Real Estate Security Token Offerings and the Secondary Market: Driven by Crypto Hype or Fundamentals?

Julia Kreppmeier[a], Ralf Laschinger[a], Bertram I. Steininger[b,*], Gregor Dorfleitner[a]

[a] *Department of Finance, University of Regensburg, Germany*
[b] *KTH Royal Institute of Technology, Stockholm, Sweden*

Abstract

Tokens, the digital form of assets, are an innovation that has the potential to disrupt how to transfer and own financial instruments. We hand-collected data on 173 real estate tokens in the USA between 2019 and 2021 and trace back 238,433 blockchain transactions. We find that tokens provide broad real estate ownership to many small investors through digital fractional ownership and low entry barriers, while investors do not yet hold well-diversified real estate token portfolios. We analyze the determinants of security token offerings (STOs), secondary market trading, and daily aggregated capital flows. In addition to some property-specific determinants for the STO, we find that crypto-market specific determinants, such as transaction costs and the related sentiment, are relevant both to the STO and capital flows.

Keywords: Digital Asset, Security Token Offering (STO), Real Estate Token, Blockchain, Distributed Ledger Technology (DLT), Decentralized Finance

JEL: G24, G32, K22, L26, M13

---

*Corresponding author: Bertram I. Steininger, bertrams@kth.se, +46 87907333, Teknikringen 10B, 100 44 Stockholm, Sweden

[1] *Conflicts of Interest:* One author bought a few digital tokens issued by the company RealT so that they could describe the process of tokenization. The current value is lower than 200 USD. The other authors have no commercial relationship with the company or management whose data we mostly rely on.

Preprint submitted to EFMA 2023 *2023-05-01*

1. Introduction

Innovation and technology have influenced and enhanced financial services and products for a long time. The drivers of innovation are lower costs for transactions and verification, economies of scale, financialization, and personalization (see, e.g., Gozman et al., 2018; Thakor, 2020). One of the most important technical innovations in this context is the *Distributed Ledger Technology* (DLT), especially the *blockchain* as a decentralized transparent verification system. In this article, we use the terms DLT and blockchain synonymously, even if the blockchain is only one subtype of DLT.[2] The blockchain solves the *double-spending* problem, i.e. the possibility that the same digital token could be spent more than once. The focus of public attention lies mainly on cryptocurrencies, such as Bitcoin or Ripple, and their tremendous price movements and volatility. However, cryptocurrencies are just one case of use. The possibility of securitizing assets and rights in digital tokens is even more relevant to the future of the financial sector. By reducing the involvement of financial intermediaries by automatically executing *smart contracts*, the financial industry can become more efficient. The concept of fractional ownership of digital tokens allows assets to be fragmented into many tokens. In particular, lumpy and illiquid asset classes with high entry barriers, such as the real estate sector, can, as a result, attract new investors and open up diversification opportunities, while significantly reducing costs and illiquidity premia. This development paves the way towards fully digitalized financial markets.

This article examines investor behavior and the determinants of tokenized real estates, such as fundamental factors affecting value, investment offering characteristics, or the particularities of the crypto market.

Digital tokens are issued through token offerings on the blockchain that provide an innovative decentralized verification and issuance mechanism for finance. After the token offering has taken place, the tokens can be traded on secondary markets, which enables token liquidity. Baum (2021) identifies assets such as land and properties as most suitable for digital asset tokenization as they are costly and not easily divisible as well as they involve many intermediaries and regulatory efforts. We contribute to the literature on blockchain technology, or, more specifically, on the economics of digital assets, real estate investments, as well as portfolio construction and diversification by

[2]For a detailed discussion, see Liu et al. (2020b).

studying real estate tokens. We hand-collected data on 173 real estate tokens together with their property and financial characteristics in the USA, which represents the most developed market so far, between the years 2019 and 2021. In addition, we examine the related 238,433 blockchain transactions to analyze investor behavior. We have enriched this database with crypto market-specific characteristics and macroeconomic indicators. In this regard, our main findings are threefold.

First, we are among the first to trace back the underlying blockchain transactions in an empirical analysis to derive insights into investor behavior. In our dataset, investors do not yet hold a well-diversified real estate token portfolio with a mean of 10 different tokens and an investment amount of 4,030 USD. Ownership of the properties is not concentrated on some single large investors emphasizing that tokenization provides broad access to real estate ownership for many small investors. Investors acquire tokens mainly during the STO, while secondary market trading plays a minor role. Second, we analyze the determinants of STO success, such as the number of days until all tokens are sold and the mean funding amount per day. For the latter and primary success variable of interest in this study, we find that some property-specific fundamentals explain most of the success of the STO apart from crypto market-related transaction costs. Third, we switch from the individual STO to the macro-level view of aggregated daily capital flows per property to account for the specific crypto market over time. We observe that real estate token investors similarly consider the crypto market sentiment and transaction costs when buying tokens, while only transaction costs that directly reduce the return on investment are relevant when selling. The effects on capital outflows representing token sales are less pronounced. Additionally, macroeconomic factors appear to have a minor role in capital flows.

The remainder of the paper is organized as follows. Section 2 provides an overview of the process of tokenization. In Section 3, we discuss the related literature and derive our hypotheses. We describe our data and methods in Section 4. The main analyses and discussion of our empirical results are presented in Section 5, followed by further analyses and robustness checks in Section 6. In Section 7, we conclude our study.

2. Tokenization: an overview

2.1. Blockchain, Smart Contract, Digital Token, Security Token Offering

The blockchain saves information in a tamper-proof form in a database using different nodes in a network in a decentralized manner and compares them in order to verify that the transactions are legitimate and not manipulated. Thus the blockchain transfers the traditionally centralized ledger system by using a single book to the digital world. It can be used to create and trade the digital form of assets: the tokens. Adding new assets to the blockchain is called tokenization (Schär, 2021). As with traditional forms of ownership (e.g., stocks or funds), a token can be equipped with value, rights, and obligations. Tokens can be issued time and cost-efficiently and transferred through smart contracts. The idea of smart contracts as automatically executed transaction protocols was introduced by Szabo (1994). Smart contracts self-execute if the pre-specified conditions are fulfilled (Buterin, 2013) without the involvement of an intermediary, such as banks, exchanges, clearing houses, or law firms. On the Ethereum blockchain, computing power is required to perform operations successfully. For that, the user has to pay a so-called *gas fee*.

Different rights and assets can be tokenized using utility or security tokens (or hybrid forms). Utility tokens are consumption or user rights that are often linked to platform services and issued by an initial coin offering (ICO). Security tokens represent shares of ownership in corporate equity, commodities, currencies, or real estate and are issued through an STO. After ICOs suffered from a lack of investor protection and frequent fraudulent activities (Momtaz et al., 2019), security tokens issued through STOs emerged as innovative and more trustworthy investment products (Lambert et al., 2022). Security tokens are classified as conventional securities and are subject to the corresponding regulatory requirements. In our study, we focus on security tokens and their issuance through STOs in the USA. The Securities and Exchange Commission (SEC) refers to the *Howey test* to verify whether a product or service is an investment contract. Based on the case law of the US Supreme Court, it "exists when there is the investment of money in a common enterprise with a reasonable expectation of profits to be derived from the efforts of others."[3] In light of this assessment, digital assets are

[3]See SEC v. W.J. Howey Co., 328 U.S. 293 (1946) ("Howey").

investment contracts and, therefore, securities as specified by the SEC. Securities must be registered with the SEC and are subject to laws and regulations protecting investors.

2.2. Real estate tokenization: theory

Real estate is a rather illiquid asset class with sticky prices, and high entry barriers, such as high investment volumes. However, it has attractive characteristics, such as a payoff in the form of constant cash-flows and a low correlation with stocks or bonds. Thus the financial industry has developed various solutions for (in-)direct and fractional investments in real estate (e.g., open-end and closed-end funds or REITs) so that even retail investors can include properties in their portfolios for diversification reasons. Real estate has been identified by investors, project developers, and financial service providers as a suitable market for tokenization via the blockchain. This new form of investment solves a range of problems of direct investments from which investors can profit in addition to existing forms of indirect investment. Properties can be split into many single tokens, which enable fractional ownership, so that retail investors gain access to previously unattainable assets and can diversify their portfolios. Real estate tokens are the digital counterpart of owning property directly (Baum, 2021). A real estate token, in a manner similar to closed-end funds, mostly comprises one property and not a portfolio of properties, such as open-end funds and REITs. In the case of REITs or funds, investors do not own the properties and, unlike tokens, cannot influence the decision to invest in a particular property. A token gives fractional ownership of the property to the investor, making it the technically closest form to fractional direct investment to date. In contrast to closed-end funds, token investors can avoid high minimum investment amounts and high administrative costs.

The tokenization of real estate in the narrow sense refers to the fact that the property and the related ownership rights are directly tokenized, which entitles the token holder to claim a share of the property, the earnings and expenses derived therefrom, and the legal obligations.[4] In contrast, the tokenization of real estate in the broader sense refers to securities from which a claim to the cash-flows of the property can be derived, which is tokenized (de la Rubia et al., 2021). Due to the lack of clear regulation of tokenizing

[4] A form to fully digitize ownership are non-fungible tokens (NFTs) or with the help of Decentralized Autonomous Organizations (DAOs). However, these are only theoretical concepts not often applied to the real estate market and, consequently, lie beyond the scope of this paper.

the property itself, most real estate tokenizations are, so far, realized according to the broader definition, where a company is tokenized, the only asset of which is the property.

Other advantages of tokens include that a token issuer can raise capital faster and at a lower cost, and reach more investors globally through online platforms. The securitization process is less regulated and disclosure requirements are lower. Tokens increase the transparency of the transactions and entail lower transaction times and costs since the costs for third parties (e.g., a broker or notary) are much lower, plus clearing and settlement take place more quickly and at any time (Ante and Fiedler, 2020; Lambert et al., 2022; Yermack, 2017). These costs are high for the real estate market. For example, Damodaran (2005) quantifies the costs of illiquidity and assumes a discount of 20%-30%. Markheim and Berentsen (2021) assume a commission fee of 5%-6% of the property value. Another major benefit of tokens is the potential liquidity provided through the possibility of trading tokens on centralized exchanges (CEX) and decentralized exchanges (DEX) as a means of decentralized finance.[5]

2.3. Real estate tokenization: practice

In 2018, the tokenization of the St. Regis Aspen Resort in the USA was the first securitization of a property using the blockchain worldwide. Our dataset, which is presented below, comprises real estate tokens issued by the platform RealToken (RealT), a very active issuer and platform for real estate tokens, which are also traded on secondary markets. We illustrate the process of real estate tokenization and STOs in the case of RealT in Figure 1 and describe the process below.[6] Since properties cannot be digitalized directly, for every property the RealToken LLC creates one RealToken Series LLC, which acts as a special purpose vehicle (SPV) and holds the deed to the property. The properties are primarily rented residential buildings. Property management is outsourced to local professionals. These SPVs stand solely and legally on their own and are in the next step tokenized using the technical standard of the Ethereum ERC-20 token. RealT offers the tokens in unregistered securities offerings, or private placements, under Regulation D 506(c) (US-accredited investors) and Regulation S (non-US persons)

---

[5]For a detailed discussion see Aspris et al. (2021).

[6]For a detailed description of the ICO or STO process, see Momtaz (2020) and Lambert et al. (2022).

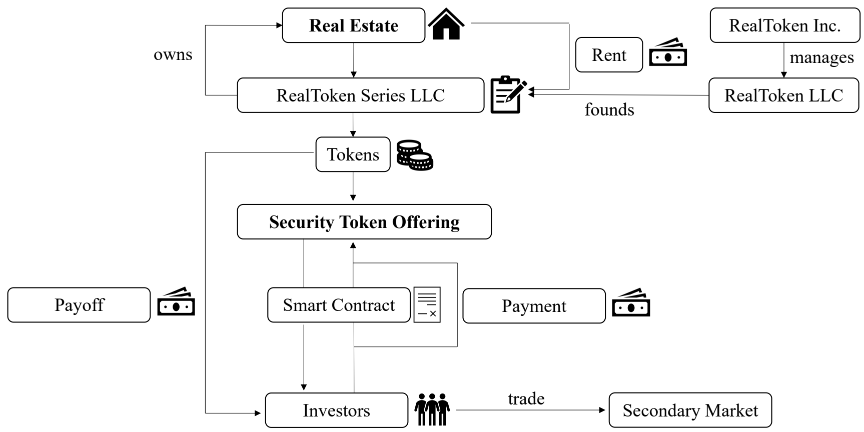

Figure 1: Process Map

of the Securities Act. Investors can purchase the tokens during the STO and, after successful payment and signing the offering memorandum digitally, they automatically receive the tokens in their wallets by means of a smart contract. The tokens provide the investor with a deed in the respective tokenized RealToken Series LLC. The net rent after operating costs, insurance, and real estate taxes is submitted weekly to the RealToken rent contract linked to the property and automatically issued to the token holders' wallets. The value of a token is specified by the assessed property value after a maintenance and repair reserve that is divided by the total number of tokens issued. RealT charges a fee of 10%, for which investors in exchange receive governance tokens from RealT itself. Afterwards, the security tokens can be traded on online exchange platforms or returned to RealT, mostly at the issue price. The properties are re-valued annually, resulting in the depreciation or appreciation of the tokens. After the rapid increase in transaction costs in combination with longer execution times on the Ethereum blockchain at the beginning of 2021, RealT decided to alternatively enable transactions on the Gnosis blockchain.[7] In particular, for the relatively low weekly rent payments, it is favorable to use Gnosis and avoid high transaction costs on the Ethereum blockchain.

[7]Gnosis (formerly xDai) blockchain is a second-layer protocol to create, trade, and hold digital assets on Ethereum.

3. Literature and conceptual framework

3.1. Related literature

Our study contributes to several streams of literature. First, we add to the literature on the blockchain technology and the economics of digital assets. The first wave of academic literature in this field studies ICOs as an innovative form of crowdfunding, bearing the advantage that the blockchain tokens enable secondary market trading (Lee and Parlour, 2022). Existing empirical studies on ICOs analyze success determinants (e.g., Fisch, 2019; Howell et al., 2020), investor characteristics and motives (Fisch et al., 2021; Fahlenbrach and Frattaroli, 2021), white papers (Florysiak and Schandlbauer, 2022; Thewissen et al., 2022), and post-ICO performance (Benedetti and Kostovetsky, 2021; Fisch and Momtaz, 2020; Lyandres et al., 2022). Momtaz (2023) highlights that the primary reasons for security tokens being the driver of digitization in finance are interoperability, fractional ownership, market liquidity, and instantaneous settlement. Gan et al. (2021) theoretically investigate the optimal design and pricing of utility tokens in comparison with security tokens and find that STOs entail lower agency costs, lower token turnover, lower cash diversion, and raise higher amounts of funds and firm profits. The existing empirical literature on STOs primarily studies success determinants during the funding process, focusing on the issuer and offering characteristics (Lambert et al., 2022; Ante and Fiedler, 2020).

Second, we contribute to the literature on real estate investments. The real estate sector has been identified as a major sector for study in its own right in the literature on crowdfunding (Jiang et al., 2020; Schweizer and Zhou, 2017; Shahrokhi and Parhizgari, 2020). Another study compares ICOs and, among others, REITs to analyze whether gender, ethnicity, and geography have an influence on the decision of ICOs in contrast to traditional financing (Fisch et al., 2022). While the authors point out that real estate is a highly relevant use case for blockchain-based financing, they do not directly examine real estate STOs and the market-specific determinants associated with them as we do. In a sample of 1,125 ICOs for external firm financing, Howell et al. (2020) find that ICO success in terms of employment as the real outcome is positively related to the operating sector of tokenizing real assets. They attribute this result to the underlying concept of security tokens but do not deepen the analysis further on this aspect. Therefore, both aforementioned strands of literature need to be combined to gain a holistic picture of real estate tokenization. STOs of real estate projects need to be considered separately, while simultaneously taking into account the underlying asset class and the specific crypto market environment.

Third, we complement the literature on portfolio construction and diversification. Diversification is a fundamental concept in portfolio theory in finance (Markowitz, 1952). Goetzmann and Kumar (2008) document that 60,000 individual US investors hold under-diversified equity portfolios resulting in high idiosyncratic risk and, consequently, a welfare loss. The small investment amount resulting from fractional ownership through digital tokens theoretically makes diversification easy. Therefore, we aim to verify whether real estate tokens deliver on their promise of portfolio diversification.

The literature on real estate tokens is, to this point, mostly of a theoretical nature regarding the general procedure (Gupta et al., 2020; Liu et al., 2020a; Markheim and Berentsen, 2021), financial application (Baum, 2021; Markheim and Berentsen, 2021), legal (Konashevych, 2020), and technical aspects (Gupta et al., 2020). Markheim and Berentsen (2021) present descriptive data based on a small sample for real estate tokens in the USA and Switzerland. Despite the many theoretical advantages of digital tokens, the authors also point towards challenges, such as regulatory uncertainties, relatively long transaction times, and high energy consumption. Swinkels (2023) empirically examines real estate tokens in regard to the number of owners, the actual portfolio diversification of the investors, property liquidity, and the relationship of tokenized assets to economic fundamentals. He uses the same data source as we do with an earlier end date so that he considers 58 tokens. He finds that a tokenized property has in the mean 254 owners and that the ownership changes on average annually. In addition, he concludes that investors are interested in the exposure to the residential house price index since the token prices are linked to housing prices. Our study starts one step earlier and focuses on the determinants of STOs and daily capital flows. We split the perspective between the transaction-level of the STO and the macro-level impact on capital inflows and outflows of STOs over time.

3.2. Derivation of hypotheses

We first tackle the impact of different property-specific factors on the perceived quality, risk, and expected cash-flow, which can be related to the success of an offering. From a theoretical perspective, property type and location are the major factors among the property-specific characteristics that influence value. These factors are empirically confirmed by various studies (see, e.g., Cronqvist et al., 2001; Pai and Geltner, 2007; Ro and Ziobrowski, 2012; Hartzell et al., 2014). Real estate is naturally immobile, which means that the location determines its value to a large extent. Therefore, a purchaser acquires both the building and the site at the same time (Kiel and Zabel, 2008). The options for determining the location's quality are manifold: political or historical classifications, indirect factors, such as the school quality of the district, or the distance to important places, such as the central business district. These indicator variables mostly imply indirect influences on house values since investors consider specific locations or location characteristics to be more or less favorable. In particular, the low minimum investment amount for tokens enables investors to diversify their portfolios more broadly, especially in terms of location. This makes the location an important factor for the attractiveness of the STO for an investor and could, consequently, also influence the success of a real estate STO.

The size of the property measured by its value determines the rent and return in a manner similar to the size factor on the stock market (Fama and French, 1993). Geltner et al. (2014) report that size is a suitable factor for explaining the return variation of real estate on a large scale. Pai and Geltner (2007) use the market value as a size factor and find the opposite impact compared to the stock market – larger properties have a higher expected return premium. Esrig et al. (2011) state that large properties outperform other properties on an absolute and risk-adjusted basis for different property types. Sirmans et al. (2005) conduct a review of around 125 studies using hedonic modeling to estimate house prices and report that lot size had a positive effect in the vast majority of observations. Therefore, we expect that the size has a positive relation with the success of the STO.

If the property quality is not given directly, the age of the property can be used as an alternative proxy instead. A lower quality induces higher uncertainty for maintenance and repair costs and, thus, higher risk for the buyer (Bourassa et al., 2009). Since investors try to avoid this kind of risk, older properties may be less attractive to investors. This is supported by Sirmans et al. (2005) who find in their review that the influence of age on house prices was almost entirely negative.

The major risk regarding the expected cash-flow is a rent default. This risk can be reduced by splitting the rent between several different tenants. Therefore, single-tenant buildings limit the diversification possibilities of potential investors in contrast to multi-tenant properties. The limited diversification options, hence, make single-tenant properties, in contrast to multi-tenant properties, less attractive, which may result in a less successful funding process. For private homes, Ling and Archer (2021) conclude that single-family properties have a lower risk than multi-family homes because single-family homes are often located in favorable suburban areas with constant demand. Based on the importance of both effects – lower default risk for multi-tenant buildings vs. location – an exact expectation cannot be formulated and the issue has to be settled empirically.

In the USA, low-income households can receive rental housing assistance via Section 8 of the United States Housing Act of 1937 (42 U.S.C. §1437 et seq.). This program helps them in finding a decent and affordable place to live. The landlord receives the rent directly from the state through this program and the risk of payment difficulties or even a default is largely mitigated. The Section 8 program guarantees a stable and predictable rent payment for token purchasers. Consequently, investing in such properties bears a lower risk of a rent default. This could make properties with a higher portion of rental assistance through the Section 8 program more attractive for investors. As such, our Hypothesis 1 reads:

> **Hypothesis 1:** *The quality of a location, the size of a property, and a higher portion of rental assistance through Section 8 are positively related to the success of an STO, while age is negatively related.*

Apart from the property and financial characteristics, we additionally consider campaign features that are primarily known from the literature on crowdfunding (CF) (Belleflamme et al., 2014). In the context of CF, it is decisive for the funding success of a campaign, to be able to signal the quality of a project to potential investors (Ahlers et al., 2015). Conventional CF campaigns often have a short or missing track record or lack a market-ready product. Therefore, investors need to base their decision on other information, such as the description in text and pictures on the platforms. This is a way for companies to reduce information asymmetries and signal project quality (Diamond, 1984). Apart from the text, pictures assist in visualization and enable an evaluation of the location and the actual condition of the property. In previous CF studies, a detailed project description was identified as a means to overcome information asymmetries and increase campaign success (De Crescenzo et al., 2020; Gao et al., 2023). This effect has also been investigated in the literature on real estate for its impact on home prices and home-buyer attention in a similar vein (Luchtenberg et al., 2019; Nowak and Smith, 2016; Seiler et al., 2012). The more detailed and larger the number of pictures, the more realistic and accurate the presentation of the potential investment is for an investor. High-quality projects have the incentive to deploy detailed project descriptions, whereas low-quality projects will tend to be vaguer in their disclosures. Therefore, we assume that a detailed project description is a positive quality signal for an investor, which prompts an investment and can increase the success of an offering.

> **Hypothesis 2:** *A detailed project description is positively related to the success of an STO.*

As on other markets, the investment decision is potentially driven by the market-specific environment and investor or market sentiment. Investors follow investment recommendations and central strategies and retail investors mostly exhibit herding behavior which can be caused by market sentiment. Herding behavior has been studied in the traditional stock market (Chang et al., 2000; Chiang and Zheng, 2010; Litimi et al., 2016), but also on the cryptocurrency market (Ajaz and Kumar, 2018; Bouri et al., 2019). Investors, particularly non-rational investors, such as many crypto investors, are potentially subject to herding behavior. Investor sentiment can be particularly pronounced in the market for tokens (Drobetz et al., 2019), as this seems to be the case in such highly subjective asset classes (Baker and Wurgler, 2006). From an investor perspective, we assume, similarly to Ante and Fiedler (2020), that in the market for STOs there exists a house money effect, meaning that investors take higher risks after prior gains (Thaler and Johnson, 1990), especially during periods of positive market sentiment. Since issuers anticipate this irrational investor behavior, they will await the right time on the market to place the offers. For example, Drobetz et al. (2019) show that companies seeking funding via ICOs avoid phases of general negative market sentiment for their exchange listing which result in short-term negative returns of the tokens. Token platform operators can time the publication of a project to periods of positive market sentiment. Thus we expect a positive link between market sentiment and the success and daily capital inflows as token purchases and a negative link with daily capital outflows as token sales.

With regard to the specific market environment for blockchain-based tokens, a cost effect that runs counter to the market sentiment must also be taken into account. Apart from the administrative fees directly imposed by the token issuer, specific transaction costs called *gas fees* are additional costs associated with a token investment that need to be considered and paid by the investor. Since gas is needed to perform operations and space is limited on a block, the resulting transaction costs may vary due to fluctuations in supply and demand on the network.[8] Gas fees rise when demand increases, and vice versa, hence they are a sign of crypto popularity. Furthermore, if demand is high, users can offer an additional priority fee or tip to increase the chance that their transaction will be included in the next block. Gas fees can be observed and predicted easily for investors on corresponding websites opening up the possibility to time the investment and avoid high transaction costs. Momtaz et al. (2022) provide first empirical evidence of tokens on the Ethereum blockchain including stablecoins, startup tokens, and lottery tokens. The authors find that investors reduce their trading activity when transaction costs are high. Concluding, we expect that crypto market transaction costs are negatively related to the success of an STO as well as capital inflows and outflows because investors seek to circumvent high transaction costs. The decision of an investor to make a real estate token investment can therefore be based on two counteracting effects as a signal of crypto popularity, which is why an empirical investigation is required.

> **Hypothesis 3a:** *Crypto market sentiment is positively related to capital inflows, while it is negatively related to capital outflows.*

> **Hypothesis 3b:** *Crypto-market related transaction costs are negatively related to the success of an STO as well as capital inflows and outflows.*

4. Data and method

4.1. Data sources

We collect the US real estate token data directly from the RealToken platform, resulting in 173 financed projects as of December 31, 2021. The data comprises information at the property level and its financial characteristics. The blockchain transaction

[8] By definition, 'gas fee' and 'transaction fee' are not synonyms, as the actual total cost per transaction is the multiplication of gas used and a base gas fee. For more detailed information on the mechanism and calculation of gas fees, see Ethereum.org (2022).

data comes from two blockchain explorer and analytic platforms, namely *Blockscout* and *Etherscan*, which was also used by Lyandres et al. (2022). We rely on these two different sources for the transaction data as RealT enables transactions on the Gnosis blockchain since the beginning of 2021.

4.2. Method: blockchain transaction analysis

The blockchain is a digital ledger in which one entry corresponds to one transaction. We derive all blockchain transactions related to the real estate tokens in our sample until the end of our observation period in December 2021. The structure of a blockchain transaction comprises the respective token, a unique transaction hash (transaction ID), a time stamp, the quantity of tokens, and the sending and receiving addresses. We trace back investors through their unique and pseudonymous *wallet* address, which is comparable to the account number in the traditional banking sector. Even if an investor can have several wallets and, thus, more than one unique wallet address, our assumption is that the majority of investors have only one wallet.[9] The switch of the blockchain from Ethereum to Gnosis is no issue in terms of the unique wallet address, as Gnosis is built upon Ethereum and, therefore, the wallet addresses remain the same. Due to the focus of our study, we do not consider other investments by investors in their wallets besides real estate tokens. We can clearly distinguish transactions from the STO from secondary market transactions by identifying the emitting wallet address of the platform operator from which tokens are transferred to investors for each property. Consequently, the remaining transactions from non-emitting wallets are secondary market buy-or-sell transactions.

Based on the transaction data, we derive several variables which shed light on both investors and their investment strategies with respect to tokenized properties. To this end, we analyze first two distinct perspectives: the wallet-investor and the token-property perspective. In the wallet-investor perspective, the variable *Properties per Investor* accounts for the number of properties in which an investor is invested. As outlined in Subsection 3.1, this variable addresses the extent to which investors diversify

[9]This assumption can be justified for several reasons. On the RealT platform, a user can only deposit one wallet at a time. Swinkels (2023) has submitted a request to the platform operator confirming the assumption. From an academic point of view, Fahlenbrach and Frattaroli (2021) have conducted tests in an ICO sample and find similar results.

their real estate token portfolio. Further, we convert the number of tokens as observed in the transactions into a more easily interpretable and meaningful dollar amount, using the price of the tokens from the STO and calculate the *Holdings per Investor as of Dec 2021* in dollars. To measure the time dimension of the investments and thus the willingness to speculate on the side of the investors, we analyze the *Holding Period all Investors as of Dec 2021* in days. From the token-property perspective, we consider the concentration of ownership with the Herfindahl-Hirschman index (Herfindahl, 1950; Hirschman, 1964). We calculate the Herfindahl-Hirschman index as

$$HHI = \sum_{i=1}^{N} s_i^2$$

in which s is the percentage of ownership of an investor i, and N constitutes the total number of investors on the property level. The index ranges between $1/N$ and 1. The latter implies that the complete ownership is concentrated on a single investor. To account for variations in the HHI caused by a different number of investors in the properties and to facilitate direct comparison between properties, we consider the normalized Herfindahl-Hirschman index as

$$HHI^* = \frac{HHI - 1/N}{1 - 1/N}.$$

This measure varies between 0, which corresponds to equal ownership of all investors, and 1, which corresponds to a single investor with full ownership. The variable *Investors per Property* measures the number of unique wallets that have invested in a specific property.

In addition, we examine investors' trading activities on both the buy and sell sides. With the variable *STO Buy* we measure the absolute dollar amount of purchases during the STO. In contrast, the variable *Secondary Market Buy* depicts how large the investment amounts are in the secondary market. The variable *Secondary Market Buy/Existing Exposure* indicates the percentage of purchases on the secondary market compared to the existing investment. On the sell side, we analyze with the variable *Secondary Market Sell* the dollar amount investors sell on the secondary market. The variable *Secondary Market Sell/Existing Exposure* puts this in relation to the existing investment. Lastly, the variable *Holding Period Sellers* measures how many days investors who sell their tokens have previously held them. The latter two variables provide insights into the question of whether investors are rather interested in regular cash-flows from the rent payments or the changes in the value of the token itself.

4.3. Method: multivariate analysis STO success determinants

In the first multivariate analysis, we test for determinants of the success of real estate STOs. We operationalize the funding time and speed as our measures of success. The funding time measures the number of days until 95% of the tokens have been transferred to the investors' wallets since RealT retains tokens to ensure liquidity in the secondary market, based on the blockchain transaction data.[10] Therefore, it is a proxy for the pure time dimension of success. We define projects as being more successful if the funding time is lower. We sub-categorize the funding time into the *Funding Time until Success* for the sub-sample of successfully funded projects which have been transferred to the investors' wallets. As the second sub-category of funding time, we examine successful and unsuccessful projects simultaneously regarding the *Funding Time until Dec 2021* to obtain a sample free of survivorship bias. We estimate the parametric accelerated failure-time (AFT) survival model to account for unsuccessful projects properly, and because the proportional hazards assumption is violated for the semi-parametric Cox model. We apply the lognormal and loglogistic distributions since both present the most appropriate statistical fit for the distribution of our dependent variable. The AFT model is an alternative to modeling survival times often used in crowdfunding (Jiang et al., 2020; Felipe et al., 2022).

The funding time may be positively related to higher amounts of *Total Investment*. Therefore, we alternatively consider the measure speed. It is the relationship of 95% of the *Total Investment* to the funding time. Thus speed measures the mean investment amount funded per day.[11] Successful projects have a higher speed which corresponds to a higher funding amount per day. Analogously to the analysis of the funding time, we sub-categorize speed in the first specification with the corresponding *Funding Time until Success* into the dependent variable *Speed until Success* for successful projects. In

[10]In Subsection 6.1, we vary and verify the 95% assumption for an STO in order for it to be considered successful.

[11]This definition is analogous to the average velocity in physics, based on the investment amount instead of distance.

the second model specification, we examine all projects as of December 2021 with *Speed until Dec 2021*. For projects that have not been successfully funded until the end of our observation period and are on the market longer than the mean time of *Funding Time until Success*, we equate *Speed until Dec 2021* to 0 to proxy a low speed and prevent distortions from unsuccessful projects with a large *Total Investment*. For projects that have not been successfully funded until the end of the observation period and are on the market shorter than the mean time of *Funding Time until Success*, we use the actual amount of money raised instead of *Total Investment*.

In the baseline regression, we include the financial, property, and campaign variables which we expand in the second specification with crypto market-specific characteristics. We use robust standard errors that are one-way-clustered in all regressions and quarter-year dummy variables. The financial characteristics of the property include *Rent per Token p.a.* for the annual rent a token holder receives per token. The variables *Expected Yield* and *Total Investment* are data publicly available before funding. These variables are given by the property characteristics and can be indirectly influenced by the token issuer. The financial ratio *Expected Yield* is given by the ratio of the net rent to the token price. *Total Investment* describes how much money is required for successful funding. This variable is commonly used in the CF (Block et al., 2018; Mollick, 2014), ICO (Adhami et al., 2018; Fisch, 2019), and STO literature (Ante and Fiedler, 2020; Lambert et al., 2022) to determine project success and represents the funding amount actually collected. However, due to the technical procedure on the blockchain, the *Total Investment* is, in our context, always completely issued within the tokenization, but not necessarily completely transferred to investors, while the remaining tokens stay with the issuer. Therefore, we do not apply this variable as a measure of success.

The property characteristics comprise the variables *Age*, *Lot Size*, *Section 8* as the percentage of the share of financially supported housing within one property, and the type of use with the dummy variable *Single Family* if one family is the only tenant. For a suitable location variable, we rely on the dummy variable *Detroit* and the metric variable *Distance DTWN* to account for location quality, since these variables are easily accessible and straightforward to understand for a retail investor. Similar to Swinkels (2023), we assume that rental properties which are located outside of Detroit are more attractive for investors for reasons of diversification since the majority are located in Detroit. In addition, we also measure the distance to downtown in miles with the variable *Distance DTWN* to incorporate the micro-effects of the location. The campaign characteristics related to the literature on crowdfunding include the number of pictures with the variable *#Pictures* and the length of the descriptive text with *#Characters* for the particular property project.

For market-specific variables, we include for the crypto environment the variable *Gas Fees* for transaction costs on the Ethereum blockchain, converted to USD. Additionally, we include the S&P Case-Shiller Home Price Index with the variable *Housing Market* for the respective regions corresponding to the particular cities where the properties in our sample are located (Detroit, Chicago, Cleveland, New York, and Florida), lagged for one month. Since investors participate in the value depreciation or appreciation of the property with the value of their token, they care about the growth potential of the real estate market and may be more willing to purchase a token if the regional real estate market is growing. All variables are defined in Table A.1 in the Appendix.

4.4. Method: multivariate analysis funding determinants

With the multivariate analysis of STO success determinants, we analyze the STO at that specific point in time. However, when considering the crypto market in its entirety over time, we need to detach from mostly time-invariant STO characteristics and move on to the macro-level view of real estate token market activity. Hence, we can additionally account for daily fluctuations, and in particular for short-term particularities and shocks. In concrete terms, this shifts our models from the STO perspective to a daily view of capital inflows and outflows over time. To account for unobserved effects, both regarding individuals as well as time, we employ a two-way fixed effects panel regression to analyze the determinants of daily inflows and outflows per property.

The dependent variables daily *Inflow* and *Outflow* per property are calculated based on the blockchain transaction data. *Inflow* indicates how much money investors spent during the STO or on the secondary market per property on a given day. *Outflow* measures which amount of money the investors sold from a property on the secondary market on a given day. The *Inflows* and *Outflows* in the market for real estate tokens may be influenced by determinants and shocks both in the crypto market and the macroeconomy. Therefore, to account for the peculiarities of the crypto market, we consider from the sentiment perspective the five-day cumulative return of the native token of the Ethereum blockchain, Ether (ETH) with the variable *ETH Price* denominated in USD. The market capitalization of ETH is the second largest after Bitcoin on the cryptocurrency market as of December 31, 2021 and Ethereum is the major platform for security tokens. As the cryptocurrency market is still in its infancy and the general conditions are changing, it is characterized by high volatility. To take short-term shocks in the crypto market into consideration, we include the dummy variables *ETH Shock* and *Gas Shock*. *ETH Shock* equals one if the cumulative return of five days prior the observation decreased by more than 5% and *Gas Shock* which equals one if the cumulative return of *Gas Fees* increased by more than 5% in five days. For the macroeconomic environment, we include the *One-month Treasury*, *Ten-year Treasury*, and the *Aruoba-Diebold-Scotti* (*ADS Index*) Business Conditions Index of Aruoba et al. (2009). According to the Federal Reserve Bank of Philadelphia, the *ADS Index* covers seasonally adjusted macroeconomic indicators including initial jobless claims (weekly), payroll employment (monthly), industrial production (monthly), real GDP (quarterly), etc. The index offers the advantage that, unlike e.g. GDP or the unemployment rate, the data is provided on a daily basis corresponding to the daily frequency of our dependent variables. Due to its high frequency, the index is increasingly used in academic research, c.f. Caporin et al. (2022) or Da et al. (2014).

4.5. Descriptive statistics

The descriptive statistics for the analysis of success determinants are displayed in Table 1 in Panel A. Of our total sample of 173 real estate STOs, 72% were successful, which means that 95% of the tokens were transferred to investors. The sub-sample of successful STOs has a mean *Funding Time until Success* of 48.72 days and a median value of 26.92 days. In contrast, the *Funding Time until Dec 2021* for the entire sample is correspondingly longer with 73.01 days in the mean. The minimum of 2.63 indicates that some very attractive projects are sold off within a short period of time. The money-oriented variable *Speed until Success* has a mean of 10,550 USD/day for successful projects and a median of 4,190 USD/day. When considering successful and unsuccessful projects regarding the *Speed until Dec 2021*, the mean of 8,300 USD/day is subsequently lower. The minimum *Speed until Dec 2021* of 0 represents projects not fully funded within the mean of *Funding Time until Success* of 48.72 days.

For the *Expected Yield*, the mean is at 11%. The mean property value measured

Table 1: Descriptive Statistics

	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Panel A: Variables for STO success determinants								
Dependent variables								
Funding Success	173	0.72	0.45	0	0	1	1	1
Funding Time until Success	125	48.72	49.53	2.63	9.87	26.92	82.29	226.70
Funding Time until Dec 2021	173	73.01	67.03	2.63	11.91	56.53	121.00	323.00
Speed until Success	125	10.55	20.38	0.27	0.95	4.19	9.22	128.48
Speed until Dec 2021	173	8.30	18.45	0.00	0.27	1.78	8.64	128.48
Explanatory variables								
Rent per Token p.a.	173	5.98	1.59	3.96	5.53	5.81	6.08	21.82
Total Investment	173	168.02	205.54	48.08	60.58	66.50	144.45	985.91
Expected Yield	173	0.11	0.01	0.07	0.11	0.11	0.12	0.13
Age	171	85.02	18.48	2	74	84	94.5	134
Lot Size	166	5,338.20	2,951.67	871	3,920	4,792	5,644.5	29,620
Section 8	173	0.18	0.37	0.00	0.00	0.00	0.00	1.00
Single Family	173	0.64	0.48	0	0	1	1	1
Distance DTWN	173	4.70	1.73	1.08	3.61	4.51	5.40	9.63
Detroit	173	0.80	0.40	0	1	1	1	1
#Pictures	173	4.34	4.77	1	2	3	5	35
#Characters	172	205.65	305.82	0	0	0	364.2	1,654
Gas Fees	173	6.68	4.53	1.11	1.78	6.79	9.42	16.85
Housing Market	173	150.67	24.35	127.56	139.63	148.45	155.38	343.64
Panel B: Variables for funding determinants								
Dependent variables								
Inflow	26,940	1,189.39	11,201.43	0.00	5.00	16.01	117.98	493,278.80
Outflow	26,016	218.44	1,484.38	0.00	4.87	13.80	65.50	71,819.98
Explanatory variables								
Gas Fees	654	4.37	4.23	0.76	1.41	1.78	8.11	18.00
ETH Price	654	1,266.96	1,392.49	110.61	202.23	387.98	2,232.96	4,812.09
Gas Shock	654	0.38	0.49	0	0	0	1	1
ETH Shock	654	0.30	0.46	0	0	0	1	1
One-month Treasury	627	0.53	0.77	0.00	0.05	0.09	1.52	2.26
Ten-year Treasury	627	1.29	0.44	0.52	0.84	1.43	1.63	2.13
ADS Index	654	−0.47	5.64	−26.33	−0.31	0.18	0.86	8.99

Note: This table reports the descriptive statistics (number of observations, mean, standard deviation, minimum, 25th percentile, median, 75th percentile, and maximum) for the full sample. For the analysis of STO success determinants, the number of observations of 125 of *Funding Time until Success* and *Speed until Success* refers to the successful projects in the sample; the remaining variables represent the entire sample of 173 observations. For the analysis of the funding determinants, the number of observations differs between *One-month Treasury*, *Ten-year Treasury*, and the remaining explanatory variables, as these data are not provided on bank holidays. All variables are defined in Table A.1 in the Appendix.

by the *Total Investment* is highly skewed at 168,020 with a median of 66,500, which shows that most properties have a rather low value. Among the housing characteristics, we observe that 80% of the properties are located in *Detroit* and 64% are *Single Family* properties. The campaign variables show that the offers, on average, are illustrated with four pictures and described in 205.65 characters. Since the median value of *#Characters* is 0 and this value is based on the fact that the platform did not provide any descriptive text at the beginning, we do not consider the variable further in our multivariate analysis. The *Gas Fees* at the day of the STO range from a minimum of 1.11 to a maximum of 16.85, with a mean of 6.68, highlighting that blockchain-related transaction costs can be of crucial interest to token investors.

Panel B presents the descriptive statistics for the analysis of funding determinants. The unbalanced panel data set is based on 26,940 daily *Inflow* and 26,016 daily *Outflow* observations per property per day over our observation period of about two and a half years as of December 2021. One property realized a mean of 1,189.39 *Inflows* per day, highly distorted by the maximum of 493,278.90 from a large and quickly sold property. The daily *Outflows* per property amount to a mean of 218.44. The medians of daily *Inflows* and *Outflows* are in a similar range of magnitude at 16.01 and 13.80. The daily *Gas Fees* range between a minimum of 0.76 and a maximum of 18.00 throughout the observation period. The mean of *ETH Price* is 1,266.96 with a median of 387.98. The latter two variables illustrate the high volatility of the crypto market, which is why an additional examination of short-term shocks is required. A *Gas shock* is present in 38% and a *ETH Shock* in 30% of the daily observations. Table A.2 in the Appendix displays the Bravais-Pearson correlation coefficients for all of the variables we consider in the analysis of STO determinants. The correlation coefficients between the explanatory variables are moderate and provide initial evidence for our hypotheses.

5. Main analyses

5.1. Analysis of blockchain transaction

Based on 238,433 blockchain transactions related to all real estate tokens in our sample, we identify 6,806 unique wallets representing the corresponding number of real estate token investors. The different number of observations per variable is due to different transactions and filtering methods both of which serve to derive the respective variable of interest. From the wallet-investor perspective in Table 2 in Panel A, we

Table 2: Blockchain Transaction Analysis.

	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Panel A: Wallet-Investor perspective								
Properties per Investor	6,806	10.2	20.7	1	1	3	9	171
Holdings per Investor as of Dec 2021	6,544	4,029.35	32,319.99	0.00	57.96	259.45	1,398.34	1,439,474.00
Holding Period all Investors as of Dec 2021	165,161	244.51	160.59	0	133	221	286	850
Panel B: Token-Property perspective								
HHI* STO	173	0.03	0.06	0.01	0.01	0.02	0.04	0.68
HHI* as of Dec 2021	172	0.03	0.04	0.01	0.01	0.02	0.04	0.28
Investors per Property	173	401.2	201.2	31	258	328	501	1,173
Panel C: Buy side								
STO Buy	87,048	317.82	2,467.28	0.00	35.98	57.96	162.60	155,010.00
Secondary Market Buy	35,351	88.70	721.13	0.00	2.92	6.72	25.43	58,462.74
Secondary Market Buy/Existing Exposure	35,351	0.38	11.67	0.00	0.01	0.03	0.10	2,104.88
Panel D: Sell side								
Secondary Market Sell	31,697	99.97	802.28	0.00	3.00	7.65	25.69	58,462.74
Secondary Market Sell/Existing Exposure	31,697	0.09	0.16	0.00	0.01	0.02	0.07	1.00
Holding Period Sellers	31,638	105.09	86.06	1	36	86	155	701

Note: This table reports the descriptive statistics (number of observations, mean, standard deviation, minimum, 25th percentile, median, 75th percentile, and maximum) for the wallet-investor perspective (Panel A), token-property perspective (Panel B), as well as the buy side (Panel C) and sell side (Panel D). The sample includes 238,433 blockchain transactions from 2019 to 2021. All variables are defined in Table A.1 in the Appendix.

document that one single investor invests in 10.2 properties on average although at least 25% of all investors have invested in only one property. One reason for this observation could be the novelty and peculiarity of real estate tokens. The respective investors do not yet appear to hold a diversified real estate token portfolio. This result is in line with a previous study of ICO investors which finds that the main reason for a token investment is technological motives, followed by financial reasoning (Fisch et al., 2021). The maximum of 171 distinct properties out of 173 exemplifies that there are also investors who have invested in almost every property and have well-diversified tokenized real estate portfolios.[12] After converting the number of tokens into dollar holding amounts, we find that the mean of *Holdings per Investors as of Dec 2021* is 4,029.35 USD and the median is 259.45 USD. The mean of *Holding Period all Investors as of Dec 2021* is 244.51 days with a maximum of 850 days, indicating that investors

[12]Due to the pseudonymity of wallets on the blockchain and the fact that we can only trace back the issuing wallets of RealT, we cannot completely rule out the possibility that our maxima are influenced by other wallets used for handlings and shifts by the token issuer.

of the first STO are still holding the tokens.

If we switch to the token-property perspective in Panel B, we see a high dispersion and less concentration of ownership based on the mean of the normalized HHI^* of 0.03 both after the STO and as of December 2021. This means that the majority of tokens is not held by just a few investors, but that tokenization in practice provides broad access to real estate ownership for a large number of small investors. This result is in line with the evidence of Swinkels (2023), who utilizes a smaller sample. The maxima of both HHI^* can be attributed to a not fully transferred project with a single investor who sold off large parts of the investment after the STO. Apart from the maxima, the overall distributions remain the same, suggesting that secondary market trading does not change the ownership structure. Digitized properties are held in the mean by 401.2 different investors. Even though we obverse extreme cases, such as one property being held in 1,173 wallets, this variable is affected by the amount of *Total Investment*, since most issued tokens amount to around 50 USD and a higher *Total Investment* enables more investors to invest in a particular property.

The analysis of blockchain transactions on the buy side in Panel C shows that investors spend 317.82 USD in the mean during the STO and a median amount of 57.96 USD, which approximately equals the value of one token. With a mean *Secondary Market Buy* amounting to 88.70 USD, investors appear to acquire tokens mainly during the STO, while secondary market purchases play a subordinate role. This finding is underpinned by the ratio *Secondary Market Buy/Existing Exposure*, which indicates that investors raise their investment by a median value of 3% on the secondary market in comparison to their existing exposure.

Lastly, in Panel D we examine the sell side. The *Secondary Market Sell* has a mean value of 99.97 USD. The ratio *Secondary Market Sell/Existing Exposure* reveals that, in the mean, 9% of the existing exposure is sold, while the median value is 2%. The latter two variables highlight that most real estate token investors tend to hold their tokens and do not liquidate the investment quickly. The *Holding Period Sellers* additionally shows that investors who sell their tokens initially hold them for 105.09 days in the mean. This result is also consistent with Auer and Tercero-Lucas (2022) who find evidence that the increasingly popular *"hodling strategy"* among crypto investors who buy-and-hold tokens for a long-term time horizon to avoid exposure to short-term volatility in fact exists in the crypto market.

5.2. Analysis of STO success determinants

To test our hypotheses for STO success, we run different regression specifications for the two success variables: funding time and speed. First, we sub-categorize funding time into *Funding Time until Success* for the successfully funded projects with OLS regressions (Models 1-2) and *Funding Time until Dec 2021* for all projects with parametric accelerated failure-time (AFT) survival models with a lognormal distribution (Model 3), and loglogistic distribution (Model 4). We report the results in Table 3.

In the block of property characteristics for Hypothesis 1, only *Single Family* is positively related to the funding time of successfully funded and all projects. Based on the regression estimations, we find that *Single Family* increases the funding time of successfully funded projects by over 20 days in Models 1-2 and delays the success by around 79% ($e^{0.58} - 1$) for all projects in Model 4. The coefficients of *Detroit* and *Age* are significant for all projects in Model 4 and delay the success by 256% and 1%, respectively. Thus properties outside of *Detroit* – a city suffering from an enduring economic decline and shrinking population – are funded more quickly for reasons of diversification. In sum, we find supportive evidence in favor of Hypothesis 1 for funding time , i.e. that the variables *Single Family*, *Detroit*, and *Age* are positively related to the success of an STO. However, since the remaining property-specific variables *Lot Size*, *Section 8*, and *Distance DTWN* are insignificant in all model specifications, we cannot provide further empirical support for Hypothesis 1. Particularly interesting is the irrelevance of the factors of size and location, which are normally important predictors in the real estate sector.

The campaign variable *#Pictures* is insignificant in all four models.[13] Therefore, we cannot provide empirical evidence for Hypothesis 2 and the common finding in CF that a more detailed description reduces information asymmetries and, hence, increases project success. The reason for this could be that, in contrast to conventional CF, in which information asymmetries are high (Courtney et al., 2017), the quality of a property can be determined more easily. Thus information asymmetries are, in general, lower for real estate tokens than for CF projects.

The coefficient of *Gas Fees* is significant and positively related to both sub-categories

[13]We do not anymore consider *#Characters* in the multivariate analysis, as outlined in Subsection 4.5; however, we find in unreported analysis that it is also insignificant.

Table 3: Determinants of Funding Time

	Dependent variable:			
	Funding Time until Success		Funding Time until Dec 2021	
	OLS		*AFT*	
			lognormal	*loglogistic*
	(1)	(2)	(3)	(4)
Rent per Token p.a.	10.05***	9.92***	0.20**	0.19**
	(2.71)	(3.15)	(2.00)	(2.20)
Expected Yield	−1,392.25	−519.07	−57.31***	−67.48***
	(−1.53)	(−0.55)	(−3.18)	(−3.72)
Total Investment	−0.004	−0.03	0.001	0.001*
	(−0.13)	(−0.91)	(1.47)	(1.78)
Age	0.05	−0.07	0.01	0.01*
	(0.17)	(−0.27)	(1.08)	(1.74)
Lot Size	0.002	0.002	−0.0000	0.0000
	(1.16)	(1.13)	(−0.32)	(0.35)
Section 8	−13.04	−3.56	0.12	−0.06
	(−1.45)	(−0.38)	(0.39)	(−0.22)
Single Family	24.84**	21.68**	0.47	0.58**
	(2.28)	(2.24)	(1.53)	(2.00)
Distance DTWN	0.83	0.70	0.01	0.002
	(0.39)	(0.34)	(0.12)	(0.05)
Detroit	7.10	5.03	1.05***	1.27***
	(0.46)	(0.36)	(3.21)	(3.83)
#Pictures	−0.89	−0.09	−0.03	−0.01
	(−0.56)	(−0.06)	(−0.96)	(−0.37)
Gas Fees		3.15**	0.10***	0.09***
		(2.27)	(4.04)	(3.56)
Housing Market		0.54**	0.01	0.01
		(1.96)	(0.88)	(0.78)
Constant	126.00	−44.36	6.53**	7.02**
	(1.30)	(−0.36)	(2.26)	(2.50)
Quarter-Year FE	Yes	Yes	Yes	Yes
Observations	122	122	164	164
R^2	0.48	0.52	/	/
Adjusted R^2	0.38	0.42	/	/
Log Likelihood	/	/	-577.14	-573.64
χ^2 (df = 21)	/	/	178.48***	193.30***

Note: The table reports the results for the sub-sample of successfully funded STOs with the dependent variable *Funding Time until Success* in Models 1-2 estimating OLS regression with robust standard errors. Models 3-4 present the results of the Accelerated Failure-Time (AFT) models with a lognormal and loglogistic distribution for all STOs including unsuccessful ones with the dependent variable *Funding Time until Dec 2021.* The table contains the coefficient estimates and the corresponding *t*-statistics; the coefficients for the AFT model need to be exponentiated to interpret them as time ratios. All of the models include quarter-year dummies for time fixed-effects. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Table A.1 in the Appendix.

of funding time. For example, higher transaction costs delay the success by around 9% for all projects in Model 4. This finding is in line with Momtaz et al. (2022) who find that investors limit their trading activity for tokens when transaction costs are high. In sum, we find supportive evidence for Hypothesis 3b that investors reduce their trading activity when blockchain-related demand-driven transaction costs increase which makes real estate STOs less successful.

The *Housing Market* coefficient is only significant and positively connected to *Funding Time until Success* in Model 2. However, funding time is positively correlated with *Total Investment* and, as both *Total Investment* and *Housing Market* increase in our sample over time, we observe a positive coefficient for *Housing Market*. Among the financial controls, *Expected Yield* is significant for all projects and decreases the funding time strongly since a higher *Expected Yield* makes a project more attractive for investors. In contrast, *Rent per Token p.a.* positively impacts the funding time in all models. This result is based on the fact that *Rent per Token p.a.* is in the same range for most observations due to the setting of the token issuer; however, just the few STOs above the 75% percentile (see Table 1) have not been successful and are the reason for the counterintuitive direction of effect of the *Rent per Token p.a.* coefficient. The *Total Investment* which is significant for all projects with a loglogistic distribution delays the success by merely 0.1%.

Models 1-2 consider only successful projects and the estimations could therefore be subject to a survivorship bias. However, comparing the results of the models of the successfully funded projects (Models 1-2) with those of all projects (Models 3-4), we do not observe clear differences in signs and significances of the coefficients that would indicate a bias. Additionally, the results of the two AFT models with different distribution assumptions do not differ essentially.

To obtain the full picture of STO success and to rule out effects caused by the magnitude of the *Total Investment* amount, we study the newly-constructed dependent variable speed and present the results in Table 4. Since the STO is more successful if it raises more money within a certain period of time, the signs' interpretation of the coefficients should be opposite to the previous analyses of the funding time. Again, we sub-categorize the dependent variable into *Speed until Success* in Models 1-2 and *Speed until Dec 2021* in Models 3-4 and run OLS regressions.

Lot Size and *Detroit* are significant variables within property characteristics in all

Table 4: Determinants of Speed

	Dependent variable:			
	Speed until Success		Speed until Dec 2021	
	(1)	(2)	(3)	(4)
Rent Per Token p.a.	−3.60	−3.94*	−2.84	−3.92*
	(−1.60)	(−1.74)	(−1.32)	(−1.75)
Expected Yield	656.78*	737.05	481.33	666.49*
	(1.71)	(1.43)	(1.53)	(1.73)
Age	−0.04	−0.03	0.004	0.07
	(−0.36)	(−0.25)	(0.04)	(0.61)
Lot size	0.003**	0.003**	0.002*	0.003**
	(2.00)	(2.12)	(1.83)	(2.19)
Section 8	−2.79	−3.58	0.19	−1.91
	(−0.54)	(−0.72)	(0.04)	(−0.44)
Single Family	−2.96	−2.34	−0.84	−1.41
	(−0.64)	(−0.53)	(−0.24)	(−0.42)
Distance DTWN	−1.28	−1.19	−0.24	−0.18
	(−1.51)	(−1.47)	(−0.31)	(−0.22)
Detroit	−28.70***	−26.08***	−16.79***	−13.26**
	(−3.30)	(−3.02)	(−2.77)	(−2.36)
#Pictures	0.63	0.57	0.88	0.45
	(0.78)	(0.71)	(1.34)	(0.73)
Gas Fees		−0.92**		−1.24***
		(−2.13)		(−3.14)
Housing Market		0.12		0.18
		(0.76)		(1.29)
Constant	−19.75	−43.90	−31.76	−66.76
	(−0.42)	(−0.54)	(−0.71)	(−1.08)
Quarter-Year FE	Yes	Yes	Yes	Yes
Observations	122	122	164	164
R^2	0.59	0.61	0.43	0.48
Adjusted R^2	0.51	0.53	0.36	0.41

Note: The table reports the results for the sub-sample of successfully funded STOs with the dependent variable *Speed until Success* in Models 1-2 and for the whole sample with *Speed until Dec 2021* in Models 3-4 estimating OLS regression with robust standard errors. The table reports the coefficient estimates and the corresponding t-statistics; all of the models include quarter-year dummies for time fixed-effects. The dependent variable *Speed until Success* is the fraction of *Total Investment/Funding Time until Success* and *Speed until Dec 2021* is the fraction of *Total Investment/Funding Time until Dec 2021*. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Table A.1 in the Appendix.

models for the speed variables. *Lot Size* is positively associated with both speed variables. Properties in *Detroit* have a lower *Speed until Success* of 26,080 USD/day for successful projects and a lower *Speed until Dec 2021* of 13,260 USD/day for all projects. In line with the traditional real estate literature on location, we conclude that this factor is relevant, particularly for successfully funded projects. Since the majority of property characteristics are insignificant, we find only statistical support in favor of Hypothesis 1 for *Lot Size* and *Detroit*.

The campaign variable *#Pictures* is also insignificant for the speed variables.[14] The reason is probably the same as outlined for the funding time above. Consequently, we find no empirical evidence for Hypothesis 2.

We find a significant and negative relationship between the transaction costs *Gas Fees* and both speed variables, indicating that higher transaction costs are related to a lower level of STO success. For example, a one-standard-deviation increase in *Gas Fees* is associated with a 5,617 USD/day decrease in the *Speed until Dec 2021*. In comparison to Model 2, the effect is more pronounced in terms of significance and magnitude of the coefficient for Model 4, which considers the full sample. This finding is reasonable because this specification additionally takes into account unsuccessful projects whose success is obviously more negatively affected by high transaction costs. Thus we find strong empirical support for Hypothesis 3b.

As assumed after taking the *Total Investment* into account for the dependent variable, *Housing Market* is insignificant. Among the financial characteristics, *Rent per Token p.a.* again has a negative impact in Models 2 and 4. The coefficient of *Expected Yield* is significant and positive on the 10% level in Models 1 and 4 and highly increases the speed of funding.

The adjusted R^2 ranges from 0.36 to 0.53. In summary, we observe that, with regard to both speed sub-categories, the traditional property characteristics of size and location (*Lot Size* and *Detroit*) are relevant determinants of STO success in addition to transaction costs on the crypto market (*Gas Fees*) and financial controls. The coefficient of *Lot Size* has the same magnitude for all models, *Detroit* shows a larger effect when only successfully funded projects are considered. The unattractive location of the city of *Detroit* reduces the speed for successfully funded projects. *Gas Fees* is the only variable

[14]The same applies if we include *#Characters*.

with a stronger effect when considering the entire sample, including unsuccessfully funded projects whose success is more negatively affected by high transaction costs. In line with Table 3, we do not observe clear differences in the signs and significances between the models relying only on successfully funded projects and those comprising all projects.

5.3. Analysis of funding determinants

Table 5: Funding determinants

	Dependent variable:	
	Inflow	Outflow
	(1)	(2)
ETH Price	139.72***	2.65
	(3.39)	(0.52)
Gas Fees	−1.28***	−0.10***
	(−11.04)	(−6.78)
ETH Shock	−607.06***	−33.96
	(−2.81)	(−1.29)
Gas Shock	−489.47**	49.25*
	(−2.20)	(1.81)
One-month Treasury	1,202.02*	64.15
	(1.86)	(0.73)
Ten-year Treasury	315.63	−28.49
	(0.51)	(−0.37)
ADS Index	−32.89	−8.99**
	(−0.90)	(−2.01)
Individual FE	Yes	Yes
Time FE	Yes	Yes
Observations	18,182	17,606
R^2	0.062	0.049
Adjusted R^2	0.053	0.040

Note: This table presents the analysis of funding determinants based on OLS regressions. It reports the coefficient estimates and the corresponding *t*-statistics. The dependent variable is either daily *Inflow* or daily *Outflow* per property in a fixed-effects panel regression with individual and time-fixed effects. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Table A.1 in the Appendix.

In the following, we study the funding determinants to analyze the entire crypto market on the macro-level and to account for its particularities over time. In Model 1 of Table 5, we present the regression estimations for the dependent variable daily *Inflows* per property from investors purchasing tokens. Model 2 exemplifies the daily *Outflows* per property from investors selling tokens.

At first, we analyze the determinants that relate specifically to the crypto market. Model 1 exhibits a significant and negative coefficient of the *ETH Price* for *Inflows*, and no significance for *Outflows*. An increase of 1 USD in the *ETH Price* is associated with an increase of 139.72 USD in daily *Inflows* per property. Consequently, the crypto market sentiment appears to be a relevant predictor for capital *Inflows* on the market for real estate tokens probably because crypto investors are subject to herding behavior caused by the sentiment on the crypto market. The results of *ETH Price* for *Inflows* provide statistical support for Hypothesis 3a, whereas we find no evidence of *Outflows* for Hypothesis 3a. Further, the coefficients of *Gas Fees* are negatively related to both capital *Inflows* and *Outflows*. The results of *Gas Fees* are consistent with Hypothesis 3b that investors limit their trading activity to avoid high transaction costs, regardless of whether *Inflows* or *Outflows* are considered. It is worth noting that the crypto market sentiment *ETH Price* is not significantly related to *Outflows*, but crypto market transaction costs are. The reason for this could be that, when real estate token investors have already made their decision to liquidate the investment, they time the sale primarily based on the transaction costs, as these directly affect their return on investment. Both dummy variables for short-term shocks on the crypto market are significant and negatively associated with *Inflows*, although with low or no significance for *Outflows*. To be more precise, the coefficient of *ETH Shock* decreases *Inflows* for 607.06 USD when the cumulative Ether return decreased for five days prior to the *Inflow*. The effect for a *Gas Shock* is less pronounced and implies that the occurrence of a *Gas Shock* decreases *Inflows* by 489.47 USD. The shock results for *Inflows* are also in line with our crypto-market related Hypotheses 3a and 3b since a shock of the crypto market sentiment and the transaction costs reduce *Inflows*. Interestingly, short-term shocks in the crypto market do not seem to play a major role in *Outflows*. Possibly this is due to the fact that regular cash-flows from the tokens are based on rent payment and are not affected by short-term crypto shocks, so there is no incentive to sell and cause an *Outflow*. Consequently, we cannot provide empirical evidence for *Outflows* and the shock variables with respect to our Hypotheses 3a and 3b.

Regarding the macroeconomic factors *One-month Treasury*, *Ten-year Treasury*, and the *ADS Index*, we find occasional and low significances for both *Inflows* and *Outflows*. The short-term interest rate has a positive and significant influence on *Inflows*, whereas long-term interest is insignificant for both capital flows. An increase in the *ADS Index*, indicating progressively better-than-average conditions for doing business, significantly reduces *Outflows*. Thus the macroeconomic situation does not appear to be an important criterion in the decision-making process of a real estate token investor. Our finding is consistent with Yermack (2015) and Bianchi (2020) who conclude that trading volumes and daily exchange rates of the main cryptocurrencies are not driven by macroeconomic events and factors.

In sum, we find that the crypto market-related transaction costs, sentiment, and the corresponding short-term shocks are relevant predictors of daily *Inflows* for purchasing tokens rather than for daily *Outflows* of selling tokens.

6. Robustness and further analysis

6.1. Adjustment of financing threshold

It is common practice that RealT retains around 5% tokens of a property to ensure liquidity on secondary markets in the future, which is why the success of a project was defined as transferring 95% of the tokens. We vary the threshold for the definition of "successfully" funded between 90% and 100% in unreported analyses. Our results remain qualitatively unchanged and robust with respect to these adjustments.

6.2. Analysis of the determinants of Total Investment and Expected Yield

Digging deeper into the structure of the projects offered in the STO, we investigate the determinants of the money-oriented variable *Total Investment* and present the estimations in Models 1-2 in Table A.3 in the Appendix. Regarding the financial variables, the coefficient of *Expected Yield* is significant and negative in both model specifications. When considering the property characteristics, we find that lower quality properties, which are older and have higher risk diversification among tenants, are offered with a lower *Total Investment*. The variables *Lot Size* and *Section 8* have a significant positive impact across all models. The lower risk of a rent default of *Section 8* supported rents is associated with a higher *Total Investment*. The coefficient of the CF variable *#Pictures* is insignificant, probably because this variable is less relevant to the token issuer. Both market-related variables *Gas Fees* and *Housing Market* are insignificant. In a next step, we switch from the dollar amount of *Total Investment* to a return perspective and study the determinants of *Expected Yield* in Models 3-4 in Table A.3. As expected, the *Rent per Token p.a.* is positively related to the *Expected Yield*. In line with the previous results for *Total Investment*, the coefficient for *Single Family* is also negatively related to *Expected Yield*. The coefficient of *Distance DTWN* indicates that a higher distance from downtown reduces the yield due to lower rent in more unattractive locations further afield. The *Housing Market* is negatively associated with the *Expected Yield*. A higher housing index is connected with higher housing values and token values and, consequently, a lower *Expected Yield*.

In summation, only for *Single Family* do we find consistent signs and significances for both *Total Investment* and *Expected Yield*, while the evidence for the remaining variables is mixed. While crypto-market transaction costs are significantly related to the success of the STO as measured by funding time and speed, see Subsection 4.3, they are not related to the *ex-ante* set structure of the offered projects by the token issuer.

7. Conclusion

Digitization is transforming various industries, including the financial and real estate sectors. We highlight the new way of securitizing assets, using the blockchain as well as digital security tokens and their issuance processes through STOs. Real estate has been identified as a suitable market for tokenization due to this technical innovation overcoming the drawbacks of direct real estate investments, such as high entry barriers and illiquidity. Technical features facilitate the investment of small amounts of money, eliminate the need for financial intermediaries, and increase transaction speed, which consequently lowers the costs for all parties involved. Thus investors can diversify their portfolios more easily among asset classes and countries. The tokens can be traded after issuance on secondary markets, which enables liquidity. Even though the possibility of fractional ownership already exists in indirect investment instruments, such as funds or REITs, real estate tokens come closer to direct ownership with controlling rights.

Based on STO data of 173 real estate tokens and more than 238,433 blockchain transactions, we analyze investor behavior, the determinants of STO success, as well as capital flows over time. During our observation period, real estate token investors hold a mean of 10 different tokens and an investment amount of 4,030 USD, which shows that investors do not yet hold well-diversified real estate token portfolios. Ownership of the properties is not concentrated on some large investors emphasizing that tokenization provides broad access to real estate ownership for a large number of small investors. Further, we conclude that investors acquire tokens mainly during the STO, while the secondary market plays a subordinate role both in terms of token purchases and sales. We consider the mean funded investment amount per day (*Speed*) to be the major success variable of interest in this study. The property-specific fundamentals and crypto market-related transaction costs are positively related to STO success, apart from the financial characteristics. In line with the well-known explanatory power of location factors in real estate, we find that location as well as the crypto market-related transaction costs are important determinants of STO success. The success of STOs appears to be independent of crowdfunding campaign characteristics probably because for a property the quality can be determined more easily and information asymmetries are lower than for conventional crowdfunding projects. Investors appear to seek diversification possibilities through location choice to reduce the idiosyncratic cash-flow risk of the investment and try to avoid high transaction costs in order not to reduce the return additionally. From the perspective of capital inflows (token purchases) and capital outflows (token sales) per day, we find that real estate token investors pay similar attention to the crypto market-specific sentiment and transaction costs when purchasing tokens, while only the transaction costs that directly reduce the return on investment are relevant for sales. Both short-term shocks have a strong negative impact on capital inflows. Macroeconomic factors appear to have little effect on capital flows in general. These results highlight the importance of taking into account the specific crypto market environment in addition to characteristics of the underlying asset class for real asset tokenization.

A limitation is our small sample size of 173 projects, which results from the fact that tokens are coming into the focus of public attention. It is possible that our results cannot be generalized, as they are derived from observing a small but growing number of crypto enthusiasts who are familiar with the technical background. Therefore, there is an avenue for future research to test and verify our results in a broader sample in terms of other asset classes, time periods examined, geographic scope related to different jurisdictions and implementation options, and the number of investors.

Our study has practical and policy implications. As discussed at the G-7 meeting in May 2022, various regulators and politicians have called for an acceleration of global crypto regulations for better financial stability in order to enable innovative digital finance solutions and investor protection. Our findings contribute to the last two objectives of this regulatory effort. We find that the particularities of the crypto market are important determinants for the success of real estate STOs and capital flows. This may raise the concern that token investors mainly follow trends that do not reflect the fundamental asset characteristics, implying a high need for consumer protection. Such technical innovation can also support investors in building more diversified portfolios. However, this possibility has not been used sufficiently until now, according to our results. We conclude that regulators need to find a compromise to achieve both investor protection and foster the development of digital finance products without suppressing the opportunities for technology and innovation.

References

Adhami, S., Giudici, G., Martinazzi, S., 2018. Why do businesses go crypto? An empirical analysis of initial coin offerings. Journal of Economics and Business 100, 64–75.

Ahlers, G.K.C., Cumming, D., Günther, C., Schweizer, D., 2015. Signaling in equity crowdfunding. Entrepreneurship Theory and Practice 39, 955–980.

Ajaz, T., Kumar, A.S., 2018. Herding in crypto-currency markets. Annals of Financial Economics 13, 1850006.

Ante, L., Fiedler, I., 2020. Cheap signals in security token offerings (STOs). Quantitative Finance and Economics 4, 608–639.

Aruoba, S.B., Diebold, F.X., Scotti, C., 2009. Real-time measurement of business conditions. Journal of Business & Economic Statistics 27, 417–427.

Aspris, A., Foley, S., Svec, J., Wang, L., 2021. Decentralized exchanges: The "wild west" of cryptocurrency trading. International Review of Financial Analysis 77, 101845.

Auer, R., Tercero-Lucas, D., 2022. Distrust or speculation? The socioeconomic drivers of U.S. cryptocurrency investments. Journal of Financial Stability 62, 101066.

Baker, M., Wurgler, J., 2006. Investor sentiment and the cross-section of stock returns. The Journal of Finance 61, 1645–1680.

Baum, A., 2021. Tokenization–the future of real estate investment? The Journal of Portfolio Management 47, 41–61.

Belleflamme, P., Lambert, T., Schwienbacher, A., 2014. Crowdfunding: Tapping the right crowd. Journal of Business Venturing 29, 585–609.

Benedetti, H., Kostovetsky, L., 2021. Digital tulips? Returns to investors in initial coin offerings. Journal of Corporate Finance 66, 101786.

Bianchi, D., 2020. Cryptocurrencies as an asset class? An empirical assessment. The Journal of Alternative Investments 23, 162–179.

Block, J., Hornuf, L., Moritz, A., 2018. Which updates during an equity crowdfunding campaign increase crowd participation? Small Business Economics 50, 3–27.

Bourassa, S.C., Haurin, D.R., Haurin, J.L., Hoesli, M., Sun, J., 2009. House price changes and idiosyncratic risk: The impact of property characteristics. Real Estate Economics 37, 259–278.

Bouri, E., Gupta, R., Roubaud, D., 2019. Herding behaviour in cryptocurrencies. Finance Research Letters 29, 216–221.

Buterin, V., 2013. Ethereum: A Next-Generation Smart Contract and Decentralized Application Platform. White Paper.

Caporin, M., Costola, M., Garibal, J.C., Maillet, B., 2022. Systemic risk and severe economic downturns: A targeted and sparse analysis. Journal of Banking & Finance 134, 106339.

Chang, E.C., Cheng, J.W., Khorana, A., 2000. An examination of herd behavior in equity markets: An international perspective. Journal of Banking & Finance 24, 1651–1679.

Chiang, T.C., Zheng, D., 2010. An empirical analysis of herd behavior in global stock markets. Journal of Banking & Finance 34, 1911–1921.

Courtney, C., Dutta, S., Li, Y., 2017. Resolving information asymmetry: Signaling, endorsement, and crowdfunding success. Entrepreneurship Theory and Practice 41, 265–290.

Cronqvist, H., Hogfeldt, P., Nilsson, M., 2001. Why agency costs explain diversification discounts. Real Estate Economics 29, 85–126.

Da, Z., Engelberg, J., Gao, P., 2014. The sum of all FEARS investor sentiment and asset prices. The Review of Financial Studies 28, 1–32.

Damodaran, A., 2005. Marketability and Value: Measuring the Illiquidity Discount. Working Paper 841484. Social Science Research Network.

De Crescenzo, V., Ribeiro-Soriano, D.E., Covin, J.G., 2020. Exploring the viability of equity crowdfunding as a fundraising instrument: A configurational analysis of contingency factors that lead to crowdfunding success and failure. Journal of Business Research 115, 348–356.

Diamond, D.W., 1984. Financial intermediation and delegated monitoring. The Review of Economic Studies 51, 393–414.

Drobetz, W., Momtaz, P.P., Schröder, H., 2019. Investor sentiment and initial coin offerings. The Journal of Alternative Investments 21, 41–55.

Esrig, D., Hudgins, M.C., Cerreta, L., 2011. Revisiting the impact of large assets on real estate portfolio returns. The Journal of Portfolio Management 37, 125–136.

Ethereum.org, 2022. Gas and fees. `https://ethereum.org/en/developers/docs/gas/`. Accessed 28 November 2022.

Fahlenbrach, R., Frattaroli, M., 2021. ICO investors. Financial Markets and Portfolio Management 35, 1–59.

Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.

Felipe, I.J.S., Mendes-Da-Silva, W., Leal, C.C., Braun Santos, D., 2022. Reward crowdfunding campaigns: Time-to-success analysis. Journal of Business Research 138, 214–228.

Fisch, C., 2019. Initial coin offerings (ICOs) to finance new ventures. Journal of Business Venturing 34, 1–22.

Fisch, C., Masiak, C., Vismara, S., Block, J., 2021. Motives and profiles of ICO investors. Journal of Business Research 125, 564–576.

Fisch, C., Meoli, M., Vismara, S., 2022. Does blockchain technology democratize entrepreneurial finance? An empirical comparison of ICOs, venture capital, and REITs. Economics of Innovation and New Technology 31, 70–89.

Fisch, C., Momtaz, P.P., 2020. Institutional investors and post-ICO performance: an empirical analysis of investor returns in initial coin offerings (ICOs). Journal of Corporate Finance 64, 101679.

Florysiak, D., Schandlbauer, A., 2022. Experts or charlatans? ICO analysts and white paper informativeness. Journal of Banking & Finance 139, 106476.

Gan, J.R., Tsoukalas, G., Netessine, S., 2021. Initial coin offerings, speculation, and asset tokenization. Management Science 67, 914–931.

Gao, Q., Lin, M., Sias, R.W., 2023. Words matter: The role of texts in online credit markets. Journal of Financial and Quantitative Analysis 58, 1–28.

Geltner, D., Miller, N.G., Clayton, J., Eichholtz, P., 2014. Commercial real estate. 3 ed., OnCourse Learning, Mason OH.

Goetzmann, W.N., Kumar, A., 2008. Equity Portfolio Diversification. Review of Finance 12, 433–463.

Gozman, D., Liebenau, J., Mangan, J., 2018. The innovation mechanisms of Fintech start-ups: Insights from SWIFT's innotribe competition. Journal of Management Information Systems 35, 145–179.

Gupta, A., Rathod, J., Patel, D., Bothra, J., Shanbhag, S., Bhalerao, T., 2020. Tokenization of real estate using blockchain technology, in: Zhou, J., Conti, M., Ahmed, C.M., Au, M.H., Batina, L., Li, Z., Lin, J., Losiouk, E., Luo, B., Majumdar, S., Meng, W., Ochoa, M., Picek, S., Portokalidis, G., Wang, C., Zhang, K. (Eds.), Applied Cryptography and Network Security Workshops, Springer International Publishing, Cham. pp. 77–90.

Hartzell, J.C., Sun, L., Titman, S., 2014. Institutional investors as monitors of corporate diversification decisions: Evidence from real estate investment trusts. Journal of Corporate Finance 25, 61–72.

Herfindahl, O., 1950. Concentration in the steel industry.

Hirschman, A.O., 1964. The paternity of an index. The American Economic Review 54, 761–762.

Howell, S.T., Niessner, M., Yermack, D., 2020. Initial coin offerings: Financing growth with cryptocurrency token sales. The Review of Financial Studies 33, 3925–3974.

Jiang, Y., Ho, Y.C.C., Yan, X., Tan, Y., 2020. When online lending meets real estate: Examining investment decisions in lending-based real estate crowdfunding. Information Systems Research 31, 715–730.

Kiel, K.A., Zabel, J.E., 2008. Location, location, location: The 3L approach to house price determination. Journal of Housing Economics 17, 175–190.

Konashevych, O., 2020. General concept of real estate tokenization on blockchain: The right to choose. European Property Law Journal 9, 21–66.

Lambert, T., Liebau, D., Roosenboom, P., 2022. Security token offerings. Small Business Economics 59, 299–325.

Lee, J., Parlour, C.A., 2022. Consumers as financiers: Consumer surplus, crowdfunding, and initial coin offerings. The Review of Financial Studies 35, 1105–1140.

Ling, D.C., Archer, W.R., 2021. Real estate principles: A Value Approach. 6 ed., McGraw-Hill Education.

Litimi, H., BenSaïda, A., Bouraoui, O., 2016. Herding and excessive risk in the American stock market: A sectoral analysis. Research in International Business and Finance 38, 6–21.

Liu, N., Duncan, R., Chapman, A., 2020a. A critical review of distributed ledger technology and its applications in real estate. RICS Research Report.

Liu, X., Farahani, B., Firouzi, F., 2020b. Distributed ledger technology, in: Firouzi, F., Chakrabarty, K., Nassif, S. (Eds.), Intelligent Internet of Things, Springer, Cham. pp. 393–431.

Luchtenberg, K.F., Seiler, M.J., Sun, H., 2019. Listing agent signals: Does a picture paint a thousand words? The Journal of Real Estate Finance and Economics 59, 617–648.

Lyandres, E., Palazzo, B., Rabetti, D., 2022. Initial coin offering (ICO) success and post-ICO performance. Management Science 68, 8515–9218.

Markheim, M., Berentsen, A., 2021. Real estate meets blockchain: Opportunities and challenges of tokenization of illiquid assets. Zeitschrift für Immobilienökonomie 7, 59–80.

Markowitz, H.M., 1952. Portfolio selection. The Journal of Finance 7, 77–91.

Mollick, E., 2014. The dynamics of crowdfunding: An exploratory study. Journal of Business Venturing 29, 1–16.

Momtaz, P.P., 2020. Initial coin offerings. PLoS One 15. E0233018.

Momtaz, P.P., 2023. Security tokens, in: Baker, H.K., Benedetti, H., Nikbakht, E., Smith, S.S. (Eds.), The Emerald Handbook on Cryptoassets: Investment Opportunities and Challenges. Emerald Publishing Limited, Bingley, pp. 61–78.

Momtaz, P.P., Nam, R.J., Fisch, C., 2022. Blockchain investors. Working Paper 4163004. Social Science Research Network.

Momtaz, P.P., Rennertseder, K., Schröder, H., 2019. Token Offerings: A Revolution in Corporate Finance? Working Paper 3346964. Social Science Research Network.

Nowak, A., Smith, P., 2016. Textual analysis in real estate. Journal of Applied Econometrics 32, 896–918.

Pai, A., Geltner, D., 2007. Stocks are from Mars, real estate is from Venus. The Journal of Portfolio Management 33, 134–144.

Ro, S., Ziobrowski, A.J., 2012. Wealth effects of REIT property-type focus changes: evidence from property transactions and joint ventures. Journal of Property Research 29, 177–199.

de la Rubia, C., Sandner, P., Groß, J., 2021. Studie zur Tokenisierung von Immobilien: Wie die Blockchain-Technologie den Immobilienmarkt revolutioniert. Frankfurt School Blockchain Center, Hamburg Commercial Bank.

Schweizer, D., Zhou, T., 2017. Do principles pay in real estate crowdfunding? The Journal of Portfolio Management 43, 120–137.

Schär, F., 2021. Decentralized finance: On blockchain- and smart contract-based financial markets. Federal Reserve Bank of St. Louis Review 103, 153–174.

Seiler, M., Madhavan, P., Liechty, M., 2012. Toward an understanding of real estate homebuyer internet search behavior: An application of ocular tracking technology. Journal of Real Estate Research 34, 212–242.

Shahrokhi, M., Parhizgari, A.M., 2020. Crowdfunding in real estate: evolutionary and disruptive. Managerial Finance 46, 785–801.

Sirmans, G.S., Macpherson, D.A., Zietz, E.N., 2005. The composition of hedonic pricing models. Journal of Real Estate Literature 13, 3–43.

Swinkels, L., 2023. Empirical evidence on the ownership and liquidity of real estate tokens. Financial Innovation 9, 1–29.

Szabo, N., 1994. Smart contracts.

Thakor, A.V., 2020. Fintech and banking: What do we know? Journal of Financial Intermediation 41, 100833.

Thaler, R.H., Johnson, E.J., 1990. Gambling with the house money and trying to break even: The effects of prior outcomes on risky choice. Management Science 36, 643–660.

Thewissen, J., Thewissen, J., Torsin, W., Arslan-Ayaydin, Ö., 2022. Linguistic errors and investment decisions: the case of ICO white papers. The European Journal of Finance forthcoming, 1–43.

Yermack, D., 2015. Is bitcoin a real currency? An economic appraisal, in: Chuen, D.L.K. (Ed.), Handbook of Digital Currency. Academic Press, San Diego, pp. 31–43.

Yermack, D., 2017. Corporate Governance and Blockchains. Review of Finance 21, 7–31.

Appendix

Table A.1: Definition of all variables

Blockchain transaction analysis		
Properties per Investor	Number of distinct real estate tokens per unique wallet	Own calculations
Holdings per Investor as of Dec 2021	Dollar Holdings per Investor as of 31 Dec 2021	Own calculations
Holding Period all Investors as of Dec 2021	Holding Period of all Investors in Days as of 31 Dec 2021	Own calculations
HHI	Herfindahl-Hirschman Index per property	Own calculations
HHI STO*	Normalized Herfindahl-Hirschman Index per property after the tokens have been transferred during the STO, based on the actual quantity of issued tokens comprising successful and unsuccessful STOs (between 0 and 1)	Own calculations
HHI as of Dec 2021*	Normalized Herfindahl-Hirschman Index per property as of 31 Dec 2021 (between 0 and 1)	Own calculations
Investors per Property	Number of unique wallets per real estate token	Own calculations
STO Buy	Amount of money of buy transactions during the STO in USD	Own calculations
Secondary Market Buy	Amount of money of secondary market buy transactions in USD	Own calculations
Secondary Market Buy/Existing Exposure	Percentage ratio of the *Secondary Market Buy* to the existing exposure	Own calculations
Secondary Market Sell	Amount of money of secondary market sell transactions in USD	Own calculations
Secondary Market Sell/Existing Exposure	Percentage ratio of the *Secondary Market Buy* to the existing exposure	Own calculations
Holding period Sellers	Holding Period of investors selling tokens in days	Own calculations
Analysis of STO determinants		
Dependent variables		
Funding Time until Success	Number of days until all tokens (95 percent, since RealT keeps around 5 percent to themselves) are transferred to wallets. For this variable, only successful projects are considered. The start date of the funding period is derived from the HTML code on the website and the end date from the blockchain explorers.	Own calculations
Funding Time until Dec 2021	Number of days until all tokens (95 percent, since RealT keeps around 5 percent to themselves) are transferred to wallets. For this variable, both successful and unsuccessful projects are considered. The start date of the funding period is derived from the HTML code on the website and the end date from the blockchain explorers.	Own calculations
Speed until Success	95% of *Total Investment* divided through *Funding Time until Success*, (in thousands USD/day) for the sub-sample of successful projects	Own calculations
Speed until Dec 2021	95% of *Total Investment* divided through *Funding Time until Dec 2021* (in thousands USD/day) for all projects. For projects that have not been successfully funded until the end of our observation period and are on the market longer than the mean time of *Funding Time until Success*, the *Speed until Dec 2021* is equated to 0. For projects that have not been successfully funded until the end of the observation period and are on the market shorter than the mean time of *Funding Time until Success*, the actual amount of money raised is used instead of *Total Investment*.	Own calculations
Explanatory variables		
Rent per Token p.a.	Rent per token per year	RealT
Total Investment	Amount of money required for the funding, technically the number of tokens multiplied by the token price (in thousands USD)	RealT
Expected yield	Expected income calculated as net rent divided by token price	RealT
Age	Difference between the publication date of the project and the construction year	RealT
Lot Size	Size of the real estate (in square foot)	RealT
Section 8	Percentage of rents supported by Section 8 in the whole property	RealT
Single Family	A dummy variable for the property type of use that shows whether the building is a single-tenant property, 0 otherwise.	RealT
Distance DTWN	Distance to downtown in miles	Walk Score
Detroit	A dummy variable that shows whether the property is located in Detroit, 0 otherwise.	RealT
#Pictures	Absolute numbers of pictures of the property published on the platform	RealT
#Characters	Absolute number of characters of the descriptive text of the project on the platform	RealT
Gas Fees	Transaction costs on the Ethereum blockchain at the day the project is published online or on the day of the observation, converted to USD	Coinmarketcap
Housing Market	S&P Case-Shiller Home Price Index for the corresponding region, lagged for one month	S&P Dow Jones Indices
Analysis of funding determinants		
Dependent variables		
Inflow	Daily capital inflows per property per day in USD (STO and secondary market buy transactions)	Own calculations
Outflow	Daily capital outflows per property per day in USD (secondary market sell transactions)	Own calculations

Explanatory variables		
One-month Treasury	Market yield on US Treasury Securities at 1-month constant maturity, quoted on an investment basis	FRED, Federal Reserve Bank of St. Louis
Ten-year Treasury	Market yield on US Treasury Securities at 10-year constant maturity, quoted on an investment basis	FRED, Federal Reserve Bank of St. Louis
ADS Index	Aruoba-Diebold-Scotti (ADS) Business Condition Index based on Aruoba et al. (2009) to measure macroeconomic activitiy at a daily frequency	Federal Reserve Bank of Philadelphia
ETH Price	Cumulative return of Ether over a period of five days before the observation	Coinmarketcap
ETH Shock	A dummy variable that equals one if the cumulative return of *ETH Price* decreased by more than 5% over a five-day window before the observation, 0 otherwise.	Own calculations
Gas Shock	A dummy variable that equals one if the *Gas Fees* cumulatively increased by more than 5% over a five-day window before the observation, 0 otherwise.	Own calculations

Note: List and definitions of all variables plus the corresponding sources. RealT as source corresponds to information obtained from RealToken's website.

Table A.2: Correlation table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Total Investment	1													
(2) Expected Yield	−0.03	1												
(3) Funding Time until Success	0.01	0.06	1	1										
(4) Funding Time until Dec 2021	0.01	0.06	1	1										
(5) Speed until Success	0.43	0.01	−0.37	−0.37	1	1								
(6) Speed until Dec 2021	0.43	0.01	−0.37	−0.37	1	1								
(7) Rent per Token p.a	0.26	0.42	0.29	0.29	−0.04	−0.04	1							
(8) Age	0.12	0.03	−0.17	−0.17	0.24	0.24	−0.24	1						
(9) Lot Size	0.55	0.24	0.13	0.13	0.36	0.36	0.60	−0.17	1					
(10) Section 8	0.19	−0.19	−0.23	−0.23	0.08	0.08	0.06	−0.02	0.05	1				
(11) Distance DTWN	−0.08	−0.02	0.03	0.03	−0.13	−0.13	0.13	−0.02	0.08	0.03	1			
(12) #Pictures	0.30	0.05	−0.18	−0.18	0.38	0.38	0.14	0.11	0.32	−0.02	−0.01	1		
(13) Gas Fees	0.19	−0.03	0.39	0.39	−0.12	−0.12	−0.16	0.12	−0.01	−0.28	0.04	−0.11	1	
(14) Housing Market	0.34	−0.49	0.06	0.06	0.24	0.24	−0.28	0.29	−0.08	−0.09	−0.12	0.01	0.27	1

Note: This table reports the Bravais-Pearson correlation coefficients of the dependent and explanatory variables. All variables are defined in Table A.1 in the Appendix.

Table A.3: Determinants of Total Investment and Expected Yield

	Dependent variable:			
	Total Investment		Expected Yield	
	(1)	(2)	(3)	(4)
Rent per token p.a.	-1.61	-8.84	0.002^{**}	0.002^{***}
	(-0.11)	(-0.56)	(2.47)	(3.91)
Expected Yield	$-6,629.80^{**}$	$-4,471.23^{*}$		
	(-2.55)	(-1.77)		
Age	-2.74^{**}	-2.31^{*}	0.0001^{**}	0.0000
	(-2.40)	(-1.82)	(2.33)	(0.60)
Lot Size	0.02^{***}	0.02^{***}	0.0000	-0.0000
	(2.84)	(3.02)	(1.57)	(-0.07)
Section 8	139.29^{**}	149.49^{***}	-0.002	-0.003
	(2.56)	(2.75)	(-1.27)	(-1.64)
Single Family	-240.42^{***}	-238.69^{***}	-0.004^{***}	-0.003^{**}
	(-5.74)	(-5.75)	(-2.73)	(-2.25)
Distance DTWN	-8.08	-6.60	-0.001^{**}	-0.001^{***}
	(-1.25)	(-1.04)	(-2.18)	(-2.82)
Detroit	-10.88	6.95	0.01^{***}	0.004^{**}
	(-0.22)	(0.13)	(3.30)	(1.99)
#Pictures	5.99^{*}	3.67	-0.0002	0.0002
	(1.67)	(0.89)	(-1.01)	(0.65)
Gas Fees		3.11		-0.0001
		(1.19)		(-1.09)
Housing Market		1.42		-0.0002^{***}
			(1.53)	(-4.17)
Constant	$1,289.40^{***}$	887.10^{**}	0.09^{***}	0.11^{***}
	(3.95)	(2.32)	(5.54)	(9.90)
Quarter-Year FE	Yes	Yes	Yes	Yes
Observations	165	165	165	165
R^2	0.58	0.70	0.65	0.66
Adjusted R^2	0.54	0.66	0.61	0.61

Note: This table presents the results of OLS regression for the dependent variables *Total Investments* and *Expected Yield* with robust standard errors. The table reports the coefficient estimates and the corresponding t-statistics; all models include quarter-year dummies for annually and quarterly fixed-effects. The dependent variable *Total Investment* is measured in thousands USD. The symbols *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. All variables are defined in Table A.1 in the Appendix.