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Evaluating the Hype

The Current Potential of Blockchain for Land Registries

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Acknowledgments

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About New America

We are dedicated to renewing America by continuing the quest to realize our nation's highest ideals, honestly confronting the challenges caused by rapid technological and social change, and seizing the opportunities those changes create.

About Future of Property Rights

The Future of Property Rights initiative engages with policy makers, technologists, academics, civil society, and jurisdictions, as well as the property rights formalization community of practice. Property rights formalization is a powerful tool for creating wealth, opportunity, and security. A number of recent technology developments and advancements greatly reduce the time, cost, and complexity of property rights formalization. As a result, there are many ripe opportunities to apply this policy solution. Our role is to highlight these opportunities, expand the conversation and facilitate instances of property rights formalization improving lives.

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Introduction: Blockchain For Land

Blockchain,¹ the distributed database technology underlying Bitcoin and other cryptocurrencies, has garnered substantial interest from the public sector in recent years. The global blockchain market is large and growing—it is predicted to exceed \$2.3 billion by 2021—and governments and their private partners are exploring a wide range of use cases.² Examples include voting, taxes, healthcare, and, perhaps most substantially, land administration.³

The technology could revolutionize portions of the land administration and real estate sectors. Within high performing economies, blockchain promises to streamline transactions and allow for greater investment opportunities. It may also help protect poor communities from land grabbing and lower the chances of record tampering throughout the developing world.

This potential has started to bear out in several places. The country of Georgia and the blockchain firm Bitfury successfully anchored⁴ 1.5 million land titles on a blockchain in order to help fight corruption and bolster public trust in government institutions.⁵ Elsewhere, the Smart Dubai Office plans to use blockchain to increase efficiency in the city's real estate sector, allowing residents to find a new apartment and sign a lease within minutes.⁶

But much like the larger blockchain ecosystem,⁷ blockchain-for-land has suffered from uneven growth over the past few years. Some projects have scaled to reach larger populations, while others, such as those in small Vermont towns⁸ or Brazilian municipalities,⁹ have struggled to grow.

Why?

Part of the explanation is technical. In 2018, my colleagues Michael Graglia and Christopher Mellon presented seven prerequisites for a successful blockchain-for-land project,¹⁰ including a working identity system, digital records, accurate data, and internet connectivity.¹¹ One year later, these prerequisites still appear correct.

But we are discovering a larger, more fundamental problem: blockchain projects are often being undertaken by governments who are enthusiastic about the technology but fuzzy on how it actually works and what it can and cannot deliver.

Put differently, our technical criteria are necessary but not sufficient for successful adoption of blockchain. Projects must also be based on the following expectations: the land registry in question is more or less functional; officials understand what blockchain can do for their registry; blockchain will be applied to a problem that it can fix; and myriad land administrators will be early adopters of the technology, helping blockchain-based solutions to scale in an ever growing

ecosystem. If any of these initial assumptions prove false, a blockchain-for-land project may encounter serious obstacles, or might not even advance past the initial exploratory phase.

It may be tempting for governments to experiment with an exciting new technology, but time, energy, and resources are not unlimited. And for the people and places that could most benefit from the technology, the misdirection of resources also translates into missed opportunities for development. In order to more successfully implement a blockchain-based land solution, governments must first think more critically about their capabilities, needs, and ecosystems.

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The purpose of this report is to assist land officials during their exploration of blockchain technology. A number of suggestions for preliminary steps will be discussed:

- **Get the Right People Involved:** At its most basic, blockchain is a database technology. But it may also have far-reaching political, social, and economic effects. Any project should engage with a variety of stakeholders.
- **Identify the Problem You are Trying to Solve:** A land registry can suffer from many different problems. Blockchain cannot help to solve them all.
- **Be Realistic About Your Expectations:** Blockchain is a powerful new tool, but it is not a panacea. Potential benefits are limited.
- **Make Sure Your Solution Can Scale:** Bureaucratic and political factors must be taken into account if a solution is to impact large populations.

Get the Right People Involved

Previous blockchain-for-land projects often excluded key stakeholders, leading to misunderstandings of both registry needs and the potential of blockchain. Moving forward, include the right people during the “needs assessment” phase to better understand the political, social, economic, and technical aspects of blockchain. This group encompasses senior land officials, IT professionals, and the broader real estate community.

Senior Land Officials

Involve C-Suite officials in the initial blockchain-for-land pilot instead of outsourcing decisions to technical staff. Senior decision-makers can offer perspectives on the political feasibility of a project, as well as on financial constraints. Executives can also provide long-term strategic vision, as blockchain “is a social technology, designed to govern the behavior of groups of people through social and financial incentives,”¹² and may have unintended consequences.

A rise in peer-to-peer transactions on a blockchain without matching laws and regulations, for example, could result in unwanted foreign investment, investment of ill-gotten capital in properties, and the gentrification of neighborhoods.¹³ Corbin Page, co-founder of Meridio,¹⁴ believes that, “we’re still in the early days of understanding how blockchain technology will impact society and our communities.”¹⁵ Senior officials possess the experience and institutional knowledge to spot unintended consequences and risks.¹⁶

Project leaders must address low levels of blockchain education as early as possible. Knowledge of blockchain can vary widely, as with most new technologies. Do not assume that senior officials enjoy in-depth understanding of blockchain.

Several blockchain companies interviewed for this report cited education as the greatest obstacle encountered in 2018.¹⁷ Sam Tannian-Reynolds, chief operations officer of Ubitquity,¹⁸ said, “the biggest challenge will be educating the [land and real estate] industry as a whole. Blockchain technology is extremely complex and utilizes very esoteric terminology which will not be understood by most lay persons.”¹⁹ Another blockchain executive likened previous efforts to a science fair, during which officials gained only a cursory understanding of blockchain.

Better options are available. There are public resources, such as the Blockchain Trust Accelerator’s *Blueprint for Blockchain and Social Innovation*²⁰ and guides from Microsoft,²¹ IBM,²² and various blockchain websites.²³ And companies such

as ConsenSys²⁴ and ChromaWay²⁵ provide opportunities for public institutions to learn about blockchain via formal training sessions.²⁶

Information Technology Professionals

Blockchain, most basically, is a database. It is “a series of computers...that keep the same record of an event or transaction in a ledger that is open to the public.”²⁷ Any blockchain-for-land project is therefore primarily technical and must involve IT professionals from the beginning.

The vice president of a prominent blockchain firm noted a widespread disconnect between decision-makers and technology companies during a recent conversation with our team. He said that executives often view blockchain through a high-level business or social impact framework. These are valuable perspectives, but C-Suites might have difficulty evaluating blockchain as back-end technology. For example, a senior registry official involved with a current project admitted to a lack of prior knowledge concerning blockchain and remained unsure about its specific purpose.

Advice from the IT team can help mitigate gaps in knowledge during the “needs assessment” phase. These professionals better understand nuances associated with blockchain, such as node hosts, certificate authorities, data standards, and encryption techniques. Specialists can also provide insight on the digital capabilities of a registry, as well as cost-benefit analyses from a technical point-of-view. Perhaps the team determines that integration of blockchain offers only marginal improvement at best;²⁸ decision-makers can direct valuable resources elsewhere.

The Broader Real Estate Community

Describe any blockchain-based solution as a business tool to improve real estate operations, not a threat to livelihoods. Such constructive engagement with the broader real estate community can promote adoption of the technology. This group includes brokers, title companies, escrow agents, attorneys, inspectors, appraisers, and notaries;²⁹ the individuals regularly interacting with a land registry, in other words.

Myriad articles and blog posts claim that blockchain will eliminate the need for real estate agents, make title companies obsolete,³⁰ or even render the whole industry redundant.³¹ This talk is overblown, as experts argue that nothing can replace the human role of a real estate agent during a sale.³² Nor will blockchain leave title insurance workers jobless. Steve Day, president of the American Land Title Association, points out that, “there is more to title than just the effective recording of documents...and many rights that impact the title are recorded

within documents several steps back in the chain, and are not always adequately reflected in current recorded documents.”³³ Any digital ledger will not automatically detect fraud, title defects, or human error either.³⁴

Advertise blockchain as another tool to cut costs and increase workplace efficiency. Secure sharing of data in real time can help reduce emails, phone calls, and paperwork associated with property transactions.³⁵ Smart contracts could also automatically execute escrow functions, cutting waiting time during the final stages of a sale.³⁶

Emphasize proactive exploration of blockchain and adaptation of business models to encourage industry adoption.³⁷ Real estate companies can follow examples from institutions like the Barranquilla Chamber of Commerce in Colombia, a traditional manager of local business registries. The Chamber is exploring possible incorporation of blockchain within its operations instead of worrying that the technology will replace it.³⁸ Blockchain can help improve processes when entrenched parties have an open attitude.

Much like registry officials, many in the broader real estate community do not adequately understand the technology. Yet these stakeholders must become comfortable with using blockchain-based solutions on a regular basis.³⁹ Companies such as Propy emphasize the need for education and user-friendly solutions: “We have had our reality check with people that have much less exposure or desire to be exposed to frontier technology, [we are] trying to make our solutions friendly and easy-to-use by more tech-naive users.”⁴⁰ Demos⁴¹ and existing applications can help familiarize the broader community with blockchain.

Identify the Problem You are Trying to Solve

Land registry performance varies greatly around the world, as made clear by the World Bank ease of doing business rankings.⁴³ Institutional capacity, laws and regulations, and the adoption of certain technologies and methods can all affect functionality. Each registry experiences different problems as a result, and blockchain is not the appropriate answer to every issue.

Engagement with senior land officials, IT professionals, and the broader real estate community can facilitate proper identification of any issues at a registry. Based on our conversations with government officials and blockchain companies, many past pilots appear rushed. Yet a “needs assessment” is critical before any land registry seriously considers the use of blockchain.

Stakeholders must work together to answer the question: what is limiting the everyday functionality of the registry?

Stakeholders must work together to answer the question: what is limiting the everyday functionality of the registry? There are many possible answers, leading to the creation of two general categories based on blockchain’s ability to promptly address the issue.⁴⁴

Blockchain Can Help With The Issue

Blockchain is sometimes derided as a “hammer looking for nails,”⁴⁵ but the technology can help to alleviate the following problems:

- **Corruption:** Government officials and other elites can tamper with records or engage in land grabbing to enrich themselves, often at the expense of marginalized communities. Fraud is especially easier within paper-based systems or those with poorly-built digital registries.⁴⁶ Governments from Brazil⁴⁷ to Ukraine⁴⁸ to the country of Georgia⁴⁹ have identified blockchain as a tool to fight corruption. A blockchain-based solution is not controlled by a single party, but cross-checked by many users. And while blockchain cannot completely prevent the initial entry of

fraudulent data, anyone attempting to delete or change records leaves a visible trail.⁵⁰

- **Lack of Trust:** Opaque operating systems and bureaucratic red tape can contribute to distrust between a land registry and its constituents.⁵¹ Landowners may not be able to track decisions regarding their property or easily access their ownership information. Use of a distributed ledger can allow registries to publish certain data widely and securely. In addition, incorporation of digital signatures and time stamps can help customers better track any bureaucratic or legal processes regarding their property.⁵² A number of projects, from Wyoming⁵³ to Sweden⁵⁴ to Colombia,⁵⁵ aim to enhance access to data and process tracking.
- **Inefficient Services:** Property sales are notoriously sluggish, and usually involve a mass of paperwork, interaction with several intermediaries, and slow transaction times.⁵⁶ Blockchain securely replicates data across numerous computers, allowing different stakeholders to concurrently view a record of documents being created, reviewed, and changed. Easier data access can help smooth workflows⁵⁷ and reduce processing delays.⁵⁸ The Swedish national land registry is exploring blockchain to track a sale across its stages, saving time and costs in the process.⁵⁹ Elsewhere, the Smart Dubai Office plans to use blockchain to help residents sign a new apartment lease within minutes.⁶⁰
- **Insecure Data:** Centralized digital databases are susceptible to destruction. For example, the U.S. state of Maine likely deleted a huge number of emails and public documents from government servers due to use of inadequate technology and short-sighted policies.⁶¹ Transfer of a digital registry to a blockchain-based solution would replicate data across multiple computers or servers. Trusted institutions, such as other government agencies, NGOs, or intergovernmental organizations, can host a node if a registry is hesitant to widely share its data. And while a well-designed traditional database will have backup servers, the combined advantages of blockchain, as discussed below, make the technology an attractive option.
- **Vulnerability to Cyberattacks:** A large and centralized database is vulnerable to hacks or data leaks.⁶² A recent security breach of Aadhaar, the Indian identity database, for example, left 1 billion individuals at risk of identity theft.⁶³ An Australian family lost over AUD100,000 due to a 2018 hack of PEXA, the national e-conveyance platform.⁶⁴ Blockchains are not absolutely invulnerable to hacks,⁶⁵ but they are more difficult to attack than traditional databases;⁶⁶ and it is almost impossible to retroactively manipulate data.⁶⁷

Blockchain Is Not The First Answer

Blockchain cannot help to address every issue. Land administrators must explore other options for the following problems:

- **Inaccurate Records:** Blockchain cannot automatically perfect records, compensate for incomplete data, or clean titles, as is sometimes claimed.⁶⁸ Accuracy may increase over time, as transactions are clearly recorded on a blockchain, but this is not an immediate benefit. A network will accept incorrect data as input and add it to the blockchain-based solution as long as proper protocols are used.⁶⁹ Put differently: garbage in, garbage out.
- **A Paper-Based Land Registry:** Although my colleagues previously identified digital records as a prerequisite for a blockchain-based solution, it is necessary to emphasize that digitization is no simple task—bureaucratically or logistically.⁷⁰ The real estate industry is “slow to adopt new technologies in any form.”⁷¹ Even in the United States, under half of all registries used e-recording in 2017.⁷² Sloppy record-keeping can severely limit reform. Sorting through stacks of dusty records, standardizing and verifying information, and finally entering data into a digital system is resource-intensive and time-consuming.⁷³
- **Informal Land:** Millions of individuals around the world lack land titles.⁷⁴ Sometimes a large percentage of the population does not possess a formal title despite the existence of a functional registry.⁷⁵ A blockchain-based system can be a secure and transparent location to store data, but it is of little use during the actual formalization process. Senior officials must hire surveyors to map parcels and direct bureaucrats to collect and process ownership information. Innovative techniques, such as community land mapping, are an option if a government and private surveyors lack the resources to efficiently complete a titling project.⁷⁶
- **Lack of Institutional Capacity:** Blockchain is software. The technology cannot solve many of the political or bureaucratic problems that occur at a land registry. Blockchain will not compensate for poor data collection or other inadequate techniques. It does not change unsuitable laws hindering operations or broader socioeconomic development. Nor can it offset a widespread lack of employee training. Despite the recent hype surrounding blockchain, it is not a panacea.

Be Realistic About Your Expectations

Blockchain generates strong opinions among its advocates and detractors.⁷⁷ Evangelists can make sweeping claims about its potential. Articles asserting that “blockchain will end poverty and save the world”⁷⁸ or that it is a “magic bullet” able to save the rainforests⁷⁹ portray the technology as an unprecedented solution to global problems. Opposing pieces claim that “blockchain is dangerous”⁸⁰ or that “blockchain is not only crappy technology but a bad vision for the future,”⁸¹ leaving their audience highly skeptical or dismissive. In reality, the potential of blockchain is somewhere in between.

Stakeholders need realistic expectations from the start of any project. Blockchain is not magic. It cannot solve every problem, nor should it. But the technology can broadly provide the following:

- **Increased Resiliency:** Centralized databases are susceptible to data loss. In a blockchain-based system, replicas of the same database are held by a number of computers. Management and maintenance of the system is also dispersed across this network. Any distributed system, including blockchain, is less likely to fail as it relies on many redundant components.⁸²
- **More Transparency:** A central authority, such as a government, a bank, or a firm, manages a centralized database. The opaque structure of these systems can contribute to data tampering and fraud. In addition, data storage in a centralized silo may create information asymmetries among partners. A blockchain-based system ensures that every participant can view the same data and/or track processes in real time.⁸³
- **Greater Protection Against Hacks:** A centralized system stores data in one place. These treasure troves frequently suffer security breaches, notably Equifax in 2017⁸⁴ and Marriott in 2018.⁸⁵ In part, a blockchain-based solution is more difficult to attack or exploit because it lacks a sensitive central point to easily target.⁸⁶
- **Tamper Resistance:** Corrupt officials and other system participants may collude to manipulate data in a centralized database.⁸⁷ It is more difficult to tamper with records in a blockchain-based system for three reasons: control is distributed among many users; all users work together to verify new data through consensus; and all data is paired with a unique digital fingerprint, or hash, to ensure integrity.⁸⁸

- **Improved Workflow in a Growing Blockchain Ecosystem:**

Blockchain can allow multiple computers to securely view the same data in real time. Given widespread adoption of blockchain-based tools and solution compatibility—admittedly no simple tasks—a blockchain-for-land ecosystem can boost efficiency and lower costs for registries, real estate firms, and customers. Data sharing combined with smart contracts and the legal acceptance of digital signatures can help to streamline work, remove non-value-add intermediaries, and decrease transaction times.

It is critical for stakeholders to understand the limited potential of blockchain. Similar to other tools, the technology can certainly assist with a number of issues, but it is not a cure-all.

Make Sure Your Solution Can Scale

After a registry understands the utility of blockchain and determines it can help with a specific problem, project leaders must ensure that a solution can scale. Pilot projects are a good first step to work out kinks, yet many have struggled to expand and impact larger populations. Crucial stakeholders were ignored or a solution did not address an actual need. There were often unrealistic expectations concerning project outcome. Below are two other recommendations to help ensure a project scales, as implementation under the wrong bureaucratic or legal conditions will also frustrate progress.

National-Level Registries Are the Better Option

It is difficult to scale a blockchain-for-land project in a fragmented land administration system. Propy, for example, tested blockchain to record property in the small Vermont towns of South Burlington and Hubbardton, but expansion elsewhere is slow.⁸⁹ Most property databases in the United States function at the county level,⁹⁰ and management is at the municipal level in Vermont.⁹¹ That is well over 3,000 different ecosystems with their own laws, procedures, and institutional structures. Land is similarly managed at 3,400 privately-owned *cartorios* in Brazil.⁹² Implementation with each individual record office would be a grueling process. It is likely more efficient to deploy a solution at a national-level registry, with local offices channelling information into a larger database.⁹³

Change Pertinent Laws and Regulations

Any project will not exist in a vacuum; it will be subject to the laws and regulations of a particular jurisdiction. Governments may need to adapt or pass legislation recognizing the legality of digital signatures, the electronic recording of deeds, online conveyancing, or electronic notarization.⁹⁴ Some places are more responsive to change than others. The U.S. states of Vermont, Wyoming, and Arizona have proactively “passed laws to carve out a legal framework for blockchain,”⁹⁵ while change is sluggish in Brazil and Ukraine.⁹⁶ As Sergio Jacomino, head of the Institute of Property Registry in Brazil, reflected on a pilot: “I registered [a property transfer] in the blockchain and what is the legal value of it? None.”⁹⁷

Conclusion

Blockchain-for-land has experienced fitful growth over the past few years. Some projects successfully scaled, while others have been non-starters or struggled to impact larger populations. Everyone may want to experiment and innovate with emerging technology, but land registries must better prepare their exploratory processes of blockchain.

Engagement with senior land officials, information technology specialists, and the professional real estate community is necessary. All three groups will help a registry grasp the political, social, economic, and technical opportunities and challenges created by blockchain. These stakeholders, in turn, must identify issues that blockchain can solve within a land administration system and maintain realistic expectations regarding outcomes. The technology is not a “magic bullet” after all. Project teams should also ensure that a blockchain-based pilot can scale, as resources are not unlimited.

If blockchain is a viable solution, a land registry should further engage with a vendor, as technical implementation is a specialized skill. Firms will certainly recommend a solution design, and my colleagues also shared some thoughts on this matter last year.⁹⁸

Blockchain-for-land can positively impact populations around the world if implemented correctly. It is our hope that land registries will better analyze its potential.

Notes

1 This paper does not intend to discuss the highly technical intricacies of blockchain at length. For purposes of clarification, however, below is a high-level explanation of blockchain technology:

Blockchain is “software that [allows] thousands of [users] to simultaneously serve as custodians of the same continuously updating body of records[, or ledger.]...The time and origin of every [transfer or transaction is] recorded and revised at the same time on a multitude of independently run computers. A majority of these computers [must] validate any new “block” of transactions [for it to be added to the “chain”] (hence the term, blockchain). For these reasons, it [is] virtually impossible for anyone to hack it, cheat it, or manipulate it. And since the ledger [is] not confined or reliant on a single server, but many independently run “nodes,” no single entity [controls] it.” Since its invention, programmers have built increasingly sophisticated blockchains, and some incorporate self-executing “smart contracts,” which can automatically exchange assets between two parties after certain conditions are met (Adam Piore, “Can Blockchain Finally Give Us The Digital Privacy We Deserve?,” *Newsweek*, February 22, 2019, <https://www.newsweek.com/2019/03/08/can-blockchain-finally-give-us-digital-privacy-we-deserve-1340689.html>).

2 Brittany Ryan, “Beyond the Buzz: The Real Impact of Blockchain Technology on Real Estate,” *Growth House (blog)*, Follow Up Boss, August 10, 2018, <https://www.followupboss.com/blog/beyond-buzz-real-impact-blockchain-technology-real-estate>.

3 Jordan Woods, “Blockchain: Public Sector Use Cases,” *CryptoOracle (blog)*, Medium, October 2, 2018, <https://medium.com/crypto-oracle/blockchain-public-sector-use-cases-49a2d74ad946>.

4 “Anchoring” is an auditing mechanism that involves storing a unique, cryptographic “fingerprint” of data on a blockchain in order to ensure data integrity (Tomicah Tillemann, Allison Price, Glorianna Tillemann-Dick, and Alex Knight, *The Blueprint for BI*

Blockchain and Social Innovation, Washington, D.C.: Blockchain Trust Accelerator, last updated January 22, 2019, <https://www.newamerica.org/bretton-woods-ii/blockchain-trust-accelerator/reports/blueprint-blockchain-and-social-innovation/>) (Disclosure: the Blockchain Trust Accelerator is an initiative within Bretton Woods II, another program at New America).

5 Qiuyun Shang and Allison Price, “A Blockchain-Based Land Titling Project in the Republic of Georgia: Rebuilding Public Trust and Lessons for Future Projects,” *Innovations* 12, no. 3-4 (Winter-Spring 2019): 72-78.

6 Rohma Sadaqat, “Blockchain addresses key issues related to efficiency, trust,” *Khaleej Times*, January 15, 2019, <https://www.khaleejtimes.com/blockchain-addresses-key-issues-related-to-efficiency-trust>.

7 For example, see Jeff Kauflin and Sarah Hansen, “Cryptopia in Crisis: Joe Lubin’s Ethereum Experiment Is A Mess. How Long Will He Prop It Up?,” *Forbes*, December 5, 2018, <https://www.forbes.com/sites/jeffkauflin/2018/12/05/cryptopia-in-crisis-billionaire-joe-lubins-ethereum-experiment-is-a-mess-how-long-will-he-prop-it-up/#22f0699d2f0a>.

8 Anne Wallace Allen, “Business group aims to position Vermont as a blockchain magnet,” *VTDigger.org*, December 12, 2018, <https://vtdigger.org/2018/12/12/business-group-aims-position-vermont-blockchain-magnet/>.

9 “Can blockchain save the Amazon in corruption-mired Brazil?,” *The Economic Times*, last updated January 25, 2018, <https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/can-blockchain-save-the-amazon-in-corruption-mired-brazil/articleshow/62648953.cms>.

10 The original report was presented at the 2018 World Bank Conference on Land and Poverty in Washington, D.C. (J. Michael Graglia and Christopher Mellon, “Blockchain and Property in

2018: At the End of the Beginning,” paper presented at the 2018 World Bank Conference on Land and Poverty, Washington, D.C., March 20, 2018). A revised and shortened version of the report was later published in the peer-reviewed journal, *Innovations*, published in summer 2018 (J. Michael Graglia and Christopher Mellon, “Blockchain and Property in 2018: At the End of the Beginning,” *Innovations* 12, no. 1-2 (summer-fall 2018): 90-116).

11 Graglia and Mellon, “Blockchain and Property in 2018,” *Innovations*, 94.

12 *Ibid.*, 90.

13 Stuart Miller, “A Blockchain Building in Bushwick,” *The New York Times*, May 25, 2018, <https://www.nytimes.com/2018/05/25/realestate/a-blockchain-building-in-bushwick.html>.

14 Meridio is a blockchain-based “...platform that allows participants to easily create and trade digital real estate shares with full transparency.” It is a component of ConsenSys and based in New York, NY (“About Us,” Meridio, accessed February 21, 2019, <https://www.meridio.co/about>).

15 Corbin Page, email message to Tim Robustelli, February 1, 2019.

16 *Ibid.*

17 Inclusion of companies within this report does not imply an endorsement. The majority of these companies were originally selected for the 2018 paper, “Blockchain and Property in 2018: At the End of the Beginning,” due in part to access to their leadership (Graglia and Mellon, “Blockchain and Property in 2018: At the end of the Beginning,” paper presented at the 2018 World Bank Conference on Land and Poverty).

18 Ubitquity is a company based in Wilmington, Delaware that describes itself as “pioneers in blockchain real estate” (“About,” Ubitquity, accessed

February 21, 2019, <https://www.ubitquity.io/about.html>).

19 Nathan Wosnack and Sam Tannian-Reynolds, email message to Tim Robustelli, February 12, 2019.

20 See Tillemann, Price, Tillemann-Dick, and Knight, *The Blueprint for Blockchain and Social Innovation*, <https://www.newamerica.org/bretton-woods-ii/blockchain-trust-accelerator/reports/blueprint-blockchain-and-social-innovation/>.

21 For example, see “Blockchain Technology and Applications,” Microsoft Azure, accessed March 11, 2019, <https://azure.microsoft.com/en-us/solutions/blockchain/>.

22 For example, see Kathryn Harrison, Eileen Lowry, John Widdifield, and Matthew Hamilton, *The Founder’s Handbook: Your guide to getting started with blockchain* (Edition 2.0); Armonk, New York: IBM Blockchain, April 2018, <https://www.ibm.com/downloads/cas/GZPPMWM5>.

23 For example, see Ameer Rosic, “What is Blockchain Technology? A Step-by-Step Guide For Beginners,” *Blockgeeks*, last updated March 1, 2019, <https://blockgeeks.com/guides/what-is-blockchain-technology/>; “How Blockchain Technology Works. Guide for Beginners,” *Cointelegraph*, accessed March 11, 2019, <https://cointelegraph.com/bitcoin-for-beginners/how-blockchain-technology-works-guide-for-beginners>; and “A Beginner’s Guide to Blockchain Technology,” *CoinDesk*, accessed March 11, 2019, <https://www.coindesk.com/information>.

24 ConsenSys describes itself as “a market leading blockchain technology company” and is headquartered in Brooklyn, New York. It lists its other global office locations as Washington, D.C., San Francisco, Toronto, London, Paris, Dublin, and Sydney (“About,” ConsenSys, accessed February 21, 2019, <https://consensys.net/about/>; “Global Office Locations,” ConsenSys, accessed February 21, 2019, <https://consensys.net/about/office-locations/>).

25 ChromaWay defines itself as a “pioneer within using blockchain technology” and is headquartered in Stockholm, Sweden (“About Us,” ChromaWay, accessed February 21, 2019, <https://chromaway.com/aboutus/>).

26 For example, see “ConsenSys Academy,” ConsenSys, accessed March 11, 2019, <https://consensys.net/academy/>.

27 Mark Zilbert, “The Blockchain For Real Estate, Explained,” *Forbes*, April 23, 2018, <https://www.forbes.com/sites/forbesrealestatecouncil/2018/04/23/the-blockchain-for-real-estate-explained/#ddf79ad781eb>.

28 Peter Rabley, Twitter Post, February 13, 2019, 6:40 AM, https://twitter.com/Peter_Rabley/status/1095648851955011584 (Disclosure: Peter Rabley is a venture partner at Omidyar Network. Omidyar Network is a funder of the Future of Property Rights Program at New America, and provided financial support for this report).

29 Graglia and Mellon, “Blockchain and Property in 2018,” *Innovations*, 93.

30 For example, an article on the blockchain news website *Cointelegraph* asserts that “blockchain real estate platforms eliminate the need for intermediaries like lawyers and agents by providing a means of property verification and payment to buyers” (Hazel Agoni, “Blockchain Set to Change the Face of Commercial Real Estate As We Know It,” *Cointelegraph*, November 11, 2018, <https://cointelegraph.com/news/blockchain-set-to-change-the-face-of-commercial-real-estate-as-we-know-it>). A blog post on *Medium* conveys a similar message with the title “How Blockchain can eliminate the need for Real Estate Agents, Brokers, Title & Escrow” (Paul Bryzek, “How Blockchain can eliminate the need for Real Estate Agents, Brokers, Title & Escrow,” *Medium*, January 24, 2018, <https://medium.com/@bryzek/how-blockchain-can-eliminate-the-need-for-real-estate-agents-brokers-title-escrow-291db5d7ad6>).

31 Ryan, “Beyond the Buzz.”

32 Ibid.

33 Benny L. Kass, “Does the future of real estate include Blockchain technology?,” *The Washington Post*, July 13, 2018, https://www.washingtonpost.com/realestate/does-the-future-of-real-estate-include-blockchain-technology/2018/07/12/0a556a50-7bdf-11e8-ae44-4d04c8ac6158_story.html?utm_term=.95b50b63c14d.

34 Ibid.

35 Ibid.

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