Demystifying Blockchain: A New Wave of "Creative Destruction" or Hype?

Demystifying Blockchain:

A New Wave of "Creative Destruction" or Hype?

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Abstract

Much confusion surrounds the newly emerged blockchain technology—from critics denouncing it as the most overhyped and least useful technology of all time, to others who consider it a panacea capable of saving the world. The goal of this thesis is to reconcile these differences and explore real-use cases of how blockchain technology stacks up against a systematic framework of disruptive innovation.

I conducted two distinct case studies—one each in the private and public sectors—and this thesis evaluates the technological features, marketplace dynamics, and external factors of the two blockchain companies. Brave Technologies attempts to disrupt the internet browser market, while BitFury provides a blockchain-based land title technology offered to the country of Georgia.

This research study shows that blockchain technology does indeed demonstrate some of the key features of a disruptive innovation, such as novel ownership, simplification, and value networks. I also discuss other long-term implications of blockchain technology, including its impact on disintermediation, transparency, and trust.

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Chapter I

Introduction

In his 1934 book *Capitalism, Socialism, and Democracy*, Austrian economist Joseph Schumpeter[1] brought forward a new theory of economic cycles. Contrary to popular belief at the time, Schumpeter concluded that economic growth is cyclical rather than linear, and that growth is caused by a few inflection points he called *disruptive innovations*. He concluded that innovators (i.e., entrepreneurs who develop new ways of doing things) are the drivers of disruptive innovations. Therefore innovators are the ultimate cause of what he called *creative destruction*. As a result of creative destruction, Schumpeter argued, monopolies inevitably collapse and are replaced by new and emerging players that eventually grow into monopolies – and the cycle repeats itself. Although the inevitable consequence of Schumpeter's idea of creative destruction is temporary economic devastation—reflected in elimination or displacement of jobs and workers, loss of revenue and market share by major companies—in the long term the innovators/disruptors create more value than they destroy. Creative destruction, Schumpeter argued, is the ultimate force of human progress.

Over the centuries, several waves of creative destruction have occurred, including the Industrial Revolution, with its invention of industrial-scale machinery and mass production, to today's digital era triggered by the invention of the internet. These

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[1] Joseph Schumpeter, *Capitalism, Socialism, and Democracy*. 1942 (New York: Harper, 2008, Third Ed.).

inflection points challenged the status quo while creating trillion of dollars' worth of economic value.

Yet another innovation, blockchain technology, has recently emerged to challenge the internet itself. Thought leaders such as Tim Berners Lee (inventor of the world wide web) and others[2] believe that blockchain technology is the next step on the future of the internet: decentralized, democratized, and open to all. Invented by anonymous Satoshi Nakomoto during the 2008 financial crisis, blockchain became known as the foundational technology behind Bitcoin—a decentralized ledger digital currency that works without any regulation or oversight by any central banking authority. Since its inception, Bitcoin has risen and fallen in popularity through several cycles, its price rising from $0.08 in 2008 to nearly $20,000 in 2018, back down to around $3,500 by January 2019.[3]

Beyond Bitcoin, other use cases of blockchain have emerged, giving rise to the broader so-called "token economy," collectively worth over $100 billion in market capitalization at the time of this writing. Is all this just hype, or does blockchain technology represent a new wave of what Schumpeter would call *creative destruction*? This is the fundamental question this thesis seeks to answer.

Some critics argue that the hype around blockchain technology has no substance. New York University economics professor Nouriel Roubini argues that blockchain technology is "the most overhyped—and least useful—technology in human history." He claims that blockchain is "nothing more than a glorified spreadsheet," and that its rising

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[2] Nathan Bentley, "Tim Berners-Lee, The Father Of The Internet Believes In Blockchain," *CryptoDaily*, 3 July 2018. https://cryptodaily.co.uk/2018/07/tim-berners-lee-the-father-of-the-internet-believes-in-blockchain/. (Accessed 1 February 2019.)

[3] https://coinmarketcap.com/currencies/bitcoin/. (Accessed 30 January 2019.)

market capitalization represents "the mother of all bubbles." Roubini believes decentralization is the utopian dream of libertarians and anarchists who have no regard for the rule of law or central authority. He concludes that despite its claims of decentralization (the blockchain ecosystem is highly centralized) exemplified in high levels of centralization among "miners" (i.e., parties responsible for maintaining the blockchain network), centralized exchanges and high centralization of wealth concentrated in the top one percent. For example, Roubini believes that if Bitcoin were a country, its coefficient of decentralization (0.88) would be worse than that of North Korea (0.86).[4] Other critics conclude that after ten years of blockchain existence, no meaningful use cases have achieved mainstream adoption.[5]

On the other hand, blockchain enthusiasts argue that the distributed ledger technology is destined to revolutionize virtually every industry, from healthcare to government services. According to a research report by Garrick Hileman and Michel Rauchs,[6] as of 2017 more than 90 central banks have engaged in blockchain technology use, more than 24 countries have announced favorable regulation of blockchain companies, and more than 2,000 blockchain-related jobs were created. Further, in April 2016, the country of Georgia successfully piloted a blockchain-based land title system,

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[4] Nouriel Roubini, "The Big Blockchain Lie," *Project Syndicate: The World's Opinion Page*, 15 October 2018. https://www.project-syndicate.org/commentary/blockchain-big-lie-by-nouriel-roubini-2018-10?barrier=accesspaylog. (Accessed 24 January 2019.)

[5] Kai Stinchcombe, "Ten years in, nobody has come up with a use for blockchain," 22 December 2017. Hackernoon website. https://hackernoon.com/ten-years-in-nobody-has-come-up-with-a-use-case-for-blockchain-ee98c180100**.** (Accessed 1 February 2019.)

[6] Garrick Hileman, and Michel Rauchs, "Global Blockchain Benchmarking Study," September 22, 2017 (UK: Cambridge Center of Alternative Finance, University of Cambridge). https://ssrn.com/abstract=3040224 or http://dx.doi.org/10.2139/ssrn.3040224 (Accessed 24 January 2019.)

which resulted 300,000 records transferred to a decentralized exchange.[7] Other countries have followed suit, with Estonia, Sweden, and Honduras completing various blockchain proofs of concept.[8] Blockchain technology ranks as the number one priority among chief information officers of *Fortune* 500 companies[9] as well as global government leaders such as President Xi Jinping of China, who allegedly called blockchain a "breakthrough technology."[10]

The goal of this research study is to reconcile these contradicting viewpoints and to determine whether blockchain technology indeed represents the next wave of "creative destruction" or if it is an over-hyped and temporary fad.

Statement of the Problem

A lot of hype, excitement, and confusion surrounds blockchain technology. While a growing number of research publications discuss various facets of this emerging technology, more than 80% of available research focuses on the Bitcoin system, and only 20% evaluate the current state and implications of the underlying blockchain

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[7] Marcell Nimfuehr, "Blockchain Application Land Register: Georgia and Sweden Leading," *BitcoinBlase*, 3 December 2017. https://medium.com/bitcoinblase/ blockchain-application-land-register-georgia-and-sweden-leading-e7fa9800170c. (Accessed 28 January 2019.)

[8] Laura Shin, "The First Government to Secure Land Titles on the Bitcoin Blockchain Expands Project," *Forbes*, 7 February 2017. https://www.forbes.com/sites/laurashin/2017/02/07/the-first-government-to-secure-land-titles-on-the-bitcoin-blockchain-expands-project/#4ebf7ebc4dcd. (Accessed 27 January 2019.)

[9] Kasey Panetta, "The CIO's Guide to Blockchain," Gartner Research, 13 July 2018. https://www.gartner.com/ smarterwithgartner/the-cios-guide-to-blockchain/. (Accessed 24 January 2019.)

[10] Evelyn Cheng, "Chinese President XI Jinping Calls Blockchain a 'Breakthrough Technology'," CNBC 30 May 2018. https://www.cnbc.com/2018/05/30/chinese-president-xi-jinping-calls-blockchain-a-breakthrough-technology.html. (Accessed 24 January 2019.)

technology.[11] In addition, much of the research on blockchain technology elaborates on technical limitations, security, usability, consensus algorithms, and/or electricity consumption requirements for blockchain mining applications. To my knowledge, no comprehensive study has been conducted to evaluate blockchain technology in a systematic framework of disruptive innovation.

Objectives of the Study

The main objectives of this study are the following:

- analyze blockchain technology as the next inflection point of *creative destruction* via a systematic framework of disruptive innovation in order to determine whether it poses a threat to incumbent businesses, governments, or systems;
- compare the impact of blockchain technology on both private- and public-sector use cases;
- determine key factors influencing the level of disruptiveness of blockchain technology in each sector; and
- based on the findings, to discuss key takeaways and broader implications of this technology.

[11] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where is Current Research on Blockchain Technology?—A Systematic Review, PLoS ONE 11, vol. 10 (2016). https://doi.org/10.1371/journal.pone.0163477. (Accessed 24 January 2019.)

Research Questions

I formulated the following research questions to guide this study:

- What are the measures of technological features, marketplace dynamics, and external factors of blockchain technology in the context of private- and public-sector use cases?
- How does the impact of blockchain technology compare in a private- versus public-use case?
- What is the role of a token in a blockchain-based firm, and what is its level of disruptiveness?
- How does blockchain technology impact disintermediation and trust?

Theories and Frameworks

Although the concept of *disruptive technology* is ubiquitous today, it was originally developed in 1997 by Clayton Christensen, a professor at Harvard Business School. He described *disruptive innovation* as a type of innovation that can substantially alter competition and create problems for incumbent firms. Specifically, Christensen differentiates between *disruptive innovation* and *sustaining innovation*. While the latter can provide marginal or radical improvements to an existing product to satisfy an existing customer base, sustaining innovations rarely force established incumbents out of business. To the contrary, disruptive innovations often under-perform existing products in their respective categories, especially initially. “They bring to a market a very different

value proposition,"[12] and as a result originally appealed only to niche rather than mainstream customers. However, it is disruptive innovations that typically challenge incumbents, as they fail to respond effectively due to initial lack of profitability in the niche segments disruptors choose to target. These types of innovations have become known as lower-end innovations. Over time, it became obvious that description was not sufficient to describe other disruptions that have come into the world, such as the transistor pocket radio or open-source software. Therefore, in order to capture the diversity of disruptive innovations that have emerged over the years, the following three types of disruptions should be considered: (1) lower-end innovation, (2) new market innovation, and (3) ownership innovation. I discuss each one below.

Lower-End Innovations

Lower-end innovations take advantage of an incumbent's tendency to over-serve the target market, which means that they offer more features at a higher price than a typical customer would want or need. Lower-end innovations take advantage of this opportunity by utilizing "new materials or new processes in the creation of existing technologies."[13] These innovators come in at the lower end of the market, hence the name "low end innovation." They offer discontinuous technical standards. Examples of lower-end innovations include computers, steel minimills, and discount retailers.

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[12] Clayton M. Christensen, *The Innovator's Dilemma* (New York: Collins Business Essentials, 1997), xv.

[13] Olaf Kowalik, "Low-End and New-Market Disruption Innovation," Product Bookshelf, May 20, 2011. https://www.productbookshelf.com/2011/05/low-end-and-new-market-disruption/. (Accessed 30 January 2019.)

New Market Innovations

New market innovations offer *radical functionality*. They enable a new customer "to undertake a new behavior or accomplish a new task that was impossible before the invention of the innovation,"[14] unlike the previous innovation that typically leads to the creation of new markets rather than serving the lower end of an existing market. It is important to emphasize that new market innovators do not necessarily mean state-of-the-art performance improvement of an existing product or service. In fact, these innovations may underperform the established players for a long period of time until the quality catches up and surpasses that of competitors. As a result, radical innovations often do not meet current customers' needs and therefore are not viewed as attractive investment opportunities for existing incumbents. Examples of these types of innovations include the transistor pocket radio, virtual reality technology, or shared economy apps like AirB&B.

Ownership Innovations

Innovations that have inherently novel ownership structures often leverage new forms of production or distribution in terms of use, thus impacting how an innovation is received in a marketplace. An example of this type of innovation is open-source software. Rather than offering radically new features or appealing to lower-end customer segments, this innovation disrupted the fundamental ownership structure of the product; rather than having a single owner, it is collectively owned and maintained by a group of volunteers.[15]

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[14] Jianfeng Guo, Jiaofeng Pan, Jianxin Guo, Fu Gu, and Jari Kuusisto, "Measurement Framework for Assessing Disruptive Innovations, *Technological Forecasting and Social Change*, vol. 139: 252. https://www.sciencedirect.com/science/article/pii/ S0040162518306656#!. (Accessed 24 January 2019.)

[15] Delmer Nagy, Joseph Schuessler, and Alan Dubinsky, "Defining and Identifying Disruptive Innovations," *Industrial Marketing Management* (2016): 121 .

As a result, this type of innovation aligns incentives in favor of a product's continuous improvement without incurring as much cost or resources as would a traditional firm. As a result, "alternative forms of ownership in established industries have disrupted the status quo of these industries by changing characteristics like price, or services surrounding the innovation. These changes have effects on marketplace expectations surrounding innovations."[16]

What all three types of innovations have in common is that they displace existing incumbents and create exponential value. The following section describes in more detail how various characteristics of these innovations could be combined into a multidimensional framework of disruptive innovation.

Proposed Framework

I began by combining elements of several established frameworks that have been proposed over the years. Some of the most prominent scholars who have conducted useful research on this topic include: P. Thomond and F. Lettice, who proposed the original framework in 2002[17] (updated by D. Nagy, J. Shuessler, and A. Dubinsky

[16] Nagy, Schuessler, and Dubinsky, "Defining and Identifying Disruptive Innovations," 121.

[17] P. Thomond, and F. Lettice, "Disruptive Innovation Explored," Proceedings from the Ninth IPSE Concurrent Engineering Conference, July 2002. https://www.researchgate.net/publication/238788884_Disruptive_Innovation_Explored. (Accessed 24 January 2019.)

2016)[18]; C. Christensen and M. Raynor (2003)[19]; V. Govindarajan and P. K. Kopalle (2006)[20]; Hardman, et al. (2013)[21]; and Guo, Pan et al. (2016).[22]

One framework that stands out is that of Thomond and Lettice who categorize innovations based on a descriptive set of features that fall into one of three categories: radical functionality, discontinuous technical standards, or novel ownership. They describe radical functionality as a product or service that enables a user "to undertake a new task that is impossible before the coming of the innovation." The authors conclude that the innovation possessing radical functionality "disrupts markets by creating new markets." Discontinuous technical standards, on the other hand, "utilise new materials or new processes" and novel ownership innovations dictates how an innovation is received in a marketplace.[23]

Nagy, et al. extends this theory and proposes that "an innovation that changes the performance metrics or consumer expectations of a market by providing radically new functionality, discontinuous technical standards, or new forms of ownership." The

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[18] Nagy, Schuessler, and Dubinsky, "Defining and Identifying Disruptive Innovations."

[19] Clayton M. Christensen, and Michael E. Raynor, *The Innovator's Solution: Creating and Sustaining Successful Growth* (Boston: Harvard Business School Press, 2003).

[20] V. Govindarajan, and P.K. Kopalle, "The Usefulness of Measuring Disruptiveness of Innovations Ex Post in Making Ex Ante Predictions," *Journal of Product Innovation Management,* 26 (2006): 12-18. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00176.x. (Accessed 30 January 2019.)

[21] S. Hardman, R. Steinberger-Wilckens, and D. van der Horst, "Disruptive Innovations: The Case for Hydrogen Fuel Cells and Battery Electric Vehicles. *Int. J. Hydrog. Energy,* 38 (2013): 15438–15451.

[22] Guo, Pan, et al., "Measurement Framework,"

[23] Thomond and Lettice, "Disruptive Innovation Explored."

authors also point out that "radical innovations and discontinuous innovations are corresponding to new market innovations and low-end innovations, respectively."[24]

Since no single framework is sufficiently explanatory and measurable enough to be used independently, I have combined the over-arching elements of the Thomond and Lettice framework with the explanatory characteristics borrowed from the Guo, Pan methodology.[25] The combination of these two frameworks not only encompasses most of the important factors that have been proposed in evaluating a disruptive innovation, but it also provides a structured way to measure blockchain technology in the context of technological features, marketplace dynamics, and external factors. Therefore, by extracting the key characteristics of the three types of innovations, the proposed framework breaks down the key features into three segments: 1. Technological Features, 2. Market Dynamics, and 3. External Factors, as illustrated in Table 1.

Table 1. Summary of Proposed Framework

CATEGORY	**INDICATOR**	**RESULT**	**SCORE**
TECHNOLOGICAL FEATURES	Simplification	Yes / No	1/0
	Cost Reduction	Yes / No	1/0
	Novel Ownership	Yes / No	1/0
MARKETPLACE DYNAMICS	Value Networks	Yes / No	1/0
	Profit Margins	Yes / No	1/0
	Target Market	Yes / No	1/0
EXTERNAL FACTORS	Policy	Yes / No	1/0
	Macroeconomic Factors	Yes / No	1/0
SCORE			**8/0**

Source: thesis author

[24] Nagy, Schuessler, and Dubinsky. "Defining and Identifying Disruptive Innovations."

[25] Guo, Pan, et al., "Measurement Framework," 252.

Technological Features

These features include: simplification, cost reduction, and novel ownership. Each is discussed below.

Simplification. The degree to which the product or service offers simplification. Typically, these innovations are inferior to the mainstream product, and many product attributes are either nonexistent or oversimplified compared to a level that incumbents currently offer.

Cost Reduction. The degree to which the product or service fulfills the need of an over-served or a new customer segment by offering a "good enough" product or service at a lower price point.

Novel Ownership. The degree to which the product or service offers novel ownership factors that can influence costs, employee motivation, and organizational performance. It also includes the degree to which a product or service leverages novel methods of resource utilization or effect changing characteristics like price, or services surrounding the innovation, or marketplace expectations

Marketplace Dynamics

Value Networks (customers, suppliers, competitors). The degree to which the innovation taps into unmet need in the market by creating and adding differentiated value to customers. It also includes the degree to which the extent an innovation offers radical functionality, which means that these innovations disrupt the "value networks," impacting other stakeholders such as suppliers, competitors, business processes (e.g., assembly line or inventory management), resources (required to sell this product, for

example), values, etc. If the value network is mostly disrupted, it is considered a disruptive innovation.

Profit Margins. The degree to which profit margins of the innovations are less attractive than those of existing technologies. Typically, this makes it an unappealing investment opportunity for existing incumbents, and for that reason it is often ignored or dismissed.

Target Market. The degree to which these disruptive innovations appeal to a niche audience before attacking the mainstream customer. Typically, as product features are improved, the niche customer grows into larger audience.

External Factors

Policy Change. The degree to which the disruption influences policy change. This also includes the degree to which policy change influences the disruptive innovation

Macroeconomic Factors. The degree to which the disruptive innovation positively influences long-term economic growth. It also includes the degree to which, in the long term, disruptive innovation can produce an outsized impact in terms of economic growth and job creation.

Scope of the Research

In defining the scope of this research, I differentiated between the technology and its applications. For example, the technology itself is the underlying protocol or the infrastructure layer on top of which applications are built. Drawing a parallel to the digital era, the TCP/IP is an example of the underlying protocol while Facebook, Amazon, or Google are examples of the applications. Examples of the infrastructure layer

of blockchain technology include companies like Ethereum, Stellar, Hyperledger, and others, all of which provide the underlying platform on top of which distributed applications could be built. Examples of application-layer companies that facilitate the process of value exchange include Steemit (distributed content and social media platform), Golem (application for idle computing power), and Ethlance (a distributed alternative to companies like Upwork, etc.).

The scope of this research study will be limited to application-layer companies that leverage blockchain technology rather than the underlying protocol itself, because without meaningful applications this technology could not be disruptive per se. Other types of companies that will be excluded from the scope of this analysis are existing incumbents that leverage blockchain technology for process improvements or efficiencies, and companies that facilitate the blockchain ecosystem, i.e., payment providers such as Coinbase. While the former might effectively transform an existing incumbent and the latter represent a gateway for a retail or institutional consumer to access the ecosystem, neither are examples of disruptive innovation, but rather a classic example of sustaining innovations.

Methodology

In order to systematically evaluate blockchain technology against the above outlined metrics, I propose a case study method, as case studies are best used in qualitative rather than quantitative research. The qualitative method is applicable for this analysis because it is a nascent industry that is rather immature, with a lack of historical data that might facilitate a comprehensive quantitative study.

I introduce two case studies: one in the private sector and one in the public sector. In the private sector, I discuss the impact of blockchain technology on digital value chains, such as digital advertising, as this industry represents one of the prime opportunities where blockchain technology (rather than Bitcoin) can have a significant impact. For the public-sector case, I analyze the impact of blockchain on the land titles and registries market in the country of Georgia (part of the former USSR). This is considered to be one of the most prominent use cases where a blockchain pilot was successful, leading to the initial adoption of this technology.

Throughout this study, my goal is to first trace the evolution of the broader blockchain industry in order to understand the status quo, identify key challenges that blockchain aims to solve, and then evaluate two specific companies—Brave Technologies and BitFury Group—in the context of the framework presented earlier. Brave Technologies is an example of a blockchain-enabled innovation that is disrupting the private-sector browser market currently dominated by incumbents such as Google, Microsoft, and others. BitFury Group is a software and hardware provider that has successfully piloted a land title project in several countries, including the country of Georgia. These two companies represent two differentiated business models: Brave Technologies issues a token called Basic Attention Token (BAT), and Bitfury chose not to do so. Comparing these two business models in the context of the usefulness of having a token will also be part of the scope of this study.

Interpreting the Results

The aim of the case studies is to evaluate the relative level of disruptiveness of blockchain technology using a three-dimensional framework. As the first step, each of the two case study companies will be scored on whether it meets the sub-category criteria (Yes/No) within each metric of the framework. In the second step, the results will be analyzed, and if the proposed innovation meets at least one of the metrics in each category, then the hypothesis of the blockchain technology's "creative destruction" potential will be supported. The score alone should not be used to draw any specific conclusions, but rather used for comparative purposes.

For example, using the same methodology, disruptive innovations such as PCs can be explained. PCs exemplified the cost-reduction factor because they appealed to a new market segment. Unlike earlier supercomputers that targeted only government agencies, universities, and other specialized institutions, the new Apple computer was cheaper and appealed to the average computer—despite being inferior to competing mainframes and minicomputers. Christensen noted, "Prior to its introduction, mainframes and minicomputers were the prevailing products in the computing industry. At a minimum, they were priced around $200,000 and required engineering experience to operate."[26] PCs also scored highly in the marketplace dynamics category, specifically the value networks and the target customers segments. PCs tapped into the unmet needs of a niche customer base before targeting a larger customer base. Lastly, PCs exhibited high

[26] Christensen Institute, "Disruptive Innovation." https://www.christenseninstitute.org/key-concepts/disruptive-innovation-2/. (Accessed 30 January 2019.)

levels of policy change and macroeconomic impact, as their proliferation significantly influenced policy change, such as cybertheft regulations, and led to economic growth of the technology sector.

The minimum requirement for achieving the designation of "creative destruction" is expressed as follows:

(MIN) Satisfactory Overall Performance (OP) = Technological Features (TF) * 1 (Yes) + Market Dynamics (MD) * 1 (Yes) + External Factors * 1 (Yes)

An example of a successful outcome of a case study is shown in Table 2 below.

Table 2: Example of a "Disruptive Innovation."

CATEGORY	**INDICATOR**	**RESULT**	**SCORE**
TECHNOLOGICAL FEATURES	Simplification	No	0
	Cost Reduction	Yes	1
	Novel Ownership	No	0
MARKETPLACE DYNAMICS	Value Networks	Yes	1
	Profit Margins	No	0
	Target Market	Yes	1
EXTERNAL FACTORS	Policy	Yes	1
	Macroeconomic Factors	Yes	1
SCORE			**5**

Source: thesis author

It is important to point out that because scoring is inevitably subject to the evaluator's bias and other influencing factors, the results of this study are not meant to be taken as scientific evidence but rather as a starting point for additional analysis of this complex emerging innovation.

Chapter II

Blockchain Technology: A Brief Overview

This chapter addresses several key questions about the nature of blockchain technology. I begin by discussing what blockchain technology is, how it is different from a traditional database, and why it is secure. One of the most common confusions about blockchain technology that is worth clarifying upfront is its relationship with currencies like Bitcoin. I also briefly introduce basic terms such as mining, tokens, and private versus public blockchains.

In its most simplistic terms, blockchain technology is a form of database or ledger. However, unlike the traditional database (e.g., a spreadsheet), blockchain is not maintained by a single party but rather by a globally distributed network of entities called *nodes*. Nodes are machines that complete complex computational algorithms to validate every change to the original database. If a majority, or 51%, of the nodes agree to the proposed modification to the status quo, the database is successfully updated. This process of validating every transaction is known as *mining*, and the method by which the nodes agree to each single version of truth is called *consensus algorithm*. Nodes are incentivized to participate in maintaining this distributed ledger by being paid with rewards called *tokens*. Blockchain is generally tamper-proof or immutable because unlike the traditional database, it does not rely on a single point of failure. Instead, blockchain's integrity depends on an expectation that the majority (51%) of nodes maintaining it will remain truthful.

Common misconceptions exist regarding the difference between cryptocurrencies or tokens, such as Bitcoin, and the underlying blockchain technology. Bitcoin is a form of currency that does not require a central authority such as bank to maintain the ledger of records. What makes Bitcoin a viable alternative to a current fiat currency such as the US dollar, is blockchain technology which prevents the double-spending problem[27] through the process of distributed verification. Blockchain is the underlying protocol that facilitates the peer-to-peer exchange of value, although the value is not limited to financial exchange. According to former Gartner Fellow Ray Valdes:

> In the same way that the Internet is a global-scale, distributed, peer-to-peer network that allows any node in the network to send a packet of TCP/IP data to any other, the vision of blockchain technology is to allow any node on the global network to send a packet of value (to conduct a dynamic and potentially complex exchange of value, digital asset or other information).[28]

This means that while Bitcoin is one of the first relatively successful applications of blockchain, the broader technology offers a platform for other applications to emerge. The key distinction is this: while Bitcoin is strictly limited to the exchange of money, blockchain technology can enable any form of exchange—from land titles to digital rights—in secure, transparent, and immutable way.[29]

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[27] Refers to an entity spending an amount of cryptocurrency more than once, creating a disparity between the spending record and the amount of cryptocurrency available. Cash does not have a double-spending issue; if you pay for a sandwich with a $10 bill, you give that bill to the sandwich maker. You cannot spend that same $10 elsewhere. A transaction using a digital currency like Bitcoin occurs entirely digitally, which means it is possible to copy the transaction details and rebroadcast it such that the same currency could be spent multiple times by a single owner.

[28] Ray Valdes, "Blockchain Topic Overview," December 2017 (Gartner: Unpublished paper, given to thesis author), 1.

[29] Wall Street Mojo website, "Bitcoin vs. Blockchain," https://www.wallstreetmojo.com/bitcoin-vs-blockchain/. (Accessed 30 January 2019.)

Like Bitcoin, the purpose of blockchain technology is to disintermediate the central authority, i.e., a bank, a government institution, or any party responsible for maintaining a ledger, and whose trustworthiness is largely unchecked. Essentially, blockchain technology created a self-enforcing system of checks and balances where the single version of the truth is verified by a distributed network of independent agents rather than a centralized party.

Another important development that took place since the invention of distributed ledger technology (DLT) is the advent of *smart contract capability*. Originally proposed by Nicholas Szabo in 1995,[30] smart contracts are essentially digitized contracts that use computer code instead of legal language to allow one to self-execute a contract based on a pre-defined set of criteria: "stores rules for negotiating the terms of an agreement, automatically verifies fulfillment, and then executes the agreed terms."[31] A smart contract facilitates the process of value exchange between parties that engage in a transaction, i.e., the exchange of any form of asset. The key advantage of smart contracts is that they are self-enforcing and immutable, which means they often reduce settlement costs, minimize dispute resolution, and improve efficiencies. The proposed case studies in this thesis will discuss specific applications and benefits of blockchain technology in greater detail.

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[30] Nicholas Szabo, "Smart Contracts: Building Blocks for Digital Markets," *Extropy*, 1996.

[31] "A Guide to Smart Contracts and Their Implementation," *Ruby Garage*, 2019. https://rubygarage.org/blog/guide-to-smart-contracts. (Accessed 24 January 2019.)

Chapter III

Introduction to Case Study 1: Disruption in the Advertising Industry

Since the 1980s, the advertising industry was dominated by news moguls who collected advertising revenue with little transparency and almost unlimited negotiating power.[32] Between 1981 and 1996, the per-line price of advertising in the *Washington Post* tripled—from $2.85 per line of advertising to $7.93.[33] With more than 30% profit margins, these incumbents were determined to control any threat to their business models by using political lobbying and alliance building. For example, when a new competitor, AT&T, attempted to challenge the incumbents by introducing an electronic version of Yellow Pages,[34] in an attempt to hold onto their unlimited powers the newspapers and publishers formed alliances like the prominent trade group ANPA with more than 1,300 U.S. daily newspapers. They leveraged available political pressures to halt the threat. Not until the internet boom and proliferation of websites did this industry truly experience collapse.

The first serious challengers to the newspaper classified advertising business emerged during the peak of the internet boom in the early 1990s. With the proliferation of

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[32] Jack Shafer, "Don't Blame Craigslist for the Decline of Newspapers," *Politico*, 13 December 2016. https://www.politico.com/magazine/story/2016/12/craigslist-newspapers-decline-classifieds-214525. (Accessed 24 January 2019.)

[33] Shafer, "Don't Blame Craigslist."

[34] Conrad C. Fink, *Strategic Newspaper Management* (New York: Pearson, 1995), 381.

personal computers, the invention of TCP IP, and the creation of the first widely used web browser (Netscape), an online business model became possible. Early examples of these emerging challengers were Amazon (founded in 1994), Cars.com (1998), EBay.com (1995), RealEstate.com (1995), Google.com (1998), Linkedin.com (2003), and Facebook.com (2004). While some firms went out of business, the ones that have survived thrived. They are now regarded as disruptive innovations because they displaced the market share of many brick-and-mortar incumbents.

The most serious threat to the newspaper advertising business emerged in 1995 in the form of Craigslist. A free advertising marketplace for everything from jobs to furniture to housing, Craigslist was viewed as a more efficient alternative to the long-established newspaper advertising business. As a platform for both buyers and sellers to transact directly rather than going through an intermediary such as a newspaper, Craigslist made the process of value exchange easier, faster, and more frictionless. According to a recent study by Robert Seamans and Feng Zhu,[35] between 2000 and 2007 Craigslist took more than $5 billion worth of revenue away from traditional newspapers. Newspaper revenue fell by $7 billion (from $17 billion to $10 billion) between 2005 and 2009, according to a study by Pew Internet and American Life Project.[36] Figure 1 illustrates how advertising revenue has plummeted.

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[35] Robert Seamans, and Feng Zhu, "Responses to Entry in Multi-Sided Markets: The Impact of Craigslist on Local Newspapers," NET Institute Working Paper No. 10-11, May 28, 2013. https://ssrn.com/abstract=1694622. (Accessed 24 January 2019.)

[36] Sidney Jones, "Online Classifieds," Pew Research Center, Internet & Technology, May 22, 2009. http://www.pewinternet.org/2009/05/22/online-classifieds/. (Accessed 29 January 2019.)

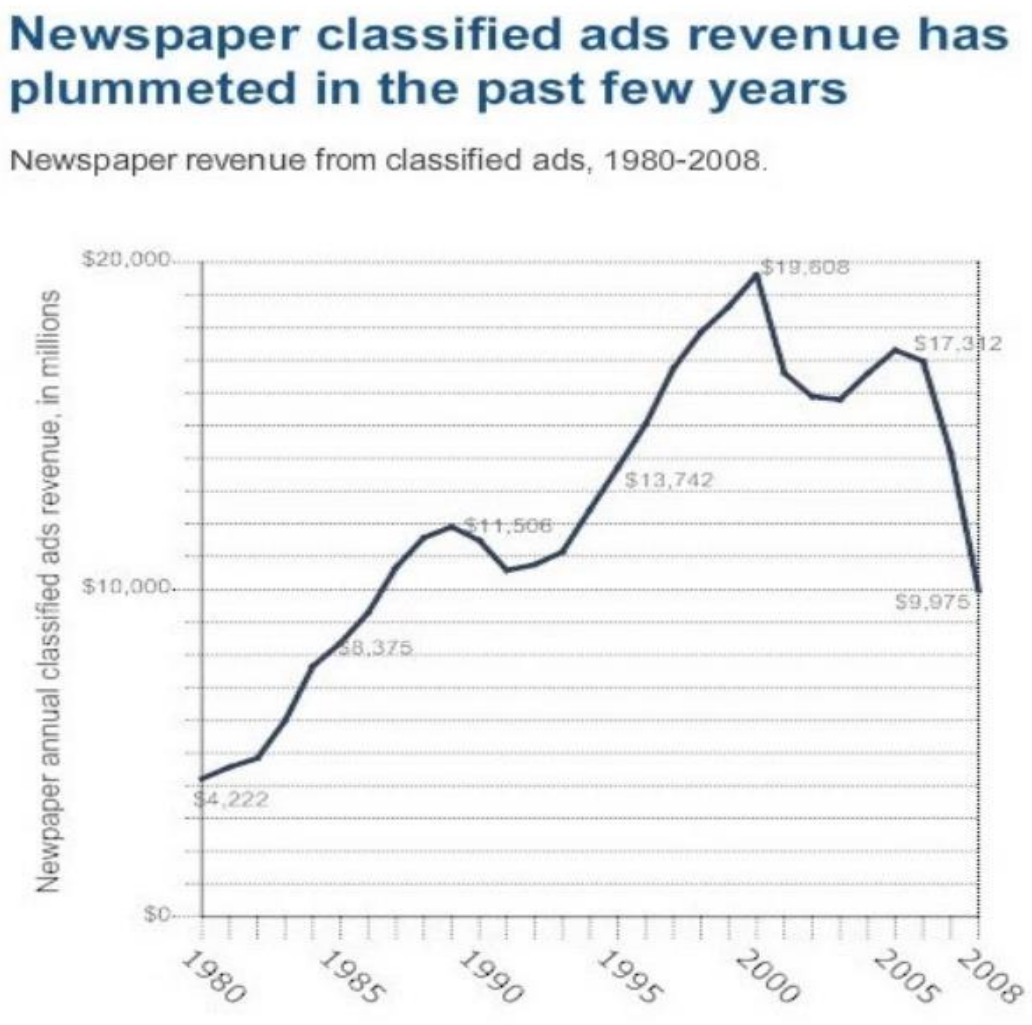

Figure 1: Newspaper classifies ads revenue, 1980-2008.

Source: Jones, 2009.

As Figure 1 shows, newspaper classified ad revenue experienced a sharp decline: first temporarily in 1999 during the peak of the internet boom, and then permanently declining beginning in 2005. By 2008, newspaper revenue from classified adds had declined by half, to less than $9 billion, and the trend continues today. Some leaders in the newspaper and publishing industry blamed the founder of Craigslist, Craig Newmark,

for singlehandedly slashing the entire industry. Others believe that even without Newmark, such a fate was inevitable as the proliferation of personal computers and digital technologies created opportunities to exchange and access information more freely, which gave rise to the new business models.

Today newspaper advertising has shifted almost exclusively to online sources. While global advertising revenue amounts to some $558 billion worldwide in 2018,[37] the newspaper advertising market share in 2017 was about $87 billion worldwide.[38] And while traditional newspapers still struggle to make ends meet, the data aggregator moguls—Facebook, Google, Amazon, and others—are collecting billions of dollars worth of revenue. As the exponential curve in Figure 2 below shows, Google's ad revenue grew from less than $70 million in 2001 to $110.9 billion in 2018. Facebook's ad revenue amounts to more than $30 billion in 2018,[39] and this number grows consistently. In other words, a significant portion of global advertising revenue today is no longer collected by legacy newspapers or publishers or broadcasters. It is split mostly among the two giants – Facebook and Google.[40]

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[37] Statista, "Global Advertising Spending From 2010 to 2018." https://www.statista.com/statistics/236943/global-advertising-spending/. (Accessed 29 January 2019.)

[38] Statista, "U.S. Newspaper Industry - Statistics & Facts." https://www.statista.com/topics/994/newspapers/. (Accessed 29 January 2019.)

[39] "Facebook's U.S. and non-U.S. advertising revenue from 2014 to 2018." https://www.statista.com/statistics/544001/facebooks-advertising-revenue-worldwide-usa/. (Accessed 24 January 2019.)

[40] "Google and Facebook Tighten Grip on US Digital Ad Market: Duopoly to grab more than 60% of 2017 digital ad spend," September 21, 2017. eMarketer website. https://www.emarketer.com/Article/Google-Facebook-Tighten-Grip-on-US-Digital-Ad-Market/1016494. (Accessed 1 February 2019.)

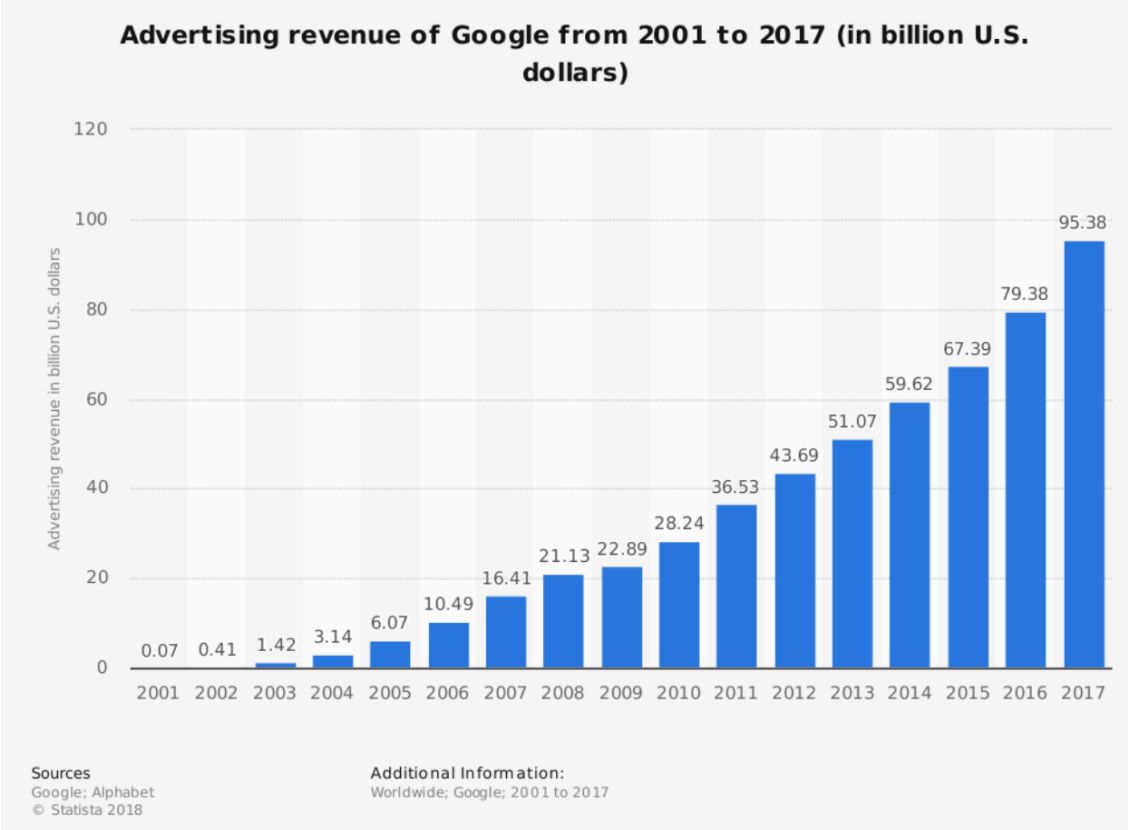

Figure 2. Google advertising revenue, 2001 to 2017 (US$, billions).

Source: https://www.statista.com/statistics/266249/advertising-revenue-of-google/.

Key Challenges Facing Digital Advertising

Before analyzing how blockchain technology can disrupt digital advertising, it is important to discuss the key challenges facing this industry today. Three key challenges face the digital advertising industry: (1) lack of transparency and accountability; (2) fraud or tampering with official records; and (3) misalignment of incentives. These challenges not only permeate the digital advertising space but are also present in many other industries: supply chains, healthcare, any other sector where data such as records pass through multiple parties—intermediaries—that are not trustworthy. Therefore, the outcomes of the case studies could apply to other industry use cases.

Lack of Transparency and Accountability

Just as newspaper classified ads in the 1980s provided little visibility into the price markups of ads, there is little visibility into the value chain of each dollar spent on digital advertising.[41] For example, for each advertising dollar Procter & Gamble spends to acquire a customer for an Ivory Soap product, there is a complex layer of middlemen that collect tolls. These are demand-side platforms (DSPs), supply-side platforms (SSPs), tax collectors, agencies, exchanges, data aggregators, data sellers, content providers, and others. In addition, because of their market domination, Google and Facebook essentially "act as virtual online gatekeepers."[42] Unquestionably, these intermediaries currently fulfill a set of necessary functions, from bulk data aggregation to matchmaking services to personalized search results. However, despite the value that these incumbents provide, the toll tax they collect squeezes the margins of many publishers, content providers, and advertisers, forcing many content creators out of business as "products and services are increasingly commoditized by these gatekeepers."[43] According to one report, more than 40 cents of each dollar spent on advertising goes to fees charged by middlemen.[44] Another study showed that the total "tech tax" in the program advertising industry

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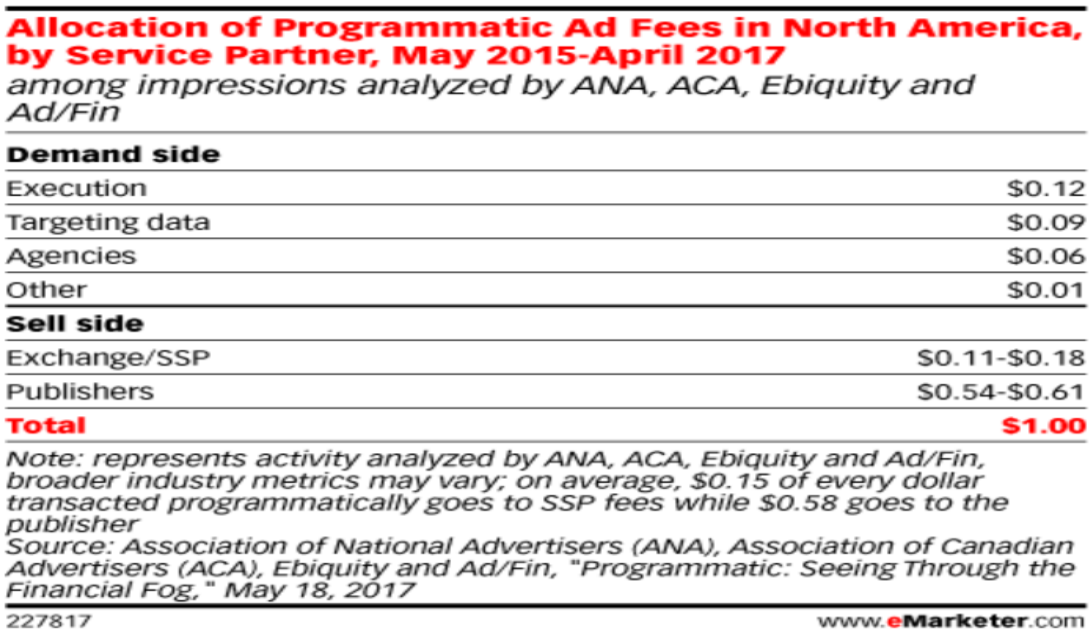
[41] Shafer, "Don't Blame Craigslist."

[42] Avivah Litan, David Mahdi, Adrian Leow, "Cool Vendors in Blockchain Technology," Gartner Research, 31 August 2018: 5. https://www.gartner.com/doc/3889066/cool-vendors-blockchain-technology. (Accessed 1 February 2019.)

[43] Litan, Mahdi, and Leow, "Cool Vendors," 5.

[44] Nicole Perrin, "What Blockchain Might Mean for the Digital Ad Supply Chain," *eMarketer*, 26 March 2018. https://www.emarketer.com/content/what-blockchain-might-mean-for-the-digital-ad-supply-chain. (Accessed 24 January 2019.)

amounts to about 55 cents for each dollar spent.[45] Figure 3 illustrates how various fees are allocated in each advertising dollar.



Allocation of Programmatic Ad Fees in North America, by Service Partner, May 2015-April 2017

among impressions analyzed by ANA, ACA, Ebiquity and Ad/Fin

Demand side	
Execution	$0.12
Targeting data	$0.09
Agencies	$0.06
Other	$0.01
Sell side	
Exchange/SSP	$0.11-$0.18
Publishers	$0.54-$0.61
Total	**$1.00**

Note: represents activity analyzed by ANA, ACA, Ebiquity and Ad/Fin, broader industry metrics may vary; on average, $0.15 of every dollar transacted programmatically goes to SSP fees while $0.58 goes to the publisher

Source: Association of National Advertisers (ANA), Association of Canadian Advertisers (ACA), Ebiquity and Ad/Fin, "Programmatic: Seeing Through the Financial Fog," May 18, 2017

227817 www.eMarketer.com

Figure 3. Allocation of Program Ad Fees in North America by Service Partner.

Source: Perrin, 2018.

Fraud

Lack of visibility also creates another major pain point for digital advertisers today—fraud, which is estimated at $19 billion of lost revenue worldwide.[46] According to

[45] Ross Benes, "Why Tech Firms Obtain Most of the Money in Programmatic Ad Buys," *eMarketer*, 16 April 2018. https://www.emarketer.com/content/why-tech-firms-obtain-most-of-the-money-in-programmatic-purchases. (Accessed 24 January 2019.)

[46] Juniper Research, "Ad Fraud to Cost Advertisers $19 billion in 2018, Representing 9% of Total Digital Advertising Spend," 26 September 2017. https://www.juniperresearch.com/press/press-releases/ad-fraud-to-cost-advertisers-$19-billion-in-2018. (Accessed 29 January 2019.)

Chad Peplinski, Senior Vice President of Media at Conversant, a digital marketing company:

> The most common forms of ad fraud are pixel staffing, which is the placement of an invisible pixel containing an ad that is not seen on a page; ad stacking, in which ads are layered on top of each other where one will be seen; misrepresentation or misidentification, where an ad is placed on an illegitimate domain used to deceive the buyer; ad injection, where a publisher has not given permission to an application or a browser to insert an ad onto their page.[47]

Ad fraud primarily occurs due to lack of transparency, i.e., there is no trustworthy way of verifying the information that publishers and intermediaries share with the advertisers. A recent Forbes article noted:

> The lack of a reliable and trusted settlement layer between all the businesses involved—advertisers, agencies, exchanges, networks, publishers, and so on—means there's no single source of truth for any of the players to rely upon. [48]

Specifically, several allegations have been made against prominent industry players:

- Yahoo was not serving ads to 30–70% of the locations that they claimed;
- Facebook had been overstating video ad metrics by an estimated 60–80% for two years, resulting in a class action lawsuit;

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[47] Josh Sternberg, "What Is Ad Fraud and How Does It Happen?" Adweek website, 24 July 2018. https://www.adweek.com/digital/what-is-ad-fraud-and-how-does-it-happen/. (Accessed 1 February 2019.)

[48] Darryn Pollock, "Advertising Fraud Falls Flat When Faced With Transparency: How Can Blockchain Help?" *Forbes,* 22 November 2018. https://www.forbes.com/sites/darrynpollock/2018/11/22/advertising-fraud-falls-flat-when-faced-with-transparency-how-can-blockchain-help/#1e25b4715768. (Accessed 30 January 2019.)

- Google was exposed by MalwareBytes as having its ad network abused by a fraud operation that targeted European users by using layered ad injection that displayed fraudulent cookie disclosure notifications.[49]

In total, ad fraud today represents roughly 10% of the entire digital advertising value chain. In other words, middlemen who collect taxes in the digital advertising value chains collectively accumulate roughly 40-70% of advertising dollars spent to acquire a customer.

Misaligned Incentives

Another challenge with the current *modus operandi* in the digital advertising space is the lack of alignment of incentives. The monetization of personal data is skewed toward intermediaries, and the end consumer has very little control over how their personal data is being collected and used. To put things in perspective, Google sells $100+ billion worth of consumer data to advertisers while consumers receive none of the revenue. In exchange for collecting and selling users' data, search engines like Google are simplifying the internet browsing experience, while social media like Facebook are connecting users all over the world. While many users see value in leveraging these hubs for various purposes, it is clear that a large portion of users do not wish to be exposed to ads, evidenced by the fact that "about 11% of internet users used some form of ad blockers in 2017."[50] While these so-called 'freemium' models have grown in popularity

[49] "Reducing Digital Ad Fraud: A New Deal with BAT." https://basicattentiontoken.org/reducing-digital-ad-fraud/. (Accessed 30 January 2019.)

[50] Litan, Mahdi, and Leow, "Cool Vendors in Blockchain Technology," 6.

over the years, if successful, an alternative structure that compensates a user, content providers, and other ecosystem players could pose a threat to the status quo.

A Hypothesis for a Blockchain Solution

Blockchain technology has the potential to solve most of the challenges outlined above. First, it brings more transparency to digital value chains such as digital advertising. By utilizing distributed ledger technology, advertisers, publishers, and users have visibility into the financial supply chains and can account for how each advertising dollar is spent throughout the digital value chain, including what cut each party receives in each transaction relative to the value add it brings during the process of acquiring a customer. Second, because of its decentralized nature, the ledger is fundamentally secure and tamper-proof, potentially challenging the $19 billion advertising fraud industry, and increasing the accountability of each party in every transaction. Third, blockchain technology allows advertisers to optimize and align their spent advertising revenue with the parties that contribute most to each transaction—ultimately enabling them to acquire every customer quicker, cheaper, and more efficiently.

Chapter IV

Case Study I: Brave Technologies

One example of a company that is working to solve some of the problems outlined above is Brave Technologies, and its associated product Brave Browser. Essentially, Brave is a decentralized version of internet browsers such as Firefox, Chrome, or Internet Explorer—except for it pays the customer for consuming ads. In other words, it pays the customer for attention, hence the name of its token, Basic Attention Token (BAT). It claims to improve privacy (it does not store any of its users' personal data on its servers), speed (Brave loads no advertising content on the website), while providing monetization opportunities for its consumers. In addition, it allows for a concept called "self-sovereign identity," which means the individual has the full right to own and monetize his/her data. This data is one of the most valuable assets a firm can possess and create value from, and Brave poses a threat to such firms by assigning this asset to an individual rather than to a firm.

About Brave Browser

Like the rest of the digital advertising space, the general browser market lacks transparency, and is dominated by several major incumbents that charge fees—search royalties, marketplace fees, etc.[51] For example, 97% of Mozilla Firefox's $314M revenue

[51] Bertil Hatt, "How do internet browsers actually make money?" Quora website. https://www.quora.com/How-do-internet-browsers-actually-make-money. (Accessed 1 February 2019.)

in 2013 came from search royalties calculated as a percentage of advertising revenue from the use of search engines like Google.[52] Brave Browser—created as an open-source initiative utilizing the decentralized protocol Ethereum—aims to solve these problems and to challenge incumbents such as Google Chrome, Mozilla Firefox, and Microsoft Internet Explorer. One of Brave's key value proposition is that it blocks all advertising by default, including programmatic advertising, i.e., ads placed by pre-programmed software. Unlike traditional browsers that use tracking cookies that follow users around the Internet, Brave leverages a user's local browsing history to select the most relevant advertising content to be pushed toward the users that opt to receive ads. Overall, there are four key value propositions for Brave internet users: (1) an ad-free browsing experience, (2) data monetization (users get compensated in exchange for viewing targeted ads by advertisers), (3) a safer and faster browsing experience, as it blocks all the tracking software and (4) Brave lowers the cost of mobile data use, with an average bill of $23 per month in the U.S.

For publishers, the key value proposition is the ability to monetize the content. In fact, the compensation structure is skewed toward content publishers who will receive 55% of replaced ad revenue. In addition, users will have the capability to compensate publishers further by donating a portion of their revenue by using blockchain-based micropayments.[53] That said, it is not clear whether any meaningful donations can be

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[52] Gregg Keizer, "Mozilla Reports Flat Revenue From Google-Firefox Search Deal," Computerworld website. 21 November 2014. https://www.computerworld.com/article/2850881/mozilla-reports-flat-revenue-from-google-firefox-search-deal.html. (Accessed 1 February 2019.)

[53] Sebastian Anthony, "Mozilla Co-Founder Unveils Brave, A Browser that Blocks Ads by Default," *ARSTechnica*, 21 January 2016. https://arstechnica.com/information-technology/2016/01/mozilla-co-founder-unveils-brave-a-web-browser-that-blocks-ads-by-default/. (Accessed 31 January 2019.)

expected from users, but the channel to do so does exist. Another key value is Brave's claim that leveraging its AI technology and ad customization strategy will help click-rates and ad viewership to rise significantly, thereby creating better outcomes and ROI for advertisers. However, a potential downside to this strategy is that by developing a proprietary ad-targeting model, Brave essentially fulfills the role of other intermediaries, as ultimately Brave is responsible for selecting and placing the ads. That said, the value capture model is more distributed and favors various players in the ecosystem rather than just Brave itself. Hence, it would be fair to assume that the strategy Brave would pursue in placing ads would most likely benefit the rest of the players as much as it would benefit Brave. Figure 4 illustrates these key value propositions.

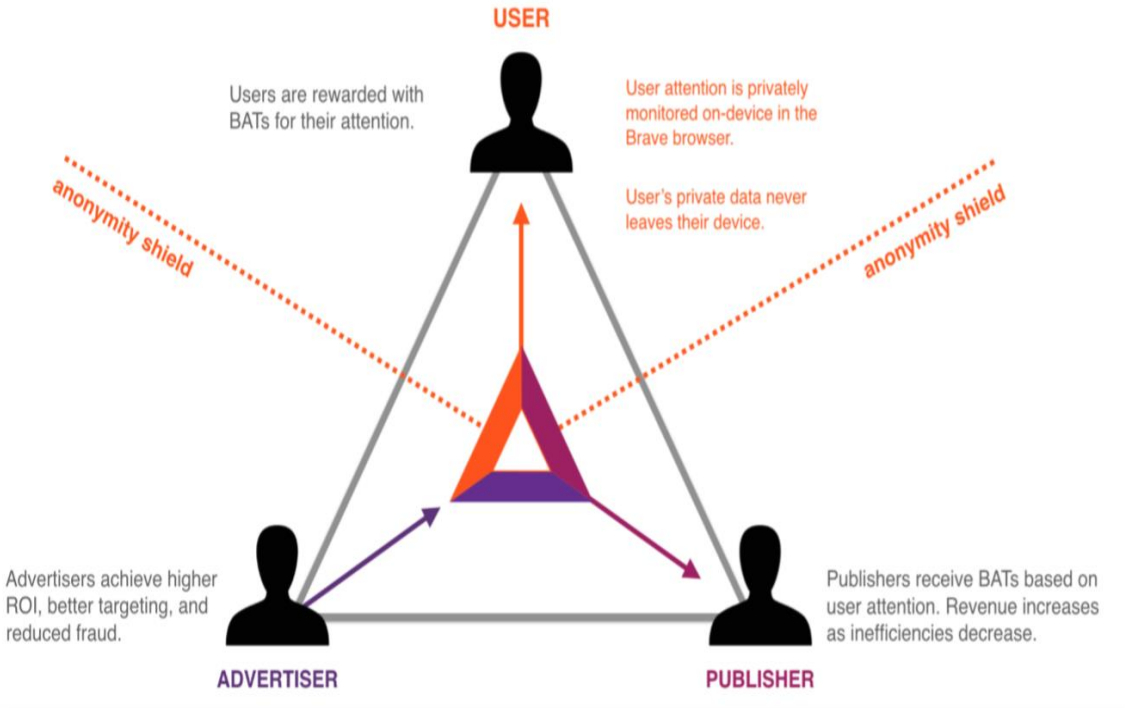

Figure 4. BAT Digital Ad Flow

Source: https://basicattentiontoken.org/BasicAttentionTokenWhitePaper-4.pdf, p. 28

The project was developed by the creator of Javascript and the co-founder of Mozilla Firefox, Brendan Eich and Brian Bondy, who also worked on a number of prominent projects such as Khan Academy, Mozilla, and Evernote. In order to fund the development and incentivize partners in the ecosystem, Brave Technologies created its Basic Attention Token (BAT). In 2017, the company offered one billion of BATs via a token sale, allegedly generating $35 million in 30 seconds.[54] Although the token sale was open to the public, only 130 addresses were able to participate in the initial sale – with 5 buyers taking more than half of the entire token supply. Even though initial distribution of BAT tokens became concentrated in the hands of the few rather than in the hands of many, over time the distribution evened out as more individuals were able to purchase the token on exchanges.[55] At the time of writing, the ownership of a token is distributed in the hands of more than 80,000 unique addresses.[56] Considering that a number of publishers were awarded BATs in exchange for signing up to the platform, it would be fair to assume strong level of decentralization of the token among key participants in the ecosystem.

Even though the project is relatively new, originating in May 2015, Brave has already started to demonstrate early signs of traction. Less than two years into its official launch in January 2016, Brave browser had already acquired four million monthly active

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[54] Corey Petty, "A Look at the BAT Token Distribution," Blockchannel website. 6 June 2017. https://medium.com/blockchannel/a-look-at-the-bat-token-distribution-771d163393f3. (Accessed 31 January 2019.)

[55] Jonathan Keane, "$35 Million in 30 Seconds: Token Sale for Internet Browser Brave Sells Out." Coindesk website, 31 May 2017. https://www.coindesk.com/35-million-30-seconds-token-sale-internet-browser-brave-sells. (Accessed 31 January 2019.)

[56] "BAT Top 100 Token Holders," Etherscan website. https://etherscan.io/token/tokenholderchart/0x0d8775f648430679a709e98d2b0cb6250d2887ef. (Accessed 1 February 2019.)

users.[57] By comparison, Facebook attracted a similar number of users within the same period of time after its official launch, reaching six million in 2005.[58] Although this could be explained by the fact that from 2004 to 2006 the total number of internet users was much lower than today, these numbers still indicate significant traction and some indication of Brave's future potential to take market share away from the incumbents. Furthermore, the platform enjoys an increased interest from both publishers and users. *Forbes* noted: "As of last month [August 2018], the Brave browser had been downloaded over 10 million times."[59] According to a Gartner report, in the same timeframe,

> Brave had verified over 20,000 publishers, of which 13,500 are YouTube creators, all of which signed up to be Brave publishers. The 13,500 YouTube channels have more than 260 million subscribers. Brave also has a few notable large publishers signed up as partners, including Dow Jones Media Group publications and Townsquare.[60]

Furthermore, one of the most prominent exchanges, Coinbase, began to list the BAT token in 2018. All of these early signs of traction signify that this is an excellent example for inclusion in this research study.

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[57] Francisco Memoria, "Brave Browser Reaches 4 Million Monthly Active Users, 26,000 Publisher Accounts," *CryptoGlobe*, 2 September 2018. https://www.cryptoglobe.com/ latest/ 2018/09/brave-browser-reaches-4-million-monthly-active-users-26000-publisher-accounts/. (Accessed 31 January 2019.)

[58] "Number of Active Users at Facebook Over the Years." Associated Press website, 23 October 2012. https://finance.yahoo.com/news/number-active-users-facebook-over-years-214600186--finance.html. (Accessed 1 February 2019.)

[59] Elad Natanson, "Blockchain For Digital Advertising: Cure-All Or Disruption?" *Forbes*, 27 September 2018. https://www.forbes.com/sites/eladnatanson/2018/09/27/blockchain-for-digital-advertising-cure-all-or-disruption/#7f618dc02437. (Accessed 31 January 2019.)

[60] Litan, Mahdi, and Leow, "Cool Vendors in Blockchain Technology," 6.

Chapter V

Analysis of Case Study 1

This chapter analyzes the Brave Browser, a new blockchain-based browser, in the context of the three dimensions of disruptive innovation. These are: Technological Features, Marketplace Dynamics, and External Factors.

Technological Features

In order to qualify as a disruptive innovation, Brave Technologies must exhibit at least one of three Technological Features. These are simplification, cost reduction, or novel governance structure.

Simplification

- *Degree to which the product or service offers simplification.* Typically, these innovations are inferior to the mainstream product. Many product attributes are either nonexistent or oversimplified compared to the level currently offered by incumbents.

Brave browser does not meet the Simplification criteria because the product in fact claims to offer superior features compared to the status quo—Brave offers faster loading speed, and it offers additional functionality: private browsing and compensation for viewing ads. Even in its current version, Brave browser is on a par with established incumbents in terms of total number of features, and no features are oversimplified

compared to the status quo. Therefore, Brave does not meet the "simplification" criteria as outlined above.

Rating: No

Cost Reduction

- *Degree to which the product or service fulfills the need of an over-served or a new customer segment by offering a "good enough" product or service at a lower price point.*

Even though Brave browser claims to offer significant cost reduction to customers, advertisers, and publishers, it would not satisfy this category's requirement, as the product's purpose is to outperform the current version of the browser rather than offer a less-expensive alternative with "good enough" functionality. As an outcome of its functionality, and due to smart contract technology, Brave Technologies claims that the costs associated with eliminating intermediaries are lowered but not completely eliminated. In fact, elimination of intermediaries is the biggest cost reduction associated with leveraging blockchain technology.

Costs of verification, through the process of instantaneous settlement, are removed. In their research paper, Christian Catalini and Joshua Gans point out that the cost of verification is one of the key costs significantly impacted by blockchain technology.[61] That said, Brave's goal is to offer transparency and browsing privacy, features that go above and beyond the core functionality of an incumbent browser, rather

[61] Christian Catalini, and Joshua S. Gans, "Some Simple Economics of the Blockchain," Rotman School of Management Working Paper No. 2874598; MIT Sloan Research Paper No. 5191-16 (September 21, 2017). https://ssrn.com/abstract=2874598. (Accessed 25 January 2019.)

than present a lower price-point version of Google Chrome or other competitors. Hence these criteria are not fulfilled.

Rating: No

Novel Ownership

- *Degree to which the product or service offers novel ownership factors that can influence costs, employee motivation, and organizational performance.*
- *Degree to which the product or service leverages novel methods of resource utilization, or affects changing characteristics like price or services surrounding the innovation, or affects marketplace expectations.*

A distinction must be made here between the underlying company (Brave Technologies), and the BAT. If I analyze BAT independently from the firm itself, it does meet the criteria for novel ownership, as the token is rather distributed among the ecosystem players such as the users; it changes the price and profit-sharing dynamics of the firm; and it also aims to create an alignment of incentives—a novel ownership structure whereby all parties in the ecosystem are compensated for their fair share of contribution, and the incentives are aligned toward more favorable outcomes and away from ad fraud.

> BAT protects against fraud by eliminating third-party traffic sourcing, which the 2015 White Ops & ANA Baseline Bot Study concluded was more than three times as likely to contain bots than unsourced traffic. Also, by reducing middlemen, BAT eliminates the fees, latency, and additional round trips in the ad-serving process. This means fewer ads and trackers, thus a much better user experience with better economics for users, advertisers, and publishers.[62]

[62] "Reducing Digital Ad Fraud," Basicattentiontoken.org website.

However, the holding company, Brave Technologies, does not satisfy the criteria. The ownership structure of the company is no different than that of a traditional software firm, with CEO, executive team, and VCs owning equity shares in the company. Therefore, I conclude that Brave Technologies does not meet the criteria of novel ownership, while its BAT token qualifies for the novel ownership factor of a disruptive innovation.

Rating: Brave Technologies, No; BAT, Yes

Marketplace Dynamics

In order to qualify as a disruptive innovation, Brave Technologies must exhibit at least one of the following Marketplace Dynamics features: Value Networks, Profit Margins, and Target Markets. I will discuss each of these features to determine if they apply to Brave Browser.

Value Networks

- *Degree to which the innovation taps into the unmet need in the market by creating and adding differentiated value to customers.*
- *Degree to which innovation offers radical functionality*, meaning that these innovations disrupt the value networks by impacting other stakeholders (suppliers, competitors), business processes (assembly line or inventory management), resources (required to sell this product), and values. If the value network is mostly disrupted, the innovation is considered a disruptive innovation.

Brave scores highly in this category as it fundamentally transforms the existing value chain by eliminating the need for advertising exchanges, audience segmentation companies, third-party tracking software, data management platforms, and other middlemen. It simplifies the value capture in the ecosystem among four players: publishers or content providers, advertisers, users, and the company itself. In addition, unlike the traditional incumbents, the value captured is skewed toward publishers and users, and away from the intermediaries. Advertiser benefits are subject to Brave's proprietary artificial intelligence matching software. In addition, since Brave's inception, competitors like Mozilla Firefox have come out with new versions of their browser, offering full privacy and ad blocking—a sign of the impact Brave is having on its competition. This fundamentally disrupts value networks that are already well established in the digital advertising space.

Rating: Yes

Profit Margins

- *Degree to which the profit margins of an innovation are less attractive than those of existing technologies.* Typically this makes an innovation an unappealing investment opportunity for existing incumbents, and for that reason it is often ignored or dismissed.

Like a traditional browser, Brave browser's revenue streams depend on advertising revenue. Unlike traditional browsers, Brave browser blocks all ads by default, and therefore it depends solely on funding, customer donations, or customers who opt it to view ads. The company's goal, once it has a strong percentage of customers who opt in

for advertising, is to create the following compensation structure: Brave will capture 15% of all advertising revenue; the rest of the revenue stream (85%) is distributed between the publisher (55%), internet users (15%), and ad suppliers (15%). Gartner notes: "Brave has a fixed-fee structure, which is 15% for publisher-hosted ads, and 30% for user-private ads."[63] Although it is too early to tell what the exact profit margins are within the Brave browser, it would be fair to assume that the profit margins are far slimmer than those of traditional incumbents. Therefore, Brave would qualify for this criterion as a disruptive innovation.

Rating: Yes

Target Market

- *Degree to which these disruptive innovations appeal to a niche audience before attacking the mainstream customer.* Typically, as product features are improved, niche customers grow into a larger audience.

Brave's initial goal is to attract niche customers who value their data privacy and data by currently using ad-blocking software when they browse the web. Brave's long-term strategy is to capture market share away from established players. The company indeed targets a niche audience although only initially.

Rating: Yes

[63] Litan, Mahdi, and Leow, "Cool Vendors in Blockchain Technology," 6.

External Factors

In order to qualify as a disruptive innovation, Brave Technologies must exhibit at least one of the following External Factors: Policy Change or Macroeconomic Factors. I will discuss each of these features to determine if they apply to Brave Browser.

Policy Change

- *Degree to which the disruption influences policy change.*
- *Degree to which policy change influences the disruptive innovation.*

Blockchain technology, specifically the Initial Token Offering, has been a topic of heated debate at the government level. However, within the context of the browser market, it is unlikely that any policy or regulation would be influenced by Brave Technologies as, at its core, the market itself is not highly regulated. On the flip side, if BAT is going to be regarded as a security, the company's future might be in jeopardy since it would likely be forced to return all funds to investors and potentially shut down. Unless the token reaches high levels of decentralization and utility to the point that it is mined, owned, and used by millions of users around the world, policy impacts on this technology could be rather significant.

Rating: Yes

Macroeconomic Factors

- *Degree to which the disruptive innovation positively influences long-term economic growth.*

- *Degree to which, in the long term, disruptive innovation can produce an outsized impact in terms of economic growth, including job creation.*

It would be fair to assume that if Brave browser succeeds in eliminating several third-party intermediaries from the ecosystem, the total value of the network will decrease significantly, at least in the short term. In the long term, however, Brave can create value for the entire ecosystem by generating new revenue streams for consumers, and adding value to advertisers and publishers. The question remains whether this business model is sustainable. If it is, the macroeconomic impact could be quite significant.

Rating: Yes

Summary

According to my analysis, in its current form Brave Technologies does not meet the criteria for disruptive innovation as it fails to fulfill the Technological Features criteria of the framework. However, its token, BAT, qualifies based on its novel ownership structure. BAT's ownership is now distributed in the hands of thousands of users, many of whom are using the token to pay for the service that Brave provides, as well as be compensated for viewing ads in BAT. In addition, BAT enables faster micro-payments compared to its fiat alternative, which could either enhance the simplification of the user experience or make it more complex, depending on how difficult it is to obtain the tokens. That said, the long-term implications of BAT have yet to be seen and also are contingent on the level of policy change that is required for the token adoption to take place. Table 3 summarizes my analysis.

Table 3. Summary of Level of Impact of Brave Browser

CATEGORY	INDICATOR	RESULT (LEVEL OF IMPACT)	SCORE
TECHNOLOGICAL FEATURES	Simplification	No	0
	Cost Reduction	No	0
	Novel Ownership	Brave Technologies (No) / BAT (Yes)	0.5
MARKETPLACE DYNAMICS	Value Networks	Yes	1
	Profit Margins	Yes	1
	Target Market	Yes	1
G30EXTERNAL FACTORS	Policy Change	Yes	1
	Macroeconomic Factors	Yes	1
SCORE			5.5

Source: thesis author

Overall, the company scored the highest in Marketplace Dynamics and the lowest in Technological Features. The indication of strong Marketplace Dynamics demonstrates this technology's high impact on value networks, such as competitors, customers, suppliers, and other stakeholders in the ecosystem. Specifically, Brave browser provides an alternative business model to the web browsing market by redistributing value capture in favor of publishers, users, and advertisers (in descending order of magnitude), and away from middlemen collecting fees throughout the digital value chains by aggregating and selling consumer data. In addition, by blocking third-party traffic sourcing, BAT increases protection against fraudulent actors such as bots. Because BAT serves as an adverting exchange, connecting the user, publisher and advertiser directly, the

ecosystem's intermediaries, such as measurement and verification agents like Nielsen, Google, or DoubleVerify (see Figure 5), could be eliminated. In addition, Brave's proprietary token creates an alignment of incentives by rewarding good actors (valuable contributors) in the ecosystem who are paid for increased attention from the viewers—either directly through donations or via advertising revenue. As a result, this innovation has the potential to lower costs, align incentives, and increase the value to all three constituents. This also means that the traditional Web 2.0 business model predicated on data monetization strategies could find it challenging to remain relevant if this technology permeates the browser market.

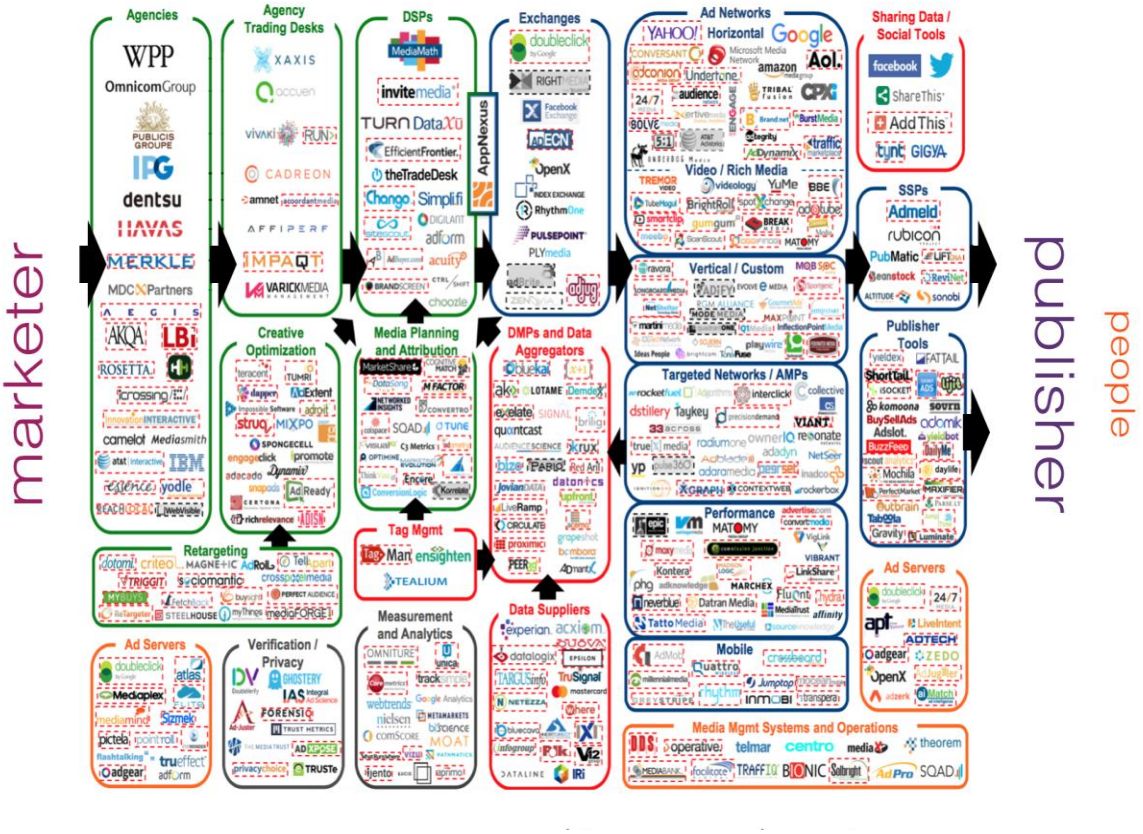

Figure 5. Example of a Value Chain from Advertiser to Publisher.

Source: Brave Software, 5.

Time will tell the macroeconomic and policy implications of this technology. However, it would be fair to conclude that the long-term economic benefits to society could be significant. Specifically, Brave is seeking to re-design the architecture of an internet firm toward more equal and democratized ownership, more fair distribution of revenue, and toward embedded privacy.

That said, there are a number of challenges that this company has to overcome. Since the user data is anonymized, one foreseeable obstacle lies in Brave's ability to measure and track the effectiveness of ad campaigns. Another challenge is the lack of industry standards for onboarding advertisers and publishers to ensure no bad actors enter the system in the first place. In addition, Brave must ensure that it does not take the role of a centralized arbiter deciding which ads get to be placed, thereby undermining the decentralized nature of the project. Lastly, due to the scale of existing incumbents, it might prove difficult for Brave to gain mainstream traction beyond the initial wave of privacy-seeking users.[64] Even though Brave Technologies does not meet the standard criteria of a disruptive innovation, its novelty lies in three categories: (1) BAT's intrinsic novel ownership structure (decentralized nature of ownership) and alignment of incentives; (2) the impact of its business model on disrupting the value chain and the costs of coordination; and (3) its impact on the privacy and self-sovereignty of personal data.

[64] Litan, Mahdi, and Leow, "Cool Vendors in Blockchain Technology," 6.

Key Takeaways

1. To gauge the level of disruptiveness of blockchain innovation, the distinction must be made between the underlying technology, the firm building on top of the select blockchain technology, and the token entity issued by the holding company, such as BAT. As this study demonstrates, while Brave Technologies—the firm behind BAT—failed to satisfy the criteria for novel ownership, its token did enable distributed ownership structure among multiple players in the ecosystem. Should the network succeed in gaining traction, its token would likely appreciate. As a result, the increased value would be captures by this distributed network of owners and ecosystem participants. That said, to enhance the robustness of this conclusion and as a topic for further research, it would be helpful to extend the research and data collection further to track the development of key milestones, such as new user acquisition targets, revenues collected, revenues shared, and number of publishers brought on board.
2. The idea of removing the need for a central authority is evident in the architecture of blockchain's first application, Bitcoin, when Satoshi Nakomoto sought to create a decentralized currency that no longer relied on the trustworthiness of the financial world. As a result of this case study of Brave Technologies, it was evident that the idea of disintermediation of a centralized system of trust was one of the company's key intended consequences. Specifically, Brave's aim was to reduce complexity in the convoluted digital advertising space by connecting the advertiser, publisher, and end user directly. In theory, if all internet traffic were to go through Brave browser instead of the current incumbents, internet users would be able to either opt in for

complete privacy or be compensated for their attention if they chose to view ads. With that said, while the system does play a disruptive role in the value networks, one can argue that it does not provide disintermediation. Users will likely have to leverage centralized search engines like Google or Yahoo in order to locate information they are looking for. Additionally, one could argue that by serving as an arbiter of which ads users will see, Brave in fact takes the role of a middleman, thereby defeating the purpose of the decentralization altogether. As a topic of further research, it would be useful to evaluate how successful each of these companies were in removing rather than substituting the central authority.

3. While the goal of this research was to leverage existing frameworks of disruptive innovation as proposed by scholars like Christensen, it is clear that even if updated occasionally, this framework is not sufficient to capture the complexities of new disruptions since it was originally developed to fit the mold of past well-studied innovation such as PCs or hard disk drives. Universally applying the same framework to any new technology or disruption might not be appropriate. For example, one can argue that the concept of decentralization is disruptive to the status quo, yet no measure of decentralization was tested in this case study. In addition, any research method used to study disruptive innovation is subject to bias. Therefore an updated framework needs to incorporate more objective, rather than subjective, criteria.
4. As is evident from the case study, blockchain technology's disruptive potential lies not only in the technology itself but in the business model that it enables. Specifically, blockchain-enabled firms like Brave Technologies can challenge incumbents whose revenues rely on data monetization and offer an alternative structure—rewarding

various participants in the ecosystem for their contribution. As a topic for further research, analyzing the blockchain technology's impact on data monetization strategies of existing incumbents could prove useful.

5. Effectively studying a disruptive technology is a daunting task to any researcher because of the lack of historical data to either support or refute its true disruptiveness. Thus, evidence that was collected for this study is limited to just ten years of development, with only 12 to 18 months within which to find signs of early adoption by end consumers—in this case, adoption of Brave browser. For that reason, further quantitative data needs to be collected in order to make my conclusions more conclusive, as the evidence presented is mostly anecdotal.

Chapter VI

Blockchain in the Public Sector

This chapter provides some industry background, discusses key challenges, and pose a hypothesis for a blockchain solution. An applicable case study follows in the next chapter.

Industry Background

In his book *The Mystery of Capital,* prominent Peruvian economist Hernando De Soto presents a case for a high correlation between poverty reduction and strong property rights. He declared that the true reason why developed countries succeed with capitalism while the developing world lags behind is not due to cultural differences but rather due to the developing countries' inability to properly enforce property rights. De Soto points out that enforcing property ownership is a basic human right in developed countries such as the United States where land and property are not just forms of shelter but a gateway to other forms of capital, like borrowing money against that property, accessing liquidity from the property, etc.[65] Yet, this feature remains a luxury in developing countries, resulting in more than 80% of the population being "under-capitalized."[66] De Soto

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[65] Hernando De Soto, *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else* (New York: Basic Books, 2007).

[66] "Book Review: *The Mystery of Capital* by Hernando de Soto," *FutureCasts* Online Magazine, vol. 4, no. 8 (1 August 2002): 204-208. http://www.futurecasts.com/book%20review%204-08.htm. (Accessed 29 January 2019.)

established the term *dead capital*, which he defines as assets such as land property that are owned but not officially recognized due either to a lack of formal records or a lack of government systems that formally recognize and enforce the ownership of such assets. In his analysis, De Soto concluded that dead capital represents around $9.3 trillion or roughly 12% of the Global World Product (GWP).[67]

Furthermore, the impact of this economic burden is unevenly distributed and/or skewed toward the disadvantaged groups of global society, including the poor of the world—some five-sixths of humanity. De Soto writes that they "have things, but they lack the process to represent their property and create capital. They have houses but not titles; lands but not deeds; businesses but not statutes of incorporation."[68] In other words, roughly 5.3 billion people around the world either lack any formal representation of the land where they reside, or have to rely on the inefficient bookkeeping handled by often corrupt third-party systems or governments in developing nations.[69] For example, it is estimated that in China more than 150,000 protests take place in the rural areas as a result of properties being unlawfully confiscated from the poor in favor of the wealthy.[70] In addition, this economic disadvantage further amplifies the gender gap, as the lack of property rights for females impacts women far more than men. Although women

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[67] Chris Arsenault, "Property Rights for World's Poor Could Unlock Trillions in 'Dead Capital'," *Reuters Business News*, 1 August 2016. https://www.reuters.com/article/us-global-landrights-desoto/property-rights-for-worlds-poor-could-unlock-trillions-in-dead-capital-economist-idUSKCN10C1C1. (Accessed 27 January 2019.)

[68] De Soto, *The Mystery of Capital*, 6, 7.

[69] Arsenault, "Property Rights for World's Poor."

[70] Arsenault, "Property Rights for World's Poor."

represent roughly half of the world's population, officially they own a mere one percent of all global property assets.

The process of establishing formal property ownership in the West did not happen overnight. In fact, it took over 200 years in most nations, and in some cases much longer. For example, Germany was one of the earliest nations to officially put in place a single integrated system, in 1896. California had eight different jurisdictions that governed title law after the Gold Rush of 1849; Japan did not establish the process of integration until 50 years ago.[71] De Soto writes: "Over decades in the nineteenth century, politicians, legislators, and judges pulled together the scattered facts and rules that have governed properties throughout cities, villages, buildings and farms and integrated them into one system."[72] In many developing nations this process of integrating official title records is just beginning, and will likely take decades to complete.

Even when this process is completed, reliance on a centralized system of records will bring a number of challenges. Often corrupt governments lack the rule of law and integrity to enforce property rights and contracts. Furthermore, records kept in a central location are vulnerable to natural disasters and catastrophes, as was the case with the earthquake in Haiti in 2010 when records stored in multiple government buildings were lost when the buildings were destroyed. These inefficiencies resulted in chaos, fraud, and stolen/taken property and other assets.

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[71] De Soto, *The Mystery of Capital,* 52.

[72] De Soto, *The Mystery of Capital,* 52.

Key Challenges With the Current Land Title System

There are several challenges associated with the current land title system. The following section discusses in more detail key implications vis-à-vis the lack of formal documented and enforceable land and property title records.

Security

The first challenge with the lack of a reliable system of property records is security of individual assets. In many nations, due to the lack of formal and reliable record keeping, the integrity of an asset is often subject to the veracity of a trusted third party such as the government. This results in instances of property or land taken from rightful owners because a third party tampered with or destroyed official records. For example, in 2004 a number of corrupt bureaucrats in Honduras hacked the government title system and re-assigned ownership of a series of beachfront properties into their own names.[73] The rightful owners were forced out of their properties with no ability to prove their rightful ownership other than a piece of paper that no longer matched official government records.

Transferability

Another challenge is the difficulty of transferring or trading an asset from one party to another. If a formal process of property management does not exist, or if it is broken or inefficient, then the process of selling or buying a property becomes extremely

[73] Victoria Lemieux, "Trusting Records: Is Blockchain Technology the Answer?" (School of Library, Archival and Information Studies, University of British Columbia, Vancouver, Canada, 4 December 2015): 122. Available from: www.emeraldinsight.com/0956-5698.htm.

complex and expensive. Both parties in a transaction would have to confirm that one party is indeed the rightful owner of the property. This might prove tricky if no records were established in the first place. Often the only proper way to verify the true ownership of one's own asset is by obtaining verbal signals from neighbors—the only available and sometimes highly unreliable witnesses in such transactions.[74] This results in a time-consuming, expensive, and often flawed process.

Fungibility

Another challenge with the lack of a verifiable property right is that land or property does not function as a fungible asset. This means that the asset is not easily "divided, combined, or leveraged for business deals."[75] For example, a single property, such as a factory, can be owned, managed, and sold by multiple stakeholders without affecting other stakeholders or the property itself.[76]

The fungibility of an asset also refers to the buyer's ability to obtain the economic and social qualities of an asset without having to see the asset itself. With no verifiable records, the only way to obtain an asset's characteristics is via an in-person meeting often including multiple witnesses. This results in bottlenecks in the trading process, which may limit the trading process to the geography of the buyer rather than allowing for a free international trade to take place. On the flip side, with a credible and immutable property

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[74] De Soto, *The Mystery of Capital,* 45.

[75] De Soto, *The Mystery of Capital,* 55.

[76] De Soto, *The Mystery of Capital,* 56.

ownership record system, the trading volume of such an asset would be uncapped, leading to better economic outcomes for buyers, sellers, and the broader economy.

Hypothesis of a Blockchain Solution

Blockchain technology has recently emerged as a potential disruptive solution to the land title registration industry, especially in countries where trust is missing. Due to its distributed ledger, no single party controls the database, therefore no one person or entity is able to manipulate the records in their favor. As Figure 6 illustrates, like the centralized system, citizens are able to initiate entry of a record either via a service hall or

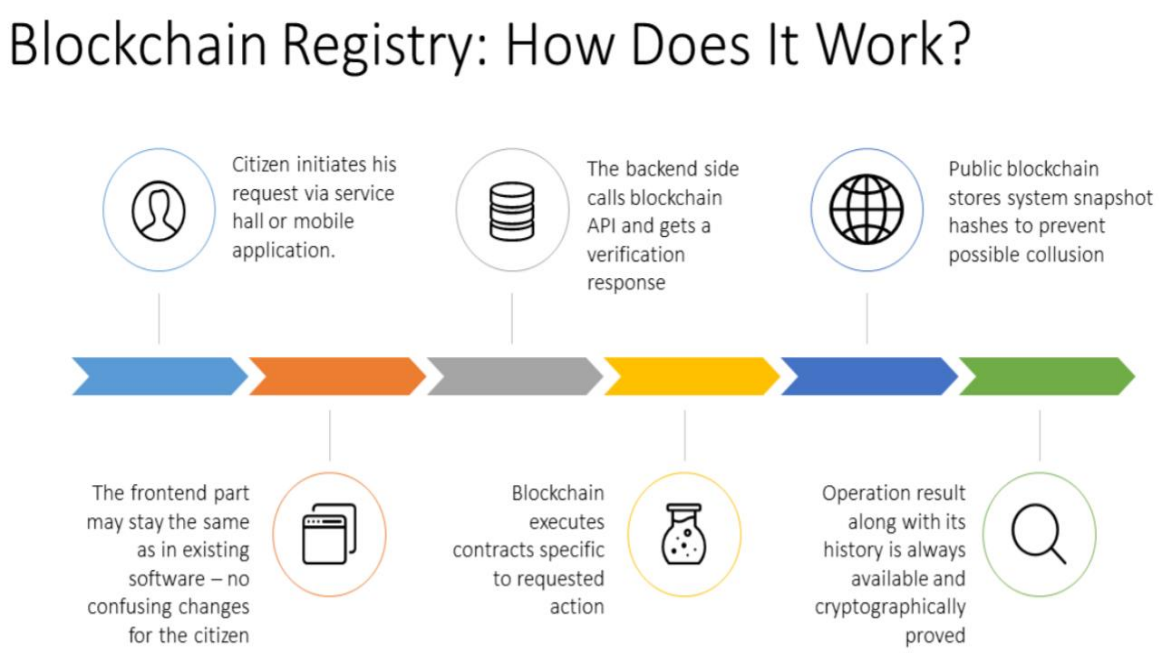

Figure 6. Blockchain Registry: How Does It Work?

Source: Pippan, Bitfury Group, 2016.

a mobile application. While the front-end portion of the database remains the same, the back end connects with a blockchain-based program interface that receives a verification response confirmed by 51% of the nodes in the ecosystem. If approved, the blockchain executes the contract, and the cryptographic "hash" associated with the transaction is entered into the distributed ledger, thus making the transaction immutable. This means that at any point any party has viewing access to the ledger but no ability to edit any transactions.

Therefore, as alluded in the introduction, a blockchain solution claims to bring integrity, transparency, and authenticity to the title record system. Specifically, blockchain technology companies leverage both public and private chains to create a fully transparent, time-stamped public ledger as it records changes to all transactions. In the case of a public chain, such as Bitcoin, the integrity of the data is maintained by thousands of geographically dispersed nodes or computers. In a private chain, such as IBM's Hyperledger, land title records are maintained by a select number of known nodes that have been agreed upon by a consortia of parties ahead of time. The integrity of the chain in either a public or private use case depends on the integrity of the nodes/machines validating transactions. As long as a majority (51%) of nodes in the network are honest, the network's integrity is intact, and the records remain tamper-proof.

Furthermore, in order to maintain the authenticity and privacy of the data on the blockchain, the records are turned into a cryptographic "hash," a "type of digital fingerprint that enables anyone to verify that the data matches what's on the blockchain without seeing the data itself." This is also called the concept of "zero knowledge proof,"

which enables privacy of data on a blockchain.[77] As a result, the system of maintaining and updating land and property title records is not only more secure than one maintained by a centralized third party such as the government, but it is also private.

Although blockchain technology provides clear benefits (discussed in more detail in the sections below), a number of challenges need to be solved in order for the system to become fully tamper-proof and effective. Three of these are described as follows:

- The land title system is vulnerable to corrupted data at the entry point of the funnel. For example, if the data that enters the blockchain is not trustworthy, the blockchain solution does not add any credibility to the data. In fact, unlike a traditional database, it is much more difficult to change the record once it is on the blockchain.
- The blockchain solution provider would likely be required to work with and integrate with the existing government and its current database. If the government is dishonest, then there is a high likelihood that the data entering the blockchain will be invalid or corrupt.
- If the system of law enforcement in a specific country is broken, technology alone will not solve the problem. While blockchain technology will provide more evidence for the lawful owner of the land (the defendant), it does not guarantee that legal ownership will be upheld.

A blockchain solution for the land title industry is a useful test case as an example of a disruptive innovation, especially because it solves a number of challenges that earlier systems were unable to resolve.

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[77] Shin, "The First Government to Secure Land Titles."

Chapter VII

Case Study 2: Bitfury Group

Several initiatives are being developed to solve the challenges of authenticity, reliability, and provenance in the land and property title industry in a number of countries, including Sweden, UAE, Brazil, and in Cook County, Illinois in the United States. To assess the disruptiveness of blockchain technology in the public sector, I analyzed potential opportunities to bring trust and transparency to the land and property registration industry in the country of Georgia (former USSR). In April 2016, Georgia became one of the first countries in the world to successfully pilot a blockchain use case in cooperation with the country's Ministry of Justice.[78] Bitfury Group, in cooperation with the Georgia government, completed this successful pilot, in the process successfully migrating more than 300,000 records.[79] An analysis of this use case may reveal if the broader distributed ledger technology (DLT)-based land title solution can meet the criteria of a disruptive innovation.

About Bitfury

Bitfury Group is "the leading full service Blockchain technology company and one of the largest private infrastructure providers in the blockchain ecosystem,"

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[78] Shin, "The First Government to Secure Land Titles on the Bitcoin Blockchain Expands Project."

[79] Nimfuehr, "Blockchain Application Land Register."

according to global investment database Crunchbase.[80] Bitfury was established in 2011 and recently grossed more than $100 million in annual revenue.[81]

Among its many services, Bitfury provides hosting infrastructure hardware for mining Bitcoin, as well as software and consulting services for governments and *Fortune* 500 companies around the world. The latter is accomplished through a subsidiary company named Exonum, a software framework that enables clients to build blockchain applications, such as land title solutions, by leveraging the underlying infrastructure of the Bitcoin blockchain.[82] According to an official Bitfury announcement: "Exonum is the direct result of extensive research and testing by our elite team of best-in-class mathematicians, scientists, developers and analysts coming together to create this inimitable platform."[83] The platform represents one of the more mature technologies in the market today.

Case Study Overview

In 2016 Exonum successfully engaged with the National Agency of Property Records (NAPR) of the Republic of Georgia to resolve the following challenges: overall

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[80] Crunchbase, "Bitfury Group: The Leading Full Service Bitcoin and Blockchain Technology Company." n.d. https://www.crunchbase.com/organization/bitfury#section-overview. (Accessed 28 January 2019.)

[81] Michael del Castillo, "Think Bitcoin is Small Business? Bitfury is Making Almost $100 Million Annually," 12 January 2018. https://www.coindesk.com/think-bitcoin-small-business-bitfury-making-almost-100-million-annually. (Accessed 28 January 2019.)

[82] https://exonum.com/. (Accessed 28 January 2019.)

[83] Bitfury Group, "The Bitfury Group Announces Launch of Exonum," 16 July 2017. https://medium.com/meetbitfury/the-bitfury-group-announces-launch-of-exonum-a7128644693f. (Accessed 28 January 2019.)

system transparency, fault tolerance, and intelligibility for end users. To do this, Exonum developed and built a customized distributed ledger solution that is integrated with the government system of land title records. Bitfury claims:

> This private, permissioned Blockchain is anchored to the Bitcoin Blockchain through a distributed digital timestamping service. Distributed digital timestamping allows NAPR to verify and sign a document containing a citizen's essential information and proof of ownership of property.[84]

Figure 7 illustrates the step-by-step process of the new versus old land title process. Instead of relying on a centralized database that is subject to significant risk of

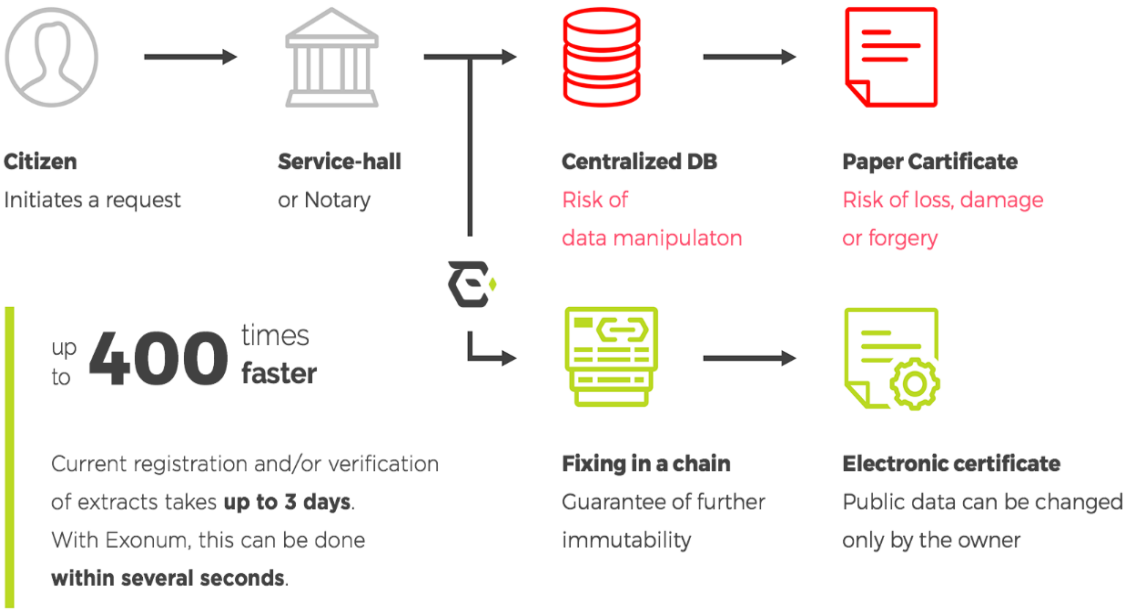

Figure 7. Visual Representation of Exonum's Land Title Framework.

Source: Exonum, "Blockchain Land Registry."

[84] Rachel Pippan, "The Bitfury Group and Government of Republic of Georgia Expand Historic Blockchain Land-Titling Project," 7 February 2016. https://bitfury.com/content/downloads/the_bitfury_group_republic_of_Georgia_expand_blockchain_pilot_2_7_16.pdf. (Accessed 28 January 2019.)

data manipulation when issuing paper certificates that are further subject to loss, damage, and forgery, the Exonum solution is fixed on the distributed chain which produces an electronic certificate that ensures immutability and authenticity of data. While the pilot only provided basic functionalities such as a timestamping service that allowed citizens to verify the authenticity of information without revealing private details, Exonum's roadmap includes other smart contracting capabilities, including instantaneous settlement during the sale or transfer of ownership of the property.

As a result of utilizing their process, the company claims that the following outcomes were achieved:

- Service delivery time was shortened, from 1-3 business days, to a few seconds.
- Operating costs were lowered up to 90% (for the specific service).
- Real-time audit capabilities were enabled.

In addition to creating a more effective and efficient property management system, the Republic of Georgia became one of the top six countries in the World Bank Group's "Doing Business" survey,[85] while leading among the top three countries for "ease of property registration."[86]

[85] World Bank, "Doing Business: Measuring Business Regulations, " Doing Business in Georgia, 2019. http://www.doingbusiness.org/en/data/exploreeconomies/georgia# (Accessed 28 January 2019.)

[86] Pippan, "Bitfury Group," 2016.

Chapter VIII

Analysis of Case Study 2

In order to qualify as a disruptive innovation, Bitfury's blockchain solution must exhibit at least one characteristic in each of the three criteria: Technological Features, Marketplace Dynamics, and External Factors. Below I discuss each of the criteria and their relevant features, and then make a rating determination as to whether Bitfury meets these criteria.

Technological Features

In this category, there are three technological features: simplification, cost reduction, and novel governance structure. I will discuss each of these to determine how they apply to Bitfury.

Simplification

- *Degree to which the product or service offers simplification*. Typically these innovations are inferior to mainstream product. Many product attributes are either non-existent or oversimplified compared to a level that incumbents currently offer.

In order to properly gauge Bitfury's level of simplification, it is important to first differentiate between the short-term and long-term benefits of this technology. In the short term, because multiple parties were forced to make changes to the existing *modus operandi*, Bitfury's solution did not offer simplification in the current method of record

keeping. In fact, it added significant complexity when new stakeholders and novel processes were introduced into the system. For example, in order to maintain the permanent integrity of the ledger, all the records had to be verified by numerous trusted nodes, as well as stored permanently and maintained regularly. Further, the process of persuading multiple agencies to agree to use the distributed database was time-consuming and complex. However, once the system was in place, it simplified the process of storing, maintaining, and ensuring the integrity of the property records. For example, in the previous system accessing and changing records could taken as many as three days (refer to Figure 7 in the previous chapter). Using the new system, any parties in the transaction—buyer, seller, bank, broker, government—could access any record in the system in seconds. Figure 8 below shows that the number of total procedures needed in order to register a property in Georgia was reduced to one compared to an average of 5.3

Registering Property - Georgia

Indicator	Georgia	Europe & Central Asia	OECD high income	Best Regulatory Performance
Procedures (number)	1	5.3	4.7	1 (4 Economies)
Time (days)	1	20.3	20.1	1 (New Zealand)
Cost (% of property value)	0.0	2.6	4.2	0.0 (Saudi Arabia)
Quality of the land administration index (0-30)	21.5	19.6	23.0	None in 2017/18

Figure 8. Registering Property in Georgia

Source: “Doing Business Report 2019,” 21.

in Europe and Central Asia. The number of days was reduced to one, compared to an average of 20.3 days in Europe and Central Asia. Finally, once the blockchain's smart contract capability was in place, the process of settlement was instantaneous.

Rating: Yes

Cost Reduction

- *Degree to which the product or service fulfills the need of an over-served or a new customer segment by offering a "good enough" product or service at a lower price point.*

One of the key benefits of this decentralized land title solution is reduced transaction costs. Specifically, citizens will see up to 1000% cost reduction and reduced complexity of the process. According to Laura Shin of *Forbes*:

> Currently, buying or selling land in Georgia is a one-day process requiring the buyer or seller to go to a public registry house and pay between $50 and $200, depending on how quickly they want the transaction to be notarized. The pilot project will move elements of this process onto the blockchain and cost buyers and sellers in the range of $.05-$.10.[87]

The blockchain solution reduced the cost of registering a property to less than 0.03% of property value, as shown in Figure 9. It also facilitated a more frictionless validation of ownership, purchase, or transfer of a record, removing the need for the buyer and seller to visit a registrar and find notary services to confirm the validity of ownership and record transfer, saving both parties time in executing the transaction. In addition, an automatic audit by recording and timestamping each transaction for

[87] Laura Shin, "Republic Of Georgia To Pilot Land Titling On Blockchain With Economist Hernando De Soto, BitFury," *Forbes*, 21 April 2016. https://www.forbes.com/sites/laurashin/2016/04/21/republic-of-georgia-to-pilot-land-titling-on-blockchain-with-economist-hernando-de-soto-bitfury/#428dc58644da (Accessed 31 January 2019.)

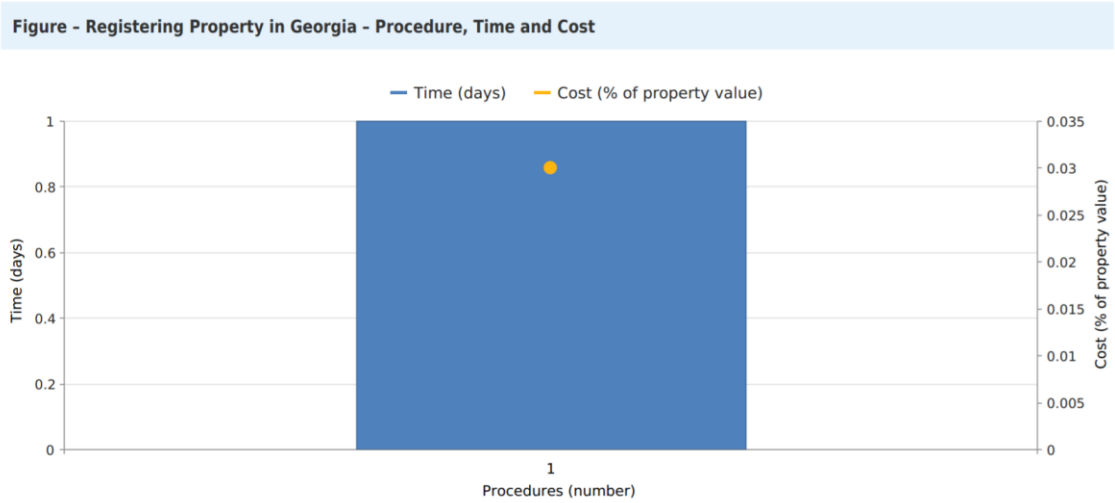

Figure 9. Registering Property in Georgia: Procedure, Time, and Cost

Source: World Bank, "Doing Business," 2019:21.

immediate reconciliation became possible, which also reduced operating costs by 90%, according to representatives of Georgian government.

However, this land title offering does not qualify under the cost reduction criterion as a disruptive innovation, since the product it offers is in fact more sophisticated than the original centralized offering. It goes above and beyond the "good enough" functionality of the previous solution, and offers an advanced service.

Rating: No

Novel Ownership

- *Degree to which the product or service offers novel ownership factors that influence costs, employee motivation, and organizational performance.*

- *Degree to which the product or service uses novel methods of resource utilization or effect-changing characteristics like price, services surrounding the innovation, or marketplace expectations.*

The Bitfury solution partially qualifies for novelty of ownership, although it fails to fully meet the criteria. Unlike the traditional centralized database where records are owned and controlled by a single party, i.e., the centralized government, Bitfury gives the citizens of Georgia a partially decentralized solution where the process of block validation takes place in a distributed fashion: anyone with access to the appropriate level of computation is able to participate in the process of validation and be rewarded. Although technically no single authority is in charge of verification of records, the custody of the records takes place on a private blockchain, an internal network of nodes native to the government of Georgia. In other words, although the cryptographic hashes of each record are published and validated via a public chain (Bitcoin), the records are stored in a more centralized fashion. In addition, unlike Brave, no token is offered to incentivize participation in the network. Therefore the profits from the transactions are not distributed in a decentralized manner but are retained by the government. Therefore, the platform is rated as "medium" with regard to the impact of ownership criterion.

Rating: No

Marketplace Dynamics

In order to qualify as a disruptive innovation, Bitfury must exhibit at least one of the following Marketplace Dynamics features: Value Networks, Profit Margins, and Target Markets. I will discuss each of these features to determine if they apply to Bitfury.

Value Networks (Customers, Suppliers, Competitors)

- *Degree to which the innovation offers radical functionality*. This means that these innovations disrupt the value networks and impact other stakeholders such as suppliers, competitors, business processes (assembly line or inventory management), resources (required to sell this product), values, etc. If the value network is mostly disrupted, it is considered a disruptive innovation.
- *Degree to which the innovation taps into the unmet need in the market by creating and adding differentiated value to customers.*

The key value proposition of Bitfury's land title solution is the additional reliability and authenticity it brings to Georgia's record system, which increases its citizens' trust into the overall system. Bitfury impacts key stakeholders—buyers, sellers, governments, title insurance companies, brokers, banks—in a number of ways. Like the previous study of Brave Technology, Bitfury's solution eliminates the need for intermediaries (like title insurance companies) that previously existed due to the system's inefficiencies. Once the system is running successfully, a title is permanently stored and regularly updated, which reduces the risk of the title being stolen or altered. As a result, title insurance companies could see their business revenues plummet since the service they offer would no longer be needed in the marketplace.

Rating: Yes

Profit Margins

- *Degree to which profit margins of the innovations are less attractive that those of existing technologies.* Typically, this makes it an unappealing investment opportunity for existing incumbents, and for that reason they are often ignored or dismissed.

Unlike the private-sector case, the current solution is an in-house-developed government system rather than one purchased through a private company. That means the profit margins are meant to be very low or nonexistent because the purpose of government is not to generate profit but rather to provide good service to its taxpayers. If the solution were developed in-house, it would be fair to assume that Bitfury's alternative would indeed present an appealing investment opportunity for the government's technology teams. However, if the solution were initially outsourced through other technology providers, then the profit margins of the Bitfury solution would need to be compared to that of existing technology providers.

Based on available information, Bitfury's business model is similar to that of a traditional software company in which the company generates revenue by charging both licensing and implementation fees. The profit margins are no less attractive than those of a traditional technology firm. Therefore, it is fair to conclude that in either scenario the profit margins are either equally or more attractive than the current offering. Hence, Bitfury's blockchain land title technology would score low in this criteria.

Rating: No

Target Market

- *Degree to which these disruptive innovations appeal to a niche audience before attacking the mainstream customer.* Typically, as product features are improved the niche customer grows into a larger audience.

Although the initial success of Bitfury's technology is evident mostly in niche markets like Georgia, the applicability of this technology is generally universal. Any developing or even developed country could potentially benefit from leveraging Bitfury's land title technology to increase integrity, reliability, authenticity, and the efficiency of their respective land title systems. A number of other nations, such as Sweden, Estonia, and UAE, have recently embarked on the blockchain-based land-title proof of concepts which is further evidence of Bitfury's universal appeal. However, the current version of the product provides rather bare-bones functionality that is meant to improve over time to become more tailored to a specific audience with specific needs. Bitfury scores medium in this category.

Rating: No

External Factors

In order to qualify as a disruptive innovation, Bitfury must exhibit at least one of the following External Factors: Policy Change or Macroeconomic Factors. I will discuss each of these features to determine if they apply to Bitfury.

Policy Change

- *Degree to which the disruption influences policy change*
- *Degree to which policy change influences the disruptive innovation*

Georgia's Ministry of Justice played a key role in Bitfury's proof of concept and successful implementation. In fact, without policy changes, the system would not have been able to function effectively. Since the technology has brought policy change, and that change subsequently enabled the impact of the technology, Bitfury's solution scores highly in the Policy Change category.

Rating: Yes

Macroeconomic Factors

- *Degree to which the disruptive innovation positively influences long-term economic growth.* Specifically, disruptive innovations tend to destroy more value in the short term than they create.
- *Degree to which, in the long term, disruptive innovation can produce an outsized impact in terms of economic growth including job creation.*

As De Soto concluded, properly established and enforceable property rights have a high degree of correlation to the economic prosperity of any nation. Although this case study is recent, and the outcomes of the Georgia land title overhaul must be assessed over a longer period of time, it would be fair to assume that even the limited data has demonstrated has demonstrated that this technology might have a positive impact on the long-term prosperity of the people of Georgia. For example, as Figure 10 shows, from 2016 to 2017 the total number of issued mortgages more than doubled, from 412 in 2015

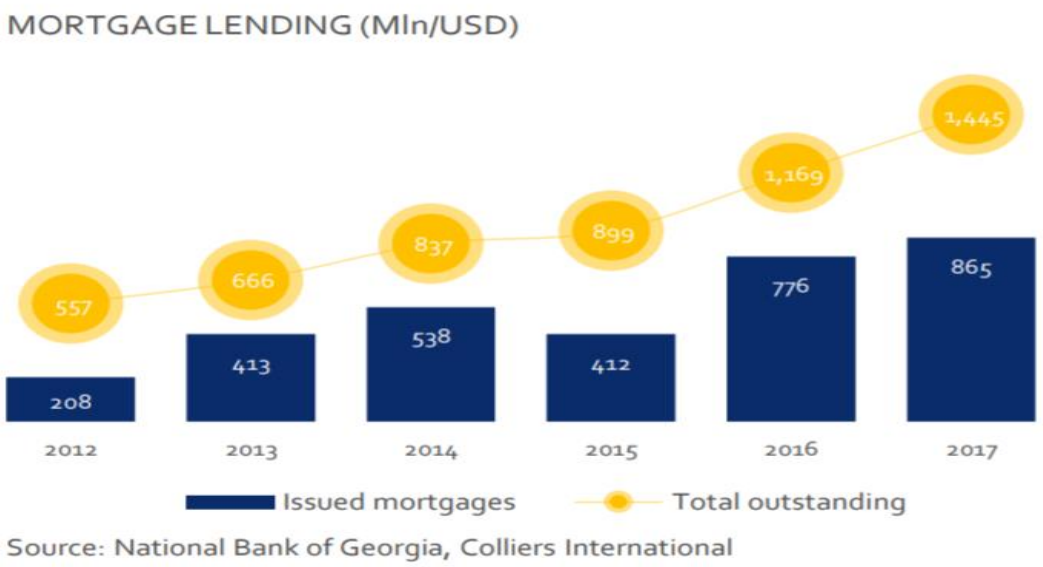

Figure 10. Mortgage Lending in Georgia

Source: Colliers International, "Residential Market in Georgia 2017, 8.

to 865 in 2017.[88] According to Colliers International, in 2017 "the number of residential transactions rose dramatically to a record 28,000 units, reflecting a 21% increase over 2016 . . . the overall transaction volume grew by 10%, reaching $1.17 billion."[89] Although many factors impact the transaction volume, these are early indications of improved economic conditions, attributable to the reduced friction in the property registration and settlement process.

Rating: Yes

[88] Colliers International, "Residential Market in Georgia 2017." https://www.colliers.com/~/media/files/emea/georgia/research/2017-research-georgia/residential-market-georgia-2017.pdf?la=en-ge . (Accessed 1 February 2019.)

[89] Colliers, "Residential Market in Georgia 2017," 3,

Summary

Unlike the previous case study, Bitfury's land title solution scored high in at least one of the three categories, thereby qualifying as "disruptive innovation." In terms of Technological Features, the Bitfury solution fell slightly short on the criteria for "novel ownership" due to lack of fully distributed custody and centralization of profits. It also scored low on "cost reduction" due to a set of more sophisticated and costly features. However, Bitfury offers a high level of simplification compared to the status quo, reducing processing time roughly 400 times, streamlining the process of verification, reducing the complexities of registering a property and the process of settlement among multiples parties such as the user, the bank, the government, and other agencies. Table 4 summarizes of the case study analysis.

Table 4. Summary of Bitfury Case Analysis.

CATEGORY	**INDICATOR**	**RESULT**	**SCORE**
TECHNOLOGICAL FEATURES	Simplification	Yes	1
	Cost Reduction	No	0
	Novel Ownership	No	0
MARKETPLACE DYNAMICS	Value Networks	Yes	1
	Profit Margins	No	0
	Target Market	No	0
EXTERNAL FACTORS	Policy Change	Yes	1
	Macroeconomic Impact	Yes	1
SCORE			**4**

Source: thesis author

As for Marketplace Dynamics, Bitfury scored high in the Value Networks category due to its disruptive impact on various parties in the value chain, having the

potential to change the behavior of multiple parties in the ecosystem: citizens, government agencies, banks, and intermediates. Like Brave Technologies, Bitfury's solution demonstrated the potential of disintermediation, i.e., removing the need for expensive brokers, title insurance agents, and other middlemen. It also offered differentiated value to customers: more transparency and therefore a trustworthy alternative. Because the profit margins of Bitfury's platform are comparable to those of any other software solution, it scored low on the profit margin criterion, failing to demonstrate how it would not serve as an attractive acquisition opportunity for incumbents. The company scored lower in the Target Market category as the solution it offered clearly appeals to the mainstream customer, i.e., any government that has to maintain a database of land and property records.

As for External Factors, Bitfury scored highly in both the Policy Change and Macroeconomic Impact categories. The former is explained by Bitfury's high reliance on policy changes, and vice versa. The latter is justified due to Bitfury's high level of impact on the country's influx of foreign investment capital and overall economic prosperity. Bitfury's land title offering provides radical transparency which ensures better security and significantly higher levels of trust in the overall system. As a result, a more trustworthy system encourages more citizens to formally declare their property without fear that it will be taken away, as evidenced in the increased number of property registrations in 2017 and 2018. The implications of this trend are significant, as this new solution can enable hundreds of thousands of citizens in Georgia levels to enjoy greater levels of economic inclusion.

Key Takeaways

This section discusses key takeaways from the Bitfury case study. Specifically, it includes potential implications from this technology.

1. By removing friction, bureaucratic red tape, and costly overhead involved in the process of storing, maintaining, and facilitating the transaction of property records, this blockchain solution enabled a more frictionless *transferability* of an asset or a property between parties that might otherwise not be able to conduct such a transaction. This is reflected in the increased number of property transfers in 2017 compared to previous years, and the early indication of an increased number of property sales, as reflected in the mortgage data. There are important implications in this phenomena, one of which is increased cross-border trade among individuals and/or institutions that might not come in contact with each other physically. Instead of assessing an asset onsite, both parties have access to an immutable record of a property and all of its qualifications and characteristics necessary to make a decision on the value of such asset. In the future, this ease of property transfer process can increase the size of the overall market (supply and demand) for any given real estate asset. That has the potential to impact the liquidity of the global real estate market and pricing. As a topic of further research, it could be helpful to evaluate further factors of increased liquidity of the real estate assets in the country of Georgia, as well as the impact of this solution on the overall economic prosperity of the country.

2. By giving the citizens of Georgia an opportunity to register their titles in a tamper-proof and secure manner, the blockchain solution has an opportunity to reduce the

scope of the "shadow economy."[90] As a result, a larger portion of the country's population could leverage the land they own to extract future capital, increase their creditworthiness, and formally participate in the broader economy. With a more mature property record system that is able to facilitate frictionless property exchange, the country can attract more foreign investments which improves overall economic outcomes for the nation. As Bates concluded: "The blockchain is not going to 'replace government' concerning how land is registered and monitored. It will make governance of land registration the simplest and most corruption resistant possible."[91] Therefore, although no data is available at this time to support this hypothesis, one of the key disruptive features of the blockchain solution as it applies to the land title market could be its ability to reduce corruption and the shadow economy. Further research could be conducted to test this hypothesis.

3. Unlike the Brave Technologies use case, Bitfury's solution does not offer a token as a mechanism of shared ownership, incentivization, or fractionalization of assets among parties. Even though the provenance of the asset can still be tracked without a token, having a token would have enabled greater fungibility of the assets, i.e., the ability to more easily fractionalize the ownership of these assets, thereby unlocking the economic value of the assets to the owners. But unlike BAT, having a token in the

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[90] Sebastian Corrochano, "Property and Title Reform on the Blockchain: The Developing World Plays Catch-Up," 24 July 2016. https://www.blockworksgroup.io/post/ propertyandtitlereformonblockchain. (Accessed 1 February 2019.)

[91] Frederick Reese, "Land Registry: A Big Blockchain Use Case Explored," 19 April 2017. https://www.coindesk.com/blockchain-land-registry-solution-seeking-problem. (Accessed 29 January 2019.)

land title management system would not have been as beneficial to the users because the system is not designed to create monetary value to be shared among the parties. The tokenization of real estate and other assets remains one of the most important areas for future research and exploration, as it represents a viable opportunity to increase the liquidity of the entire market.

4. Similar to the Brave Technology use case, one of the key aims of Bitfury's project was to provide a mechanism for bringing transparency into the system where previously the truth was maintained by a third party. Although it is a generally believed that blockchain's ability to bring trust and transparency is a benefit only applicable to immature, developing economies, that is not necessarily the case. Many developed countries, including the United States, sometimes encounter corruption at the local level. These nations often are also subject to foreign manipulation and hacking, which further amplifies the problem of trust. Since almost every country is vulnerable to natural disasters, a blockchain solution offers a much better alternative for ensuring secure and recoverable record-keeping. Therefore, both use cases scored highly in the Value Network category of disruption.

Chapter IX

Summary and Conclusions

The key objective of this study was to determine whether blockchain technology fits the criteria of Schumpeter's "creative destruction." By analyzing two specific case studies in both the private and public sectors, my research led me to conclude that companies that integrate blockchain technology do indeed exhibit signs of disruptive innovations, typically as either a "New Market Innovation" or a "Novel Ownership Innovation." Neither of the case studies demonstrated signs of "Lower End Innovations," as the value proposition these companies brought to the market went "above and beyond" the basic functionality that lower0end innovations would typically capitalize on.

Both case studies scored highly in the Value Network sub-category of the Marketplace Dynamics category, indicating that their novel business model, rather than technology alone, could play a significant role in threatening the market position of incumbent companies, governments, and systems. By leveraging distributed ownership structures and re-thinking the compensation structures of the ecosystem players, while also creating a novel alignment of incentives, blockchain technology enabled the businesses in this research study to attract consumers, users, investors, partners, and other ecosystem players to their platforms.

Both use cases demonstrated high levels of impact on Macroeconomic Factors, which is typically an indicator of an influential innovation that will affect long-term economic growth. This finding could also explain why so many governments around the

world are expressing interest in learning more about this technology. Table 5 provides a comparative summary of both research cases.

Table 5: Comparative Summary of Two Blockchain Use Cases: Brave (Private Sector) versus Bitfury (Public Sector)

CATEGORY	INDICATOR	RESULT: BRAVE	RESULT: BITFURY
TECHNOLOGICAL FEATURES	Simplification	No	Yes
	Cost Reduction	No	No
	Novel Ownership	Brave Technologies (No) / BAT (Yes)	No
MARKETPLACE DYNAMICS	Value Networks	Yes	Yes
	Profit Margins	Yes	No
	Target Market	Yes	No
EXTERNAL FACTORS	Policy	Yes	Yes
	Macroeconomic Factors	Yes	Yes
TOTAL SCORE		5.5/8	4/8

Source: thesis author

The secondary objective of this study was to compare how blockchain technology impacts private-sector versus public-sector use cases. I conclude that while both companies displayed elements of disruptiveness, the private-sector use case (Brave) delivered a slightly higher overall score than the public-sector use case (Bitfury). Specifically, Brave scored highly in every sub-category of Marketplace Dynamics,

including having a high impact on value networks, profit margins, and target market. Bitfury had a high score only in the value networks sub-category of Marketplace Dynamics. This can be partially explained by the fact that Bitfury's offering was not designed as a commercial solution that looked to generate revenue, while Brave was designed with a goal of creating sustainable revenue streams for the business and as a challenger to the market share of incumbents.

On the other hand, independent of the BAT token, Brave Technologies would have failed to meet the criteria of a disruptive innovation since it did not meet the simplification, cost reduction, or novel ownership criteria. While Bitfury caused certain complexities in the short term, it immediately delivered quantifiable efficiencies, including time reduction and streamlined operations.

Both use cases scored lower in the cost reduction category because both solutions aimed to bring to the market an offering with more features and functions than that of current incumbents. This should not to be confused with actual cost reductions to the end consumer in the form of greater efficiencies or savings, which both companies clearly demonstrated.

One of the interesting differences between the two blockchain use cases was their use of a token. Tokens and Initial Coin Offerings have been a topic of heated debate since their inceptions, so understanding the impact that tokens might have on the disruptive potential of a company leveraging it was key. From my research, I conclude that leveraging a token allows the creation of novel incentive structures, which would qualify a company for greater impact in the novel ownership factor as a disruptive innovation. Similar to open-source software, Brave's BAT does not have "a single definitive

owner,"[92] but rather its ownership is distributed among thousands of token holder, some of which are investors, users, and developers, as well as ecosystem players like advertisers and publishers.[93] As a result, Brave's BAT encouraged broader adoption of Brave as it increased awareness, incentivized participation in the network via faster micropayments, increased developer motivation, and created the alignment of an incentives structure that was favorable to the company.

On the flip side, however, BAT certainly increases the possibility of regulatory threats to the parent company Brave Technologies, especially if Brave fails to prove BAT's utility. This typically arises with a prerequisite to use the token in order to leverage the network, which increases its adoption. Without a token, however, Brave Technologies would not have met the criteria of a disruptive innovation, as it scored lower on the other technological features of simplification and cost reduction.

The last objective of this research study was to identify key takeaways about blockchain technology. This study found that regardless of the sector where blockchain technology was applied, it was able to address several common challenges.

- First, in both use cases, by leveraging blockchain technology companies were able to re-architect the economics and benefits of the solution in favor of the end consumer—either the consumer of advertising content or the owner of a land title in Georgia. In the former case, consumers of content could (a) opt in for an ad-free private browsing experience without the risk of their data being collected and

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[92] Nagy, Schuessler, and Dubinsky, "Defining and Identifying Disruptive Innovations," 121.

[93] Basic Attention Token (BAT). Top 1,000 holders. https://etherscan.io/token/0x0d8775f648430679a709e98d2b0cb6250d2887ef#balances. (Accessed 1 February 2019.)

monetized by other third parties, or (b) in exchange for their attention, users of Brave browser could be compensated in BAT tokens (subject to appreciation or depreciation depending on the network's performance). In the latter case, the process of land and property purchase was significantly simplified by reducing time, cost, and number of procedures involved in purchasing or transferring a piece of property or land. Furthermore, without revealing their proprietary information, the true owners of a land title can now see any changes made to the official records, thus making the ledger immutable and the truthful ownership defendable.

- Second, both the digital advertising and the public services industries suffered from a lack of trust and transparency within their respective ecosystems. In both cases, the information was controlled by a single or multiple centralized entities, i.e., a bureaucratic government agency controlling access to land title data, or a complex network of agencies standing between providers and consumers of content. In both cases, blockchain technology was used to increase the trustworthiness of the respective system by creating an immutable ledger of all transactions that anyone could access at any time and where every change became visible to all participants.
- Although both use cases are relatively new, in the digital advertising space the benefit of increased transparency can be quantified—$19 billion a year is lost due to advertising fraud.[94] In the land title industry, the impact could span beyond

[94] Juniper. "Ad Fraud to Cost Advertisers $19 billion in 2018."

financial returns since Bitfury has the potential to increase citizens' trust in their government institutions, help prevent title fraud, and unlock a portion of "dead capital."

Ultimately, both examples demonstrated that regardless of its disruptiveness, no technological innovation alone solves all of humanity's problems. In both cases, blockchain technology is an enabler or a tool, rather than a "cure-all" solution. In the same way that the distributed browser could be subject to abusive centralization by its creators, so the distributed system of land titles would not serve its users well without an enforceable rule of law.

Some of the negative externalities are less than predictable in the short term and it may take time to uncover them. As multi-billion-dollar cloud provider, Amazon, has enabled millions of businesses around the world to access top-grade computational resources at a negligible cost. But it also has enabled the centralization of data and resources, rendering them susceptible to exploitation. As the largest social network in the world, Facebook, has enabled billions of people around the world to be more connected —but it also enabled major breaches of personal privacy. Without a doubt, both the positive and the negative externalities of blockchain technology are yet to be seen. However, it is ultimately up to the people who create, develop, and leverage these inventions to make decisions in favor of human progress.

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