ROOST

Real Estate Cooperative and Blockchain-based Token Economy

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Abstract

Society is facing a housing crisis and a mounting wealth gap, disproportionately affecting younger adults and minorities. The price of rent and homeownership is rapidly increasing — and far exceeding income growth. Add in compounding student debt and escalating healthcare costs, and it is predicted that future generations will have insufficient savings to retire. Millenials have less saved for retirement than previous generations and, in fact, a large proportion of the population has negative net worth. To reverse this trend and help Americans build savings, tenants should be able to recapture the sunk costs of rent by earning fractional ownership in rental properties. ROOST will serve as this framework, a technology platform that enables multi-stakeholder cooperative ownership of real estate assets. This paper explores cooperative enterprises, evaluates the application of blockchain technology, develops a mathematical model for operating a stable token economy, and simulates the market dynamics and impact of fractional ownership in rental property on the long-term savings and net worth of tenants. The results suggest that, by enabling tenants to participate in a real estate cooperative at scale, they will have a means to accumulate wealth with a potential path to homeownership. By utilizing tokenized securities to represent fractional ownership in real assets, blockchain technology can be used to implement monetary policy and operate an efficient and stable token economy. The mechanics of the mathematical models and token economy are illustrated by quantitative simulations to provide empirical insights.

Keywords - ROOST, blockchain, smart contract, tokenized security, distributed ledger, co-op, fractional real estate ownership, token economy

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Preface: Next Wave

Peer-to-Peer Digital Cash

In January of 2009, the first true peer-to-peer, trustless form of digital currency was born. Bitcoin, proposed by a group or individual with the pseudonym Satoshi Nakamoto, is revolutionary for several reasons: (1) Bitcoin is a currency with no central authority and no intrinsic value or collateralized backing, (2) the Bitcoin network is open to anyone in the world, (3) it enables two parties to transfer value without the need for a financial institution or intermediating party, and (4) the launch of Bitcoin started the first foray into experimenting with consensus algorithms to govern decentralized systems.

Before Bitcoin, there were other attempts to create digital currencies, such as Digicash, Cybercash, and eCash. The primary goal of these projects was to increase privacy and security for users. There simply was very little demand for their value proposition because ecommerce was in its infancy. Consumers were willing to make sacrifices of privacy and security for the convenience of using credit cards for online payments (Pitta 1999). In addition, the reliance on centralization was a critical shortcoming for these early forms of digital cash.

Conversely, Bitcoin was introduced without a central authority—meaning no government could act to quell the network. This also allowed for a completely disintermediated and trustless network for storing and transferring value. The Proof of Work (PoW) consensus algorithm requires consensus from network participants for any proposed updates to the Bitcoin ledger, effectively protecting against duplicate information, double-spending, and coordinated attacks, such as sybil and DDoS attacks.

Smart Contracts and Decentralized Applications

With the launch of Ethereum in 2015, Vitalik Buterin built on Satoshi's innovative vision of digital cash and decentralized consensus. The smart contract-enabled blockchain serves as the infrastructure for a global network of decentralized applications (dApps) and, most importantly, expanded the capabilities of blockchain technology. The Ethereum network can implement use cases beyond the storage and transfer of value - use cases that can be written into code and executed among multiple parties using smart contracts. Hundreds of companies are already building applications on the Ethereum protocol, giving birth to numerous altcoins, and many competing projects are attempting to capture this value.

Transferable Ownership of Tokenized Real-World Assets

Building again from the vision of an innovative predecessor, tokenized securities provide all of the nuanced sophistication of traditional financial instruments but with the benefits inherent and unique to blockchain and cryptoasset ecosystems, such as liquidity, disintermediation, instant transfer and settlement, 24/7/365 market trading, and larger market exposure.

If Satoshi and Vitalik ushered in a new era of programmable money, decentralized governance, and smart contracts, tokenized securities advance this vision by creating a new paradigm of programmable and transferable ownership.

Our legacy securities markets are riddled with intermediaries adversely affecting transaction costs, transaction times, and liquidity. Building on the groundwork of blockchain technology and tokenized securities, an ideal environment will see assets transferred instantly at near zero-costs and with fewer intermediating parties. This will truly redefine asset ownership and expand access to those left behind in the existing financial system.

ROOST will operate a decentralized real-estate cooperative in which tenants are given the opportunity to participate in the value of institutional-grade real estate simply by paying rent. Through ownership of tokenized securities, renters will be entitled to some of the benefits of limited partner investors, such as access to cash flow dividends and value appreciation. At the same time, property owners will have greater liquidity in their real estate investments in addition to a differentiated market offering that will bring various benefits to their business models. The ROOST network will track and record transactions using blockchain technology, make distributions to holders of tokenized securities in the secondary market, facilitate governance at scale, and implement monetary policy that facilitates a stable and efficient market.

Introduction

The global broad money supply—physical money, checking accounts, savings accounts, money market accounts—was estimated to be $86.72 trillion in 2017 (CIA). Of the total broad money supply, 94% is represented digitally, in bank ledgers stored in central databases. Only the remaining 6%, or about $8 trillion, is physical money. This presents an undeniable opportunity for cryptoassets. With the total market cap of the cryptoasset ecosystem reaching $800 billion in early 2018, Bitcoin and other altcoins are beginning to gain significant market share.

While blockchain technology is gaining traction as a new currency, the technology has the potential to impact even larger markets. Real estate, in particular, is the world's most important asset class, with a value totaling $228 trillion in 2016, according to HSBC (HSBC 2017). Just one subset of the market—real estate, rental and leasing— accounted for more than $673 billion in revenue in the U.S. alone in 2017 (U.S. Bureau of the Census). Much of this real estate value is being captured by the wealthiest in society.

The wealthiest 20% of US households own nearly 89% of overall wealth, while the combined bottom 40% have negative net worth (Wolff 2012). America's wealth gap is likely to worsen in light of the looming housing crisis. For nearly two-thirds of Americans, rent payments account for over 25% of household income —and rent has grown at a much faster rate than income over the past few decades (U.S. Bureau of Census). Moreover, rents increased nearly 30% between 1970 and 2010, compared to only 13.8% for income during the same period (March 2017). Furthermore, rising rents may disproportionately impact the knowledge and gig economy workers who require a greater level of mobility. This makes accumulating wealth through homeownership more difficult as the economy shifts to a more transient labor force.

ROOST seeks to address many of the financial issues facing Millennials and future generations by expanding opportunities to participate in the economic benefits of real estate ownership. This paper outlines the vision and software architecture underlying the ROOST community-owned real estate network—intended to reduce income inequality through fractional ownership and transfer of value in real property. This application of blockchain technology enables new forms of cooperative property ownership at scale.

Part I: Introduction to Cooperatives

For hundreds of years, cooperative organizations have enabled groups of people to access goods, services, and other benefits through economies of scale that they alone could not achieve. There are many varieties of cooperatives, and their use-cases extend across industries. For the purposes of this white paper, we define a cooperative as: an entity owned and governed by the members who use and benefit from the cooperatives' services; those benefits are determined and distributed in proportion to the equity each member possesses (Frederick 2012). Three main principles distinguish cooperatives as unique entities: (1) user-benefit, (2) user-owner, and (3) user-control (Frederick 2012).

The User-Benefit principle refers to how members of a co-op benefit through economies of scale and increased bargaining power. Members benefit from access to the services a co-op provides, in proportion to how much they contribute. In addition, when a cooperative generates profits, members receive earnings in proportion to their participation. In traditional business models these profits would be more centrally accumulated between capitalists and intermediaries.

The User-Owner principle refers to participants' partial ownership of a cooperative. In typical cooperative models, accumulating significant equity is difficult because members earn equity on a patronage basis which makes attracting outside investment more complex than for investor-owned businesses (Frederick 2012). With the advent of new technologies and financial models, we plan to solve this problem in a novel and equitable manner.

The principle of User-Control, perhaps one of the most difficult to balance of the three principles, refers to the democratic control that members of a cooperative maintain over operations and activities of a cooperative. Ownership-control models vary widely and include 1-member-1-vote, in which members retain a single vote irrespective of their equity stake, as well as the model in which each member votes in proportion to their equity in the cooperative.

These principles guide the ethos of cooperatives and differentiate them from other business models. While the initial implementation will utilize blockchain technology to facilitate User-Benefit and User-Owner principals, advanced implementations of the ROOST Network will facilitate a more decentralized model of User-Control. This model will allow blockchain driven governance mechanisms to support features and incentives for active co-op members living in affiliate properties.

History of US Housing Cooperatives

Affordable cooperative housing developments have an extensive history dating to 19th-century Western Europe. These early cooperatives formed partly in response to the overcrowding of cities brought on by the industrial revolution, as well as the unfavorable power hierarchies that landowners typically exercised over their tenants in these settings (National Cooperative Law Center 2017).

The first residential cooperative in the United States wasn't created as affordable housing for low-income citizens but, in fact, was formed by upper-class citizens with considerable wealth. Tenants of The Randolph, built in 1876 in New York, sought the economic and social advantages of homeownership but without the responsibilities (National Cooperative Law Center 2017). It wasn't until decades later that affordable housing cooperatives started to become economically feasible in the US with the passage of the New York State Limited Dividend Housing Companies Act of 1927.

Just as residential cooperatives were being popularized, the Great Depression wiped out more than 75% of them. All 13 of the affordable housing cooperatives in New York survived the Great Depression, but luxury cooperatives were crippled by high vacancy rates and exorbitant mortgage rates. As time went on, affordable housing cooperatives were increasingly granted some of the rights and incentives afforded to individual homeowners. The ratification of Section 216 of the IRS tax code in 1942, for example, allowed individual owners of a cooperative to claim tax deductions of mortgage interest and property taxes.

The majority of housing cooperatives were formed between World War II and the mid-1970s. But in the 1970s, cooperative formation became less attractive as the government deprioritized the model. Cooperative development only flourished in New York City, where the majority of US housing cooperatives still exist today. In fact, nearly 30% of all housing in New York City is comprised of residential cooperatives (National Cooperative Law Center 2017).

Market Rate v. Limited Equity Cooperatives

An exploration of the types of cooperatives in existence today will provide a solid grounding in the model which ROOST proposes to create for the future. There are two basic types of residential cooperatives: (1) Market Rate Cooperatives and (2) Limited Equity Cooperatives (Lawton 2014).

Market Rate Cooperatives closely resemble condominiums. Namely there is no limit to the annual income of owners, and owners can sell their share of the cooperative for whatever rate the market commands.

Limited Equity Cooperatives, on the other hand, are focused on low- to middle-income participants. There are two types of Limited Equity Cooperatives: Limited Income, which limits the maximum annual income of owners, and Limited Equity, which caps the appreciation of equity an owner may realize and limits the amount for which an owner can sell their shares. Both types of Limited Equity Cooperatives are designed to ensure the properties remain attractive to lower income buyers.

Cooperative Governance

Residential cooperatives typically are governed by an elected Board of Directors—which governs similarly to any corporate Board of Directors in the US. As Julie Lawton explains, "The housing cooperative, as a corporation, has a governance structure similar to other corporations. A board of directors is democratically elected by the cooperative owners to manage the corporation according to an adopted set of corporate bylaws. The housing cooperative, like other corporations, is a legal entity with the right to own property, enter into contracts, take on debt, and sue and be sued."

Transparency, trust, and accountability within the governance of a cooperative are essential to performance. Board members are partial owners of the cooperative and therefore should be incentivized to act in the best interest of the cooperative. The application of blockchain, and the immutable, transparent, and append-only nature of the technology reduces many issues of trust and accountability in a cooperative model.

As is common with real estate holdings, liquidity remains an issue for cooperative owners. Although members can typically sell their shares to anyone, at any time, and for any amount, selling off fractional ownership remains difficult in Market Rate Cooperatives.

Cooperative Political Economic Theory

In the wake of the industrial revolution, political economist John Stuart Mill predicted that capital-managed firms would be superseded by cooperative forms of enterprises, such as the labor-managed firm. According to Mill, the free market itself would gradually and quietly transform from capital-ownership and capital-management in favor of cooperative associations.

> Eventually… we may, through the cooperative principle, see our way to a change in society, which would combine the freedom and independence of the individual, with the moral, intellectual, and economical advantages of aggregate production; and which, without…any sudden disturbance of existing habits and expectations, would realise…the best aspirations of the democratic spirit, by putting an end to the division of society into the industrious and the idle, and effacing all social distinctions but those fairly earned by personal services and exertions…As [cooperative] associations multiplied, they would tend more and more to absorb all work-people, except those who have too little understanding, or too little virtue, to be capable of learning to act on any other system than that of narrow selfishness. As this change proceeded, owners of capital would gradually find it to their advantage, instead of maintaining the struggle of the old system…to lend their capital to the [cooperative] associations; to do this at a diminishing rate of interest, and at last, perhaps, even to exchange their capital for terminable annuities. In this or some such mode, the existing accumulations of capital might honestly, and by a kind of spontaneous process, become in the end the joint property of all who participate in their productive employment: a transformation which, thus effected…would be the nearest approach to social justice, and the most beneficial ordering of industrial affairs for the universal good, which it is possible at present to foresee. (Mill 1852)

In 2018, the cooperative world envisioned by John Stuart Mill and others remains a distant utopian fantasy. Over 150 years later, traditional capitalist firms, with highly centralized ownership and control, are the predominant organizing structure. Cooperatives, with distributed ownership and decentralized democratic control, are a rarity. As Schwartz points out, “the literature shows that participatory organizations, even in capitalist firms, have significant productivity advantages over traditional hierarchical capitalist management, and the comparisons favor more fully labor-managed and labor-owned firms just as strongly and perhaps more so." (Schwartz 2012) Economic studies evaluating decision making, productivity, profit and "death" rates of labor-managed firms versus capital-managed firms show that cooperative enterprises can outperform traditional capital-managed firms. They also tend to embody the egalitarian principles, democratic management and policy making, financial transparency and economic benefits envisioned by theorists.

According to Schwartz, "the reasoning behind Mill's prediction that the labor-managed and -owned firm should come to predominate in the market over traditional capitalist rivals is not merely plausible but also well supported by empirical evidence. Such firms have a significant productivity advantage which rebuts the explanation that they have not proliferated because of their alleged inefficiency. They appear to have a profitability and survival rate no worse, and possibly better than, traditional capitalist competitors, whatever costs their operation, or their creation, may pose."

If Mill was right about the efficiencies and other appeals of cooperatives, then what did he and other proponents get wrong? Perhaps the technology did not yet exist to overcome the unique challenges that cooperative organizations face as they scale.

Part II: Blockchain and Cooperative Economics

Although blockchains can be evaluated as a general purpose information and computation technology for enhancing productivity, they can be better understood as new institutional technology for economic coordination (Davidson 2016). According to Davidson, "the true significance [of blockchain] is not as the next line of transformative information technologies, each of which powers a productivity revolution: e.g. transistors, computers, internet,... blockchains. Rather, it is as the emergence of a new species of economic coordination: governments, firms, markets, relational contracting..." (Davidson, 2016) and, we believe, perhaps cooperative associations.

This foundational shift in the way the economy operates using blockchain technology has the potential to transform economic, financial, and political institutions to more cooperative forms of association. More specifically, the application of blockchain and cryptoassets to cooperative forms of real estate ownership can unlock benefits for renters, owners, real estate developers, and investors alike.

Challenges Scaling Co-ops in a Free Market

Theories about why cooperatives have historically failed to thrive in the free market include a) Governance and Consensus, the internal transaction costs of collective decision making, b) Capital Formation, transaction costs external to the enterprise, and c) Incentives - public goods and collective action.[1] Blockchain technology provides the tools to overcome many of these challenges.

Governance and Consensus - The Costs of Collective Decision Making. The transaction costs arising within enterprises to reach agreement on what to do and how to do it are likely to diminish efficiency in cooperatives. It is expected that as organizations scale and the number and diversity of groups increases, the ability for them to come to consensus diminishes and the costs to do so for the firm rises, making cooperative forms of enterprise less efficient than centralized or capital-owned and controlled firms.

Capital Formation - External Transaction Costs. Access to capital is critical for the formation of organizations. In cooperatives, members are not able to guarantee repayment to outside investors (Dow 2003). Labor-managed firms, especially if they are capital intensive, lacking in assets and involving economies of scale or scope, face financing problems unfamiliar to capital-managed competitors (Dow 2003). The crux of the problem is that "in capitalist firms, wealthy investors simply pool their funds and acquire physical assets," while cooperative enterprises must find a way to finance assets—especially if they are capital intensive, but they are often founded by or for the benefit of those with limited wealth and liquidity constraints (Dow 2003). Moreover, financing startup ventures is often very risky, and investors expect higher risk-adjusted returns when

[1] It should be noted that because there are so few cooperatives, there is limited data to support many of the arguments reviewed on the challenges that cooperatives face relative to traditional capital-owned and centrally managed firms. However, for the purposes of this paper, we consider the arguments put forth by leading analysts of the subject in spite of their logical defects and empirical inadequacy, as critiqued by Justin Schwartz.

providing capital to new entrepreneurial endeavors. The higher return requirements may reduce the ability of enterprises to share profits with members.

Incentives - Public Goods and Collective Action. Perhaps the strongest argument for examining the challenges that cooperative systems face is that of public goods and collective action. According to Schwartz, “a labor-managed firm is a public good that faces the obstacles set forth by Olson, according to which collective action to provide public goods tends to generate incentives to “free ride” and produce suboptimal outcomes. Being unfamiliar, [cooperatives are] therefore less attractive to workers and perhaps investors and lenders." A public good is defined as “one that satisfies the common interest of the members of a group and from which no member can be excluded whether or not he/she participates.” As Olson and Schwartz point out, each member in a cooperative has an incentive to be a “free rider,” taking advantage of the actions of others in providing the public good by enjoying it without contributing, or contributing as much. Moreover, the likelihood and seriousness of opportunistic behavior varies inversely with the size of the group. With larger groups, the contribution of any individual member matters less, while the marginal share of benefit per contribution declines—as does the incentive to contribute. Additionally, the risk associated with startup enterprises is mostly borne by founders, early employees, first movers and seed and early stage investors. Thus, if startups could be considered a public good, individuals are incentivized to “free ride” as well and mitigate their risk by investing their time, labor and capital in established companies, or those that they believe will provide outsized returns for early contributors and participants. This provides a disincentive for enterprises to more equitably maximize economic and political benefits for its members.

Blockchain and Cooperative Associations

Blockchain technology enables unprecedented innovation in decentralized consensus models. As Davidson et. al. point out, “distributed ledgers are a technology for manufacturing consensus about facts that are instrumental to economic coordination, a role historically dominated in market capitalist economies by governments and large firms. The economic impact of this new technology can be more clearly seen when viewed from the perspective of institutional governance, rather than the perspective of total factor productivity” (Davidson 2016).

We believe Blockchain technology presents an opportunity for a renaissance of the co-op movement by addressing many of the previous challenges faced by cooperative organizations. Blockchain technology can be utilized to a) facilitate governance and consensus to reduce internal transaction costs, b) attract capital and distribute economic benefits to reduce external transaction costs, and c) program incentives that solve the public goods challenge.

Governance and Consensus - Internal Transaction Costs. “Blockchain-based applications present a genuine promise for new kinds of scalable innovations in governance and institutional design, where ideals for corruption free and effective democracy may come true” (Wright and Defillipi 2015). There are many problems with corporate elections, including ballot distribution, inaccurate voter lists, and sometimes chaotic vote tabulation (Kahan and Rock 2008). The greater transparency, speed, and accuracy of blockchain voting could motivate shareholders to participate more directly in corporate governance and facilitate votes on more topics and with greater frequency (Wright and Defillipi 2015 and Yermack 2015). By providing incentives for better collaboration, and facilitating transparent decision-making, blockchain technology could make it easier for large communities to reach consensus and implement innovative forms of self-governance.

Capital Formation - External Transaction Costs. With most transactions being facilitated over the internet, it is becoming easier for enterprises to raise capital through crowdfunding—from many people in a distributed fashion. In 2017, blockchain companies raised $5.6 billion through ICOs, nearly six times the amount raised through traditional venture capital investment. The pace continues to accelerate, with $6.3 billion raised through ICOs in Q1 2018 alone. This may signal the beginnings of a shift from capital formation facilitated by centralized institutional intermediaries to a more distributed form of capital allocation.

Incentives - Public Goods and Collective Action. Over the past few decades, open-source software development projects have demonstrated how incentives can be used to promote collective action. Although volunteer software development would seem vulnerable to the tragedy of the commons, open-source has evolved a number of strategies to overcome this problem and several projects have gone on to profoundly impact the market (DeLong 2000). For example, the World Wide Web exists because of Tim Berners-Lee open-sourced HTML and HTTP (DeLong 2000).

As mentioned by DeLong, the absence of the prospect of an enormous payout may have limited the development of new features in large, collaborative open-source projects. However, "today, traditional issues related to shared common-pool resources- such as the free rider problem or the tragedy of the commons[2]- could be addressed with the implementation of blockchain-based governance" (Wright and Defillipi 2015). Building on the legacy of open-source software development, blockchain technology provides a way to incentives collective action. As Wright and Defillipi discuss, new types of organizations could emerge that enable people to monetize their creative and cognitive surpluses in more efficient ways, making it easier to engage in various forms of cooperative enterprise, such as peer-to-peer production.

On the "Why Blockchain" Question

Although Blockchain technology has shown the potential to solve a unique set of challenges in the economy, due to market hype and speculation, many discerning investors are starting to ask the common "why blockchain" question when evaluating projects. Even if someone has demonstrated they *can* apply blockchain technology for a given use case, they often are being asked whether they *should* apply it.

Blockchain technology can be utilized in a wide range of use cases involving public records requiring consensus. Many of these are in early stages of development and implementation. However, skeptics often note that legacy sustaining technologies can be used to meet the technical requirements of many of the use cases put forth by blockchain enthusiasts. Based on the arguments

[2] Footnote referenced in Wright and Defillipi 2015. "J. Bradford DeLong & A. Michael Froomkin, *Speculative Microeconomics for Tomorrow's Economy*, FIRST MONDAY (Feb. 2000), http://firstmonday.org/ojs/index.php/ fm/article/view/726/635 (outlining that traditional economic theory dictates that open source software is susceptible to "tragedy of the commons issues" and detailing how open source communities attempt to address this problem through due to reputation)."

put forth by Christensen in *The Innovator's Dilemma*, we believe new entrants will find useful applications of blockchain technology in niche markets, ultimately enabling them to overtake incumbents (Christensen 1997).

While the "Why Blockchain" question seems like an obvious due diligence question on its surface, it is based on an incomplete argument at best, and flawed reasoning at worst. The implied reasoning behind the question is that:

- If you *can* utilize a more centralized legacy solution to meet the technical requirements for a project
- Then you *should* utilize a legacy solution to meet the technical requirements of the project.

In other words, "if you can use a sustaining technology to solve this problem, then you should use a sustaining technology to solve this problem." In essence, the "why blockchain" question is not a question at all; it is an assertion.

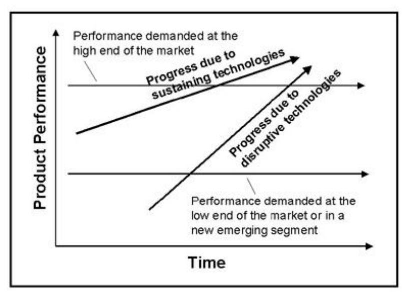
The Innovator's Dilemma provides a rebuttal to such reasoning in its examination of the forces that cause large enterprises to be disrupted by new entrants that utilize disruptive technologies. Based on Christensen's research in *The Innovator's Dilemma*, we propose that, if (a) blockchain technology can be utilized by a new enterprise to meet the performance requirements of a niche market opportunity, and (b) blockchain technology is considered a rapidly improving disruptive technology, then (c) blockchain technology should be applied to meet that market need.

The Innovator's Dilemma: Trajectories of Market Need vs. Technology Improvement

According to Christensen, disruptive technologies are often initially embraced by the least profitable customers in a market. For large established firms, investing aggressively in disruptive technologies is not a prudent financial decision. The framework is supported by three reasons:

- Disruptive products are simpler and cheaper; they generally promise lower margins, not greater profits.
- Disruptive technologies typically are first commercialized in emerging or insignificant markets.
- Leading firms' most profitable customers generally don't want, and indeed initially can't use, products based on disruptive technologies.

As the following figure from the Innovator's Dilemma shows, sustaining technologies often can exceed the performance needs demanded in a new emerging market segment. The observation that technologies can progress faster than market demand means that in their efforts to provide better products than their competitors and earn higher prices and margins, suppliers often overshoot their market. They give customers more than they need or are willing to pay for. Moreover, disruptive technologies that may underperform today, relative to what users in the market demand, may be fully performance-competitive in that same market tomorrow. (Christensen 1997)



Applying Blockchain Technology

As the Innovator's Dilemma shows, the evaluation methods utilized by large enterprises on applications of disruptive technologies often causes them to be overtaken by new entrants applying disruptive technologies to niche markets.

Sustaining innovations and legacy systems have overshot the market, and are leaving people and opportunities behind. Blockchain technology has advanced to meet the technical requirements of niche markets and new opportunities that are not being served by existing solutions. This is evidenced by the nascent but growing use cases of blockchain protocols, applications, and cryptoassets. Additionally, blockchain technology is on a steep advancement curve and qualifies as a disruptive technology. Therefore, if blockchain technology can meet the performance requirements of a niche market opportunity, perhaps blockchain technology should be applied to meet that market need.

With this in mind, investors should ask themselves when evaluating startups that do not utilize blockchain technology where they otherwise could, why would a new entrant that seeks to create and/or expand a niche market utilize sustaining technology (which probably overshoots their market need today and may be obsolete tomorrow), when there are disruptive technologies available that are on a steep performance improvement curve?

Part III: Tokenized Securities

Beyond assisting with governance and cooperation of diverse sets of stakeholders and providing advantages to a business by using disruptive infrastructure, blockchain provides the building blocks for cryptoassets that store value. While still nascent, the most developed of these use cases is cryptocurrency such as Bitcoin. However, blockchain technology is moving from single use cases as digital currency into more complex economic models and even larger market opportunities that involve regulated financial instruments such as stocks, bonds and derivatives, which are often stored and traded digitally.

While cryptocurrencies are considered “programmable money,” tokenized securities are considered “programmable ownership.” (Pompliano 2018) Tokenized securities allow the market to replicate the nuanced sophistication of existing financial instruments, with additional benefits including lower fees, greater liquidity from expanded investor base, enhanced returns from free market exposure, and greater transparency (Pompliano 2018).

What is a Security Token?

In the US a security is considered an instrument that qualifies as an investment contract for the purposes of the Securities Act of 1933 and the Securities Exchange Act of 1934. Such instruments are subject to federal securities laws and require strict regulatory compliance. Case law has defined investment contracts as “a contract, transaction or scheme whereby a person invests his money in a common enterprise and is led to expect profits solely from the efforts of the promoter or a third party.” (Securities and Exchange Commission v. W.J. Howey Co., 328 U.S. 293 1946)

Thus, a crypto-token with any of the following investment interests likely constitute a security token: (i) ownership interest in a legal entity, (ii) equity interest, (iii) share of profits and/or losses, or assets and/or liabilities, (iv) status as a creditor or lender, (v) claim in bankruptcy as equity interest holder or creditor, (vi) holder of a repayment obligation from the token’s issuer, and (vii) a feature allowing the holder to convert a non-security token into one of the previous investment interests (Blemus 2018).

The Benefits of Tokenizing Securities

Tokenized securities will modernize traditional financial instruments and operational processes. Tokenized securities at their core represent a traditional security in a digital format. The primary difference between traditional securities and tokenized securities is their representative form; the former is represented by a piece of paper, and the later is digitally represented as a token recorded on a blockchain.

The digital form of a tokenized security allows investors to realize significant advantages over traditional securities, including but not limited to increased transaction speed, increased liquidity, expanded investor base, reduced fees, and increased transparency.

Increased Transaction Speed - Most businesses are highly proficient in their ability to source and come to terms on deals. Where many of these operational processes fall short is in their speed of execution due to archaic physical processes riddled with intermediaries. Smart Contracts enable ownership of tokenized securities to be transferred more efficiently and reliably using programmable code.

Increased Liquidity - In typical asset markets, there is a liquidity discount applied to asset valuations (*Marcato 2014*). Tokenized securities work to remove this liquidity discount, enabling a seller to command full market value. In addition to removing liquidity discounts, tokenized securities give issuers the ability to create fractional shares of typically large assets, such as real estate. Fractional shares enables issuers to sell to a larger pool of willing investors by decreasing the threshold for minimum investment.

Expanded Investor Base - The market for tokenized securities is not limited by border; rather, international investors can instantaneously trade with one another in an open and transparent marketplace. As such, a larger pool of readily available and willing investors will be available to purchase tokenized securities, as compared with traditional securities. This larger investor base will create a fairer market price for the underlying asset.

Reduced Fees - In traditional security offerings there are a number of intermediary stakeholders charging fees to execute transactions (i.e. lawyers, broker dealers, lenders, title insurance companies, etc.). With tokenized securities, smart contracts can be built in such a way to minimize the reliance on many of these parties, effectively reducing transaction fees.

Increased Transparency - By recording transactions and data associated with securities publicly, instantly and transparently on an immutable, distributed ledger, the financial markets will have more information and may price securities more efficiently.

Current Limitations of Tokenized Securities

The necessary infrastructure to create secondary markets and custodial solutions for tokenized securities are not fully developed yet. However, there are several projects making progress in laying the groundwork for this market to develop.

Secondary Markets - Platforms that seek to facilitate the trade of tokenized securities—such as OpenFinance, Harbor, and Polymath—have plans to launch secondary market exchanges in the near future. Additionally, the Swiss Stock Exchange (SIX) announced their intention to launch a fully compliant tokenized security asset trading platform (Bloomberg 2018). With the launch of fully compliant security token exchanges, the framework will be in place for robust tokenized asset markets to develop.

Custodial Solutions - Solutions such as Coinbase Custody are bringing institutional investors into the cryptoasset market. Coinbase Custody mitigates much of the risk associated with trading and storing traditional cryptoassets. This solution provides services such as segregated cold storage, financial and security controls (audits), dedicated coverage, SLAs on fund transfers, insurance of assets, and multi-user accounts (Coinbase).

Although progress is being made to develop market infrastructure, tokenized security exchanges and companies providing custodial solutions will need high-quality inventory in this new asset class to meet projected demand. ROOST seeks to partner with industry stakeholders to provide their platforms with a steady supply of tokenized securities in institutional grade real estate assets.

Part IV: Technology and Token Use Cases

Bringing all the philosophical perspectives and economic goals of ROOST to life is a first-rate engineering challenge. Architectural layers responsible for various datastores and running key processes will be developed and technologies will be evaluated to align with the long-term business objectives of ROOST. This section provides a summary of ROOST's technology approach, the multi-token architecture, and token use cases.

Technology Approach

Providing stable and meaningful value to renters in a way that is low-friction, transparent and useful is one of our key goals. We chose to use a tokenized asset for this purpose because it is predicted that tokenized assets will come to represent a larger and larger share of the wealth market. Now is a perfect time to start distributing tokenized assets to a broad cross-section of the demographic. The increased opportunity for people to take part in owning assets based on real estate value who otherwise wouldn't is a primary motivation for our organization. Providing those assets in the form of tokens increases the likelihood of participation in the real estate market and, thus, in wealth accumulation.

To that end, we are using the Ethereum blockchain for the flexibility of data and behavior in Smart Contracts, the health and security of the network and the community of developers providing improvements. Competing blockchain protocol layers will be evaluated as they come online and we are open to changing networks should an alternative provide a better platform. Our criteria for platform evaluation may change over time but it will always be done through the pragmatic lens of whether or not a platform helps us provide a secure and transparent infrastructure upon which we can build the most beneficial experience for our customers.

Multi-Token Architecture

ROOST uses an Ethereum-based[3] permissioned blockchain network to record the store and transfer of securities, while providing the necessary framework to comply with Know-Your-Customer (KYC) and Anti-Money-Laundering (AML) regulation[4]. These tokenized securities represent preferred equity in real estate—including regularly paid distributions and redemption. In order to provide mechanisms that enhance the stability of the market, we propose a multi-token framework that operates within a distribution layer, a tokenized security layer, and a network infrastructure layer.

Distribution Layer

[3] Information about Ethereum's smart contract and decentralized application platform can be found on the Ethereum GitHub wiki via the following link: https://github.com/ethereum/wiki/wiki/White-Paper.
[4] Xu, Kiwei et al, A Taxonomy of Blockchain-Based Systems for Architecture Design, http://design.inf.usi.ch/sites/default/files/biblio/icsa2017-blockchain.pdf (outlining the architecture of blockchain-based systems, including permissioned blockchain networks, and referencing the benefits of permissioned blockchains in regulated industries).

Active Roosters living in affiliate properties will receive distributions in fiat currency by default. Investors in the secondary market that hold RST receive distributions via cryptocurrency by default. RST holders, by providing their Bitcoin or Ethereum wallet address, can select which cryptocurrency they prefer to receive distributions in. Distributions are paid to RST holders quarterly from the investment income of properties in the ROOST Network. RST shareholders receive distributions in proportion to their RST holdings.

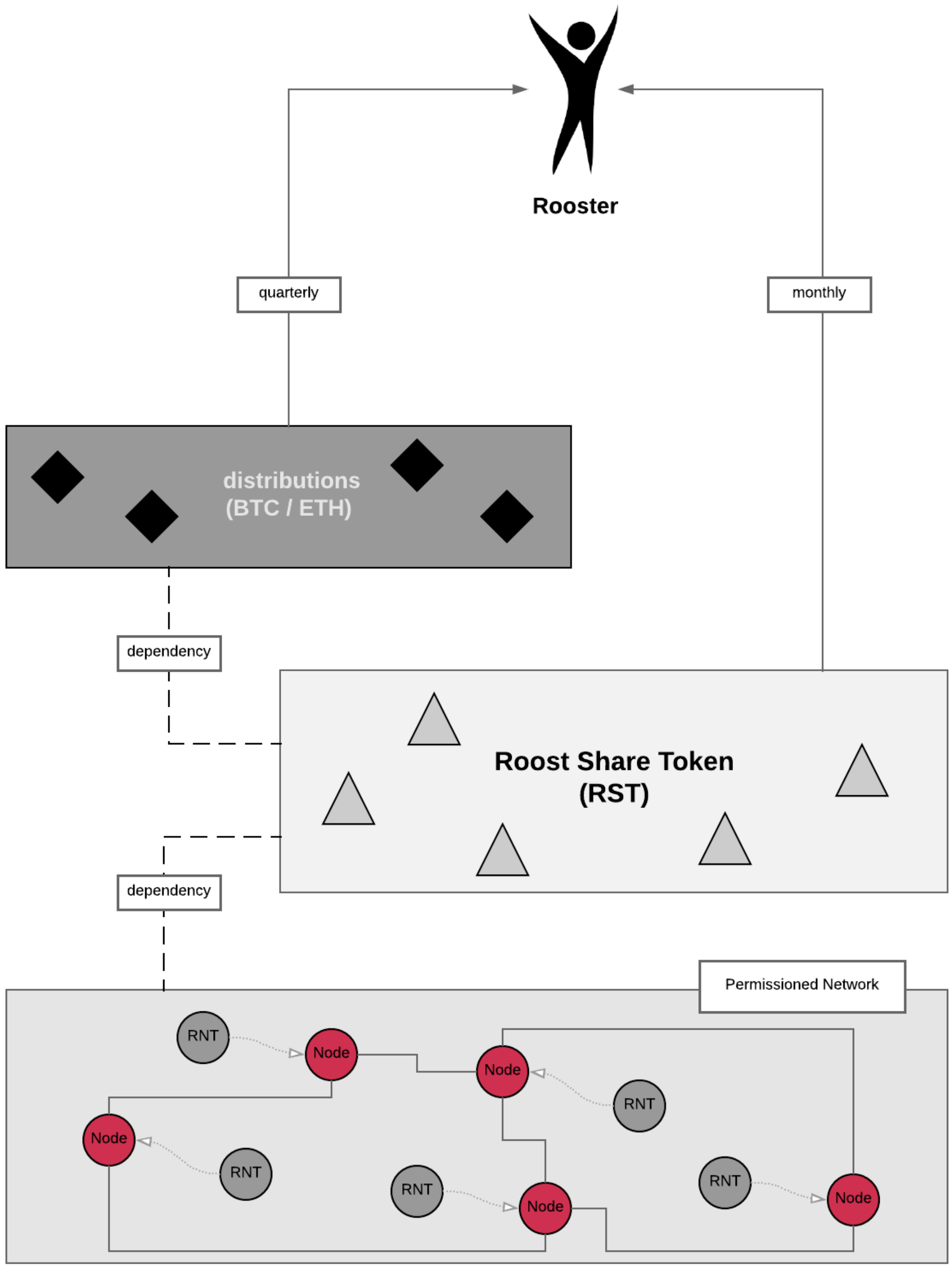
Security Token Layer

ROOST Share Tokens or RST are smart contracts that serve as a record of various tokenized securities. RST represents fractional ownership in real estate assets or special purpose vehicles that are invested in real estate assets. RST can cause the issuer to automatically pay the bearer (wallet holder of the RST) dividends based on a function that incorporates the terms set forth in the smart contract such as the preferred return, and a function of ROOST Network Tokens (RNT) which allows the network layer to enforce monetary policy. The value of RST is a function of their dividend policy which is set by the free cash flow of the underlying assets, and other variables set by the RNT smart contract, including transaction fees.

There can be various types of RST tokens. For instance, a unique RST token will be created for each market and asset type. This will allow for the development of institutional grade securities and derivatives that can meet investor needs in a robust secondary market. With a framework for a secondary market to thrive, investors can easily trade what used to be highly illiquid assets (such as many multi-family real estate properties).

Network Infrastructure Layer

Roost Network Tokens (RNT) perform an infrastructural function to compensate and incentivize nodes on the network to maintain the blockchain, record the store and transfer of value, and implement monetary policy to ensure market efficiency and stability of the token economy. These tokens are also used to incentivize multiple stakeholders to govern the cooperative system. The network layer influences the prices of securities in the market, similarly to how the Federal Reserve influences the price of bonds by setting interest rates.


Rooster
quarterly
monthly
distributions
(BTC / ETH)
dependency
Roost Share Token
(RST)
dependency
Permissioned Network
RNT
Node
Node
RNT
Node
RNT
RNT
Node
RNT
Node

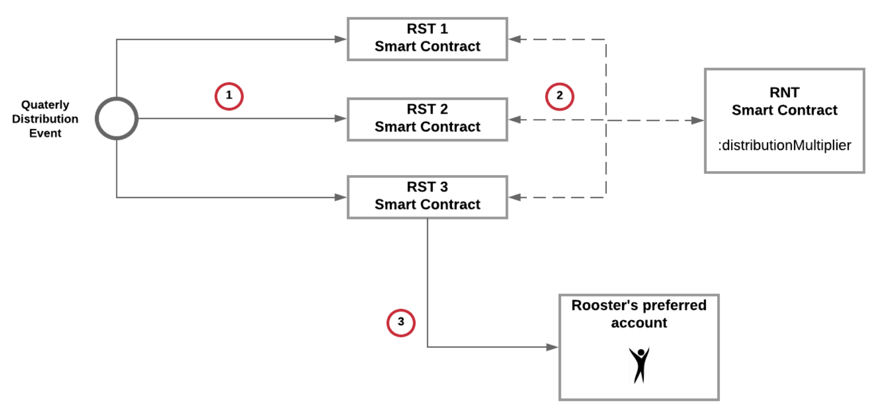
Token Use Cases

Creative uses of ROOST tokens and their relationships are the keys to achieving our business goals. ROOST will build a suite of tools to provide access to the publicly available investment data on the blockchain. Some of those tools will be websites and mobile apps that provide useful data visualizations and seamless interactions with the ROOST network. Other tools will be API-based to enable 3rd party applications a mechanism of independent verification.

Implementing Monetary Policy

One of the business goals of the ROOST Network is to maintain price stability for the RST— remaining in close range to the estimated intrinsic value of those shares— and to mitigate the risk of boom and bust cycles driven by speculation and black swan events that cause irrational market behavior. RNT tokens will achieve price stability of RST in several ways - primarily this will be realized via RNT token supply volume and a distribution multiplier that lives on the RNT smart contract.

The supply and demand of RNT can be used to influence transaction fees in the network which has an impact on the price of RST. Additionally, variables within the RNT smart contract can impact RST distribution policies to shareholders among other actions that the network might need to take to maintain market stability. The distributions that RST pay will be a function of both the terms set in relation to the free cash flow of the underlying assets and a variable distribution multiplier set by the network layer.



1 Roost distribution process initiates a transaction against the various RST smart contracts to deliver distributions to Roosters.

2 The RST contracts queriy the RNT contract for the current distribution multiplier.

3 Distributions (in ETH/BTC) are sent to the RST holder's preferred account.

Self-Governance

RNT and RST token holders will be able to vote with their tokens to grow the ROOST Network and impact the direction of products and services. For example, voting to increase the distribution multiplier on the RNT contract will have an impact of making the RST shares more valuable, but it will slow the potential growth of acquiring new properties if the money used for those distributions comes from a property investment fund.

Token holders will also be able to vote to expand the features and services of the ROOST Network. For example, if token holders want to increase the impact of price controls on RST shares, they may vote to add new variables to the RNT contract that are used in an updated RST pricing model.

Maximizing Market Value

Real estate markets will expand more than others due to a variety of factors that are outside of our view or concern. Through exposing fine-grained market segmentation attributes associated with the RST shares, we want to provide a way for the secondary market to invest in these securities however they deem fit. The experts in those markets, in picking the right macro economic trends that will influence growth, will be able to use our token segmentation data as a tool to maximize their returns for one market over another.

Decentralized Transparency

Providing transparency into real estate equity is one of the reasons why we chose to use a publicly visible blockchain to house the transactions of exchange. People wanting to invest in the currently opaque and gated world of real estate investing will benefit from ROOST bringing these transactions into the light to be examined by anyone and, thus, sanitized of investments that don't match up with advertised risk evaluations, like in what happened with the prior CDO market crash

A cornerstone to achieving all the aforementioned goals is an infrastructure that provides a way to build solutions that achieves them. ROOST seeks to expose equity investment data so people and organizations have indisputably accurate information at their fingertips and aren't reliant on trusting a corporation to give them all the details they need to make good investment decisions. A publicly visible blockchain provides this infrastructure and verifiable data in a way no other technology options do at this time, given the social dynamics of trust, value, and self-interest.

Data on the Blockchain

ROOST will store all the necessary data to determine RST smart contract behavior directly on the blockchain for maximum transparency and crowd-sourced verification. In the example above, the RST1 token smart contract could store the following data with this pseudocode:

```
function setContractData() public {
        initialBalanceUSD = 100000000;
        distributionRate = 0.04;
        perAnnumAppreciation = 0.04;
}
```

Part V: Token Economy, Pricing Dynamics and Market Simulation

Cooperatives, facilitated by carefully crafted blockchain and cryptoasset ecosystems, can offer economic incentives and social opportunities for participants who are interested in gaining control over their community and generating returns. In building a network of tokenized real estate, ROOST aims to operate a profitable and socially beneficial model that is sustained by a stable and efficient token economy. Such a system will need to be organized to mitigate the risks of speculation, bad actors, and black swan events.

ROOST implements fractional property ownership using many of the financial models relied upon by issuers of debt and equity instruments worldwide, as well as the Quantity Theory of Money and other economic theories. In this section, we discuss the following topics:

- Estimating the Value of ROOST Share Tokens (RST)
- RST Implementation Example
- Monetary Policy and Price Stabilization
- Black Scholes Pricing Model
- Market Participation and Pricing Simulation

Estimating the Value of ROOST Share Tokens

RST are securities that can be valued using fundamental financial analysis. RST in the following example will be issued as floating rate preferred equity shares.

Floating Rate Preferred Equity Shares pay dividends regularly but, unlike traditional bonds, have no maturity date. The cash flows of these shares extend in perpetuity. Issuers pay coupons on perpetual interest forever but do not have to redeem the principal. Unlike fixed-income bonds, paying coupons is discretionary. These preferred shares can have additional features such as redemption dates that allow the issuer to redeem them at their own discretion, minimum coupons and caps, fixed and floating coupon rates, voting, conversion, liquidation preferences, put options and other features.

Based on anticipated dividends, and the projected growth rate of dividend cash flows, the net present value of the security can be estimated as follows:

Growing Perpetuity
PV of Growing Perpetuity = D1 / (r – g)
D = Dividend or Coupon at period 1
r = discount rate
g = growth rate

By utilizing blockchain technology and impacting RNT, we can programmatically mitigate the risk of volatility and enforce monetary policy to increase the long term value of RST shares. The value of RST can be calculated using the following formula:

PV(RST) = (D1 * f(RNT)) / (r - g)

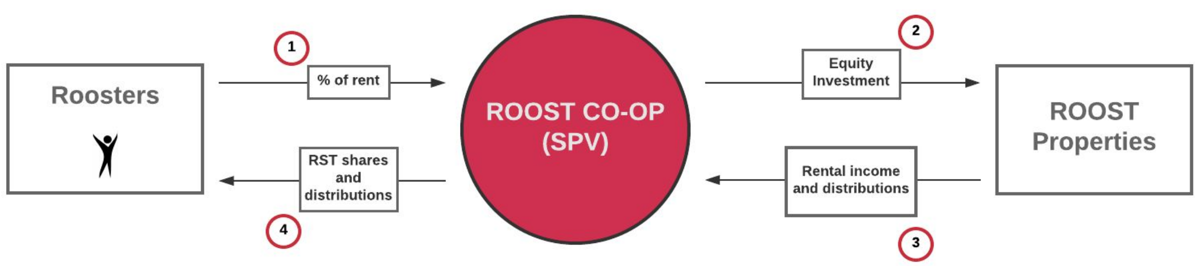
Example of RST Implementation

Suppose the ROOST Co-Op special purpose vehicle (SPV) issued its first class of ROOST Share Tokens (RST1) as a floating-rate non-cumulative preferred stock. These Shares would be recorded and tradable on the blockchain as specified in the RST smart contract.

Assumptions:

- Initial principal value of the SPV invested capital is $100 million
- Distribution payments are set at 4% of invested capital per year
- Annual appreciation of the value of the SPV portfolio is 4%, including the appreciation of the property valuations and the increase in preferred equity due to reinvestment
- Number of RST shares is growing at 2% because new shares are being issued to Roosters
- Discount rate used in calculating the PV is 7%

In this scenario, a Rooster who paid a monthly rent of $1,000 (appreciating at 2% per year) and received a 5% rent rebate in the form of 10 RST per month (with a $5 face value per RST) would accumulate $9,177 in share value and generate $275.31 in annual dividends in year 10.



1 Roosters pay the same rent as they normally do and a percentage of that rent is sent to ROOST by the property owner.

2 ROOST invests income from the Roosters in equity in real estate property as a Limited Partner (LP).

3 Rental income and distributions from ROOST's equity stake is sent to the SPV.

4 ROOST sends RST shares and distributions to Roosters.

The Impact of ROOST

The anticipated appeal of RST lies in their exposure to private real estate projects, which have the opportunity to generate higher returns than many other public securities. The average return on multifamily real estate was 12.1% from 2010 to 2016 (CBRE), and the dividend yield for equity REITs was 3.94% as of the start of 2018 (NAREIT).

Savings generated by participation in ROOST could be significant for renters considering that the average net worth of a Millenial was estimated to be -$1,989 at the age of 30 and only reaches $20,236 by the age of 36 (Farrington 2018). Moreover, according to the US Census Bureau, the average price of a home in the US is $273,000. With a 3.5% FHA loan down payment, the down payment needed for an average priced home is $9,555. If someone were to enter the ROOST Network after college graduation at the age of 22 and save their rent rebate until they reach the age of 32 (median age of a first time home buyer), their RST holdings are projected to nearly cover the downpayment on their first home purchase.

Year	Cumulative Shares	Annual Distributions	Price / Share (PV of Discounted Cashflows)	Total Portfolio Value (PV of Total Cumulative Shares)
1	120	$24	$6.67	$800
3	360	$72	$6.66	$2,400
5	600	$124.80	$6.93	$4,160
10	1,202	$275.31	$7.63	$9,177

Limitations. We recognize the limitations of this implementation model and future iterations will include market simulations and price movement of RST shares over time. For instance, it is unlikely that in year 10 year, the fair market value (FMV) of 1 RST share would be only $7.63. As illustrated in the following section, if 1 RST were purchased for $5 in July 2016, it may be worth nearly $14 in 2018. Consequently, when considering FMV in addition to the assumptions in the implementation example, the FMV of the portfolio of a Rooster in year 10 would likely be much greater than $9,177.

Monetary Policy and Price Stabilization

In the long term, ROOST expects to facilitate a more decentralized and transparent system to govern the network and implement monetary policy. Future R&D will be conducted to develop the governance mechanisms for decision making with participation from all stakeholders.

Blockchain and the Importance of Market Efficiency and Price Stability

The system that ROOST expects to create is akin to the pre-2008 mortgage backed security / collateralized debt obligation (CDO) market. However, utilizing blockchain technology, ROOST seeks to develop a more decentralized, transparent and stable asset class. Although the CDO market was abused and manipulated by bad actors, mortgage backed securities and derivatives were, in theory, promising financial instruments that increased liquidity, expanded access to capital, and created opportunities for attractive returns to investors. Similar to the CDO market, the value of RST are tied to underlying real estate assets and their associated cash flows. Rather than mortgages backing the securities, cash flows are generated by investment income that are paid to ROOST SPVs and distributed to holders of RST. In essence, RST are derivatives of preferred equity positions in multifamily residential real estate properties. As in traditional markets, investors need adequate information and stakeholders need the right incentives to efficiently price securities.

When large financial markets become unstable and collapse, there are significant consequences to not only the direct participants but society as a whole. As Crotty illustrates, although problems in the US subprime mortgage market triggered the… financial crisis, its deep cause on the *financial side* is to be found in the flawed institutions and practices of the current financial regime, often referred to as the New Financial Architecture (NFA) (Crotty 2009). His paper points out the various perverse incentives that plagued the market leading up to the crisis and the "exotic, complex, illiquid and marked-to-model" qualities of mortgage backed securities. One of the main problems in this market, was that investors both trusted banks to properly underwrite the mortgages backing the securities, and trusted rating agencies to effectively price these securities. A critical shortcoming in this scenario is that the trusted middlemen had incentives to misprice the securities and the technology did not exist to provide the necessary transparency.

Utilizing blockchain technology and giving visibility to property and unit level cash flows instantly, RST can provide more information to assist the market in effectively pricing RST. Additionally, by decentralizing the responsibility for monetary policy, the right incentives can be programmed into the blockchain to more effectively facilitate an efficient market and avoid black swan events.

Monetary Policy Mechanics

Several strategies based on the Quantity Theory of Money[5], Options and Stock Pinning[6] and various economic models can be implemented to influence the price of RST.

For instance, the quantity of RNT in circulation would impact the price of RNT. If RNT affects the transactions fees for trading RST in the network, it would have an impact on the price of RST. Before the per share price deviates too far outside the estimated intrinsic value, the network infrastructure layer can automatically and transparently impact RST prices. Additionally, this process could be utilized by stakeholders to make strategic decisions that positively influence RST prices in the long run.

Monetary Policy Example

Suppose, in addition to the assumptions of the previous RST Example, that the growth rate of dividends is 4% and the discount rate is 7%. Thus, in year 5 the present value per RST is calculated to be $6.928 and the cumulative value of 600 shares is estimated to be $4,160.

Increasing RST Prices. Now suppose that, due to bear market sentiment, the price per token is trading at $4 and the cumulative portfolio value of the Rooster declines suddenly to $2,400. ROOST Network could update the RNT smart contract which would affect certain attributes of RST. For instance decreasing RNT prices would increase RST prices by reducing network transaction fees and/or the RNT smart contract could cause higher distributions to be paid to RST holders which would also positively impact RST prices.

Decreasing RST Prices. Now suppose that instead of a bear market, the price of RST has increased rapidly from $6.928 per share in year 5 and a portfolio value of $4,160 to $50 per share and $30,000 in portfolio value. The network must have a mechanism to mitigate this type of risk to the system and support a stable market. The RNT smart contract could be updated to increase transaction fees in the network which would decrease RST prices, and/or the smart contract could cause lower dividends to be paid to RST holders which would also decrease RST prices.

Strategic Investments. Now suppose that macroeconomic conditions cause the price of multi family property in a regional market to temporarily decline. Since changes to ROOST cashflows lag market

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[5] According to the Quantity Theory of Money (QTM), the general price level of goods and services is proportional to the money supply. QTM is expressed in the following equation P = VM/Y, where P is aggregate prices, M is total money supply, Y is real output and V is velocity of money. With lower-case letters denoting percentage changes (growth rates), the QTM can be expressed as p = v + m – y, with p as the rate of inflation and y, v, and m as growth rates of output, velocity, and money stock, respectively. A central implication of the QTM is that a given change in the rate of money growth induces an equal change in the inflation rate.

[6] According to Migiro, “the literature on stock pinning makes the following conclusions. First, option trading impacts stock prices. Second, stock pinning is a real phenomenon...share prices cluster around particular strikes on option expiration days. Third, [this phenomenon is observed] across a number of stocks. Fourth, non-optionable stocks are less likely to have their prices cluster around a predetermined price on any day. Finally, stock pinning is a product of delta-hedging by hedge traders.” (Migiro 2015)

prices (rent is fixed in 12 month leases) and because at scale the network would be diversified, the cash flows generated by the ROOST Network that would usually be paid to shareholders could be used to accelerate reinvestment in properties. This change to the distribution formula could be made by updating the RNT smart contract. This would allow RST holders to capitalize on market conditions and positively contribute to the long term value of RST.

Market simulations and sensitivity analysis will be conducted to develop the algorithm for price stabilization which will be programmed into the blockchain.

Market Simulation

Introducing liquidity and free market pricing can expose RST to volatility. However, the fundamentals of pricing dividend-bearing instruments suggest reliable stability. In this section, we illustrate a model of the intrinsic value of RST based on the discounted cash flow of future distributions which are set by a function of RNT. We model the price volatility of REITs in public markets and apply the Black Scholes model for pricing options to develop a framework for setting a target price for RST. Next, we illustrate how parameters set using blockchain technology can stabilize the price of RST.

Black Scholes pricing with dividend

According to Black Scholes, if options are correctly priced in the market, it should not be possible to achieve guaranteed profits by creating portfolios of long and short positions (in options and their underlying stocks). According to their paper, almost all corporate liabilities can be viewed as combinations of options and the theoretical valuation formula for options that they proposed could be applicable to corporate liabilities such as common stock, corporate bonds, and warrants. In particular, the formula can be used to derive the discount that should be applied to a corporate bond because of the possibility of default. Their model focuses on call options, which give the right to buy a single share of common stock.

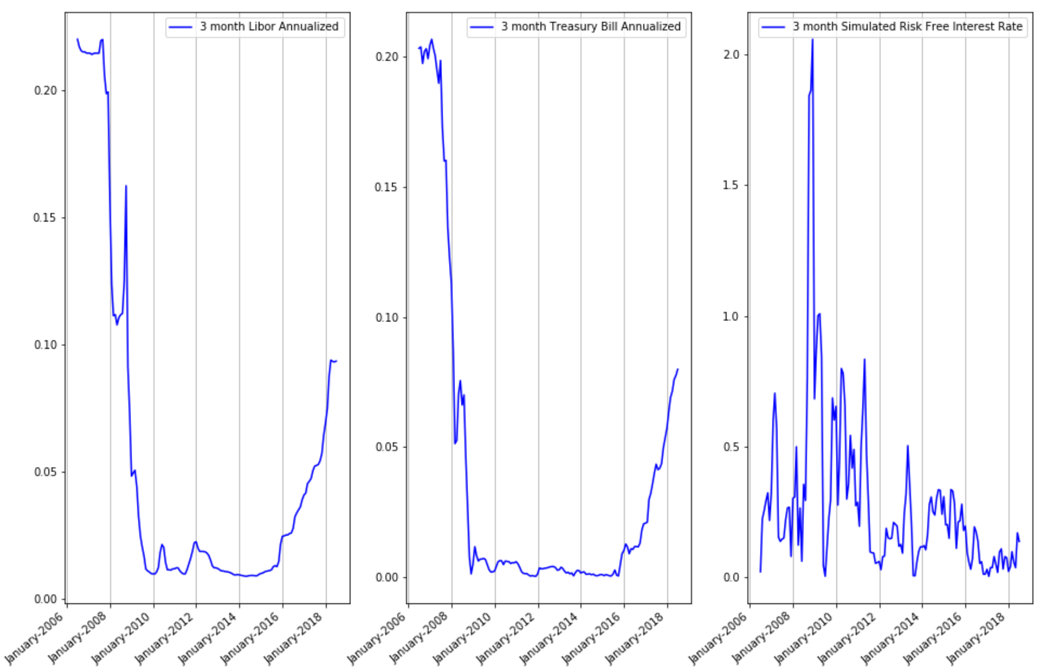
The approach is straightforward: simulate the price of the underlying shares using movement in the Commercial Real Estate Index (Green Street Advisors), then use the price of the call option as the premium on future performance of the shares. The higher the premium, the better the stock is expected to do. Finally, we simulate the application of monetary policy by adjusting the risk free interest rate based on historical performance of the shares. We give a detailed exposition below.

The price of the call option is a function of four inputs:

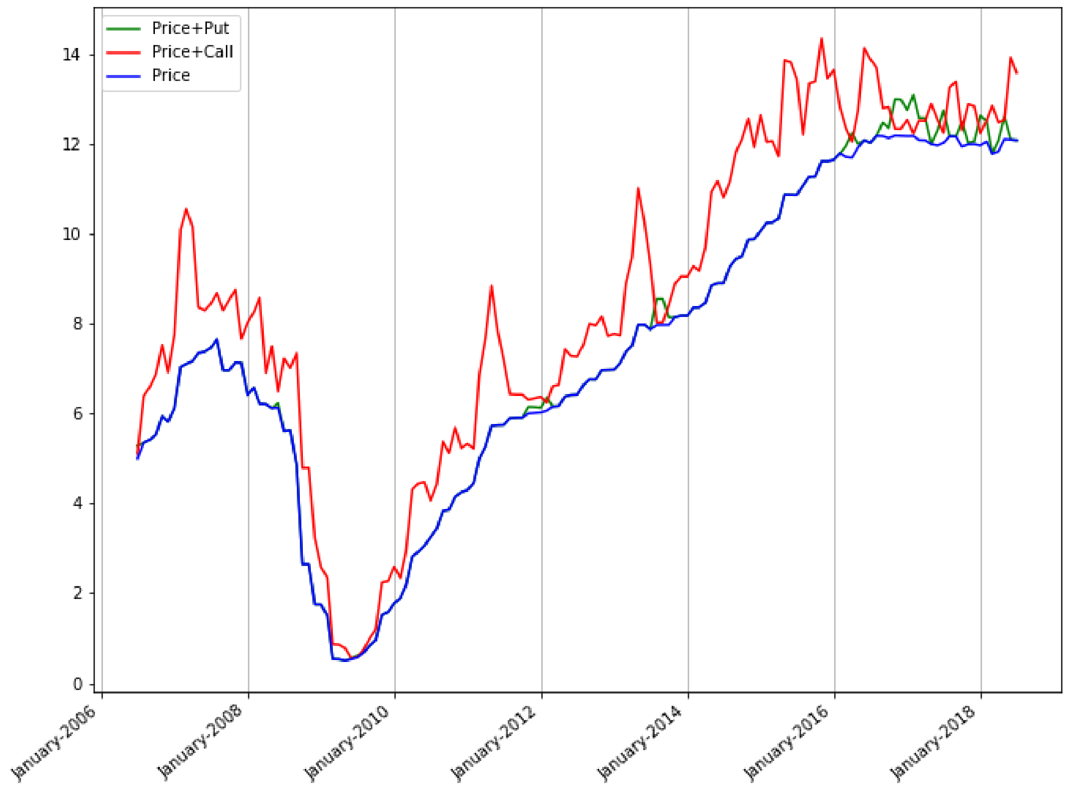
1. The price of the underlying asset,
2. The expected annualized dividend yield,
3. The implied volatility in the price of the underlying asset, and
4. The risk free interest rate.

Each of these inputs offers an opportunity to simulate the type of primary market we want to create for Roosters and any speculators in a secondary market. The price of the underlying asset can be estimated as its market valuation less outstanding debt spread over the number of shares. We fix the market valuation per share at $5, then use the movement in the commercial real estate index to simulate the fluctuation in true market value. This includes an initial debt leverage of 75% scheduled to decrease at a rate of 1.2125% annually. To draw focus on performance of an options pricing based monetary policy we begin our simulation in July of 2006 - just before the great recession of our time - and extend it to near present day July 2018. The 12 year period consisting of 144 monthly valuations provides the backdrop of harsh market conditions followed by a steady recovery.

We fix the annual dividend yield at 4%. For the purpose of the simulation, we assume the dividend is paid continuously. The implied volatility is calculated as the standard deviation of the last 3 months of price changes of the underlying asset. Finally, the risk free interest rate is also calculated as a function of the previous 3 months of price movement with the thesis that higher volatility in the market should drive the risk free interest rate up - thereby making currency more expensive. We sum the price of the underlying asset and the call option to give the final fair price.



Below, the performance of the simulation is presented. First, observe the price of the put options is almost always zero, thus the adjustment to the underlying asset is minimal - this is a great indication the asset is not over-valued. Next, the price adjusted with the call option is always above the underlying asset price. Another great sign the underlying may be undervalued and is duly adjusted. The choppiness of the price plus call is due to two things. First, the coarse monthly data. Second, since the index used to simulate valuation is also based on trading volumes, while our simulation is purely interest rate based, there is an implicit volume adjustment underlying the process. In practice, the price movements will be smooth as we would be applying them at a finer granularity and taking the volumes into account.



Call Option:

C(S,t)=Se−qtN(d1)−Xe−rtN(d2)

Put Option:

P(S,t)=Xe−rtN(−d2)−Se−qtN(−d1)

With:

d1=logSX+t(r−q+σ22)σt√;d2=d1−σt√

Where:

-S is the underlying asset price.

-X is the strike price.

-q is the dividend yield.

-r is the risk free interest rate.

We haven’t yet adjusted for a parallel execution of the quantity theory of money by contracting or expanding the share supply. In addition, the higher valuations are due to the stability in performance of commercial apartment buildings as these enjoy the benefit of advance lease contracts. We didn’t explicitly model for this and yet it appears as a consequence of making the right “monetary policy”. Finally, even as the 2008 crash hits the rest of the market, and though the adjusted price follows it at a lag, the impact is dampened and it is clear how the impact of the federal bail-out is “picked-up” by the simulation - another side effect we didn’t explicitly model for. In the near future we will extend this simulation to improve how we model the interest rate given the volatility - including the use of the options “Greeks”.

We recognize the need for iterative improvement but are confident we have a solid foundation to build upon. The model illustrates how implementing monetary policy could have stabilized the RST price through the 2008 market crash. While monetary policy would not have kept the price from dropping significantly during the recession - the default risk associated with leveraged assets should be a consideration in the price during that time period- RST consistently outperforms the market, with mitigated volatility, and would have been considered a good investment. The model suggests that 1 RST purchased for $5 in July 2016 would be worth nearly $14 in 2018.

Conclusion

It is apparent that the current economic arrangements between renters, owners, and capital providers is unsustainable and more cooperative forms of association could create value for all participants in the market. Cooperative forms of ownership have demonstrated the ability to outcompete traditional hierarchical forms of enterprise. However, they have struggled to scale due to internal transaction costs, external transaction costs and the tragedy of the commons. ROOST was conceived to apply technology, including blockchain technology, to solving these challenges. By establishing incentives and an economic framework for collaboration at scale, Roost will provide a technology platform for renters to participate in the benefits of property ownership.

The results of the implementation model and market simulations suggest that, by enabling tenants to participate in a real estate cooperative at scale, they will have a means to accumulate wealth through investments in stabilized tokenized securities that represent fractional ownership in real assets.

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