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Advances in Blockchain and Crypto Economics

Bruno Biais,[a,*] Agostino Capponi,[b,*] Lin William Cong,[c,d,*] Vishal Gaur,[c,*] Kay Giesecke[e,*]

[a] HEC Paris, 78350 Jouy-en-Josas, France; [b] Columbia University, New York, New York 10027; [c] Cornell University, Ithaca, New York 14850; [d] National Bureau of Economic Research, Cambridge, Massachusetts 02138; [e] Stanford University, Stanford, California 94305

*Corresponding authors

Contact: biaisb@hec.fr (BB); ac3827@columbia.edu (AC); will.cong@cornell.edu (LWC); vg77@cornell.edu (VG); giesecke@stanford.edu (KG)

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Abstract. Over the past decade, blockchains and cryptocurrencies have taken a central stage in financial technology (FinTech) innovation. In 2020–2021, as the academic finance and management community began actively investigating this domain, we issued a call for papers for a special issue to encourage interdisciplinary research in this emerging area. This section of *Management Science* presents the first systematic collection of knowledge, both theoretical and empirical, focusing on blockchain economics, crypto assets, decentralized finance, and Web3 ecosystems. We describe the editorial protocol employed for this special issue (now included in this volume as a special section), summarize what we learn about the field, and introduce the 15 articles included in the special section. We also offer several observations to highlight foundational issues in the new field and to guide future research in this exciting new area at the intersection of technology and finance.

Keywords: Blockchain • DeFi • Web3 • cryptography • consensus • Digital assets • FinTech

1. Introduction

The emergence of blockchain technology and crypto assets represents a major innovation in economic infrastructure with implications for financial markets, platforms, and beyond. The decentralized consensus mechanisms introduced by Bitcoin (BTC) and permissionless blockchains fundamentally change how participants can store and transfer value without centralized intermediaries. The new technological possibilities have led to an explosion of experimentation and applications in (crypto) centralized finance (CeFi), decentralized finance (DeFi), and the nascent version of Web3.

However, many design choices and economic properties are relegated to the backseat in computer science and engineering studies and, in general, remain poorly understood. Critical debates continue regarding the viability, risks, and social value of crypto-based systems. As the technology matures amid periods of intense volatility, rigorous academic research into the incentive structures, platform economics, and welfare consequences of blockchain and crypto systems has become indispensable. This section of the issue (henceforth referred to as the special section) marks an initial volume of high-quality interdisciplinary research on blockchain and cryptoeconomics. The compendium of 15 articles within employ both theoretical and empirical methodologies to elucidate core economic mechanisms underlying cryptocurrencies, mining, payments, crowdfunding, information aggregation, governance, privacy-preserving computation, and more. Collectively, they provide foundational insights into this nascent field, further enhancing our comprehension of critical aspects, including consensus protocols, token incentives, platform fragility, wash trading, and decentralized exchange (DEX) design. The studies also point toward open questions and new research directions needed as blockchain technology continues evolving.

This special section as a product of the special issue call for papers is the first one from a leading economics/finance/management science journal that focuses on blockchain and cryptoeconomics research. The call for papers received overwhelming responses, and all 15 articles included went through an extremely rigorous and competitive selection process. Even as working papers, they have been widely circulated and presented and have already generated about 900 citations as of the publication of this editorial, averaging about 60 citations per paper.

By collecting groundbreaking works employing the lens of economics, this special section signifies the emergence of blockchain and crypto research as an important subfield. The novel problems posed by cryptosystems offer opportunities to both test existing theories and derive new theoretical insights. As economies worldwide experiment with integrating blockchain-based payment rails and financial infrastructure, such academic research will remain essential for informed policy and technology design, as well as for adding fundamental

insights and knowledge to the economics and management literature.

In what follows, we describe the contributions contained in this volume briefly in an effort to guide the reader through this exciting new area of exploration and to facilitate further studies. In addition, we highlight several promising avenues of research for economists and management science scholars.

2. The Special Section and CBER Dual Submissions

A public online call for paper submissions for the special section was first distributed widely in late 2020 and then appeared in a *Management Science* issue in January 2021 (Biais et al. 2021), with an initial submission deadline in May 2021. Papers can also be submitted through a dual submission process at the inaugural Crypto and Blockchain Economics Research (CBER) Forum Annual Conference. The conference was hosted on April 16–17, 2021, by Cornell University and the University of Toronto in collaboration with *Management Science*, FinTech at Cornell, which is an Initiative of the SC Johnson College of Business, and the Rotman School of Management's FinHub.

The special section received 107 direct submissions. Furthermore, 59 articles, representing 35% of the total submissions, were concurrently submitted to the CBER conference. The significant number of submissions confirmed our perception, as the collaborating editors, of the vibrant new research activity that was taking place on these topics in the blockchain/crypto/DeFi community.[1] The organizers for the inaugural CBER conference were Maureen O'Hara, Andreas Park, Julien Prat, Fahad Saleh, and Gerry Tsoukalas. They assembled a 25-person program committee of renowned scholars in economics and FinTech research. After a prescreening for thematic relevance and quality, more than 40 papers were sent out for review, including dually submitted papers. Authors of any submitted paper are fully excluded from the review or selection of the paper for the conference or for dual submissions to avoid conflict of interest. The final conference program contained two keynote talks by Campbell Harvey and Elaine Shi and eight papers (seven of which were dually submitted to the special section). Based on program reviews and the special issue editors' own reading, six dually submitted papers were invited to proceed to the next review stage at the journal for what we believed could be an impactful special volume. All papers went through the regular review process. In the end, four of the dually submitted papers found their way into this special section.

In addition, we invited to the special section two more papers from the regular submission flow for the journal because of their thematic relevance and fit. Both were already accepted under the regular submission review at the time of invitation. In total, the special section contains 15 articles authored by researchers from a diverse set of universities and research institutions.

3. The Initial Body of Knowledge: What Is Included in This Issue?

3.1. The Economics Underlying the Challenges of the Crypto Sector

With the spectacular collapses of Terra-Luna, FTX, etc., in 2022 and recent regulatory litigation against Binance, Coinbase, etc., the crypto sector is under tremendous stress and public scrutiny. The challenges are often economic rather than technical. For example, many core issues surrounding the development of blockchain platforms and Web3 applications entail centralization versus decentralization. Yet decentralization is a technical possibility with distributed ledger technology, but it may not manifest in an economic equilibrium. CeFi players, especially centralized crypto exchanges, have witnessed exponential growth and thus far dominated the crypto sector, with many economic forces potentially leading to vertical integration and centralization. This not only defies the philosophy of blockchains as a form of decentralized consensus but also causes market manipulation. Given the gravity of the issues, the first part of the special section features three articles that shed light on the underlying economics well before the attention-grabbing developments in the industry over the past two years.

1. "Crypto Wash Trading"—Cong et al. (2023c).

Cong et al. (2023c) lead off the volume by rigorously documenting the rampant phenomenon of wash trading on centralized crypto exchanges for the first time. Specifically, the authors present a systematic approach to detect fake transactions by exploiting robust statistical and behavioral regularities associated with authentic trading. The sample consists of 29 centralized exchanges, among which the regulated ones feature transaction patterns consistently observed in financial markets and nature. In contrast, unregulated exchanges display abnormal first-significant-digit distributions, size rounding, and transaction tail distributions, indicating widespread manipulation unlikely driven by specific trading strategy or exchange heterogeneity. The authors then quantify the wash trading on each unregulated exchange, which averaged over 70% of the reported volume. These fabricated volumes (trillions of dollars annually) improve exchange ranking, temporarily distort prices, and relate to exchange characteristics, market conditions, and regulation. The study not only spurred further discussion on crypto wash trading (e.g., Aloosh and Li 2019, Amiram et al. 2022) and market manipulation in general but has also served as an academic basis for regulatory litigations against multiple crypto exchanges. More importantly, the study warned,

even before the beginning of 2020, against possible market manipulations by CeFi entities with concentrated power and limited regulation or disclosure requirements, issues that later manifested in the FTX collapse.

2. "Proof-of-Work Cryptocurrencies: Does Mining Technology Undermine Decentralization?"—Capponi et al. (2023b).

The decentralized consensus process in blockchain may have unintended consequences and be prone to market concentration. For example, the rise of mining pools raised concerns about mining concentration, which can harm network security. However, Cong et al. (2021a) dispel the myth that mining pools lead to horizontal market concentration and instead point to pools intensifying the mining arms race and exacerbating environmental damages. Capponi et al. (2023b) take a step further to incorporate miners' investment in hardware to improve the efficiency of their operations and then compete for mining rewards in a rent-seeking game. This is an important consideration given that a significant share of mining rewards was invested in mining equipment (Prat and Walter 2021). The authors show that centralization grows with heterogeneity in mining costs, but hardware capacity constraints prevent the most efficient miners from monopolizing the mining process. Investment leads to a more decentralized network unless larger miners have a significant comparative advantage in acquiring new hardware. The model not only deepens our comprehension of the industrial organizational structure within the mining industry but also generates empirically supported implications. First, mining centralization is countercyclical with respect to mining reward. Second, a change in the mining reward leads to a less-than-proportional change in the hash rates. Notably, the first result suggests that if the market capitalization of a coin decreases, mining is likely to become increasingly centralized, meaning that a "rich getting richer" phenomenon is more likely to occur. This is where proof-of-stake (PoS) protocols may have an additional edge over proof of work (PoW).

3. "Why Fixed Costs Matter for Proof-of-Work–Based Cryptocurrencies"—Garratt and van Oordt (2023).

In a related study, Garratt and van Oordt (2023) explore a novel channel for fixed mining costs to matter for PoW-based cryptocurrencies—the impact of the type of mining hardware on the feasibility of profitable double-spending attacks. The authors assess how the cost structure of cryptocurrency mining affects the response of miners to exchange rate fluctuations and the immutability of cryptocurrency ledgers that rely on PoW. The authors show that the amount of mining power supplied to currencies that rely on specialized hardware, such as Bitcoin, responds less to adverse exchange rate shocks than other currencies respond to such shocks, a fact that is instrumental to avoiding double-spending attacks. The results may change if mining equipment used for one cryptocurrency can be transferred to another. For smaller currencies with low exchange rate correlation, transferability eliminates the protection that fixed costs provide. The results weaken doomsday predictions for Bitcoin and other cryptocurrencies with declining block rewards. Together with Capponi et al. (2023b), the two articles also add to our understanding of how hardware production and investment matter in the process of generating decentralized consensus in blockchain networks.

3.2. Fee Mechanisms, Blockchain Scalability, and Smart Contracts

Even absent the various challenges related to centralization, lack of regulation, and mining attacks, blockchain systems still face several design challenges in maintaining their decentralized structure while achieving scalability. To start, without a centralized entity to price products and services, it is unclear what type of fee mechanism a distributed network should adopt to ensure long-term sustainability. Scaling blockchains and smart contracts is a well-known bottleneck in the industry. Moreover, the economic impact of blockchains and smart contracts is also largely unknown. The next three articles in the special section contribute to filling these knowledge gaps.

4. "StableFees: A Predictable Fee Market for Cryptocurrencies"—Basu et al. (2023).

Adding to the literature on transaction fees in blockchain-based networks (e.g., Easley et al. 2019, Cong et al. 2023e), Basu et al. (2023) point out that blockchain-based cryptocurrencies must solve the problem of assigning priorities to competing transactions. The most widely used mechanism involves each transaction offering a fee to be paid once the transaction is processed, but this discriminatory price mechanism fails to yield stable equilibria with predictable prices. The authors propose an alternate fee-setting mechanism, StableFees, that is inspired by second-price auctions and based on uniform-price auctions. They prove that the proposed protocol is free from manipulation by users and miners as the number of users and miners increases and show empirically that gains from manipulation are small in practice. They also show that StableFees reduces the fees paid by users and reduces the variance of fee income to miners. Data from December 2017 show that, if implemented, StableFees could have saved Bitcoin users $272,528,000 in transaction fees while reducing the variance of miner's fee income, on average, by a factor of 7.4. They therefore argue that their fee protocol also has important social welfare and environmental benefits. Whereas the presence of maximal extractable value (known initially as "miner extractable value," see, e.g., Daian et al. 2019) is not the focus of the article, it may complicate the

issues and therefore calls for future research building from this study to investigate further the design of fee mechanisms in distributed networks. Fee mechanisms also form an integral part of any discussions of consensus protocols, as the next article focuses on.

5. "Scaling Blockchains: Can Committee-Based Consensus Help?"—Benhaim et al. (2023a).

Another foundational element in distributed ledger systems is the consensus protocol. Previous studies have examined how decentralized consensus is generated under PoW and PoS (see, e.g., Biais et al. 2019, Saleh 2021). The high-stakes race for scalability has led practitioners to explore various scaling solutions for blockchains and smart contracting. Benhaim et al. (2023a) examine the committee-based consensus (CBC), whereby the chain's record-keeping rights are entrusted to a committee of block producers, elected via approval voting. Following the convention from computer science, block producers in the study are nonstrategic and have unknown types, either "honest" or "malicious." But the authors analyze the strategic behaviors of the voters. The authors find that smaller committees boost speed and scalability but can compromise security when voters have limited information. In this environment, voting strategies are naturally nonlinear, and equilibria can become intractable. Despite these hurdles, the authors show that elections converge to optimality asymptotically (in voter numbers), exponentially quickly, and under relatively weak informational requirements. Compared with popular stake-weighted lottery and single-vote protocols used in practice, they find that CBC, when paired with approval voting, can offer meaningful efficiency and robustness gains if enough voters are engaged.

6. "Can Blockchain Technology Help Overcome Contractual Incompleteness? Evidence from State Laws"—Chen et al. (2023b).

Real-world contracts are often incomplete, leading to suboptimal investment and loss of value in supply chain relationships. Blockchains and smart contracts are purported to enlarge contracting space and mitigate holdup problems (e.g., Cong and He 2019). Assuming that smart contracts are scalable, Chen et al. (2023b) investigate how the technology affects contract incompleteness. Specifically, the authors empirically examine the extent blockchains help alleviate problems by exploiting a quasi-natural experiment based on the staggered adoption of U.S. state laws that increased firms' in-state ability to develop, adopt, and use blockchain technology. The authors find that, after exposure to a pro-blockchain law, firms with greater asset specificity exhibit more positive changes to Tobin's Q, R&D, and blockchain-related innovation. Also, such firms appear to rely less on vertical integration, form more strategic alliances, and shift their emphasis to less geographically proximate customers. The findings suggest that blockchain technology can help firms mitigate constraints and inefficiencies arising from contractual incompleteness. Not only does the article relate blockchain technology to contract incompleteness—a core issue in finance—but it highlights blockchains as a distributed ledger independent of cryptocurrencies or native tokens, with anticipated real value to business operations. The findings suggest that blockchain technology provides a new, lower-cost alternative to vertical integration for solving the holdup problem in incomplete contracting.

3.3. Tokenomics: Entrepreneurial Finance, Governance, and Platform Fragility

"Tokenomics"—the economics of using and valuing (crypto-)tokens—was first coined in the 2018 working paper by Cong et al. (2021b) and initially developed in Gans and Halaburda (2015), Pagnotta and Buraschi (2018), Tsoukalas and Falk (2020), Cong et al. (2021b), Li and Mann (2021), Cong et al. (2022b), Sockin and Xiong (2023b), etc. It has since expanded into a fast-emerging literature, both theoretical and empirical, examining various types of cryptocurrencies and functionalities. Digital platforms grapple with core decisions of raising capital for their development and monetizing future services. Many blockchain-based platforms have native tokens that offer alternatives to the conventional issuance of convertible securities or equities (for financing) and fees or commission contracts (for monetization). The next six articles in the special section discuss the use of tokens for entrepreneurial finance, token-related stability issues, and platform governance.

7. "Tokenomics: When Tokens Beat Equity"—Malinova and Park (2023).

In a token offering, investors fund a venture in exchange for tokens that grant rights to future economic output. To many financial industry insiders, tokens have no intrinsic merit and exist only as a way to evade regulations. Malinova and Park (2023) demonstrate that generic revenue-based token contracts are indeed economically inferior to equity and lead to over- or underproduction. However, an optimally designed token contract, which is a combination of an output presale and an incremental revenue-sharing agreement, yields the same payoffs as equity and debt. Moreover, with entrepreneurial moral hazard, tokens can finance a strictly larger set of ventures than equity. The article adds to both the literature examining token financing within a traditional corporate finance framework, where an entrepreneur delivers a product or service at a per-unit cost (first studied by, e.g., Chod and Lyandres 2021, Gan et al. 2021) and models of blockchain-native projects that study the relationship between token financing and product platform building (Catalini and Gans 2018 is an early example). It

complements recent studies such as Davydiuk et al. (2023), Gan et al. (2023), and Shakhnov and Zaccaria (2023) that are also included in this special section.

8. "De-Crypto-ing Signals in Initial Coin Offerings: Evidence of Rational Token Retention"—Davydiuk et al. (2023).

Not only are initial coin offerings (ICOs) tied to asset tokenization (Gan et al. 2021) but the use of tokens to finance startup projects also provides an excellent setting to test mainstream economic theory. Using the market for as a laboratory, Davydiuk et al. (2023) provide evidence that entrepreneurs use retention to alleviate information asymmetry. The underlying technology and the absence of regulation make the ICO market well suited to study this question empirically. Using a hand-collected data set, which is one of the most comprehensive on ICOs, the authors show that ICO issuers that retain a larger fraction of their tokens are more successful in their funding efforts and are more likely to develop a working product. Moreover, they find that retention is a stronger signal when markets are crowded and investors do not have as much time to conduct due diligence. The study thus enriches our understanding of information economics and signaling theory in general.

9. "Utility Tokens, Network Effects, and Pricing Power"—Shakhnov and Zaccaria (2023).

A defining feature of blockchain-based fundraising is the commitment the technology brings about. Shakhnov and Zaccaria (2023) examine digital product markets where consumers are heterogeneous in their propensity to actively interact with other users, and valuations increase with the share of active users (e.g., social network platforms). The authors propose a model where entrepreneurs can issue digital claims (tokens) to promise exclusive access to benefits that specifically enhance the utility of active users. This allows entrepreneurs to extract consumer surplus through price discrimination. Because there is an incentive to renege on the "exclusivity" promise ex-post and expand the network of active users, the credibility of this commitment resides in a costly technology (blockchain) that embeds automatic contracts in the tokens sold and limits entrepreneurial discretion. The authors show that the profitability of token-based sales increases with entrepreneurial ability and with the intensity of network effects.

10. "Conflicted Analysts and Initial Coin Offerings"—Barth et al. (2023).

Another hallmark of token-based crowdfunding is the involvement of retail investors and users. Because of their lack of financial sophistication and knowledge, the role of financial analysts proves crucial. Barth et al. (2023) study the contribution of analysts to the functioning and failure of the market for ICOs. The authors find that the assessments of freelancing analysts exhibit biases because of reciprocal interactions of analysts with ICO team members. Even favorably rated ICOs tend to fail to raise some capital when a greater portion of their ratings reciprocate prior ratings. Ninety days after listing on an exchange, the market capitalization relative to the initial funds raised is smaller for tokens with more reciprocal ratings. These findings suggest that conflicts of interest help explain the failure of ICOs and likely have led to the dwindling of the market.

11. "Decentralized Platforms: Governance, Tokenomics, and ICO Design"—Gan et al. (2023).

The inherent coupling between financing (investors) and revenue generation (users) has been a defining characteristic of blockchain-based and token-based platforms (Cong et al. 2021b, Lee and Parlour 2022). But earlier studies have not explored the effectiveness of tokens compared with more traditional commission contracts in monetizing decentralized platforms from the issuers' perspective. Gan et al. (2023) fill in the gap by theoretically studying (i) how to choose the right lever to overcome moral hazard (sales commission, token retention, or both), and (ii) how to choose the right design of the ICO (capped or uncapped). The authors show that compared with platform commission, token retention cedes a fraction of issuer profits to service providers but cannot replicate revenue sharing with service providers. They found that either token retention or platform commission can overcome the moral hazard issue to enable initial financing. Whenever both are viable, the commission dominates token retention in terms of profits, but token retention, in some cases, is the only mechanism averting a financing market breakdown. Moreover, retention can not only lead to higher profits for platform designers in some markets but can also ensure higher service provider profits and service levels and attract more customers, making token retention more aligned with the tenets of decentralized governance. The authors also prove a practical result that as long as the issuer maintains enough levers to (indirectly) control the number of tokens purchased by speculators, ICO caps are redundant in either of the governance mechanisms.

12. "A Model of Cryptocurrencies"—Sockin and Xiong (2023a).

Sockin and Xiong (2023a) model cryptocurrencies as utility tokens used by a decentralized digital platform to facilitate transactions between users of certain goods or services. The network effect governing user participation, in conjunction with the nonneutrality of the token price, can cause the token market to break down. The authors show that token retradeability mitigates this risk of breakdown on younger platforms by harnessing user optimism but worsens this fragility when sentiment trading by speculators crowds out users. Elastic token issuance mitigates this fragility, but strategic attacks by miners exacerbate it because users' anticipation of future

losses depresses the token's resale value. Once again, the article highlights the hybrid nature of tokens for both usage and investment/speculation.

3.4. CeFi, DeFi, and Crypto Innovations

Although some current forms of CeFi have caused concerns, better designs of CeFi may still be sustainable in decentralized networks. Other than crypto exchanges, central bank digital currencies (CBDCs) constitute probably the most active and exciting CeFi development (e.g., Auer et al. 2022), whereas stablecoins and decentralized exchanges are the most salient DeFi applications. The last three articles in the special section touch on these topics, especially on how CeFi, DeFi, and crypto product innovations evolve and what economic insights one derives.

13. "Central Bank Digital Currency and Banking: Macroeconomic Benefits of a Cash-Like Design"—Chiu and Davoodalhosseini (2023).

Many central banks are considering issuing a CBDC. How will the CBDC affect the macroeconomy? Will its design matter? To answer these questions, Chiu and Davoodalhosseini (2023) theoretically and quantitatively assess the effects of a CBDC on consumption, banking, and welfare. Their model captures the competition between different means of payments and incorporates a novel general equilibrium feedback effect from transactions to deposit creation. The general equilibrium effects of a CBDC are decomposed into three channels: payment efficiency, price effects, and bank funding costs. The authors show that a cash-like CBDC is more effective than a deposit-like CBDC in promoting consumption and welfare. Interestingly, a cash-like CBDC can also crowd in banking, even in the absence of bank market power. In a calibrated model, at the maximum, a cash-like CBDC can increase bank intermediation by 10.2% and welfare by 0.059% and capture up to 23.3% of the payment market. In other words, the concern that a CBDC could crowd out banking is not warranted when an appropriate design is adopted. The authors also discuss some lessons for designing a CBDC.

14. "The Conceptual Flaws of Decentralized Automated Market Making"—Park (2023).

Decentralized exchanges are an essential component of the nascent decentralized finance ecosystem. The most common DEXs are so-called automated market makers (AMMs), smart contracts that pool liquidity and process trades as atomic swaps of tokens, which have recently spurred active discussion among economists (e.g., Lehar and Parlour 2021, Capponi and Jia 2021, Capponi et al. 2023a). Park (2023) highlights that AMMs price transactions with a deterministic liquidity invariance rule with no precedent in traditional finance (TradiFi). Yet in the context of transparent and open blockchain operations, any liquidity invariance pricing function allows so-called sandwich attacks (akin to front-running) that increase the cost of trading and threaten the long-term viability of the DeFi ecosystem. Invariance pricing is also not regret free. Linear pricing rules have similar problems, except for uniform pricing, which has regret-free prices and limits sandwich attack profits, but which invites excessive order splitting. Comparing trading costs using a model of liquidity provision, constant product pricing is often cheaper except when the variance of the underlying asset is small or when the order is large. The article serves as a foundational piece that informs future designs of AMMs.

15. "The Impact of Derivatives on Spot Markets: Evidence from the Introduction of Bitcoin Futures Contracts"—Augustin et al. (2023).

Finally, the blockchain and crypto sector may allow researchers to develop better understanding of the economic effect of financial innovation that is difficult to examine in TradiFi. Augustin et al. (2023) recognize that cryptocurrencies provide a unique opportunity to identify how derivatives impact spot markets. They are fully fungible, they trade across multiple spot exchanges at different prices, and futures contracts were selectively introduced on Bitcoin exchange rates against the U.S. dollar (USD) in December 2017. Following the futures introduction, the authors find a significantly greater increase in cross-exchange price synchronicity for BTC-USD relative to other exchange rate pairs, as demonstrated by an increase in price correlations and a reduction in arbitrage opportunities and volatility. They also find support for an increase in price efficiency, market quality, and liquidity. The evidence suggests that futures contracts allowed investors to circumvent trading frictions associated with short sale constraints, arbitrage risk associated with block confirmation time, and market segmentation. Overall, the analysis supports the view that the introduction of BTC-USD futures was beneficial to the Bitcoin spot market by making the underlying prices more informative.

4. Taking Stock and Looking Ahead

Whereas the articles assembled in the special section constitute a foundational body of knowledge in the field, research on blockchain and cryptoeconomics is highly interdisciplinary and fast evolving. As such, based on our observations and accumulated knowledge, we identify several promising directions that expand the current literature and further advance the frontiers of research. More importantly, we hope to highlight that economists and management science researchers have integral roles to play in blockchain and crypto research, alongside computer scientists, engineers, and data scientists.

4.1. Blockchain Forensics, Cyber Security, and Regulation

FinTech poses many challenges to the regulation of the financial system. One immediate challenge is how to regulate new blockchain-based (CeFi and DeFi) entities relative to traditional financial institutions. Although some countries have made progress, the reality is that crypto regulation is still ambiguous or lacking in most parts of the world. Some argue that it is desirable to try to regulate based on activities, and not on entities, to level the playing field and to make sure various entities engaged in similar activities are treated equally by regulation. Others propose to eliminate the sector entirely. No matter what, as regulators around the world engage themselves fighting crypto market manipulation and cybercrimes, and with a range of other regulatory initiatives on the way, two areas of research start to appear extremely useful. The first is to develop statistical analysis and blockchain forensic tools to detect and combat the dark side of the sector and ensure market integrity. Research on forensic accounting and finance has proven to be useful in TradiFi and continues being useful in CeFi and DeFi (Foley et al. 2019, Cong et al. 2023a, Griffin and Kruger 2023), especially concerning crypto-related cybercrimes and market manipulations. The second is the understanding the economic incentives to anticipate equilibrium outcomes and prove "intent" in various regulatory processes, to which many of the articles in this issue contribute. More broadly, rigorous economic research is warranted for informing governments and assisting regulators to establish clear frameworks that protect investors and consumers from fraud and criminal activity without becoming so overbearing that they stifle innovation.

4.2. Designing Distributed Systems

By taking various protocol designs as given, researchers have been analyzing the various equilibrium outcomes in blockchain-based networks (e.g., Halaburda et al. 2022, Amoussou-Guenou et al. 2023). But, increasingly, one recognizes that these designs could be ad hoc and suboptimal. Therefore, mechanism design and information design in blockchain and Web3 protocols constitute areas that economists can make unique contributions. Tokenomics design, which requires the knowledge of monetary economics, asset pricing, and corporate finance, is equally important. Exploring the various system designs can help elicit information from users (for crowdsourcing and voting, etc.; see, for example, Benhaim et al. 2023b), improve information recording (e.g., consensus mechanisms), incentivize/coordinate users' contribution, and raise capital (e.g., through ICOs).

4.3. Balance Between Centralization and Decentralization

Decentralization is no free lunch and is not equivalent to permission-less blockchains (Bakos et al. 2021). Decentralizing for the sake of decentralization is a topic for ideologists and extreme enthusiasts. As economists, we should consider the tradeoffs involved. If blockchain and crypto adoption are to scale, they need the same kind of dependable, scalable infrastructure as the internet so they can be used for most economic activities. A likely outcome of the coevolution of CeFi, DeFi, and TradiFi is that an optimal and sustainable network combines elements from all of them. As such, the discussion on how to overcome the blockchain scalability challenges (e.g., Buterin 2017, Abadi and Brunnermeier 2022) through local centralization continues to be important. For example, developers are actively working on these issues, including Layer-2 solutions, and more studies to develop an economic understanding of them are warranted (e.g., Guasoni et al. 2021, Cong et al. 2023b). Moreover, formal attempts to introduce Web3 reputation beyond heuristic discussions (Weyl et al. 2022, Tong 2023) remain a promising area in which economists can make unique contributions, given the vast academic literature on rating, reputation, and contracting. Blockchains that enable confidential AMM-based DEXs solving the issue of various attacks (e.g., sandwich attack) also require further economic analyses.

4.4. Learning from Data and Getting Real

Many people outside the blockchains and cryptoeconomics field complain that blockchains and Web3 are just hype. We should let facts speak. More understanding of whether the sector is getting real or can get real is needed. This endeavor starts with documenting basic empirical patterns such as the return dynamics of crypto assets (e.g., Liu and Tsyvinski 2021), the functionality and categories (Cong et al. 2022a), and implications on the real economy (Benetton et al. 2023). With the emergence of nonfungible tokens (NFTs), decentralized applications (DApps), and decentralized autonomous organizations (DAOs), empirical studies informing researchers of the system states can be valuable (Borri et al. 2022, Falk et al. 2022). CBDCs and stablecoins are probably the most promising large-scale applications of blockchains and smart contracts. Whereas there has been rich theoretical literature on their design and economic principles (e.g., Gorton and Zhang 2023), quantitative or empirical studies are just emerging (e.g., Chiu et al. 2023). Another important condition for mass adoption is interoperability—a simple and reliable way for digital assets to be exchanged freely and for enabling more industries to incorporate blockchain into their daily operations. Moreover, unleashing the power of smart contracts such as described in Chen et al. (2023a) requires the flow of value and information between off-chain and on-chain worlds (perhaps through Internet-of-Things sensors), the discussion of which is just starting (e.g., Bakos and Halaburda 2023, Cong et al. 2023d).

4.5. Beyond Applications in Financial Markets

Blockchain applications go beyond business economics and finance and are emerging in governance, supply chain, gaming, healthcare, etc. For example, Yermack (2017) and Erwin and Yang (2023) explore its applications in governance and sustainability. Moreover, blockchains serve as an effective tool for providing transparency in supply chains (e.g., Chod et al. 2020, Ma et al. 2022), with implications for blockchain adoption and competition (Sristy 2021, Iyengar et al. 2021, 2023). Cui and Gaur (2022) discuss how supply chain applications of this technology differ from cryptocurrency networks and identify why this technology is useful in supply chains. The authors also describe recent successful examples and use both interviews with the companies and secondary publications to examine the value generation potential. The applications include improvement of process efficiency, supply chain optimization, and creation of new and innovative use cases. These applications are differentiated by their ease of implementation and scope of benefits, but all benefit from careful economic analyses.

4.6. Data Infrastructure and Analytics on Blockchains

Finally, blockchains serve as a promising data infrastructure for secure multiparty computation (MPC). The blockchain, in some ways, is the opposite of privacy, as it is all about transparency, but paired with some of these methods, it can provide immutability, and hence, there could be synergies. Through various commitment schemes such as zero-knowledge proof built on a distributed network of databases, one can aggregate information, verify transactions, and conduct global analytics without having to reveal the local, primitive data, which often contain private information. The earliest economic studies on the topic have explored the applications and implications in auditing and financial reporting (Cao et al. 2019, 2020), stability analysis (Hastings et al. 2022), and delegated investment (Chinco 2022). Blockchain-based ecosystems also represent "data-intensive environments" described in Giesecke et al. (2022), where AI and big data analytics prove useful.

Once applied on blockchains, they can further enhance the performance of secure-MPC and dApps in terms of content production, privacy preservation, financial inclusion, fraud detection, and authentication. In particular, AI's ability to understand, audit, and improve smart contract codes may facilitate further innovation and adoption.

5. Conclusion

We would like to close with a note on what we learned from the elaborate editorial process used for this special section. There is no doubt that the interdisciplinary nature of the topics introduces additional challenges to the editorial process. It is even more difficult to make decisions when the field is fast evolving and nascent. Nonetheless, we have noticed an uptick in dialogue among researchers delving into these topics, facilitated through conferences and webinars. There is also a growing number of experts readily offering their services as reviewers, coupled with an increasing number of researchers who are embracing the challenge to investigate related, yet underexplored, areas in this field. We belief this endeavor not only results in a special section but also will bear fruit in the long run for the research community with implications in the industry and policy-making.

Many of the studies included in this special section transcend the area of finance and economics and are valuable in other fields, be it for accounting, computer science, or operations research. Indeed, exciting research in many of these areas has begun, and *Management Science* looks forward to continuing to support the most innovative work on these interdisciplinary topics and providing a timely outlet for them.

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Endnote

[1] The inaugural CBER Forum Annual Conference itself received a total of 95 submissions. The numbers of submissions to the second and third CBER conferences are 72 and 115, respectively.

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