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Property Blockchains have Failed to Realize Their Promise

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Abstract

We analyze the introduction of blockchain technology in the U.S. home sales market. The introduction of blockchain technology into the real estate industry has failed to meet high expectations to streamline operations and reduce costs. Required legal changes in the management of property deeds, high investment costs and unproven technology met resistance in a fragmented industry with many players, some holding monopoly control. Many parties in the complex chain of real estate transactions have resisted the natural Schumpeterian wave of creative destruction which, at the macro level, should bring huge savings. At the micro level, title insurers have the most to lose if a decentralized 'trustless' chain is created, since they extract high rents as middlemen.

Acknowledgements

I want to extend a big thank you to Humberto Barreto. You guided me through this process and never gave up, this thesis would've never been possible without you. While this research was strenuous and had many dead ends, you always kept me on track. I want to thank Monica Fennell and Khadija Stewart for sitting on my committee and helping me accomplish this research. Thank you to Mike Manning, 'Joe Smith', John Mirkovic, and Eric Lapin for providing incredibly valuable insights which helped build the foundation for this research. I want to thank my father, Paul Walton, for being my biggest supporter through this thesis and life. You have always shown me that anything is possible with hard work and dedication. Lastly, I want to thank the Honors Scholar Program at DePauw University for providing this incredible experience.

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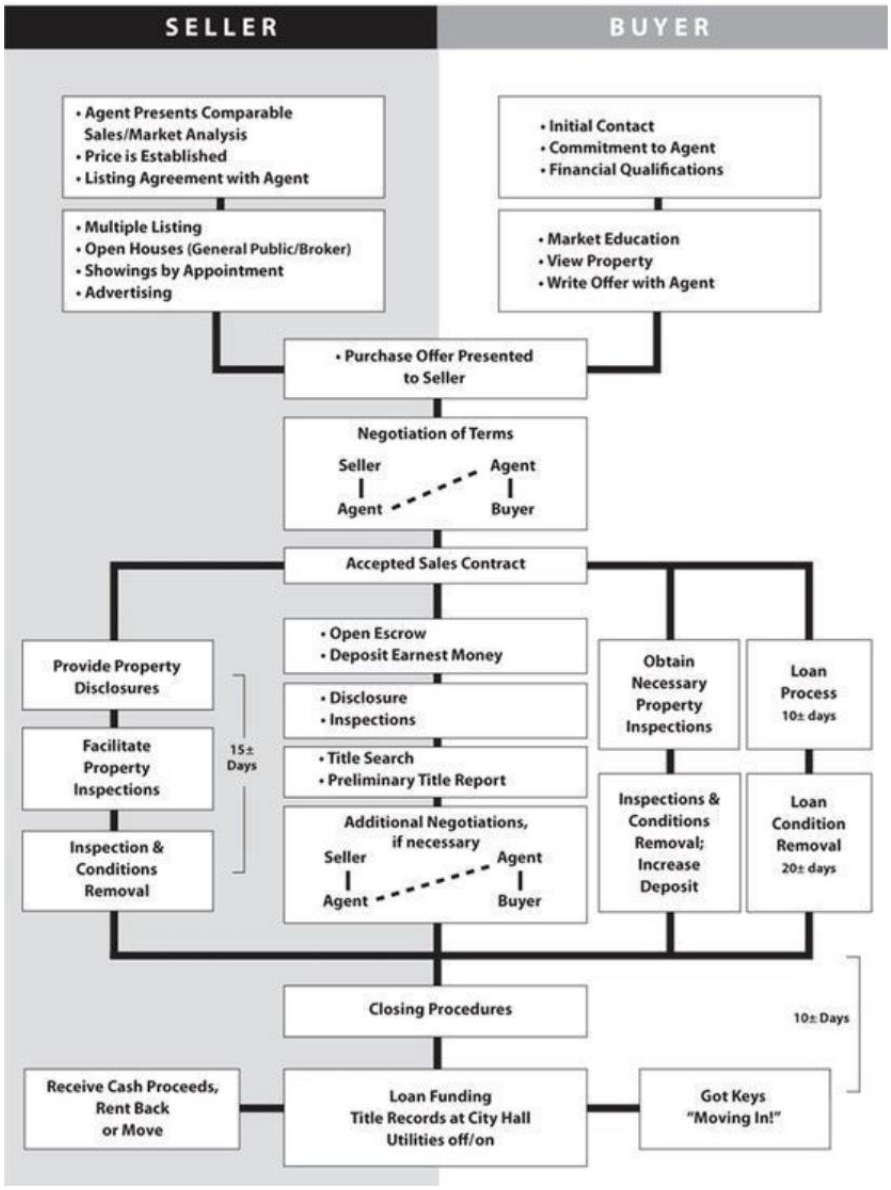
1. Introduction

This thesis explores blockchain technology and its application in real estate, specifically the creation and management of digital property rights to represent property title. While handling real estate title 'on chain' could save time, reduce cost, and minimize fraud, we show that key industry players such as title insurers do not want to change from the current inefficient system, and the failure of make infrastructure changes have stalled progress in the application of technology which has been available for many years. This reluctance to change is partly explained by operational and legal issues and partly by self-interested profit seeking and job preservation.

A traditional property transaction for a single-family home can take 12-16 weeks to close, after many months of marketing, and involves several highly paid professionals, with several manual tasks, making deals expensive and prone to error. We focus on the management of legal title, the proof of legal right to and conveyancing of a property, as the weak link in this process, reviewing evidence from the U.S. property market.

A real estate title is a set of legal rights associated with the ownership of property. Title is documented through the county office and provides the information on who owns what property. First American Title, the largest provider, describes Title Insurance as follows. "When a property is financed, bought, or sold, a record of that transaction is generally filed in public archives. Likewise, records of other events that may affect the ownership of a property, like liens or levies, are also archived. When you buy title insurance for your property, a title company searches these records to find and remedy several types of ownership issues."

Figure 1: The Real Estate Process

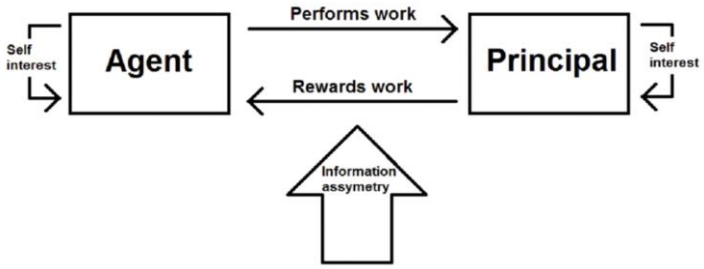


A property's ownership status and insurability of this title is determined by a title company's search public records. "Most people think that title insurance is the price they must pay so the lender can sleep well at night. Also, the premium drives up the costs they need to shell out at closing. It's not only the premium, but many other costs related to getting a clean title that consumers feel is all wrapped up in purchasing this insurance." (Bieniek, 2011.)

At a microeconomic level, we can observe that many agents in the real estate process benefitting at the expense of the principals, home buyers. The principal–agent problem typically arises where two parties have asymmetric information and different interests. The agent has more information, such that the principal cannot directly ensure that the agent is always acting in the principal's best interest or entering economically efficient transactions.

The difference between the agent and principal's interests is called the agency cost. We will argue that Title Insurers benefit from excess profits due to unnecessary agency costs because they make insurance premium decisions based on their market position in assessing title risks (asymmetric information) which would otherwise disappear with the application of blockchain technology (in which all parties would have the same information).

Figure 3: The Principal-Agent Relationship



The title industry is not competitive, with a few major players setting insurance premiums based on their market position and cost structure, as opposed to the insurance risks they face and industry competition. The five largest title underwriters controlled over 70% of market share in 2021 (American Land Title Association, 2021.) Title insurers have experimented with blockchain pilots which could streamline the management of chain-of-tile in property deeds they have declined to scale them up in operational systems.

While the benefits of a trustless economy are apparent, and would remove this information asymmetry, there is no economic force to drive a wave of Schumpeterian creative destruction and replace the current hierarchical organization in which title insurers play a key role.

At a macroeconomic level, we find that in the application of blockchain technology is a failure of de-hierarchicalization, as competing interests continue to extract meaningful economic rents from the current structural inequalities and technological shortcomings. This suggests that the Marxian-Schumpeterian model, in which large hierarchic organizations control an industry, is still in place.

Most of the studies we have reviewed, and the interviews concluded, argue that there are substantial legal, operational and investment barriers to the introduction of property blockchains. While the benefits of a trustless economy are apparent, and widely professed, in practice there is no economic impetus to drive a wave of Schumpeterian creative destruction.

Many authors are very optimistic about the benefits of blockchain technology for the property sector. (Ewendt, 2018) argues that the benefits of an immutable decentralized ledger, or blockchain register, of real property records are substantial. “The increased security, lower costs, improved user experience, and avoidance of conflicts should be a welcome change … However, it would take considerable resources to make a change from such a longstanding process that is not only engrained in the government’s infrastructure but has also spawned dependent industry markets.” (Pg. 126.)

(Saull et al., 2019) argue that the indelible proof of ownership blockchain technology will reduce need for title insurance. Utilizing a more trustworthy recordation process will provide much more value for regulators and government officials.

Goldman Sachs estimated that the successful introduction of functioning blockchain technologies could lead to an annual savings of $2-4 billion in the US real estate title insurance market alone (Schneider et al., 2016.)

However, many professionals in the title insurance industry argue that technological change is not desirable. (Sadler et al., 2018) argue that land records in the US are well maintained due to the strong processes and systems that state governments have in place. They argue that the adoption of this technology is not needed for our current system of land records, as title defects will still need to be resolved by industry professionals.

"Issues that arise due to faulty foreclosure actions, failure to properly record documents, and title contests brought by heirs of prior owners and are all scenarios which require the knowledge and curative abilities of title professionals … Homeowners and lenders have relied on the services of the title insurance and settlement industry for generations, and emerging technologies will not replace the assurances that title insurance provides." (Pg. 16.)

This paper will attempt to explore the applications and improvements brought with blockchain technology in title insurance. In section 2, we introduce blockchain technology, and its theoretical benefit to a wide range commercial transaction. In section 3, we review the literature on the benefit of blockchain technology to the property market. In section 4, we provide interviews with industry professionals to understand the pros and cons from the ground level. In section 5, we discuss the implications of our study in the context of Agency theory and Marxian-Schumpeterian economic theory. In section 6, we conclude by asserting that while in theory, blockchain could reduce many redundancies in the current system, but in practice, it would be nearly impossible.

2. Overview of Blockchain Technology

Satoshi Nakamoto's white paper (Nakamoto, 2008) described Bitcoin as a peer-to-peer transaction model based on public-key cryptography and distributed networking to create new blockchain technology. Blockchains, like Bitcoin, enable valuable transactions to be completed on a peer-to-peer basis over the internet without the need to trust each other. In real estate transactions, this provides the potential for sensitive and valuable transactions to be completed with the need for middlemen to confirm transactions.

The fundamentals of blockchain technology have elements which are simple: parties make transactions electronically; transaction data is cryptographically hashed in a short message to hide the parties' identity, timestamp, and its place on the blockchain; a public broadcast is made of hashed blocks; transactions are validated by individual nodes on the network; and, when consensus is achieved, each transaction (or block) is added to the blockchain, an immutable electronic register. Each of these steps is addressed by existing techniques which are combined in a single technology.

Public-key cryptography provides security. Each user can communicate their specific identity by solving a mathematical challenge by presenting one public key and holding another private key, which are linked numerically. A private key signs a transaction and keeps it secret through encryption, while a public key is broadcasted and is used to unlock, or decrypt, a transaction. Messages which convey transactions are valid if the sender signs with their private key. This allows users who prefer to be anonymous or are unknown to each other to validate their identify through use of their private keys. Private keys can still be stolen and enable identity theft.

Contract law, government, the courts, and attorneys are expensive and cumbersome means to enforce trust. In real estate, brokers and financial institutions guarantee, underwrite and insure

transactions, extracting a significant charge. Blockchain technology creates trustless transactions, replacing the legal and commercial infrastructure and people which have typically protected good actors or punished bad actors. Individuals should in theory be able to take control of their agency in transactions, reducing or eliminating the need for these intermediaries, saving time, and cutting costs.

In blockchain's peer-to-peer verification model, a network of peers (nodes) confirms (validate) transactions replacing a complex web of trust with a more elegant form of agreement (consensus) which shares the burden of intermediation amongst network members. Transactions are verified by consensus, a super majority (or two thirds share,) of peers/nodes, reducing the chance of error fraud. Members verify transactions by successfully decrypting/encrypting them according to complex mathematical equations ('proof or work'), gaining 'mining fees', or by putting their capital at risk ('proof of stake'), gaining 'staking fees.' These costs are significantly lower than the charges made by the intermediaries they replace; the specific blockchain protocol – of which there are many – replaces legal and commercial players.

Each transaction comprises some reference to previous transactions (blocks), to order inputs and outputs overt time, confirmed verification (validation), and timestamps. Blockchain explorers are published to allow a public record of the existence of confirmed transactions (but not their content, which remains private. For example, the occurrence of a Bitcoin or Ethereum transaction can be confirmed, but its value and amount cannot.) As the chain advances, blocks are written to the chain (hence 'blockchain') are stored and referenced by network nodes when adding new blocks to create a fixed (immutable) record.

Blockchain technology was initially adopted as open public chains by technologists working outside of the conventional commercial sphere, inventing, and promoting their own currencies and assets, but it has now been embraced by the corporate world, more often as closed

private chains. These blockchains differ in character and application. Public chains offer an infinite number of voluntary nodes seeking payment for validating transactions.

Private chains offer a limited number of nodes by invitation only. The latter, typified by projects like IBM's Hyperledger or R3's Corda, are judged to be more suitable for fully commercial applications.

Blockchain technology is a replacement for paper-based records or computer databases, offering three record registration methods: Entire records, the existence records as hashed blocks, or tokens which point to records held elsewhere. Each has it benefits and drawbacks. Entire records are complete, but the volume of data makes them difficult to access. Hashed blocks are easier to access, but must be continually encrypted/decrypted, placing a high cost on network operation.

These three forms of registration have been implanted in practice. First, entire records can be accessed on the Ethereum blockchain, in the form of 'smart contracts', self-executing code triggered when certain criteria are met, releasing the existence and contents of transactions stored on the blockchain. While elegant, the legal basis of smart contracts is not settled law – although efforts are being made to accommodate them in many US states – and this limits their applicability. Second, digital fingerprints, or hashes, are used to confirm the veracity of off-chain records. This method risks losing the contextual link between an object and its fingerprint, separating records the chain-of-evidence which proved their creation. Third, objects (tokens) can be created on the blockchain (on chain) which can be explicitly linked to objects elsewhere (off chain.) This method is preferred for maintaining the provenance and context of transactions and has become very popular to identify real objects (e.g., in Non-Fungible Tokens, or NFTs, which represent some creative product like artworks.)

The efficiency of various types of blockchain in solving real-world problems has been studied by a standards body, the International Project on Preservation of Authentic Records in

Electronic Systems (InterPARES.) InterPARES considers the requirements of any electronic system to preserve the unique authenticity and security of records.

Blockchains perform well measuring the identity of records thanks to uniqueness of records, contextual linking of transactions, crypto graphic security, immutability, wide distribution of records copies and timestamping of blocks. Blockchains fulfill a cardinal requirement of record keeping, expressed in the common acronym 'LOCKSS' ("lots of copies keeps stuff safe").

This does not mean that blockchains are without risk. Public blockchains are operated by voluntary members who could in theory act mischievously or stop their work. There have been many examples of chains splintering into new tribes, or "forks', which make it difficult to confirm transaction history. Multiple versions of the transaction can be submitted for validation such that the first to be validated is confirmed, but this could be the result of collusion of a sufficient major of nodes. With so many blockchains being offered there is a significant cost to transmitting data between chains which use fundamentally different technologies. Finally, public blockchains are unaccountable, and no party has a fiduciary duty or legal responsibility.

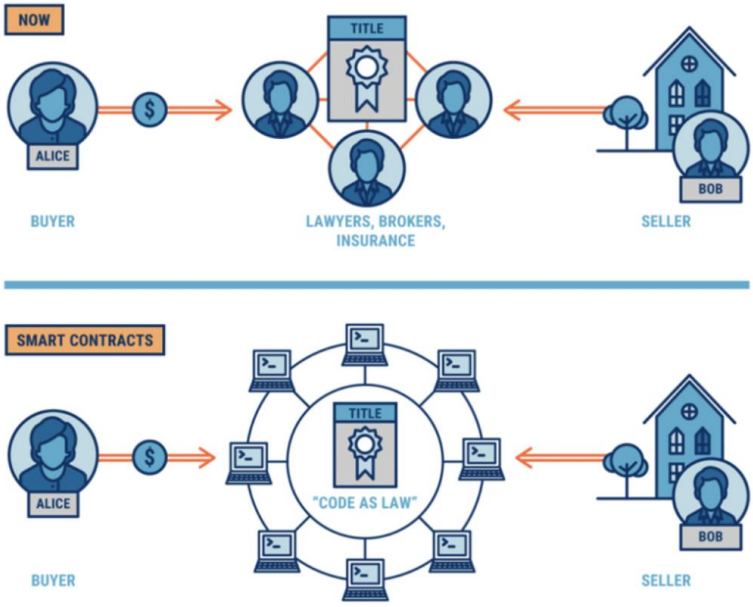
These problems lead many to argue that pubic blockchains are incompatible with traditional record custodianship, especially as it pertains to public recordkeeping. Officials acting at public capacity open themselves to liability if inauthentic records are submitted and become part of an immutable record which is costly or in some cases impossible to reverse. Private chains were organized to avoid these problems.

A limited amount of information is contained within a single transaction on the blockchain to provide computational efficiency. Fingerprinting or token models were devised to register only a small amount of information, but this means that blockchains become simple index models. Hashed records obscure underlying data (being a short string of letters and numbers) and do not allow the original record to be recovered if the private key is lost. Transactional information is

typically transferred at the local level by participants which have developed their own methods, but to work effectively, blockchain technology would need to uniformly apply everywhere in the same way at the same time. This would require significant coordination, investment, and re-training.

The application of blockchain technology to the property market can be visualized as a movement from a liner process to a circular system. Title insurance is no longer required.

Figure 4: The move from a linear flow to a decentralized network.



Many critics argue that the long-term sustainability of the current generation of blockchain models is questionable. The technology is less than a decade old. There have been significant network failures, or 'hacks', in which substantial value has been stolen. The power consumption and cost of operating some models is very high. Government attitudes to the legality of public blockchains and the regulation cryptocurrencies which sustain their commercial models is in flux. The failure of internet-based network infrastructure is a non-negligible risk (if networks fail, records will be inaccessible at best or lost at worst.) Blockchain technology might well prove to

be more efficient, but can it be trusted, is it affordable, and is there a sufficient incentive for its widescale introduction? Today the answer appears to be, ‘not yet’.

3. Literature Study

(Koronczok, 2019) breaks down land title and the implications of utilizing blockchain technology. The paper begins by breaking down the technology behind blockchain, then segments into title issues and blockchain solutions and caps off with the introduction of title plants on chain. Blockchain has created a genius new system for transactions across various parties. The author notes that blockchain has restructured market systems, voiding the need for intermediaries to form trusted transactions. A blockchain is described as “a digital protocol that enables the creation of an unalterable, decentralized distributed ledger across a public or private network.” (Pg. 404.) Simply put, the blockchain is an unalterable series of information stored across an entire network of computers. One main key to note is that once a block of information is attached to the chain, it can’t be changed by anyone. In essence, a blockchain forms a completely transparent, auditable, and immutable system of record for anyone to access.

Since the creation of this technology, two main ideas have emerged surrounding its utility in the real estate sector. First, to support real estate transactions utilizing smart contracts, a concept within the blockchain. Second, to use blockchain as a system of record keeping for real estate land titling. Smart contracts are pieces of self-executing code that take place on the blockchain. They automatically trigger when an event takes place and when created, they cannot be altered. The beauty of this is that when two parties agree on a transaction, they can express this agreement in the form of a smart contract.

When the contracts' requirements are verified, the contract executes. This allows two complete strangers to interact and transact without needing to trust or know one another. In real estate, property interest can be transferred into a smart contract, allowing users to transfer interest with little friction and complete certainty. Smart contracts allow for new vehicles of transference, allowing frictionless interaction and exchange of property rights across the globe. The biggest opportunity for blockchain integration lies in the land title process. (Koronczok, 2019) notes "By keeping relevant chain-of-title documents on a blockchain, government offices will have an organized, efficient, and unalterable system of accessing and adding property records to a publicly shared database." (Pg. 405.)

The interest of title is crucial in the sale of property as there are many possible individuals who can claim on the same interest, such as people who hold an easement over the property, will and trust beneficiaries, people who have secured lien on title, tax assessors, government agencies, and many more. The legitimacy of these claims on titles all falls on to the current state of title. The author tries to evaluate whether blockchain provides any advantages on the massive task of conducting title research. They hypothesize that blockchain will help title insurance become less expensive but not any less common (title insurance is the primary securitization on title research.)

Title insurance is the primary line of protection when transferring property, as it protects both the land and money from improper transfer. Title insurance runs at such a high premium because of the tedious tasks attached to clearing a property from all possible claims on title. Title research must ensure that all responsible agents have properly and thoroughly carried out their responsibilities in the retention or disposition of land. Research also must investigate on the current conditions of the property to clear unrecorded notices, such as constructive notice of liens, leases, or hostile claims on title. Other issues relating to title are incorrect spelling, recordation's of early or late deeds, improper recordation of deed interest and changes in state or county law.

Establishing a clear chain of title is an important pre-requisite for successfully purchasing a property and therefore requires the utmost care from title insurance agencies.

(Koronczok, 2019) asserts that blockchain technology does not erase unrecorded title defects, but more so, allows defects to be recognized without the need of legal professionals such as title insurance agencies. The author analyzes a pilot program conducted by Cook County in Illinois to examine how land recordation can be implemented on the blockchain. This program was established due to a myriad of schemes which allowed fraudsters to sell property to buyers which could not be legally acquired or inhabited before clearing a defect on title.

The Cook County Recorder of Deeds created a database of information regarding each piece of land in the county. Over a period of months, the county transferred over 190 million records, converting them to PDFs. The county hired a private firm to help construct digital abstracts for each parcel of land. The firm also created a digital chain of title, hashing all documents relating to a property on chain. The firm "then added to the digital property abstract each parcel's tax assessment attributes, such as lot size and square footage, from the tax assessor's office, its property tax payment and appeal history from the Tax Treasurer's office, a GIS satellite map of the parcel from the County Clerk's office, existing Chicago building permits and violations from the City of Chicago, latitude and longitudinal satellite coordinates from the United States Census, and a photo from Google maps." (Pg. 409.)

Finally, the firm created a tool called "Property Health" to allow potential buyers to visually analyze whether a property had any worrisome traits surrounding title interest, such as pending demolition, litigations, liens, or city code violations. However, the tool did not examine chain of title, only a basic glance at potential issues. While this program helped the public gain more transparency in what title records say, it does little to help individuals understand what the title records mean.

Investment bank Goldman Sachs (Schneider et al, 2016) reported that there was a major opportunity to register real estate titles on a blockchain and make major savings in the title insurance market. Title insurance is designed to protect mortgage lenders and homebuyers from financial loss which are be sustained from legal defects in the legal title to, or ownership, of a property. Savings of up to $4bn were projected due to lower labor costs and fewer insurance losses. However, since this report was published there have been few examples of the title industry putting such schemes into practice.

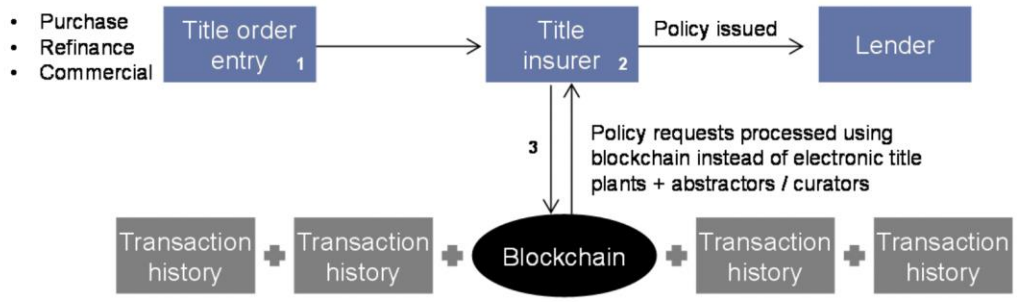
The cost of title insurance is due to the cost of the labor-intensive process of underwriting and validating title, with the addition of a profit margin, rather than the probability of insurance loss. Expenses ratios, the portion of insurance premiums which fund operating costs, are often 90% and above. In most years, this is a profitable business as the combination of operating expenses and insurance losses, or pay outs, is less than 100 percent.

During difficult periods, such as the 2008/2009 Credit Crisis and subsequent House price collapse, expenses and losses rose sharply, and title insurance was a loss-making business. In following years, the cost of title insurance rose sharply as title insurers sought to rebuild profitability. High operating costs from the manual process of title insurance, coupled with property market failure, levied real economic costs on property buyers.

Goldman Sachs describe how title insurers rely upon a complex series of transactions. In the first step, a property owner must provide a title order entry to their title insurance company. Title insurers use their own title insurance plants – parallel systems which hold title deeds and related legal documents – to complete their own search and examination process. Straight-through processing is possible for around 70% of policy requests, but circa 30% of policy requests are found to have title defects and must be addressed, or “cured”, by a team of professionals. Goldman identifies how the insertion of a public blockchain would simplify title search.

Figure 5: Blockchain technology simplifies title search

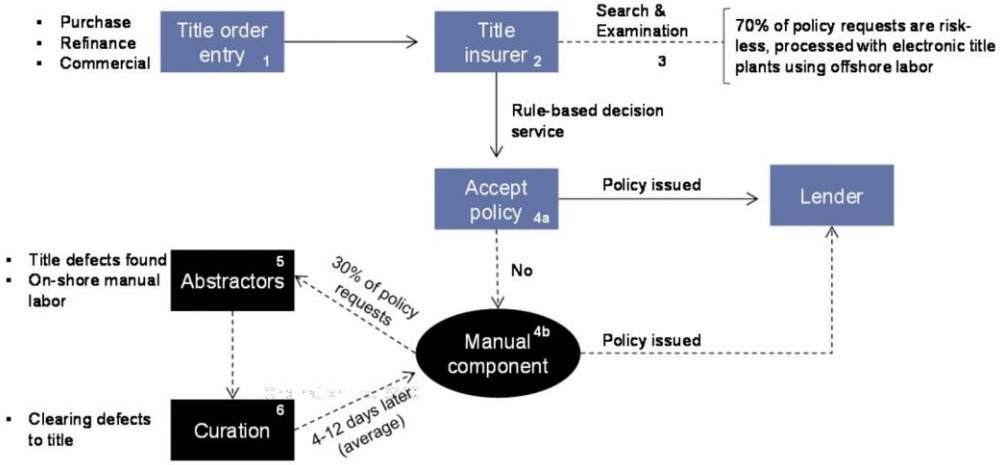
Exhibit 34: Blockchain could fundamentally disrupt the way title search is currently conducted
Blockchain title search process



Source: Goldman Sachs Global Investment Research.

Figure 6: Title search is a manual process

Exhibit 31: Title search is a manually intensive process, as abstractors and curators must process and clear paper-based property records – 30% of which are found defective at the time of the proposed transaction (sale/refinancing)
Title search process

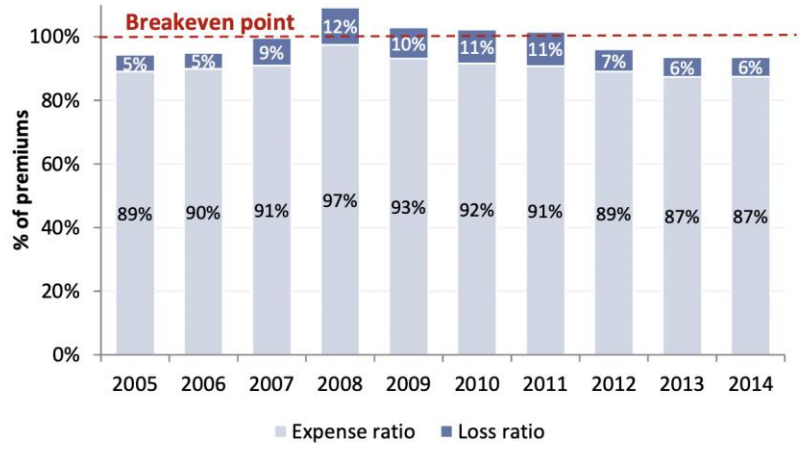


Source: Goldman Sachs Global Investment Research.

Title insurance costs are determined by an insurer's underwriting operational costs plus a small profit margin, not the actuarial risk of expected losses. Title companies' business model limits claim losses (5%-7% of premiums), but still bears the high fixed cost of checking title deeds and associated legal documents as the chart from Goldman Sachs illustrates.

Figure 7: Title insurers loss ratios and profit margins

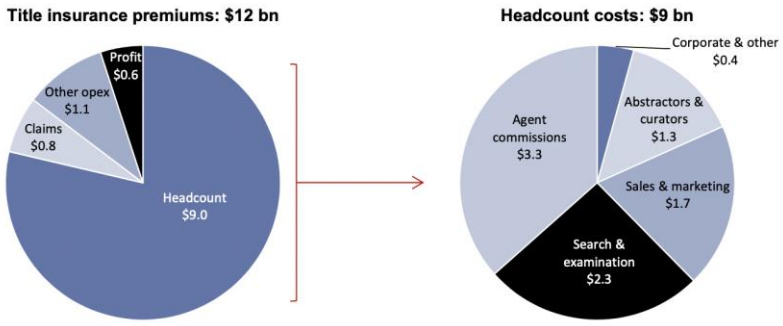
Exhibit 29: Title insurers absorb substantial costs in conducting property title searches in order to augment loss prevention, supporting profit margins of 2%-5% on average
Title insurance industry combined ratio, 2005-2014



Source: A.M. Best Information Services.

Figure 8: Title insurers operating costs

Exhibit 30: Title insurers' operating cost structure largely consists of headcount costs
Illustrative breakdown of title insurance cost structure (bn)



Source: Fidelity National Financial, American Land Title Association, Goldman Sachs Global Investment Research.

Goldman concludes by listing three challenges to the adoption of blockchain in the property sector. First, the fragmentation in the real estate industry. The property market is split up by the county level, leading to huge differences in pricing for premiums, regulation on title and the involvement of all parties. The lack of uniform variables could obstruct blockchain standardization.

Second, mortgage lenders' market participation. Financial lenders are the main beneficiaries of title insurance as it protects their investment from a multitude of issues. The willingness to adopt blockchain by the lenders is unclear.

Third, the cost of infrastructure development. The cost associated with creating a blockchain system for title would be massive. Convicting the public and funding this push would require a huge amount of time.

(Schneider et al, 2016) describes how title search is labor-intensive, organized by the management of chain of title, with historical transfers of property title being manually recorded on an ongoing paper trail that is stored in local jurisdictions. Property title is a unique contract form which gives the holder the right to a multitude of specific rights including entering the land, possessing, occupying, using, controlling, enjoying, and disposing of the land and any assets, such as housing constructions, which are built upon it.

Property titles describe concepts which often require descriptive language of characteristics and effects – the so-called 'bundle of rights' – rather than concrete terms. Qualitive language is common, with the legal system and lawyers describing good, bad, defective, perfected, cured, and marketable titles. Property law asks us to imagine a titles content so that 'evidence of title', 'deed', 'will', or 'court decrees' can be executed.

Title lawyers use the term "almost absolute" as there is no such thing as an individuals' absolute title to real estate. Governments have an absolute right to tax and confiscate land (so

called ‘eminent domain’ powers). Absolute individual rights are diminished by the outstanding rights of third parties, notably easements, sub-divisions, or community rights. A property deed is a written agreement between the ‘grantor’, or seller, who signs the deed, and the ‘grantee’, or purchaser, to whom the deed is conveyed under technical requirements for signatures, witnesses, seals, acknowledgments, and delivery which vary by state. Three major problems are identified in the current system which lead to higher costs than might otherwise be the case.

The physical control of property records at the town or county level in the U.S. has led Title insurance companies build and maintain parallel title plants to index public records geographically, so that they can increase their own search efficiency and ultimately reduce insurance claims. A title plant is a library of evidence which is required to prepare title commitments and other reports from an indexed collection of recorded documents, maps, and prior policies. Title plants are typically owned by one title insurance company so that it can standardize control of search examinations, reduce the time taken, and thus control title production costs. However, a multiplicity of title plants reduces but does not diminish the cost of title search, given that there are close to a hundred title companies in the U.S.

The use of paper-based records is naturally prone to error. Goldman reports, according to the American Land Title Association (ALTA), “almost one third of property titles are found to be defective at the time of a real estate transaction This is caused by errors in the paper-based recording of deeds, mortgages, leases, easements, court orders, and encumbrances associated with a property.” Goldman reports that “the cost of title insurance reflects search, validation, and distribution costs rather than the actual risk of losses, as it typically the casein other forms of insurance.”

(Schneider et al, 2016) argues that the application of blockchain technology could address these three problems and reduce title insurers headcount, representing 75% of industry premiums, in technically demanding, high paying jobs: title abstractors, title curators, search and

examination personnel, and lawyers examine and finally “cure” a property title. The application of blockchain technology has the potential to eliminate transactional risk from the transfer or property title in the existing land registration system, if property records were stored on a blockchain, such that clear title was readily accessible and trusted amongst all parties.

Property records would be validated by ‘consensus’, as we describe above (refence technology section), as all present and past real estate transactions would be stored on an immutable and decentralized ledger if there were no disagreement as to the ledger’s integrity. This would significantly reduce human error and potentially also title fraud risk. However, even amongst those who are optimistic about blockchain technologies’ benefit there is still caution as property data still needs to be verified and entered correctly by humans.

The central argument of those proposing the benefits of blockchain technology in property transactions is the creation of shared database of real estate transactions that would make property title searches more transparent and more efficient if localized public records are available to all parties in a commonly accessible format. However, as we will see, this is a long way from being realized in practice.

Observers agree that a national blockchain-based infrastructure is required that operates in conjunction with existing title standards and local industry is needed for commercial adoption. No U.S. administration has shown any appetite to fund such an ambitious project. Evidence from the State of Vermont and Cook County suggest that the cost and complexity of infrastructure development at the local level are major blockers.

The title insurance industry has tried to adopt its own solution. (First American Financial, 2018.) “First American Financial Corporation … announced the launch of a shared blockchain system designed by First American to increase efficiency, reduce risk and improve the title production process. The system is intended to facilitate the exchange of prior title insurance

policies between underwriters that contribute to the system. Old Republic Title Insurance Group, the nation's third largest title insurance underwriter, has committed to be the first to participate. Each policy included in the blockchain system will be coded with a unique identifier by property, streamlining the search process and increasing the accuracy of searches for prior title insurance policies." First American Title explained that this blockchain was designed to facilitate the exchange of prior title insurance policies between underwriters.

Each title insurance policy in the system is coded with a blockchain hash, as a unique identifier by property, which should streamline the title process and make it possible to locate prior title insurance more accurately. Title insurers typically exchange this information and the First American Financial blockchain was intended to streamline the process.

Real estate professionals have argued that the U.S. system is robust and provides title security at low cost. (Sadler et al., 2018) argue that human intervention for the direct review of documents will still be required. They argue that title insurers' compliance departments concern about data sharing and privacy laws prevent a truly open blockchain.

In a property conveyance, many parties work to ensure a seamless transaction in processes which are clearly delineated and well understood. Title defects are identified by human review of the land records. All parties to a transaction are bound by client confidentiality which might not allow them to share sensitive information with a blockchain in the same way as they share it with each other.

(Compton et al., 2017) describe the practical problems of creating a blockchain for real estate given the fragmented nature of the industry. According to the Census Bureau, as of 2013, there were a total of 3,143 counties and county equivalents in the US (Spielman, 2016). The recording system for property titles is disconnected as each state and local government has a role

in the transfer of real estate ownership with the latitude to create its own laws, recording requirements and fees, requiring local attorneys to close transactions.

(Sadler et al., 2018) argue that a blockchain does not have the capability to perform so-called curative work as a title insurance professional or attorney does in advance of a transaction closing successfully. Resolving such issues, title insurance professionals and attorneys ensures that the homebuyer will not be subject to any subsequent claim against a property.

The title insurance industry paid $546 million in total claims in 2017. (American Land Title Association, 2018.) Title insurance protects homebuyers so that they will not be required to pay existing debts, meet foreclosure requirements, pay debts or taxes, meet title contests from heirs, or resolve other legal problems. Many 'off-record' title defects are not obvious or disclosed in a land registry but can be identified by a professional.

(Compton et al., 2017) argue that getting all real property transaction constituents, municipalities, property owners, banks, taxing authorities, attorneys, and courts, to agree to uniform protocols and standards as well as payment processes, and retraining millions of staff, will be challenging and expensive as there are few shared goals between parties. Rather, they believe that certain limited goals might be achieved in streamlining title insurers' own 'title factories', identifying fraud, or securing party-to-party money transfers.

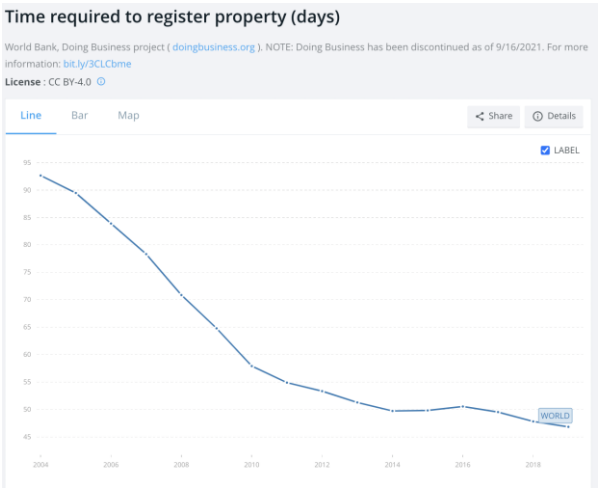
Fraud is a major problem in real estate transactions due to their high value and complexity, with identity theft and the fraudulent manipulation and filing of false documents. Blockchains validate transactions by verifying the identities of all parties with encrypted data and public/private keys, rather than obtaining the explicit consent of all parties involved. We have seen in the technology section that 'false' transactions cannot be added to a blockchain. This means that a property blockchain could resolve issues arising from identity theft and fraudulent payment schemes.

(Compton et al., 2017) warn that the protection of identify in blockchain technology is also a risk if the key is lost or stolen, as there is no recourse available under existing blockchain technology. A bad actor could pose as the user until the private key is deactivated. A blockchain network cannot distinguish between transactions performed by a legitimate user or a malevolent actor with unauthorized access to the legitimate user's private key.

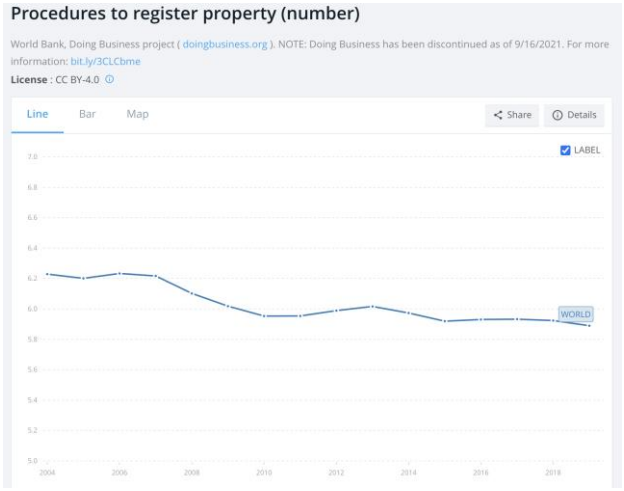
(Saull et al, 2019) describe how blockchain technology could improve the highly fragmented U.K. property market. World Bank data shows that the global real estate market has become more efficient through the streamlining of transaction processes. The average time taken to register a property has halved from 93 days to 47 days between 2004 and 2019 for a sample of around 200 countries. The UK has seen the average time taken fall from 41 days to 21 days over the period. However, the US has seen no change in the average time of 15 days over the period. World Bank data shows that most countries are taking less time to manage a fixed number of processes, but the number of distinct real estate transaction processes has not changed much, hovering round six steps in most countries. This failure to remove the number of steps in the property transaction chain is telling – with blockchain technology it could be reduced to two or three steps.

Figure 9: Title registration efficiency

Time taken to register property



Number of procedures to register property



(Saull et al, 2019) report that the property transfer success is best measured by the time taken to completion. Delays and over-runs in transactions are common in paper-based systems. They found that delays occurred in close to 40% of all transactions because of due diligence issues in title deeds registration.

Antiquated technology is reported to be a major reason for delay. They describe the most common delays in commercial property transactions and provide suggestions how technology might help (or hinder) these delays. Coordinated government action and major investment is needed to address these problems (government regulation, and tech business innovation.) They argue that private technology monopolies like Amazon, Facebook, Google could provide the answer.

(Ewendt, 2018) argues that there are significant barriers to the successful introduction of blockchain technology in the U.S. as it will require considerable spending on government infrastructure to combine two incompatible systems. A central government entity to maintain the

registry of property transfers, and the encouragement of commercial agents to manage document transfers.

(Ewendt, 2018) cites a successful pilot which was trialed in Torrens, North Carolina – a paper-based system which might provide a model for a simplified blockchain approach. (Orth, 2017) describes how the Torrens system introduced the concept of a perpetually evolving record of property rights for a land parcel. The original, perfected deed for a property is amended with every subsequent transaction involving the property, showing each transfer of rights. As the grantor's deed is never "re-written" and a new, fresh copy is never given to the grantee, as the current US system requires, so there is minimal opportunity for human error. All past transfers and encumbrances are written into a Torrens deed, significantly reducing the need for title searches and title insurance. He argues that the evolutionary 'Torrens' approach could complement blockchain technology.

The State of Vermont Archives and Records Administration, with local cities and towns evaluated the use of blockchains for public recordkeeping and for recording land records in three-year period between 2016-2019. (Vermont State Archives and Records Administration, 2019.) The Vermont study had two objectives, to explore whether blockchain would provide sufficient means for an improved recordation system and to suggest possible legislation needed to support the implementation of this technology.

Their findings found no practical benefits to blockchain technology. They state that blockchain doesn't have any real benefit as is does not further verify documentation, nor store it but rather hash documents to the chain that are stored somewhere else.

Vermont published an accompanying whitepaper which represents one of the most thorough examinations of how it attempted to apply blockchain technology to its property records. (Condos et al., 2016) states the main problem is trusting public records held by the

government. Blockchains and land transactions appear to be a natural fit, as legal and monetary costs are high, and all the parties to transaction (grantor, grantee, mortgage and loans issuer, agencies) trust town clerks for transaction confirmation. However, there is little or no oversight role, as the clerk does not judge whether the transaction is valid, only whether the proper instruments have been properly filed and recorded.

(Condos et al., 2016) describes optimistic expectations for blockchain use, stating that both parties could record all actions on chain. This could solve "double spending" issues surrounding ownership and allow for no alterations to be made once agreed upon and hashed to the chain. This solves a large issue surrounding trust and conveyance of title. They suggest new legislation, the Uniform Real Property Electronic Recording Act (URPERA) could create a safer, more efficient system for land recordation in Vermont. The act would require all paper documents to be created via an electronic system, with all signatures moving to e-signatures. It would also allow for notary of land recordation to take place online rather than in person.

(Condos et al., 2016) reports that tasks would be extremely complex, requiring all current documents to be transferred from paper to an online system. If only new documents were put on chain, it would be extremely difficult to manage a hybrid system of paper and electronic. For the system to work most efficiently, it would require 100% on chain data. Vermont describes the challenges which any electronic records system face, noting that keeping both reliability and integrity of records is very hard to do. It's often not possible to achieve both objectives at the same time as records which are easier to use, like those on a blockchain often have light integrity controls. If property records on the blockchain stored hashes or pointers to a record as opposed to the documents themselves, the original records from which those hash values derived would need to be stored on a publicly accessible system if its role is not only to validate but also store the transactions so that the public can audit their veracity.

(Condos et al., 2016) offers seven recommendations. First, to enact URPERA to allow Vermont to modernize its recording system for property. Second, to create an electronic system for notarization to capture the entire record of the property transaction. Third, to re-examine the roles that municipal clerks play to avoid replication and inefficiencies. Fourth, to form a land recordation committee to ensure all requirements and procedures for recording land are followed and preserved, regardless of the technology implemented. Fifth, to establish a plan of succession should the blockchain route be compromised. Sixth, to create a full database going back to the start on chain, rather than just adding new records to chain and using hybrid paper electronic system. Seventh, to record all aspects of land information separately, such as permits, zoning, etc.

Vermont concludes by suggesting that creating a digitized system will be more efficient and solve existing issues, but don't use blockchains which confused the process and add more headaches. Blockchains are useful for public recordkeeping only if public institutions can guarantee the long-term preservation and continued access to the data recorded.

4. Interviews

We conducted interviews with several industry professionals to better understand the operation of the title insurance sector and how the application of blockchain technology might impact this industry. We focus our questions specifically on blockchain and title insurance, looking at the upsides, the downsides, and if it could be done from a practical sense. We conclude by surveying the interviewers on a 1-5 scale and find that following issues are considered most important: authentication in the current title process, increasing efficiency and reducing the cost of title insurance, while greater transparency and cutting fraud are seen as less important.

1. **Mike Manning, head of blockchain technology and digital currencies at Amazon**.

Manning does not believe putting title on chain is either beneficial or practical. He offers two main explanations. First, putting title insurance on chain will not save enough money to justify the cost and time taken. Federal mortgage providers Fannie Mae and Freddie Mac will still require title insurance, so putting title on chain will not replace the need for title insurance until those changes. Second, putting property on chain today does not account for all the historical property information. Because there are still issues and defects on title from the data not attached to the chain, you will still need title insurance until all information from the start of the property is attached to the blockchain.

Manning believes that putting all this information across 3,000+ counties across the U.S. will be almost impossible. He emphasizes that unless an asset is originated on chain, it never belongs on chain. He argues that digitization and blockchain technology are very different things. He believes that blockchain could automate procedures across institutional boundaries.

While Manning does not see much value in adding title insurance to the blockchain, digitizing the real estate process could be immensely valuable. By originating a mortgage on chain, you can structure all the data and documents and construct them digitally to be evaluated by smart contracts to save a large amount of money. If you can provide all inputs needed for a mortgage into a loan file and digitally sign to ensure all data is valid and true, then you can use automated smart contracts to test that the buyer meets all necessary criteria for the loan. Manning concludes by noting that while blockchain integration could be valuable in a few areas of real estate, using blockchain for title insurance just doesn't make much sense.

2. Eric Lapin worked for Old Republic title. Lapin spearheaded a campaign at Old Republic to implement blockchain.

Lapin states that overall, blockchain can act as a Customer Relationship Management system and document management system for storage in an immutable and transparent manner. In

relation to title insurance, blockchain only helps lenders sell loans through the secondary market by reducing the number of times needed to process due diligence (which is around six times for every loan.) This allows costs to be reduced through the process by cutting out each individual cost for due diligence which is $500-700 every time.

Lapin notes that while it will not reduce much for the end consumer in title insurance, it can drastically cut time and cost for the lenders who buy and sell these loans through the secondary market. Lapin does explain that moving from the current system to a blockchain will be hard to accomplish as it is very expensive, not well understood, and can scare individuals through misconceptions around fraud and loss of jobs.

3. John Mirkovic is the Deputy Clerk for Cook County Illinois. Mirkovic led the Cook County pilot program using blockchain for title insurance (as previously mentioned in the literature review.)

Mirkovic expressed that blockchain was a very promising system for keeping records in a permanent, decentralized way. He believes that real estate was the sector that needed this technological update the most but was a long way off from getting all the parties needed to make it work on board. After the pilot program concluded, he and his colleagues pivoted to an educational role, trying to help teach other people about the strengths of blockchain and why it is a crucial next step in the evolution of real estate.

One issue he notes is that, while blockchain can be an efficient means for recording a chain of title, it cannot clear any clouds/defects on title when found. To check for clear title accurately and thoroughly, one must search five different offices in each county making it difficult to accurately predict clear title using blockchain.

Mirkovic mentions that to best use blockchain, it would be best to transition back to the old method of title known as the Torrens system, which relied on the government to issue clear

title and was backed by the state. The United States currently operates on a private title insurance system, which in theory should save more money for the consumer through the free market but does the opposite. He argues that with the emergence of blockchain, it makes more sense to revert to the old system and use both the chain and government to secure title.

Some of the biggest barriers to blockchain is the complexity of a real estate transaction. Learning how to boil down and reframe this transaction to fit blockchain will take time, cost, and disadvantage many parties who facilitate the system of operation currently. Another issue is that since blockchain technology is decentralized and unregulated, it is easy to make a mistake and lose all your money. When sending funds to two wallets through a blockchain, you must have a wallet address. If you input the wrong address and send the funds, you lose your asset for good and there is no one to fix the mistake.

4. 'Joe Smith' has asked to stay anonymous through the interview so we will be using a pseudonym to respect his privacy. Smith has extensive knowledge in mortgages and real estate, working close to big innovators in the space. Smith is currently the CEO of a fintech mortgage company.

Smith notes that blockchain could improve title insurance, and the real estate process, but will never happen because the title insurers and other parties involved in the process make so much money through the current inefficient system. He sees the true application of blockchain being the ability to load all information on to the ledger and having the information publicly accessible for the loan.

Smith emphasized how inefficient the current title process is. A quarter of the counties in the United States still record all information regarding title by hand, leading to high rates of error. If you could apply title to the blockchain, you cut the need for title insurance as you can see the entire chain of title publicly. Overall, he sees that blockchain is important for creating, sharing,

and giving permission to data. Today a data warehouse holding real estate loans cannot grant an outside actor to view part of the loan because it would grant access to the entire data warehouse. The blockchain gives the ability to give certain permissions for data viewing without compromising all the data, streamlining the operational process.

Smith notes that one of the biggest blockers from mass adoption would be trying to convince every county in the US that this technology is worth the time and cost to implement. He also states that the main players who control the market, title insurers, would never allow for this system to even begin to come to life as it is massively profitable for them. Joe states that over 80% of the cost for title insurance is profit for the insurer. Another main blocker is how politically entangled real estate is with the government. Lobbying congress to ensure blockchain never sees the light of day is easy and cheap for the big players at risk.

Smith concludes that emerging countries are very open to adopting blockchain to protect against fraudulent governments. Using a transparent and decentralized ledger prevents embezzlement of funds, provides a clear process to the public and fosters stability. By creating standardization and stabilization, these emerging countries can attract foreign investment and grow their economy at an exponential rate.

Quantifying Title Insurance and Blockchain

All participants in the interview were asked to rate their opinion on various questions relating to blockchain and title insurance to begin to quantify and analyze various inputs. Their responses are based on a scale from 1 to 5, with 1 being no not at all and 5 being yes extremely.

Figure 10: Summary of interviewee opinions

Name	Mike Manning	'Joe Smith' (Pseudonym)	Eric Lapin	John Mirkovic	Average
Is title insurance an important consideration in the application of blockchain in the real estate sector?	1	5	3	5	**3.50**
Do you think blockchain can reduce cost in title insurance?	3	5	2	5	**3.75**
Do you see authentication as a major issue in the current title process?	3	5	4	5	**4.25**
Do you see fraud as a major issue in the current title process?	1	5	3	2	**2.75**
Do you see efficiency as a major issue in the current title process?	3	3	4	5	**3.75**
Do you see transparency as a major issue in the current title process?	1	5	1	1	**2.00**

5. Discussion

At the macroeconomic level, the Marx-Schumpeter model of economic change is a commonly used framework to understand the impact of technological change. We consider its relevance to the failed introduction of blockchain technology in the U.S. property sector. (Davidson et al., 2018) argues that blockchain is a technology that disrupts institutions, industries, and services, but also the organization and governance of firms, markets, and governments. (Berg et al., 2019) examine the structural economic consequences of wide-spread blockchain adoption

predicting that in a Marx-Schumpeter model, technology fosters economic complexity, which in turn fosters more economic growth. To the contrary, in a blockchain-enabled world, technology fosters economic simplicity, a lower cost of trust, and more economic growth. The authors consider this process to be inevitable and label it "de-hierachicalization."

Blockchains have a simple economic model, revenues are generated in fees for the provision of services, and costs are incurred to secure the blocks upon which consensus is built. To the extent that these values are modest which, and at present they are, the cost of trust which they provide is diminished to that point those middlemen have no long-term role (having higher revenues and charging larger costs.) Blockchain technology literally creates trustless economies, and their introduction should logically follow.

The introduction of blockchains in a post-industrial economic era provides new business models which are embedded in smart contracts on distributed ledger technology. (Berg et al., 2019) argue that a capitalist economy which is built on distributed ledger technology requires a new "co-evolutionary" model which goes beyond Marx and Schumpeter. The classic Marx-Schumpeter thesis requires complexity, which is governed hierarchically, as opposed to the decentralized models of the blockchain. The authors state that both models can co-exist and hence are co-evolutionary.

The Marx-Schumpeter model predicted the rise of hierarchy as an outgrowth of industrial innovation. Complexity led to the creation of large hierarchic organizations to amass capital, creating monopolistic competition. In a Marxian model capital accumulates monopolistically, and small firms are displaced by larger firms. The growth of hierarchy – what Marx calls 'centralization' – provides economies of scale and "the progressive transformation of isolated processes of production carried on in accustomed ways into socially combined and scientifically managed processes of production" (Pg. 4.)

Hierarchy was the result of innovation, and complexity was the result of hierarchy, with both required to coordinate around large projects (such as railroads). Schumpeter adopted many of the key elements of Marx's model, for example, the dynamics of industrial capitalism led to the creative destruction in markets and firms and as the evolutionary replacement of general-purpose technologies in heavy industry. Schumpeter's concern was that the growth of hierarchy and administrative processes impeded creativity, induced regulation, and impeded entrepreneurial dynamics.

On the contrary, the long-run historical effect of blockchain technology is to disrupt the economic value of hierarchy, as it moves from public to private models, and the cost of trust is dramatically diminished. Hierarchies are no longer required to control markets or economies. (Berg et al., 2019) call this process de-hierachicalization. This process reduces the need for economic or regulatory intervention. Markets are naturally competitive, anti-trust and competition law are unnecessary, economic organization is more diverse, and companies and labor law to manage unbalanced bargaining power between shareholders, employees and management are not required.

This view is somewhat utopian and is not yet demonstrated in the application of blockchain technology in the property market. Rather, we view this process as the potential simplification of business into a decentralized world where no actor can use their dominant legal or economic position to extract economic rents over-and-above those which are required to support the network and for the provision of their specific services.

At a microeconomic level, agency theory provides an explanation for the reluctance of the property industry in general and title insurer's specifically to not introduce blockchain technology. In the absence of perfect information on title, there is an obvious information asymmetry in a real estate transaction. Title insurers have the best information on title risk and can set title insurance premiums at a level to reflect their costs and desired profits in a

monopolistic industry. We find that title insurers benefit from excess profits due to unnecessary agency costs because they make insurance premium decisions based on their market position in assessing title risks (asymmetric information) which would otherwise disappear with the application of blockchain technology (in which all parties would have the same information). Further research would look to quantify the savings which might be possible if the role of property intermediaries, like property agents, were removed, and how this compares to the investment required.

6. Conclusion

We find that in the application of blockchain technology to the chain of title in property transactions has failed for several reasons. First, the legal basis for translating physical contracts to blockchain technology is not possible (paper records are preferred and, in some cases, essential.) Second, the is no appetite to invest in the necessary technology and operational change. Third, major players in the industry, notably title insurers, have no incentive to introduce changes which would at least reduce their profitability and, at worst, not require their services. Fourth, many in the industry believe the current system works efficiently. Fifth, there is no local or central government leadership to promote innovation.

Most of the studies we have reviewed, and the interviews concluded, argue that there are insurmountable legal, operational and investment barriers to the introduction of property blockchains. While the benefits of a trustless economy are apparent, and widely professed, in practice there is no economic impetus to drive a wave of Schumpeterian creative destruction. This is a failure of ‘de-hierarchicalization’, or market simplification, as competing interests continue to extract meaningful economic rents from the current structural inequalities and technological shortcomings.

While blockchain technology might one day provide for trustless industries, with property being a prime candidate, there are many good reasons why this is not currently the case. Further research should compare the required investment in a national property blockchain in the U.S. to demonstrate that savings in time and money justify the required capital spending.

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