

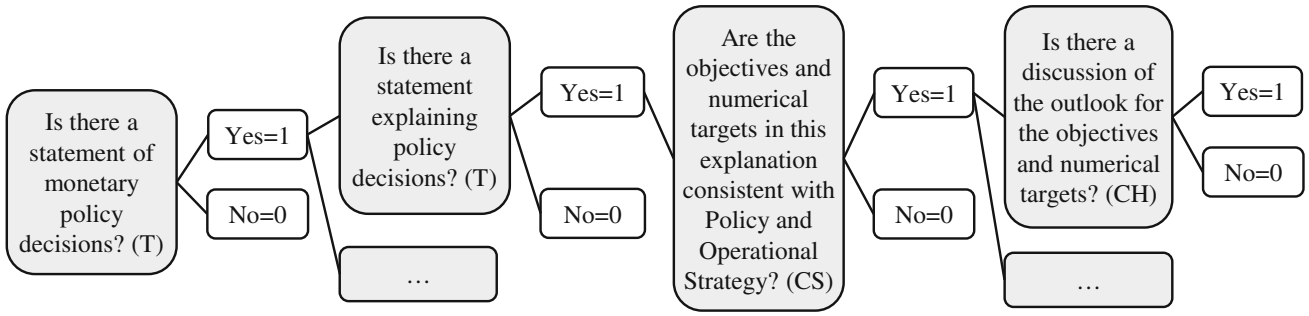

FIGURE 2 Abbreviated criteria for the IAPOC metric for communications (Unsal et al., 2022).

questions through the axioms transparency (T), coherence (CH), or consistency (CS) are queried for each sub-pillar (see Figure 2).

2.2 | Virtual economies

One may expect that the application of blockchain technology has fundamentally changed the dynamics of monetary policy in virtual worlds. In order to substantiate this assumption, we pursue three steps: First, we offer a brief introduction to blockchain technology, and, secondly, we sketch the main features of tokenomics and the corresponding academic efforts made to conceptualize it.

2.2.1 | Blockchain-based virtual economies

BBVEs are virtual economies where—instead of using traditional databases—digital assets are stored and transferred on a blockchain-based network. A blockchain is essentially a chain of digital blocks, with each block representing a data structure containing a summary of all the transactions within it. The technology can be thought of as a massive distributed ledger, where each new entry to the ledger is agreed upon through the consensus of a global network of validators. Each block written to the ledger is then immutable, with the block and all before it linked and saved across all validators. Typically, this record of transactions is then publicly viewable, creating an audit trail (Catalini & Gans, 2020).

The concept of blockchain was first popularized with the release of the bitcoin whitepaper in 2008 (Nakamoto, 2008). The article describes bitcoin as a '...peer-to-peer electronic cash system' (p. 1), powered by a decentralized peer-to-peer network, using cryptography and a proof-of-work mechanism to ensure the network's integrity and security. Nakamoto's introduction of bitcoin has been hailed by many as a radical and disruptive innovation of currency and store of value, developed and maintained without centralized issuance or control (Buterin, 2014; Catalini & Gans, 2020). It is however, arguably the underlying blockchain technology as a tool of decentralized consensus that has been of greater importance (Buterin, 2014) and is of central importance for our article.

In the 15 years following its inception, there has been immense growth and innovation within the blockchain sphere as well as increased interest from both industry and academia. New technologies and capabilities have frequently widened the scope of use. In this regard, the addition of smart contracts in the underlying protocol of a blockchain is perhaps the most important development. A smart contract is a set of rules written in code and deployed on a blockchain, which is programmed to self-execute when a transaction containing instructions is sent to the contracts address. As such, logic can be written to create sophisticated applications that are able to run autonomously through blockchain transactions (Zheng et al., 2020).

Four main use cases of smart contracts are commonly leveraged in the development and functionality of BBVEs. First, smart contracts enable the creation of new tokens upon an existing blockchain. This can be fungible tokens—commonly used to represent a BBVEs payment token or currency—or non-fungible tokens (NFTs) that are uniquely distinguishable from one another, able to represent a wide landscape of digital assets (e.g., digital images, virtual real estate or assets, virtual characters, trading cards or digital claims to real-world assets) (Vidal-Tomás, 2022). Second, smart contracts can be used to create blockchain native applications, such as decentralized applications or financial tools (Zheng et al., 2020). Third, by staking, developers may incentivize users to lock up digital assets in a smart contract in return for some form of reward—generally in the form of additional currency or tokens. The mechanisms surrounding staking vary, for example linked through the participation in a liquidity pool, to governance participation (Sharma et al., 2023), or simply through a mechanism to reward users for temporarily removing tokens from circulation (Vidal-Tomás, 2022). Finally, smart contracts can be

used to facilitate voting rights of stakeholders for groups of (pseudo anonymous) entities, thus creating decentralized autonomous organizations (DAOs) (Sharma et al., 2023).

Taken together, smart contracts enable numerous innovations in how tokens are used and implemented (Oliveira et al., 2018). In turn, this requires constant updating of knowledge as to what, in fact, tokens represent in the blockchain landscape and how they connect to their underlying business model. The field of tokenomics (Mougayar, 2017) emerged from this need and has since evolved rapidly within online media and academia (Freni et al., 2022; Lo & Medda, 2020; Malinova & Park, 2023; Oliveira et al., 2018).

2.3 | Tokenomics

The field of tokenomics provides various frameworks that classify blockchain tokens, with Oliveira et al. (2018) and Freni et al. (2022) being the most prominent ones.[2] Oliveira et al. (2018) base their token classification on a literature review and empirical data. They consider four main parameter sets: Purpose parameters describe the high-level purpose of the token's design. Governance parameters refer to the underlying representation of the token, its supply strategy and incentives provided for the use of tokens. Technical parameters define the underlying technical layer (i.e., blockchain). Finally, functional parameters capture how the token behaves on a functional level, governed by rules set within the blockchain code, protocol, or token standard.

Freni et al. (2022) propose a morphological token classification framework based on a thorough analysis of current token classifications. Their framework is based on three domains: 'technology', 'behaviour', and 'coordination' (see Figure 3). Whereas 'technology' and 'behaviour' build on the respective technical and functional parameter sets suggested by Oliveira et al. (2018), the 'coordination' domain combines aspects of token purpose

Technology	Behaviour	Coordination			
...	...	Underlying Value	Supply Strategy	Incentive Enablers	Incentive Drivers
		Asset-based	Pre-mined scheduled distribution	Right to work	Get access (to content/services)
		Network Value	Pre-mined one-off distribution	Right to use	Get discount
		Share-like	Discretionary	Right to vote	Get revenue (increase existing business)
			Matching Demand	Unit of account	Get reward (new economy creation)
				Medium of exchange	Divident/earning potential (for holding or staking)
				Store of value	Appreciation potential (Speculation)
					Participate in governance
					Gain reputation

FIGURE 3 Token classification framework with focus on coordination, from Freni et al. (2021). [Colour figure can be viewed at wileyonlinelibrary.com]

and governance whilst adding both incentive enablers and drivers. The 'incentive enabler' dimension describes *what* an ecosystem's stakeholder is potentially able to do with a token. The 'incentive driver' dimension defines *why* stakeholders may be motivated to engage in elements of the token's ecosystem. The 'coordination' domain thus covers those parts of the tokenomics structures that are closely linked to stakeholder incentives and emphasizes the vital role of communication. Furthermore, through the 'supply strategy' sub-domain it has a strong link to monetary policy in traditional economies. It thus serves our aim to analyse the communication of tokenomics best.

3 | METHODS

Our methodological approach is designed to answer the research question 'How are the structures, mechanisms, and policies of BBVEs communicated?'. It pursues two main steps. First, we select cases from the landscape of BBVEs through our employed strategies for data collection. Second, given its explorative nature, our empirical design combines both a deductive and an inductive approach in order to comprehensively compare the communication in real-world and virtual economies.[3]

3.1 | Case selection and data collection

In July 2023, we collected all BBVEs with the help of online blockchain aggregators,[4] using the platform defined categories 'play-to-earn', 'gaming' and 'metaverse'. Twenty-three individual BBVEs resulted from this process. Subsequently, we scrutinized their level of quality by applying the five criteria displayed in Figure 4 and disregarded any BBVE that did not meet all five requirements. The selection of criteria 1.1–1.4 was guided by the following considerations: transparency; existence of a legal interface payment structure between the BBVE and real-world economies; accountability; and the existence of a playable version.

The fifth criterion—oversight—is directly connected to the framework of monetary policy provided by Unsal et al. (2022). It filters the sample to include only BBVEs in which an application of the IAPOC communications criteria can be considered meaningful. The respective question (1.5 in Figure 4) indicates whether BBVEs are openly subject to direct oversight by decision makers after the initial communications of their tokenomics. To put this in the context of real-world economies, this process determines whether a central bank type entity exists for the BBVE that is able to enact some extent of monetary policy to target economic goals within the BBVE.

This case selection strategy yielded six BBVEs (Axie Infinity, Decentraland, Illuvium, My Neighbor Alice, Sandbox, and Star Atlas) which we use for our deductive and inductive approaches. Our inductive analysis systematically compares these BBVEs to six real-world economies: two advanced economies (USA and the Euro Area), two emerging markets (Argentina and Indonesia), and two low-income developing countries (Nigeria and Ghana). In our selection, we aimed to balance data availability with

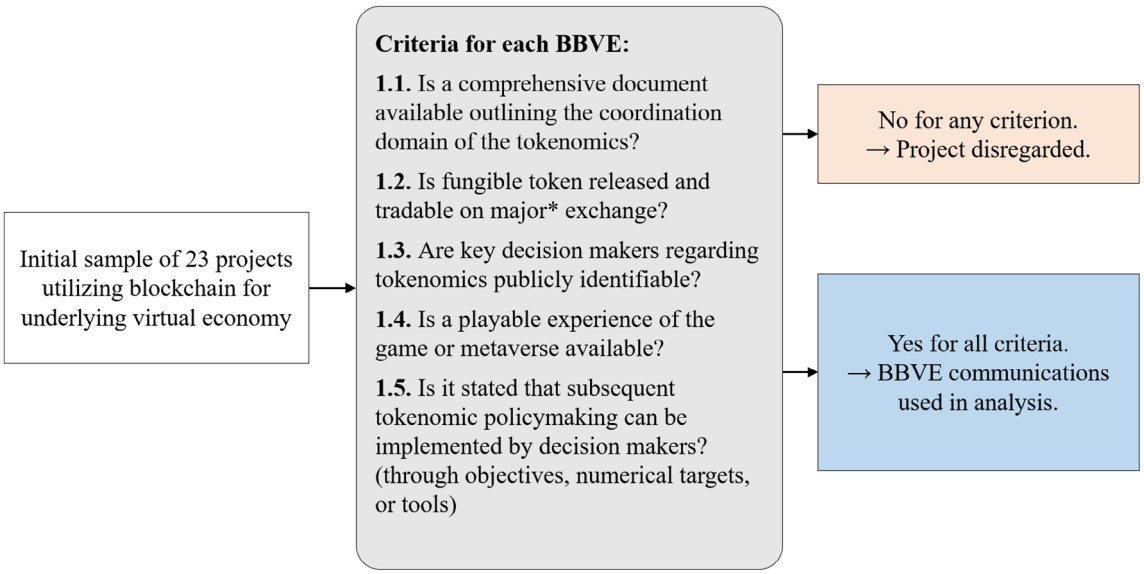

FIGURE 4 Flow chart for the filtering of blockchain-based virtual economies for further research. *By major exchange, tokens must be exchangeable to fiat currency which is subsequently withdrawable through SEPA or international wire transfer. [Colour figure can be viewed at wileyonlinelibrary.com]

geographic diversity to capture a wide range of economic conditions, cultural contexts and institutional frameworks. Thus, for the advanced economies, we selected the USA and the Euro Area as the largest and third largest economies worldwide providing central bank transparency and a stable institutional environment. For the emerging markets we selected Argentina, representing South America and an environment with high exchange rate volatility and inflation, and Indonesia, representing Asia and relatively stable economic conditions. As most low-income developing countries are located in Africa, we select Nigeria as the most populous African state and Ghana as one of the most stable economic environments in African. At the same time, both countries provide sufficient data and transparency in central bank communications for analyses. The resulting sample for both economy groups can be found in Appendix Table A.1.

Our data collection with regard to the BBVEs tokenomics and their communication builds on three main source groups: Project publications and internet documents, most importantly the most current available document of the projects' whitepapers, online blog articles, periodic newsletters, Medium[5] articles, and periodic economic reports. Blockchain data aggregators (Etherscan[6] and Coingecko[7]), that give insights into the supply, distribution, and movement of a BBVE's token(s). Finally, online social discourse platforms (Discord[8] and X[9]) that allow us to evaluate how virtual world developers or policymakers discuss with the public and stakeholders and to access social metric data.

As for the real-world economies in our inductive approach, we selected communications only if they described the currency and overall monetary policy strategy or framework. Periodic documents such as monetary policy reports or statements explaining and justifying decisions were not used. Finally, for our deductive approach in the IAPOC metric analysis there was no need to collect empirical data as the results for real-world economies are readily available from the IMF (Unsal et al., 2022).

3.2 | Empirical design

Given their character as newly and constantly emerging technologies, anyone analysing tokenomics communication in BBVEs is sailing in unchartered seas. Nevertheless, communications put forth by developers claim their virtual economies should function in parallel to their real-world counterparts, indicating that established frameworks of monetary policy are of scientific value when it comes to analysing BBVEs and their tokenomics. In recognition of this somewhat ambivalent character of our research subject, our empirical design encompasses two steps.

In the first step, we take the claims of developers for granted and apply the metric analysis of the IAPOC framework to tokenomics. This analysis starts out with a comparative description of our sample that uses the IAPOC framework as a conceptual framework. The communicated texts are analysed more systematically by metric analysis as proposed by Unsal et al.'s (2022) approach. In doing so, we analyse the structures, underlying meaning, and accessibility of communications and also follow the axiomatic approach that considers its transparency, coherence, and consistency.

In the second step, we discard established frameworks and apply an text mining analysis to the BBVEs whitepapers. To our best knowledge, using text mining for analysing tokenomics communications is a new approach within the literature. Benchimol et al. (2022) introduced a set of text mining methodologies through the use of open source software R (Ihaka & Gentleman, 1996), using the text data mining packages 'tm' (Feinerer et al., 2008). We build on Benchimol et al. (2022) as a guiding methodology for data collection, cleaning, and compiling. The results from this text mining analysis are visualized as word-clouds, where key terms within the text corpus are plotted with font sizes proportional to the overall word frequency in the document-text matrix. Additionally, we use the R package 'quanteda' (Benoit et al., 2018) that enables the visualization of contextual placement and the co-occurrence of keywords.

4 | RESULTS

Six BBVEs resulted from the selection process defined in Figure 2. Each of these operates within a computer-generated virtual world, at times described as a 'metaverse' (Sandbox, 2020, p. 6) or 'universe' (Axie Infinity, 2021a). Three BBVEs focus on social interactions (Decentraland, 2017b; My Neighbor Alice, 2021; Sandbox, 2020), the others blur boundaries as a collection of interconnected games (e.g., farming, battling, exploring, and racing) (Axie Infinity, 2021a; Illuvium, 2023b; Star Atlas, 2021b). All BBVEs had more than 100 k users as part of the social metric, calculated as an unweighted average of Twitter and Discord followers. Additionally, all BBVEs had combined market capitalizations of at least $20 million USD for their fungible token(s) as of July 2023 (see Figure 5).

A summary of each of the projects, their underlying BBVEs, and policymaking tools that is based on the projects' whitepapers is given in Table A.2 of the Appendix.

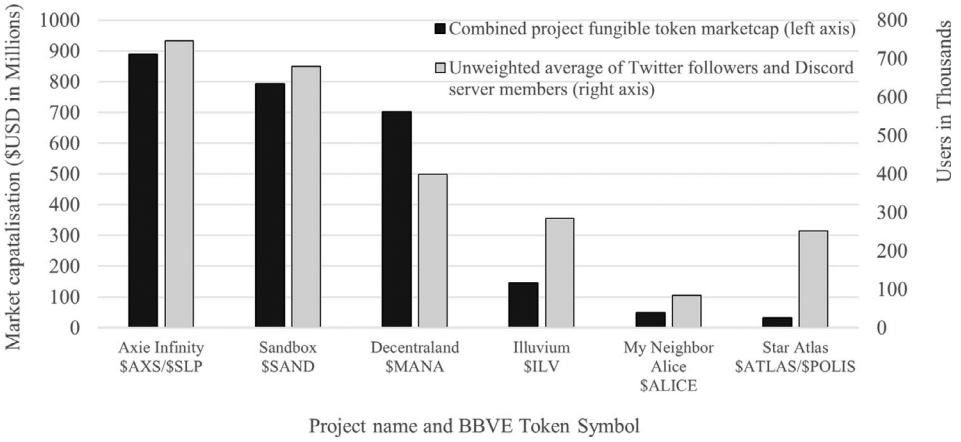

FIGURE 5 Social and market capitalisation metrics for the six shortlisted virtual worlds as of July 2023.

4.1 | Application of the IAPOC framework

4.1.1 | Comparative assessment of tokenomics

Our initial comparative assessment of tokenomics yield that three aspects are crucial for analysing BBVEs, namely inflation, fundraising and supply strategy, as well as governance participation. Shedding light onto these concepts within the BBVE context and contrasting them with real-world economies is important as they impact the meaning of monetary policy within BBVEs across all three pillars of the IAPOC framework (Unsal et al., 2022). The following rather holistic assessment of monetary policy in BBVEs thus precedes the metric analysis of tokenomics communications.

Firstly, it is important to discuss what exactly monetary policy and its implementing toolkit may represent in BBVEs. The overarching objective for monetary policy in real-world economies is well agreed on by central banks as price stability (Goodfriend, 2007). Maintaining a stable inflation rate—understood as the increase in the cost of living through the relative increase in price of a set of goods and services over a given time period (Öner, 2017)—is thus at the heart of real-world monetary policy (Bernanke & Mishkin, 1997). But what are price stability and inflation in the context of a BBVE? Our analysis suggests that the concept of inflation is fragmented and somewhat misrepresented in BBVEs. Without a peg to a real-world currency and a subjective cost of living, we miss a reference point for inflation. Indeed, the concept 'cost of living' is perhaps not easily translatable to BBVEs, especially if tokens are based on a decentralized blockchain and can be transferred or sold outside of the jurisdiction of the virtual world.[10] Nevertheless, the term inflation is used in the communications of at least two BBVEs in a potentially misleading way. Both Star Atlas and Decentraland use the term to define their supply strategies, referring to '...a standard inflation rate of 4% per annum' (Star Atlas, 2021b, p. 21) and a continuous token generation model with decreasing supply 'inflation targets' (Decentraland, 2017a), respectively. Used in this sense, 'inflation' and 'inflation targeting' represent trivial concepts as they consider only a developer-controlled token supply increase. Thus, particular caution is required when referring to inflation in BBVEs.

Instead of the goal of price stability through inflation targets, the targeting of a fixed or stable exchange rate band as a monetary policy objective could also be an interesting point of reference for BBVEs. Such policies have been implemented in many forms throughout real-world economies (Goodfriend, 2007). Also, the pre-blockchain virtual economy of Second Life has maintained a degree of currency parity to the US$ (ECB, 2012; Ernstberger, 2009). However, none of the BBVEs in our sample implements or communicates any form of exchange rate band objective.

The bottom line is, without a coherent price stability objective through inflation targets or exchange rate regimes, BBVEs are seen to lack clarity and coherency with monetary policy. The economic objectives given are rather vague: 'economic sustainability' (Axie Infinity, 2021b, p. 1) or the creation of a 'circular' (Sandbox, 2020, p. 8), 'fully decentralised and sustainable' (Star Atlas, 2021a, p. 34), or 'player-owned' (Axie Infinity, 2021b, p. 1) economy. Illuvium simply wishes to 'balance supply and demand while providing players with an engaging and rewarding experience' (Illuvium, 2023d, p. 1). None of the projects defines its objectives numerically, leaving the success of such goals open to interpretation.

With such a fundamental difference in the premise of monetary policy, the discussion is, secondly, shifted to the *who* and *how* of tokenomics. That is, in cases where tools are available to decisionmakers: Who can use them within the tokenomics landscape of BBVEs? And how do

these translate to the toolkits of central banks? Indeed, the tools available to real-world central banks vary (Friedman, 1990). One can draw parallels between central bank interest rates to the commonly used staking mechanism of BBVEs. While all the BBVEs studied with the exception of Decentraland implement staking, the surrounding mechanisms and incentives vary and are, for instance, linked to liquidity providing (Illuvium, 2022b) or the token lock amount, duration, or additional NFT based incentives (Sandbox, 2022; Star Atlas, 2021a). Changes in the implementation of staking mechanisms can thus be determined as a tool of BBVE policy. In addition, standard monetary policy instruments—such as transparent reserve requirements, open market operations, as well as forward guidance as a communication instrument—can be directly applied to BBVEs policy toolkit.

Every virtual world within the sample utilized fundraising vehicles such as initial coin offerings or initial exchange offerings as well as private sales through their release of their fungible token(s). The marketing and selling of tokens for BBVEs influences the communication strategies of policymakers, especially prior to token sales. In the case of Illuvium, for instance, it is promised that investors will '...will receive various promo NFTs for purchasing [$ILV] early, in large quantities, or both' (Illuvium, 2022a). Furthermore, supply strategies often favour private investors or insiders, as was the case for Axie Infinity, where tokens were sold at a discount to private investors (Axie Infinity, 2021b), or Illuvium, where two private investment rounds at US$1, US$3 respectively, preceded a public sale with an initial US$50 price per token (Illuvium, 2023c).

A further finding of our initial comparison is that BBVEs often communicate predetermined and somewhat rigid token supply strategies. In fact, five of the six BBVE implement a hard cap communicated on the total supply in the token, with all the projects communicating vesting and partly discretionary distribution for the complete supply in advance. This transparent and predefined token supply is commonly seen in the blockchain sphere (Meynkhard, 2019) and may attract potential investors through empowering their decision-making (Freni et al., 2022). In real-world economies, by contrast, the importance of money supply as a tool in monetary policy has diminished over time as other policy tools have more reliable influence over short term price stability (Amassoma et al., 2018; Doan Van, 2019).

Thirdly and finally, governance participation through token ownership or staking is a common incentive in our BBVE sample. In cases where some form of decentralized governance has been implemented, aspects of independence and accountability should also be discussed. Indeed, while only virtual worlds with non-anonymous key members were considered in this study (see Figure 4, p. 1.3), the implementation of a DAO in governance reintroduces the pseudonymity inherent in the underlying blockchain—where the token holdings and transaction history are transparent for a voting entity, but real-world identity may be anonymous (Sharma et al., 2023).

For the BBVEs with DAO governance structures, voting power is relative to the token holdings of a voting entity. On the one hand, this structure may be assessed critically as large holders tend to be more active in the voting process and more successful in putting forth proposals such that conflicts of interest may arise (Sharma et al., 2023). Principles of the 'Independence and Accountability' pillar from the IAPOC framework may thus be violated. On the other hand, DAO implementation improves the transparency of communication and decision making. Decentraland and Illuvium, for example, both implement dashboards with proposals and DAO reserves viewable by the public (Decentraland DAO, 2023; Illuvium, 2023a).

4.1.2 | IAPOC metric analysis

In this section, we apply the IAPOC metric analysis (Unsal et al., 2022) to the communications pillar of BBVE tokenomics with respect to monetary policy. The communication structure of each BBVE is thereby analysed alongside its sub-pillars. Results are shown in Figure 6.

With regard to the 'Communication Cycle', a BBVE receives one index point if it exhibits some form of standard vehicle for communicating information related to its tokenomics (email newsletter, website-based blog format or both), even if these are not exclusive and contains developmental or marketing related information. Fixed communication cycles are determined by a regular frequency of newsletters or blog posts, even though these do not follow an exact schedule in our sample of BBVEs. All BBVEs score weakly when subjected to criteria that concern the communication of policy changes. This is plausible as none of the BBVEs exhibit coherent overlying objectives or numerical targets.

With regard to the criteria for 'Announcing and Expanding the Policy Stance', all BBVEs receive an initial point for announcing tokenomics through their whitepaper, although the quality and extent of the tokenomics information within these vary greatly. Decentraland's whitepaper, for example, contained little more than a single sentence describing some basic token utility (Decentraland, 2017b), with more detailed tokenomics being communicated in a later Medium article (Decentraland, 2017a). The whitepapers of most other BBVEs included comprehensive tokenomics information covering all information relevant to the coordination domain. Overall, all BBVEs score poorly in

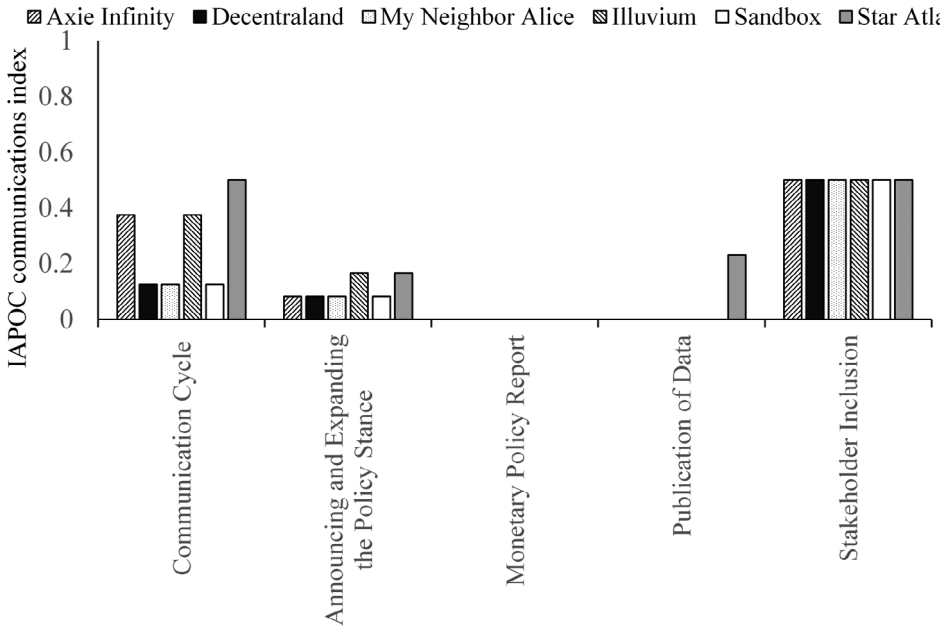

FIGURE 6 Results of the IAPOC metric for the five communication criteria sets applied to the sample of BBVEs.

this sub-pillar due to the absence of coherent overlying objectives or numerical targets that entail many criteria related to 'consistency' and 'coherency'. Additionally, all BBVEs lack coherent discussions of both current policy stance as well as future trajectories.

When applying the criteria for 'Monetary Policy Report', we scrutinize whether communications exhibit arguments that would fit to the description provided by the IMF (Unsal et al., 2022) as well as the federal reserve (FOMC, 2023). Common to these descriptions is that a monetary policy report should at least contain discussions concerning policy conduct and explanations for their rationale. For an improved score, the report should then contextualize the report with past and current policy actions, provide an outlook to the future as well as include methodologies within the discussions. None of the documents studied for the BBVEs does adequately fit the standards for a monetary policy report for their tokenomics. As such, all BBVEs scored zero in this sub-pillar.

The fourth sub-pillar—'Publication of Data'—assesses whether data relevant for monetary policymaking is published. Indeed, only one BBVE in our sample publishes some form of accessible economic report (the Star Atlas' quarterly 'State of the Economy' publication) that covers macroeconomic topics, user interactions statistics with the BBVE, and a summary of its economy's state.

Finally, the fifth sub-pillar—'Stakeholder Inclusion'—has interestingly yielded the highest scores. All BBVEs make efforts to simplify language centred around tokenomics information and to disseminate information to a wider audience by links that are easily accessible across multiple social media platforms. Several offer information in multiple languages, although these focus on regions where the BBVE has a larger stakeholder base. None of the cases includes all major languages. Also, none of the documents released by BBVEs reached the standard of research articles.

Figure 7 displays an unweighted average score across all BBVEs and compares the findings to Unsal et al.'s (2022) results for real-world economies. These include the scores for advanced economies (AEs) in 2018 as well as for low-income developing countries (LIDCs) in 2018 and 2007. The average score of BBVEs falls significantly below AEs in all communication sub-pillars except 'Stakeholder Inclusion'. The same holds for the comparison to LIDC results from 2018, though to a lesser extent.

A first major finding thus is: Although BBVEs are openly striving to function as real-world economies, they face major shortcomings with regard to tokenomics communication in comparison to the IAPOC standards reached by real-world economies in 2018, both for AEs and LIDCs.

A closer look at the development of LIDCs offers a more nuanced insight. According to the IMF, LIDCs in 2007 '*...often lacked some of the most fundamental elements of communications such as policy announcements or a monetary policy report*' (Unsal et al., 2022, p. 21). More recently, however, the IMF praises the communication progress made by the LIDC central banks that now promptly announce and explain policy decisions and hold verbal policy related press conferences. The largest improvements for LIDCs are seen in the sub-pillar 'Monetary Policy Report'. In many respects, similarities can be drawn between the scores of BBVEs and the 2007 LIDC scores. This is particularly true for the relatively low scores of both groups as regards the criteria 'Announcing

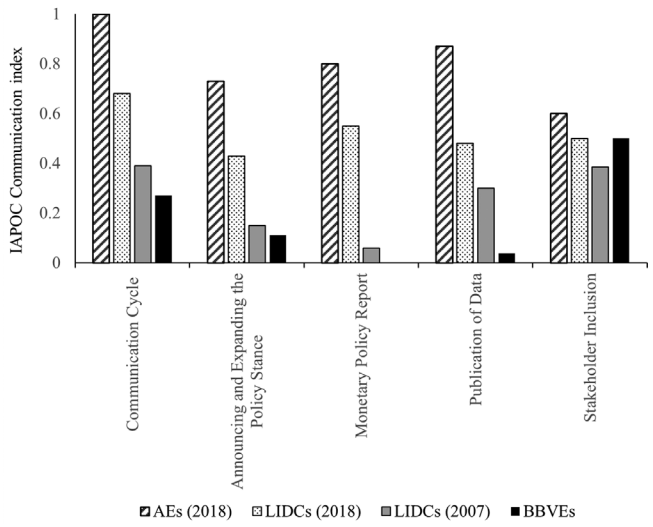

FIGURE 7 Comparison of the IAPOC communication index score for BBVEs to real economy groups: Advanced economies (AEs) in 2018, and low-income developing countries (LIDCs) for the years 2007 and 2018. Real-world economy results adapted from (Unsal et al., 2022).

and Explaining the Policy Stance' and 'Monetary Policy Report'.

4.2 | Text mining analysis

To obtain a quantitative representation of tokenomics communications that is more exploratory in character, we also apply a text mining analysis. For each of the six virtual worlds, we manually sift the corpus of communicated text to find tokenomics related information within the coordination domain. See Table A.3 in the Appendix for the referenced documents and resulting word count. The groundwork for any text mining analysis is converting the unstructured bodies of text into a structured matrix (Benchimol et al., 2022). Initially, we extract information relating to the coordination domain representing the underlying value, supply strategy, or incentive drivers of the projects' fungible tokens the project publications to form a corpus. Next, we clean the corpus from meaningless content and reduce inflected words to their base form, for example, *reward** for rewards, rewarding etc. Moreover, we remove the main subjects *token**, *tokenomics**, *money** and *monetary policy** from the corpus as they are dominant in visualizations yet do not provide additional information. The cleaned corpus is then used to create the document-term matrix.

Figure 8 shows the text mining results for the resulting sub-corpi of tokenomics communications in BBVEs and central bank communications.

Several insights stand out. Interestingly—and leaving aside obvious game related keywords such as *game** and *player**—the topic 'ownership' takes a prominent role in BBVE communication, as visible in the key placement of the terms *asset** and *land**. We find that rewarding users who interact with the BBVE is a frequently reiterated narrative in tokenomics communications through *reward**, *stake**, *distribut**, and *earn**. Additionally, topics concerned with governance can be seen to stand out in the word cloud through *DAO**, and *govern**. Promoting incentive drivers for stakeholders as listed in Figure 3, especially those of being rewarded, is thus central to BBVEs.

A comparison between the word cloud of BBVEs and that of central bank communications also displays which key terms are distinctly absent: *Inflat**, *target** and *stabil**. This finding underscores our previous argument that the monetary policy in BBVEs does not build upon reliable and valid concepts of either price stability or inflation.

Figures 9 and 10 display the results of a feature co-occurrence analysis that visualizes links between key terms. Quite obviously, the two groups of communicated texts cluster in two distinct main webs: the web of BBVE communications configures around assets and rewards, whereas central banks' communications revolve around inflation and stability. Also, they show themes related to monetary policy toolkits and objectives, such as *rate** and *target**.

In Figure 10, we further identify key terms that link the communications of BBVEs and the central banks. First and foremost, *economi** can be seen as the dominant link between both webs. This appears trivial however, as both communications stem from an economic context. More interestingly, secondary links between the webs are observed through key terms *suppli** and *exchang** related to monetary policy tools. Again however, there is a striking absence of links between both webs in key terms relating to policy goals, further underlining a key difference between the communications of tokenomics and real-world monetary policies.

5 | DISCUSSION

The previous analyses have studied the communication of tokenomics in BBVEs by two different empirical approaches—through both the application of the IAPOC metric and quantitative text mining—and compared the respective findings to those of real-world economies. They yield three main findings.

First, communication of tokenomics largely functions as a marketing tool targeting investors to purchase a BBVE's token. This interpretation is supported both by

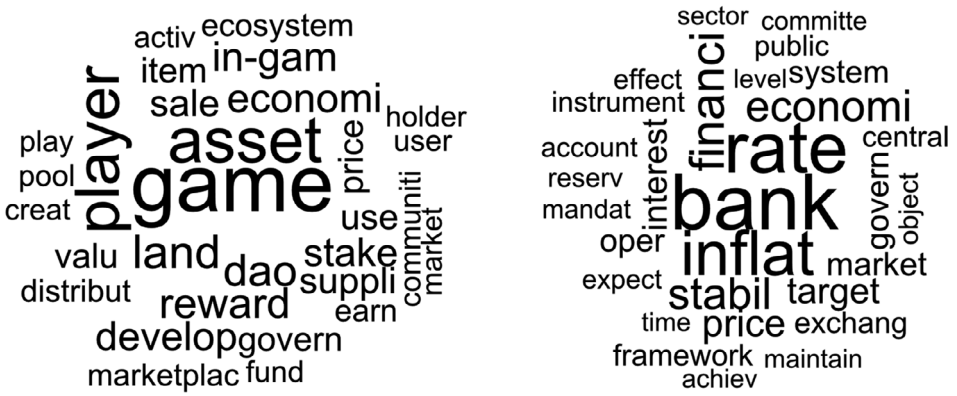

FIGURE 8 30 term word cloud results for the tokenomics communications of the six BBVEs (left), and for monetary policy communications for six central banks (right) across AE, EM, and LIDC economic groups.

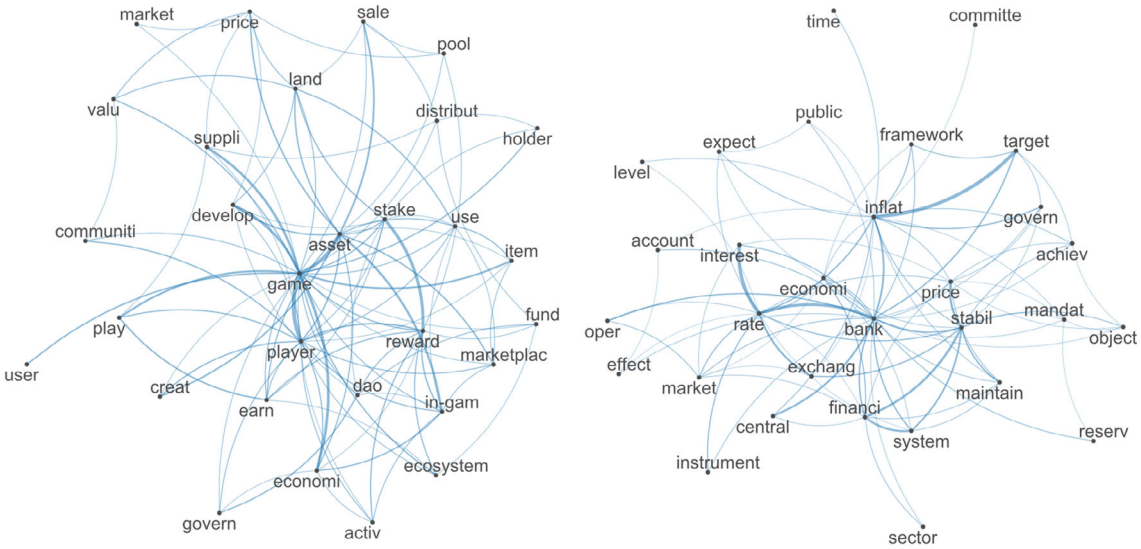

FIGURE 9 30-term *feature co-occurrence network plot* (Benoit et al., 2018) for BBVE communications (left) and for central bank communications (right) using a six word *window* variable. [Colour figure can be viewed at wileyonlinelibrary.com]

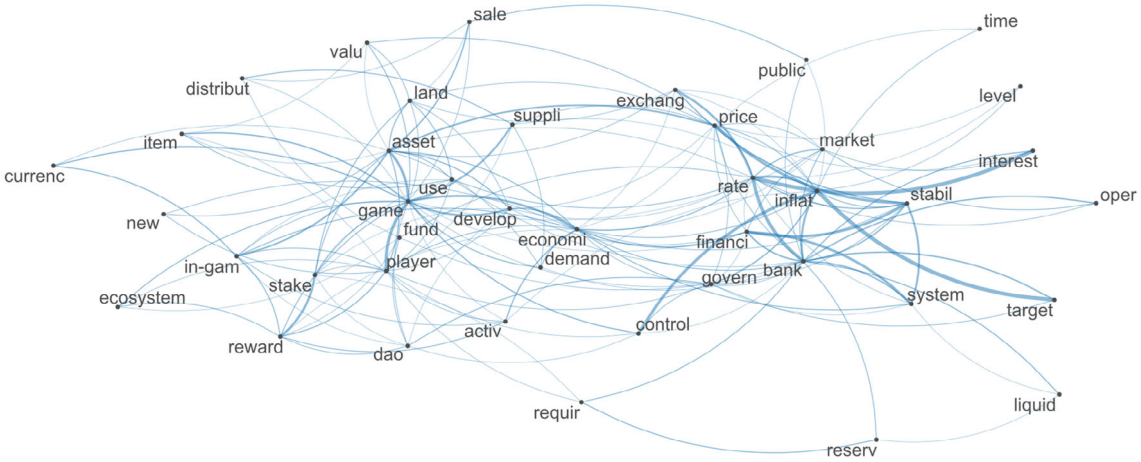

FIGURE 10 40-term *feature co-occurrence network plot* (Benoit et al., 2018) for combined corpus of BBVE and central bank communications using a six word *window* variable. [Colour figure can be viewed at wileyonlinelibrary.com]

results from the text mining analysis, which show that reward and incentive-focused terms are key to tokenomics communication, and by the IAPOC metric results, where all BBVEs display a relatively high score in the 'Stakeholder Inclusion' sub-pillar yet low scores for all others. The use of tokens as a fundraising vehicle seems to have a large influence on the communication patterns for BBVEs as significant portions of these were related to token sales and communication lessened following these events.

Second, none of the communications analysed for the BBVEs reflect on policy decisions or discuss policy outlook. The striking absence of numerical policy goals stems from the lack of crucial policy concepts such as inflation or price stability and negatively affects the standing of BBVEs from the perspective of the IAPOC metric analysis. Through the axioms consistency and coherence, numerical targets are a vital contributor for scoring well with regard to the sub-pillars 'Announcing and Explaining Policy Stance' as well as 'Monetary Policy Report'. As a consequence, BBVEs stand in strong contrast to real-world economies, where defined targets are understood to be an important tool in guiding policy (Friedman, 1990; Goodfriend, 2007). In this regard, BBVEs do not live up to the hopes and claims of their developers.

Third, the comparison of communication in BBVEs and early-stage LIDC countries suggests similarities between both. Keeping in mind that LIDCs have made substantial progress in the sub-pillar 'Monetary Policy Report' ever since, it remains to be seen whether the further development of BBVEs communication will yield an outcome that is more akin to real-world economies. This is especially true since the article at hand exhibits empirical shortcomings that arise out of the character of its main research subject. The first iterations of BBVEs have only emerged in the last 5 years, and the scale of current BBVEs in terms of market capitalization and participation still pales in comparison to real-world economies. BBVEs and their underlying policies and incentives are built upon emergent technologies, untested, and poorly understood within the field of digital economics. As such, our analysis has entered new territories, just as BBVEs do.

6 | CONCLUSION

By asking 'How are the structures, mechanisms, and policies of BBVEs communicated?' this article has analysed a central pillar of monetary policies in blockchain-based virtual economies (BBVEs). Whilst our results do not substantiate the common claim that BBVEs function just as their real-world counterparts, they provide in-depth insights into the nature and mechanics of these newly emerging technological landscapes. We are unable to identify neither explicit communication of monetary policy aims nor monetary policy communication which resembles real world examples of major central banks. These findings suggest that deficiencies in economic governance and monetary policy communication could be one reason for why tokens used in BBVEs cannot serve as reliable currencies, as observed by Vidal-Tomás (2023).

Building upon these insights, we conclude by delineating avenues for further research: First, this study has focused on the decision-makers' communication of tokenomics. Collecting qualitative information from end users and stakeholders of the BBVEs, regarding their expectations, motivations, and concerns, would be the natural next step. Second, the scope of this article is at large limited to the communications pillar defined by the IMF (Unsal et al., 2022). Further research could study BBVEs from the vantage point of the pillar 'Independence and Accountability' and thus focus on the governance and legal structures. Also, studying the 'Policy and Operational Strategy' pillar seems a promising avenue for further research. Finally, the future role of decentralized virtual currencies as a market-based alternative to government money in the real world remains uncertain. While it seems unlikely that the scale of BBVEs will rival nation states or government money as we know it, the influence of virtual worlds on the global economy may increase. Together with other technological advances, virtual worlds may foster more integrated markets and greater labor mobility. Across various industries, advances in virtual reality and robotics allow workers to operate independently from the physical location where goods and services are created. Thus, the governance of these virtual exchanges will also grow in importance. One potential scenario envisions competing virtual worlds with their respective currencies facilitating such exchanges. In our view, BBVEs provide researchers with a valuable testbed for exploring such scenarios.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in OSF at https://osf.io/xkn85.

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ENDNOTES

[1] The set of criteria relevant for the "Communications" pillar can be found in Unsal et al. (2022).

[2] Such token classification systems are not without limitations due to the blockchains nature as an emergent technology as well as due to the use of data sources that fall out of the commonly accepted sphere of scientific publications Oliveira et al. (2018).

[3] All documents and code can be found at https://osf.io/xkn85/.

[4] https://www.coingecko.com/en/categories and https://coinmarketcap.com/cryptocurrency-category/.

[5] https://medium.com/.

[6] https://etherscan.io/.

[7] https://www.coingecko.com/.

[8] https://discord.com/.

[9] https://x.com/, formerly known as Twitter.

[10] See Castronova (2005) for an assessment of inflation within closed virtual economies.

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APPENDIX A

TABLE A.1 Different economic groups for real economies and for the sample of blockchain-based virtual economies.

Advanced economies (AEs)	Emerging market economies (EMs)		Low-income developing countries (LIDCs)	Blockchain based virtual economies (BBVEs)
Australia	**Argentina**	**Mauritius**	**Ghana**	**Axie infinity**
Canada	Armenia	Mexico	Kenya	Decentraland
Czech Republic	Brazil	Pakistan	Kyrgyz Republic	Illuvium
Euro Area	Chile	Peru	Malawi	My Neighbor Alice
Iceland	China	Philippines	Moldova	Sandbox
Israel	Colombia	Poland	Mozambique	Star Atlas
Japan	Georgia	Russia	Nigeria	
Korea	Hungary	Serbia	Rwanda	
New Zealand	India	South Africa	Tanzania	
Norway	Indonesia	Thailand	Uganda	
Sweden	Jamaica	Turkey	Zambia	
United Kingdom	Kazakhstan	Ukraine		
United States	Malaysia	Uruguay		

TABLE A.2 Project summaries based on whitepapers.

Axie Infinity is a '...universe filled with fierce, collectible creatures called *Axies*' (Axie Infinity, 2021a, p. 1) where players can battle, breed, and trade NFT *Axies* as part of an '...open-ended digital pet universe' (Axie Infinity, 2021e, p. 1). Its BBVE is built using a two fungible token system. The first token, $AXS, has three main utilities: Governance, staking, and payment (Axie Infinity, 2021c) and was used as a major fundraising vehicle (Binance, 2020). The second token, $SLP, represents reward emissions for in-game battles and is required for breeding new Axies. The developing company Sky Mavis also acts as a policymaker for the BBVE, though it communicates an openness to implement a DAO governance structure (Axie Infinity, 2021d).
Decentraland is a '...decentralized virtual reality platform powered by the Ethereum blockchain' (Decentraland, 2017b, p. 1), where users can '...create, experience, and monetise content and applications' (ibid.). Its fungible token $MANA functions as a governance token and as a de facto currency to purchase virtual land, goods, and services (Decentraland, 2017b). 40% of the initial token supply was distributed through a crowdfunding sale (Decentraland, 2017a). Policymaking is implemented by a DAO system, in which current proposals and voting mechanisms are communicated through the DAOs website dashboard (Decentraland DAO, 2023).
Illuvium is a '...series of fully decentralized RPG [role-playing games] and collection games set in a fragmented world of beauty and wonder' (Illuvium, 2023c, p. 1), where users can '...explore the vast landscape, hunt dangerous creatures, and capture them for battles in the Arenas or trade on the exchange' (ibid.). Its fungible token, $ILV, is incentivized through governance participation, staking, and revenue sharing (Illuvium, 2022a). *Illuvium* fundraised through private and public sales (Illuvium, 2023d) totaling 30% of the total supply, with increasing prices in each round. Policy can be proposed and voted on by the *Illuvium* main council, where council members are elected by *stakers* of $ILV through a DAO structure (Illuvium, 2023a).
The virtual world of *My Neighbor Alice* is a complex of large islands where players '...can buy and own virtual islands, collect and build exciting items and meet new friends' (My Neighbor Alice, 2021, p. 5) and are 'able to design and decorate their property to make it as unique and special as they want' (My Neighbor Alice, 2021, p. 6). The $ALICE fungible token has the incentives of staking, decentralized governance, and use as an in-game de facto currency. Also, it was used as a fundraising vehicle through private and public token sales (My Neighbor Alice, 2021). The game developers are also interpreted as policymakers for the token. However, *My Neighbor Alice* also plans to implement a DAO structure for token holders (ibid.).
Sandbox is a '...virtual world where players can build, own, and monetise their gaming experiences' (Sandbox, 2020, p. 1). Players may own virtual land, wearables, and other assets in the form of NFTs, which may be traded or utilized. Its fungible token is $SAND, with incentives described through governance, staking, and as an exchangeable means of payment. A third of the total supply was sold both privately and publicly as an initial fundraising mechanism. Although the whitepaper states an intention to shift governance elements to a DAO, policy decisions for the BBVE are essentially at the discretion of the *Sandbox* organization (ibid.).

(Continues)

TABLE A.2 (Continued)

Star Atlas is a '...virtual gaming metaverse' (Star Atlas, 2021b, p. 4) set within an '...intergalactic conflict' (ibid.) where players can influence an '...ongoing struggle for resources, territorial conquest, and political domination' (ibid.). *Star Atlas* has two fungible tokens: $POLIS, which is used with the primary incentive of governance, and $ATLAS, which is a de facto currency for goods and services (Star Atlas, 2021a). Both currencies have staking incentives, and were used in fundraising, in which 26% of the total supply for both tokens was sold both privately and publicly (Star Atlas, 2021a). Decision making for *Star Atlas* takes place in three progressive phases (Star Atlas, 2021a). In the first, the development team directly adjusts the token emission rates. In the second, DAO voters may propose and decide changes in monetary policy. In the third, monetary policy tools are controlled by an automated algorithm, although DAO members may vote to adjust algorithm parameters.

TABLE A.3 Sample of real-world and virtual economies and the document attributes for the text mining analysis.

Economy	Category	Text origin and citation	Document type	Word count of analysed text
Axie infinity	Virtual	Whitepaper tokenomics (Axie Infinity, 2021b)	Gitbook	1615
Decentraland	Virtual	Tokenomics (Decentraland, 2017a, 2017b)	PDF download	856
Sandbox	Virtual	Whitepaper tokenomics (Sandbox, 2020)	PDF download	1092
Star Atlas	Virtual	Whitepaper tokenomics (Star Atlas, 2021a, 2021b)	PDF download	1681
My Neighbour Alice	Virtual	Whitepaper tokenomics (My Neighbor Alice, 2021)	PDF download	1574
Illuvium	Virtual	Whitepaper tokenomics (Illuvium, 2023c)	Gitbook	1197
The United States of America	Real-world AE	Conduct of monetary policy statement (FOMC, 2012)	PDF download	1091
Euro area	Real-world AE	Monetary policy strategy statement (ECB, 2021)	Website	1490
Argentina	Real-world EM	Monetary policy Guidelines (BCRA, 2022)	Website	1120
Indonesia	Real-world EM	Monetary policy functionality (Bank Indonesia, 2023)	Website	2573
Ghana	Real-world LIDC	Monetary policy framework (Bank of Ghana, 2023)	Website	1811
Nigeria	Real-world LIDC	Monetary policy measures (CBN, 2023)	Website	1010