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Inherent Qualities of Blockchain and Varied Implications

Introduction:

The fundamentals of blockchain are well understood in the academic community and research has branched into multiple fields, such as supply chain management, healthcare, energy, finance, and other industries with specialized applications. The applications are focused on solving problems characteristically innovated by blockchain's technological properties. Blockchain is a distributed ledger that is decentralized and distributed (Vergne 1). With a transparent nature, the technology guarantees trust among participants without a trusted intermediary. The state of this technology includes future regulation due to the nature of allowing value and information to cross borders independently (Catalini and Gans 8). The technology is becoming increasingly reliant on traditional systems and Carter and Jeng claim that innovation may be halted by industry concentration. This is in direct opposition to the technology's original ethos in Nakamoto's white paper. The value of this technology can be accessed in terms of economic benefits, organizational strengths, and general comparisons to current products and services. An additional perspective is a historical overlook of financial markets detailing how proposed society altering financial innovations follow a path of overexcitement, regulation, and limited growth. To explain the current research landscape, I first outline the basic technical information needed for detailed content, provide multiple perspectives on the key qualities of blockchains along different academic theories, develop a research focus for applications in financial services, and conclude with a historical perspective of innovative financial technologies. I believe Blockchain's inherent qualities need to be widely understood by capital allocators, i.e., regulators, politicians, and business leaders in order derive the immense potential value and innovation from the technology. Taking a balanced approach to the excitement and the reality of the innovations, I aim to provide an overarching picture of Blockchain's strengths and weaknesses.

Blockchain Origin:

Blockchain, Web3, NFTs, Cryptocurrency, Bitcoin, and Ethereum are all loaded terms that are used when describing the combination of technological advancements in cryptography and computation. To simplify the complexity and confusion, it is necessary to describe the main characteristic of these technologies in a framework of ideas. Nakamoto first provides a description of a distributed ledger, a blockchain, stating "without a trusted party, transactions must be publicly announced… a system for participants to agree on a single history of the order in which they were received" (Nakamoto 2). To accomplish that ledger, he describes the implementation of cryptographic hashing using public key encryption (Nakamoto 5). This means individuals will perform transactions and proceed to mathematically sign a string of a characters, public and private keys, for the record. The signed transactions are broadcasted to the network of miners (Nakamoto 3). They are incentivized to process the transaction with a collection of fees from the transactions and currently assign themselves a Bitcoin (Nakamoto 4). To facilitate the transactions miners, mathematically hash, the previous blocks of transaction records to the current batch. This can best be visualized as all the previous records produce a single phrase and then that phrase is included in the new block when processing. Linking all the previous blocks, the record is sequentially built off the longest chain. A further explanation of hashing is where computational effort is needed to find a numerical solution to the current problem. Whoever computes the problem first, in a simplified manner, shares the new state of record. At a high level, Bitcoin is the first implementation of a blockchain.

Blockchain Limitations:

Blockchains are fundamentally a distributed ledger of data enabling people and organizations to maintain data integrity throughout transformations. Presented in a systematic review by Yli-Huumo, et al. blockchain's technical limitations are as follows: "throughput, latency, size and bandwidth, security, wasted resources, usability, and versioning, hard forks, multiple chains" (Yli-Huumo, Jesse, et al. 3-4). To foreshadow, these limitations are all relevant in varied application and so forth raised later, but an initial review will clarify the bounds of the technology. Yli-Huumo, et al. states throughput is the number of transactions processable, bandwidth is related to data size of the entire blockchain records, latency is the time needed to verify a transaction, and versioning is the ability to split the record of state with a 51% majority computational power. To further illustrate the latency, at this moment Bitcoin processes 7 transactions per second while Visa processes 2000 transactions per second (Yli-Huumo, Jesse, et al.

3). As of March 8th on the Ethereum network, gas, transaction fees are approximately one dollar (Etherscan). Usability comprises the ease of use for developers and people, wasted resources outlines the energy usage from the "zero-sum-computation" problem nature, and security covers the rigidity of systems (Yli-Huumo, Jesse, et al. 16). The processing system in Ethereum and Bitcoin use Proof-of-work where more computation effects the whole system raising the need for everyone to use more energy. These limitations pose a significant challenge to further adoption. Although due to the serious positive implications, I believe immense capital and intelligence will be dedicated to fix these issues. To my point, the President Biden of the United States signed an executive order, "Ensuring Responsible Development of Digital Assets" on March 8th to study digital currencies (Kiernan and Duehren 1). To summarize the major concerns are the performance and security of the network.

Blockchain Characteristics:

The main undefined keywords that hold immense meaning include decentralization and distributed. Through reading an organization theory paper, I describe the implications in business structures and the technology that supports them. Vergne explains these qualities on two axes, centralized vs. decentralized and distributed vs. concentrated. At a fundamental level an organization is a group of individuals that gather information, add perspective to accrue knowledge, and then perform decisions (Vergne 6). A concentrated organization indicates "concentrated decision-making", and a centralized organization implicates the "exchange of data and information" is limited to a few (Vergne 4-6).

The dichotomy is explicit when comparing the use of machine learning to Bitcoin by different organizations. Machine learning is a data accumulation technology that employs algorithms on data to make increasingly better predictions (Vergne 10). This places information gathering on algorithms and a structure where information is siloed to a few decision makers. The result is data being attracted to a few large players. The opposite occurs in decentralized and distributed networks like Blockchain with inherent scaling issues as previously discussed and has a natural consequence of applications branching off (Vergne 15-16). Within a decentralized system, all information is publicly available and pushed to the network nodes. In contrast, the lack of transparency in traditional limited-information organizations concern developers as a platform operator could take value "from committed complementors by unexpectedly altering redistribution rules" (Vergne 16). This presents blockchain as an alternative attracting developer to the space, as they can be certain their work and expected value remains consistent. Blockchain is a fundamental technology to modern businesses that offers a certain ethos and technical foundation for unilateral access to information and a consensus shared decision-making feature. The direct comparison is to centralized and concentrated platforms that aim to have all the information and ultimately power. The implicit characteristics of Blockchain has an appeal to certain businesses and offers an opposing ideology to generating value from Big Data.

Blockchain Innovations:

Economic theory also provides a distinct perspective on the cost reduction benefits for this technology. Catalini and Gans state blockchain technologies reduces "the cost of verification of state, and the cost of networking" (Catalini and Gans 81). The reduction of cost has made viable a plethora of new businesses. Simply, the amount of friction in terms of regulation and meditation is reduced (Catalini and Gans 82). There is a large cost that intermediaries have traditionally accepted as mediators in transaction dispute and holding financial responsibility for fraud. Once committed transactions in the blockchain cannot be reversed and smart contracts are not programmed with any human subjectivity. Fraud is dramatically reduced with the inability of identity theft and a built-in secure public key encryption to access assets. The reverse downside is that real world identity cannot be easily linked. To connect off-chain, offline information there entails high costs (Catalini and Gans 85). Further, this highlights the strength in completely digital applications for blockchain. To summarize, to verify a transaction of value occurred less meditation and intermediaries are needed. Through placing "incentives and governance rules… into the protocol", the cost to build a network is also reduced (Catalini and Gans 88). With powerful design mechanisms in the governance of applications, Catalini and Gans state financial incentives encourage users to invest time and effort. This network effect essentially is a natural positive feedback loop for more people to interact thereby reducing cost to bootstrap it. These two efficiencies have and will promote the testing of blockchain solutions. To conclude these explicit economic benefits, prescribe a form for how blockchain can be applied by reducing network and verification costs. With a clear innovation that provides value, this technology should be looked at carefully when being regulated.

Blockchain Critique in Finance Applications:

The strongest critique is another viewpoint that traditional intermediaries offer value with human subjectivity and legal protections that is desirable. Carter and Jeng analyze the immense risk in DeFi, decentralized finance, considering the interconnectedness between traditional finance. DeFi seeks to “disintermediate finance through both familiar and new service arrangements” with smart contracts on the blockchain (Gogel 1). To start, a large amount of cryptocurrency ecosystem is tied to stablecoins that are interrelated to small community banks that if any went insolvent would have a ripple effect in the DeFi space (Carter and Jeng 10). Additionally, Carter and Jeng identify that several financial products are pegged with a mix of stable coins and if any components faced regulation could cause failure of the peg. To me, this just further clarifies that the entire financial systems is complex, and disintermediation can only occur to some extent.

Second in terms of human subjectivity there is inherent risk in smart contracts that they cannot be updated, and missing edge cases could be found too late. Oracle attacks could front run the market orders and create arbitrage opportunities for bad actors (Carter and Jeng 23). Data can be injected to manipulate an asset to affect the derivative price (Carter and Jeng 23). Governance is also a major part as the key holders could decide to siphon funds out of an application (Carter and Jeng 27). By removing oversight and regulation the contracts place immense risk on the end user in terms of technical knowledge and security.

In financial services a direct comparison of centralized ledgers and distributed ledgers is needed. Abderahman et al. details the major negatives for centralized ledgers are dealing with identity theft, agency problems, and inefficiencies of multiple financial system to complete a record (Abderahman et al. 49). The centralized system relies is based on blind trust, verification through personal information, and insurance to process services. Centralized ledgers have strong positives in terms of scalability and performance. As discussed, this concentrated data can be easily accessed for auditing purposes and financial analysis. The structure of centralized ledgers is ultimately liable to a single point of failure. The major positive attributes for decentralized ledgers in this article are provenance meaning the ability to view how data has been changed along the way, auditability in authenticating information, confidentiality in encryption, and trust to secure the exchange of "information and value" (Abderahman et al. 50-51). The continued weakness is left to the technical developers in securing the safety of the contracts. Another concern Abderahman et al. detail is that there will not be enough people with technical skills to grow the governance of projects. Finally, it is possible that the power ends up with the developers who write the financial contracts and assert control. Overall, there is still a need for third parties to provide information and act as a mediator in the efforts of risk management (Kaminska 1). By acknowledging the risks and limitations in the Blockchain I qualify that it will not necessarily replace traditional systems in all aspects. People should be wary of thinking of DeFi as a completely decentralized entity and recognize the linkage. Human subjectivity either must be incorporated into some effect or that quality will have to be formed algorithmically for smart contracts to succeed. Through this understanding I believe people will adopt it when the accessibility and usability increase in terms of user experience.

<u>Environmental Critique and Counterargument</u>:

A major critique and headline of Blockchain is the suggested environmental cost from energy consumption. To picture the concern, De Vries states in 2018, "Bitcoin network consumes at least 2.55 GW of electricity currently, and that it could reach a consumption of 7.67 GW in the future, making it comparable with countries such as Ireland (3.1 GW) and Austria (8.2 GW)" (De Vries 804). Over reading the literature, researchers have similarly created a framework measuring the lower and upper bounds of consumption for the estimate. In addition, they referenced the external factors such as cooling hardware cost and mining hardware power efficiency (De Vries 803). De Vries has an alarmist point of view as he provides no context predictions and merely labels the issue as a big problem. He does not consider the implications and other modeling perspectives in his commentary. Sedlmeir et al. reacts to this broad portrayal with a balanced analytical perspective. They first qualify Proof-of-Work cryptocurrencies "consume an amount of energy which may be regarded as disproportionate when compared to the currencies' actual utility" (Sedlmeir et al. 600). Sedlmeir et al. first recognize that the system's design is energy intensive on purpose and that these systems balance security, scalability, and throughput. A major counterargument stated is that in the long term "it is to be expected that even with ground-breaking innovation in the energy efficiency of mining hardware, Bitcoin's and other PoW blockchains' energy requirements will remain at the previous level" (Sedlmeir et al. 603). This statement contradicts the strong claim that Blockchain's will cause the global temperature to rise two degrees Celsius (Sedlmeir et al. 603). In addition, Sedlmeir et al. discuss Proof-of-Stake that uses less computation as another solution to minimize energy consumption but recognize the downgrade in security. The positive outcomes include digitizing the supply chain and thereby reducing emissions (Sedlmeir et al. 607). Also, Sedlmeir et al. state non-PoW in IT business solutions use a lot less energy than Bitcoin's consensus mechanism. I draw from this argument that the headline notion is exaggerated and that possible solutions should be weighed to the energy usage. To that testament, the number of applications and innovations springing up reflect the fact that the utility of the technology is increasing exponentially. The older studies do not reflect the current innovation utility. Further studies should be done to recognize the net gain or loss across multiple fields and problems in terms of energy consumption. The verdict should then be made.

Conclusion:

Blockchain is as a highly technical topic, but it can be concisely overviewed with a limited technical understanding and a few academic theories that provide a rounded perspective. Blockchain at its heart was created preaching an ideology of disintermediation and distrust in centralized nation states due to their involvement unfairly mediating the financial system. The result of Nakamoto's white paper and the cryptography defined the ethos for this technology. Who uses it and how is it used? The reduction in economic costs and the organization structure has generated new services that provide value to people. Consequently, intermediators and the state have concerns over further propagation diminishing their own power. The likely adoption of the digital dollar in the United States portrays this conflict. For reference, China banned cryptocurrency as a threat to their national security. This ever more perceived threat in parliaments around the world will place pressure on regulators to clamp down. I have argued that traditional financial intermediaries still provided significant value but adoption of Blockchain will unlock specified growth. For these reasons, regulation must have a technical understanding and capital allocators must understand the inherent distinctions. Further, I have outlined how the positive implications outweigh and or not correlated to the identified weaknesses. To conclude, Blockchains simply provide an immutable record of history that can be relied on for making decision.

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