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EDITORIAL

Crypto-Currencies and Crypto-Assets: An Introduction

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Introduction

In the fourteen years since official launch of Bitcoin (BTC) at the start of 2009 based on the concepts in Satoshi Nakamoto's whitepaper (Nakamoto (2008)), the number blockchain-based digital tokens has grown to over 22,000. The intended use of these digital tokens have also expanded from a goal replacing of fiat currency (Bitcoin's intent as cryptography-enabled digital currency, or cryptocurrency) to a broader system of cryptography-enabled system for assets (crypto-assets) such as a token system for automating legal contracts (smart contracts) or a record for digital art ownership (non-fungible tokens). Given the size and public interest in these space, we have decided to dedicate a special issue of the *Eastern Economic Journal* to the economics of crypto-currencies and crypto-assets. In the remaining parts of this introduction, we will provide readers a guide to this space and how the four papers contained within this issue contribute to it.

Mining

The contribution of Satoshi Nakamoto in creating Bitcoin was the process by which the transaction verification and record-keeping could be decentralized. A key element of the Bitcoin system is *Proof of Work* (PoW). In the Proof of Work system, individual entities (*miners*) compete to compile the most recent batch of transactions into a block of records, in the process verifying that the transactions are feasible given account (*wallet*) balances. The winners are paid a reward of newly created

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Bitcoin. In order for entities to engage in the process of this record-compiling, Bitcoin must have a positive price which acts as the main incentive for miners to maintain an accurate ledger as failure to do so (creating a record that is known to be false, manipulated, or inaccurate) would reduce the value of the Bitcoin they are paid.

To ensure that those with the most powerful computers are not the default "winners," a PoW system requires that miners expend computing power to "guess" a unique combination of letters and numbers associated with the record they are compiling. This *hash* is a unique function of the contents within the block, and is the key crypto-graphic design embedded within the Bitcoin system, leading to Bitcoin's original moniker of crypto-graphic currency, later shortened to cryptocurrency. The design of the Bitcoin PoW system is to adjust the difficulty of guessing the hash to maintain a "guess-time" of approximately ten minutes: the use of more powerful computers therefore correspond to a more complicated puzzle rather than any substantive change in transaction processing. These design decisions mean that while more powerful computers have a better chance of finding the hash for any block (because they can iterate through more guesses per second), in theory non-powerful entities can still "win" the accounting race through sheer luck. Biais et al. (2019) show that the design of the PoW system is one that generates multiple equilibrium and, more importantly, induces an excessive investment in computing capacity.

The excessive computing investment is largely environmental as miners use more powerful computers, and by extension more electricity, to guess the hash. Recent work by Jones et al. (2022) estimates that each $1 in BTC market value created between $0.16 and $0.82 in global climate damage, with the highest damage period occurring after China (where miners predominately used wind and solar) banned mining, with Gallersdörfer et al. (2020) estimating that BTC accounts for only two-thirds of energy consumption in the crypto-ecosystem. It must be noted that the estimates of the amount of electricity actually used in mining is subject to debate, as they are usually based on the amount of computing power implied by the hash and the type of machines it is assumed miners are using. That is the basis of the well-known Houy (2019) criticism of the Mora et al. (2018) estimates that Bitcoin mining could cause global warning to exceed the 2∘C ceiling, as their estimates relied on miners using the most powerful (and energy intensive) computers even though those machines would not have been profitable for substantial periods.

Nevertheless, these discussion lead to questions regarding the value of maintaining a decentralized record keeping system through a PoW, as the electricity is not required to speedily process the number or complexity of transactions and is merely to maintain a competitive edge over other miners by allowing more "guesses." The most well-known alternative to PoW is the Proof-of-Stake system (PoS). This system requires that validators (the equivalent of miners in the PoS system) deposit tokens into the system (their "stake" in the system continued function). The theoretical underpinnings of PoS consensus generation is analyzed in Saleh (2021), where it is shown that it can sustain consensus in much the same way as PoW. The world's second largest cryptocurrency by market capitalization, Ethereum, switched to PoS in September 2022, reducing its energy usage by a claimed 99.5% (Dillet (2022)). However, broader adoptions have slowed as the Security and Exchange Commissions signals that this change may allow the application of securities laws to

cryptocurrencies (Kiernan and Huang (2022)). Gabriel Mathy proposes an alternative change that retains the PoW system in the paper "**Eliminating Environmental Costs to Proof-Of-Worked-Based Cryptocurrencies: A Proposal**". The key proposal examined in the paper is that, instead of increasing the difficulty of hash (increasing the environmental cost of a PoW system), the PoW system could adjust the reward or account balances to decrease the benefit of mining, and therefore the incentive to use more electricity and thereby the environmental cost.

Valuation

No examination of the cryptoasset ecosystem is without a discussion of any fundamental value such assets may (or may not) contain. Early work was mostly empirical and focused on the extent of speculation in the Bitcoin market (for example, Cheah and Fry (2015) or Baur et al. (2018)) or Bitcoin's potential value as a hedging asset (for example, Dyhrberg (2016)) with the findings changing with time periods or methods, though there is agreement that there was a substantial component of speculation in early Bitcoin prices. There is also discussion about cryptocurrency's value from use as a payment means for illegal activities, though estimates vary widely as to the extent of this usage: for example, the estimates of Bitcoin use in illegal activity in 2017 varies between meager 1.42% (Chainalysis (2022)) and a substantial 46% (Foley et al. (2019)). In recent years, the ability to use crypto to make payments anonymously has become even more constrained as various enforcement agencies and academics have turned their attention to mapping the relationships between the various wallets (Bohannon (2016); Lennon (2021)).

These empirical efforts are completed by theoretical evaluations of the value of cryptocurrencies, with most finding that a positive price can be sustained even in a system with competing currencies (for example, Fernández-Villaverde and Sanches (2019); Schilling and Uhlig (2019); Benigno et al. (2022)). In a application of Kiyotaki-Wright model to cryptocurrency, Garrison Hongyu Song's "**Valuation of Cryptocurrency without Intrinsic Value: A Promise of Future Payment System and Implications to De-dollarization**" shows that even if a crypto-currency token has no inherent or fundamental value, it may still attain value role in an equilibrium as the unique token for enabling payments between agents. In the context of cryptocurrencies, these agents could be in different countries, and could be ill-served by traditional international remittance or payment options offered by financial firms.

However, if the use of a cryptocurrency as a payment is the source of its positive price a puzzle arises. Cryptocurrencies such as Bitcoin can *fork*: an analogy would be someone copy-pasting an original document and then continuing to append their own words to the copy, while someone else continues working on the original. As part of this copy-paste, fundamental changes could be introduced (deleting chapters, changing formatting decisions, etc.) The original Bitcoin protocol has had at least 17 forks leading to at least 17 new payment tokens, of which most but not all of which moved to a statistically zero price after a few months (Landoni and Pieters (2020)). If Bitcoin's value is derived from its value as a unique payment token, the introduction of these 17 competitors should have an impact on Bitcoin's price. At the very

minimum one would expect prices between Bitcoin and its competitors to be negatively correlated as the tokens compete for dominance in the payment market. The findings of N. Ahmed, O. Farooq and N. Hamed in "**The Relation between Bitcoin and its Forks: An Empirical Investigation**" pose a challenge to that theory: the authors show that the price of Bitcoin and its forked tokens are positively correlated. This implies that even if some of Bitcoin's price is attributable to its use a payment token, other reasons for positive prices must also contribute (which can include speculation).

Teaching Using Crypto Markets

As many professors know, undergraduate students have an especially keen interest in crypto-assets, yet many find it difficult to incorporate crypto-assets into their courses in a way that does not require a significant amount of self-study. In J. Zhu and L. Zhang's "**Educational Game on Cryptocurrency Investment: Gamification for Understanding Macroeconomics in Microeconomic Decisions of Human-AI Interactions**" the authors propose an exercise in which students can experience rules-based versus discretion-based monetary policy by implementing either a rules-based or discretion-based investment decision in Ethereum. The intent of the game is for student to experience the perspective of a policy-maker who will either be bound by a rule-based decision making strategy, or will have discretion, but applied to a market in which automated trading strategies are standard and in which the goal (making a profit) is easy to grasp.

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