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CATCHWORD

Blockchain Token Sale

Economic and Technological Foundations

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1 Introduction

Token sales (TSs) have emerged as a new way of raising capital on a peer-to-peer basis enabled by blockchain technology. In TSs, an issuing entity sells proprietary cryptographic tokens to finance further project development – often a blockchain-based platform or application (Catalini and Gans 2018). Since the first TS in 2013, the number of TSs and the amount of funding collected has increased rapidly. In 2017, 552 TSs were completed to collect a total amount of more than USD 7 billion, an average of USD 12.75 million per TS. By January 2019, the all-time funding volume of TSs exceeded USD 23 billion, of which EOS, an operating system for decentralized applications (dApps), collected USD 4.1 billion and the messenger app Telegram collected USD 1.7 billion (PWC 2019; Coindesk 2019; ICObench 2019). The new phenomenon of selling cryptographic tokens on the blockchain is also known as a token generation event, token launch, security token offering (STO) or most prominently initial coin offering (ICO). ICOs have come to be associated chiefly with the issuance of utility tokens, while STOs describe a more mature and regulated form of TS in which security tokens are issued. In the following, we use the neutral term token sale as it is not linked to any specific token type.

In a TS, the issuing entity generates cryptographic tokens which can be bought by investors. The change of ownership is registered on the blockchain, a distributed ledger that allows for decentralized and immutable transaction recording (Beck et al. 2017; Notheisen et al. 2017). New transactions, grouped in blocks, are only added to the blockchain after so-called miners have verified their legitimacy using a consensus mechanism. In the most common consensus mechanism, called proof-of-work, miners compete to solve a hash function (e.g., SHA-256) to approve a block of transactions for which they get remunerated. Once a miner has found the correct solution to the non-invertible hash function and the majority of network participants agrees with the proposed solution, the block can be added to the chain. Beyond "maintaining a coherent set of facts between multiple participating nodes" (Swanson 2015, p. 4), consensus mechanisms also secure the distributed ledger from attacks and prevent double spending of cryptographic assets.

Smart contracts play a central role in the implementation and execution of a TS. A smart contract is source code stored on the blockchain. It defines a set of rules for the interaction of two or more parties. The terms defined in a smart contract are automatically executed if the prespecified conditions are met. In the case of a TS, these rules concern settings such as token price or sale duration. Most

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TSs have built upon the Ethereum blockchain protocol (Buterin 2014). In contrast to the Bitcoin blockchain, Ethereum enables (quasi) Turing complete smart contracts. Issuers use smart contracts to generate (a process also called minting) and allot tokens with a set of customized properties. Once the TS goes live, the smart contract is activated and can receive funds from investors, mostly in the form of cryptocurrencies such as bitcoin or ether. Upon reception of these funds, smart contracts issue a corresponding number of tokens to the investor and transfer the received funds to the issuer's wallet. These transactions are verified by miners and stored on a blockchain. After a TS, the tokens can be listed on crypto exchanges such as Bittrex, Poloniex, or Kraken to be traded by token holders. Figure 1 illustrates the ecosystem of a TS.

Blockchain technology's decentralized, immutable, and transparent nature allows TSs to cut out many of the intermediaries present in traditional venture financing, such as banks, venture capital firms, or payment providers (Haas et al. 2015). Owing to low investment barriers and an aim to attract a large number of investors, TSs can be regarded as a novel type of peer-to-peer crowdfunding enabled by blockchain technology.

Token sales differ from traditional crowdfunding and other forms of entrepreneurial financing, such as business angel or venture capital investments, in several important ways. For investors, TSs are associated with higher asset liquidity, since tokens can usually be traded on crypto exchanges after a TS. Additionally, rights can be associated with the token, ranging from access to or discounts for services and products to profit or voting rights. However, established trust-building intermediaries are largely absent and high information asymmetries complicate due diligence, a situation that has been exploited by several fraudulent TSs (Kaal and Dell'Erba 2017; Amsden and Schweizer 2018). For issuers, TSs offer a relatively easy and fast way to raise capital, to economize on fees otherwise charged by intermediaries, and to unilaterally specify investment terms. However, economic and regulatory uncertainties and rising marketing and consulting costs are increasingly exacerbating the execution of TSs (Amsden and Schweizer 2018).

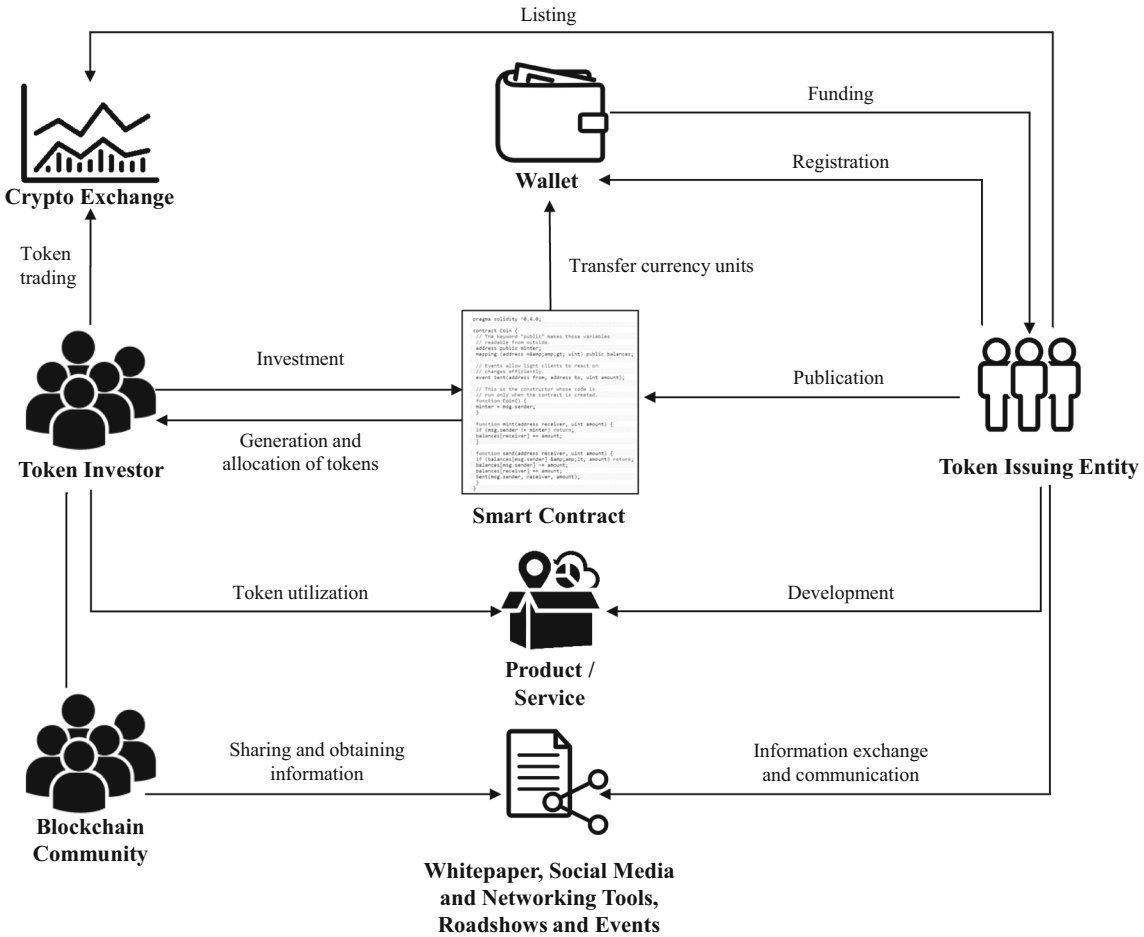


Fig. 1 The token sale ecosystem

In academia, TSs have recently attracted considerable attention from various disciplines such as computer science (e.g. Fenu et al. 2018; Hartmann et al. 2018), economics (e.g. Catalini and Gans 2018; Conley 2017), and law (e.g. Barsan 2017; Robinson 2017). The information systems (IS) community has also shown increasing interest in the phenomenon, e.g., by providing a taxonomy of ICOs (Fridgen et al. 2018), a market engineering framework (Notheisen et al. 2017), or a market analysis model (Jin et al. 2017). As TSs are an interdisciplinary phenomenon that raises a multitude of technological, economic, social, and regulatory questions, there are abundant research opportunities for various streams in IS research. To lay the foundation for future research, we aim at providing insights into TSs' market design and technological implementation, with a goal of showing how the IS community can contribute to the rapidly growing research on TSs.

2 Market Design and Technological Implementation of TSs

A TS can be clustered into three main stages (see Fig. 2) based on the most important and common activities. We concentrate on TSs' market design and technological implementation and less on issuers' internal processes such as stipulating legal or vesting structures. Because of the rapidly changing TS environment, it should be noted that the activities and their timing vary considerably between TSs. Our focus is on the most typical TS configurations. In lieu of traditional intermediaries, a myriad of technology artifacts connects different stakeholders and is thus used to enable and support TSs.

2.1 Pre-TS Activities

In the pre-TS stage, issuers select a market design from various options and determine a token model that should align with the issuers' business model and strategy and with investors' interests. First, issuers determine a token type. There are four main types. *Donation tokens* are not linked to any rights or claims for a future product or service and are used to gather funds for idealistic entrepreneurial ideas or causes. *Currency token*s serve as virtual currencies on the issuers' blockchain protocol and can be used to pay for products or services. They are often used when TS issuers set up a new blockchain protocol. *Utility tokens* serve as "digital coupons" which can be redeemed for issuers' offerings or to gain access to a platform or application. In 2017 and 2018, most TSs issued utility tokens because of regulatory considerations and product popularization (Pietrewicz 2017; Adhami et al. 2017). Finally, *security tokens* are tokens that give investors rights to a pro-rata share of future profits, e.g., dividend or revenue share. A subcategory of security tokens are equity tokens, which additionally provide control or voting rights. Due to their resemblance to securities, for which strict regulatory rules exist, security tokens have been the most disputed token type from a regulatory perspective (SEC 2017; BaFin 2018). However, financial market authorities across the globe are modifying their regulations to accommodate TSs. For instance, the German regulator BaFin has recently approved the first security TS of a FinTech start-up.

Second, in the majority of TSs, issuers set caps on the maximum supply of tokens that can be generated in a TS and specify the value of a token (see Fig. 3). Some TSs do not limit the supply of tokens, which allows issuers to raise

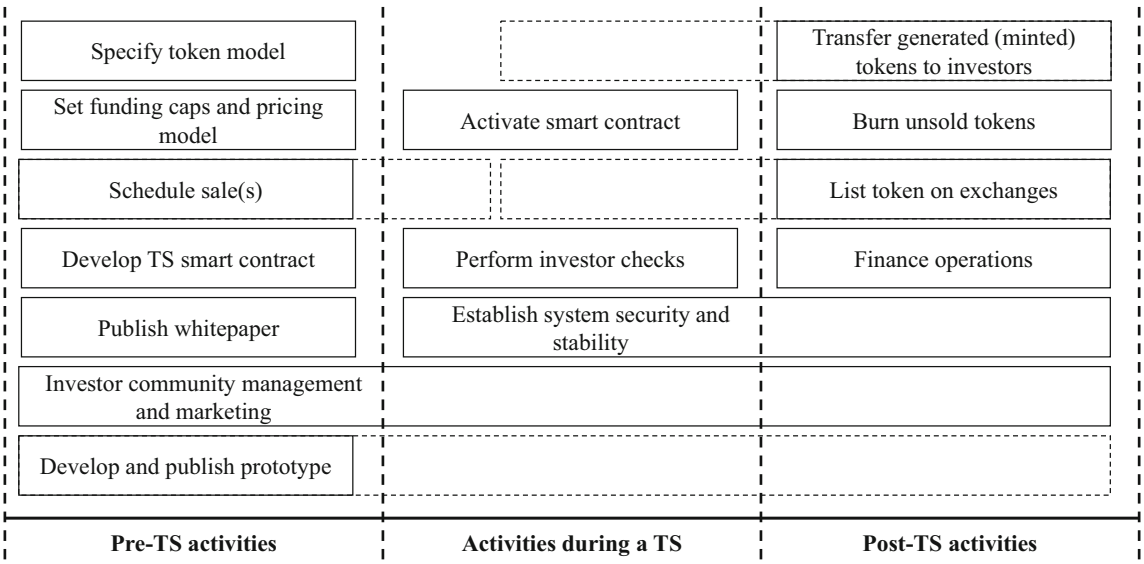
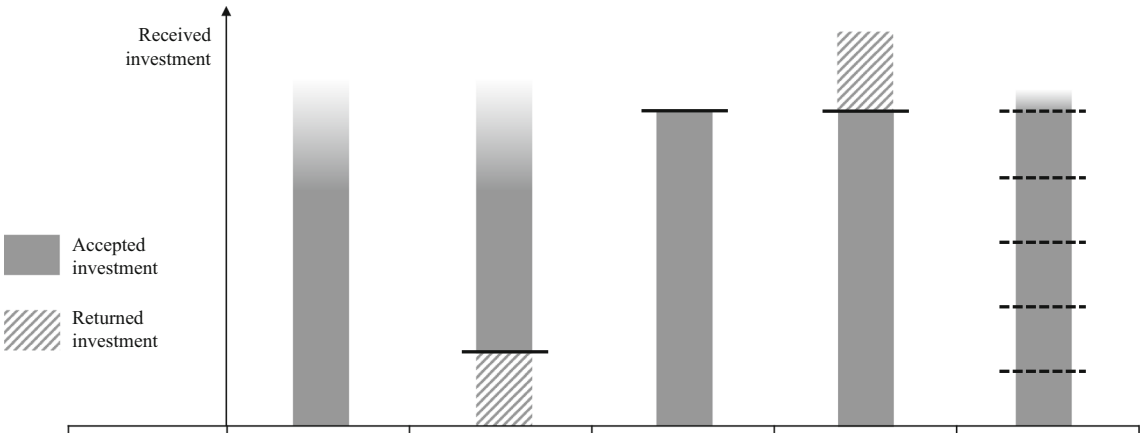


Fig. 2 Process of a token sale



	No cap	Soft cap	Hard cap	Collect & return	Dynamic ceiling
Lower limit	No	Yes	No	No	No
Upper limit	No	No	Yes	Yes	Yes, multiple
Payback when	(Not envisaged)	Soft cap not reached	(Not envisaged)	After reaching the upper limit, payback proportional to upper limit and total investment	(Not envisaged)

Fig. 3 Different token sale funding caps

an unlimited amount of funding. However, token oversupply can have negative implications for token valuation and issuer reputation. In capped TSs, issuers determine a lower and/or upper limit of funding. In the case of a lower limit, a so-called soft cap, the invested funds are paid back to investors if the defined soft cap is not reached. A hard cap defines the maximum amount of funding an issuer seeks to raise. Once this limit is reached, no more investments are accepted by the smart contract. A variant of the hard cap model is "collect and return", in which a hard cap exists, but additional investments beyond the hard cap are accepted by the smart contract. In this case, after the TS, the tokens are distributed to investors by the ratio of the hard cap to the total received funds. Excess funding is redistributed to investors accordingly. To ensure a broad token distribution, issuers can use a "dynamic ceiling" model in which the hard cap is divided into multiple (hidden) mid caps. In this way, the TS proceeds into multiple, isolated rounds to avoid dominance of major investors. Another market design option for issuers to remain key token holder is to limit the circulating supply of tokens by holding back a certain share of tokens.

Third, issuers set the pricing model. In case of capped token sales, fixed prices may be set either arbitrarily by the token issuing entity or, less commonly, a floating price is determined by an auctioning model. In Dutch auctions, the issuing entity allocates its tokens to the highest bidders and the token is charged at the lowest accepted bid's price. In a reverse Dutch auction, only a specified share of overall tokens is offered per day and the price per token declines with every day that the TS is active, until the defined funding goal is reached.

Fourth, another market design option important for TSs is the schedule of token sales. Many issuers run one or multiple rounds of exclusive TS pre-sales before opening the TS to the public in a main sale. In pre-sales, selected investors have the opportunity to buy tokens at significantly lower prices than in the main sale. Pre-sales allow issuers to attract renowned key investors, explore demand, create attention for the main sale, and test and finance the main sale. A disadvantage is that pre-investors have an incentive to sell discounted tokens at regular prices as soon as the main sale launches or the token becomes tradable, respectively. Token issuing entities may therefore impose one or multiple lock-up period(s) in which newly acquired tokens must not be traded. It can be observed that an increasing number of TSs refrains from main sales due to the lower regulatory requirements pre-sales are subjected to. For instance, the messaging service Telegram canceled its main sale after achieving the funding goal in two rounds of private sales. In pre-sales, investors are granted rights to the future token through a Simple Agreement for Future Tokens (SAFT, see www.saftproject.com).

Once issuers finalize these design options, the issuing entity develops a smart contract which administers funds and tokens during the TS. It is programmed to receive

cryptocurrencies from investors, to send them to the digital wallets of the issuing entity, and to transfer the equivalent number of tokens to investors. The tokens typically follow Ethereum's ERC-20 token standard (Vogelsteller and Buterin 2015) which allows developers to create customized and standardized tokens with relative ease. ERC stands for 'Ethereum Request for Comments', the command protocol of the Ethereum blockchain, which runs on the java-script-based programming language Solidity. The ERC-20 token standard includes all specifications required for a TS and ensures that tokens will be compatible with generic third-party transaction services and applications. The issuer can specify the TS by setting parameters, such as total token supply, burning rules, funding goal and duration, freezing options, and token value bound to a cryptocurrency like bitcoin or ether. Based on this information, the token price and transaction fee for miners – referred to as *gas* on the Ethereum blockchain – are calculated. Newer token standards, such as ERC-223 and ERC-777, aim at addressing shortcomings of ERC-20, by automatically canceling invalid transfers or offering improved handling mechanisms.

After determining the token design, TS issuers generally publish information about the token design, business model, technological solution, and the venture's roadmap in a whitepaper. Issuers distribute these whitepapers using their own website and social media platforms such as Reddit, Bitcoin Talk, or Cryptocointalk. In the absence of auditing intermediaries and content regulation, whitepapers are crucial for overcoming the substantial information asymmetries between issuers and investors. Given the high regulatory uncertainty involved in TSs, whitepapers provide information on the token sales' terms and conditions, which specify the issuing party and its place of business, timing and pricing of the token sale, use of the raised funds, and other rights and obligations associated with the token. Whitepapers also explain how to pay for the issuers' token, detailing a TS's smart contract address and a recommended gas limit. Therefore, whitepapers are a main source for investors' due diligence.

To allow investors to assess issuers' technological solution and the status quo of its implementation during the pre-TS stage, many issuers partly or fully publish their prototype's source code on a web-based hosting service (e.g., GitHub), often in an alpha or beta version. Some issuers additionally offer bounties for code auditing and bug detection in the TS's smart contract. A further important source of information is the blockchain community's sentiment, as articulated on social media (e.g., Reddit, Slack, Telegram, Facebook, Twitter). Issuers also use these channels for direct and indirect communication with the community and potential investors. To increase community interest and support, issuers frequently use so-called "airdrops" and "bounty programs" which offer token-based rewards for performing social media campaigns like Twitter posts using the TS's hashtag, blog posts, or other promotional activities for the TS. TS-related websites (e.g., Coindesk) are another important resource for investors, as they offer ratings, news, and schedules on forthcoming TSs.

2.2 Activities During a TS

The actual TS starts with the activation of the smart contract. On average, TSs last 41 days (Kostovetsky and Benedetti 2018), during which issuers are in charge of marketing, investor relations and support. Before investors can send money to the smart contract, an increasing number of TS issuers requires investors to register themselves ("whitelisting") before they can participate in the token sale. Whitelisting effectuates Know-Your-Customer (KYC) and Anti-Money-Laundering (AML) policies and thus protects issuers from regulatory scrutiny and blocks illegal investors who use TSs for money laundering or "pump and dump" behaviors.

In the actual TS, investors send funds, usually cryptocurrencies such as bitcoin or ether, to the smart contract, which transfers the currency units to the digital wallets of the issuing entity. These wallets do not actually store the currency units (this is done on the blockchain), but they store one or more public and private keys which are needed to send and receive cryptocurrencies. A wallet's data file contains the private key, a 256-bit number which is only known to the owner, and a corresponding public key which is needed to prove ownership of cryptocurrencies and to facilitate transactions.

To ensure a safe transfer and storage of funds, an errorless smart contract is crucial. In addition, the security and stability of wallets and information regarding the TS are issuers' top priorities, as hackers can use vulnerabilities to compromise the TS. For instance, the CoinDash TS lost an estimated USD 7 million in investments after cyber-attackers manipulated the smart contract address posted on the issuer's website. Thus, security precautions include professional audits of wallet and website code, smart contract verification, and two-factor authentication. As wallets are a main target of hackers, issuers use multi-signature wallets, which require more than one private key for authentication and special hardware for a secure deposit of private keys to prevent the invested funds from theft.

2.3 Post-TS Activities

In the post-TS stage, the smart contract transfers tokens to investors' wallets. Unsold tokens are mostly "burned" to decrease the number of tokens in circulation and to

increase token valuation. Further, token burning ensures that the distribution of tokens between investors, issuers, and other entities remains as communicated in the whitepaper. A key advantage for TS investors compared to conventional venture investments is the high liquidity of tokens. To facilitate an easy exchange of tokens, the token should be listed on crypto asset exchanges. However, getting listed on top-tier exchanges is difficult as exchange operators focus on tokens with high trading volumes and often charge considerable amounts for a listing. To get listed, the token should also follow a common standard, like Ethereum's ERC-20 token format, which allows easy integration on exchanges. However, even if a token gets listed on an exchange, it may get delisted at a later point due to low trading volumes, technical issues, or suspicions of fraud.

Based on the received funds and the investor network established through the TS, issuers further develop the product or service, and integrate the token in their offering. To fund these efforts, the issuer may liquidate some of the received funding into fiat currencies. Similar to traditional investor relations, token holder and community management continues to be a key priority for issuers to keep investors informed and well-disposed so as to increase user and token demand. Although rare, issuers may also perform subsequent token sales after the TS to raise more money.

3 Conclusion and Research Opportunities

Our goal was to delineate how TSs are designed from an economic and technological perspective and which activities and transactions among heterogeneous actors occur using different technology artifacts. Because of blockchain technology's decentralized nature, TSs provide a largely disintermediated funding mechanism that could diminish barriers inherent to traditional venture financing and other types of investment. Many regard TSs as a democratization of venture funding and advancement of crowdfunding, since investors can participate in projects with little means and supervision (Rohr and Wright 2017). Equally, issuers can collect capital without giving away equity and at relatively low costs (Conley 2017). However, the disintermediated nature and technological novelty of TSs pose various challenges for issuers, investors, and regulators alike (Kostovetsky and Benedetti 2018). In light of an array of fraudulent TSs, regulatory authorities struggle to find a balance between guarding against risks and empowering innovation (Lagarde 2018).

As TSs are still in their infancy and their patterns change rapidly, it would be premature to conclude that TSs will disrupt venture financing. At the same time, it is reasonable to predict that TSs and blockchain technology in general will have a significant influence on the way venture financing currently works, even it may not completely disrupt it. As such, it can be concluded that the underlying mechanisms and technologies of TSs provide new opportunities to enable peer-to-peer investments in digital and physical assets, a process called tokenization, which are transparently and securely registered on the blockchain. Thus, TSs could provide the foundation for decentralized investments and a token economy which has the potential to redefine established processes of funding and platform management, enabling new token-based business models and governance structures. A common misconception about TS is that it is a new funding mechanism only for start-ups based on blockchain technology. What is evident from our analysis of TSs is that it is a complex web of heterogeneous actors who perform a series of social and technical activities, mobilizing a heterogeneous set of technological artifacts, including but not limited to blockchain. The use of the plethora of technologies by heterogeneous actors in TSs offers an exciting context for many research opportunities in IS. The design of TSs is not just a technical exercise, nor merely an economic one. It is a unique blend of techno-economic design, where new economic logics of peer-to-peer venture funding models are technically implemented through a web of heterogeneous technologies.

Given the boundary-spanning nature of TSs and blockchain technology in general (Beck et al. 2017), the IS community is well positioned to critically investigate this emerging phenomenon from technical, behavioral, socio-technical, or regulatory perspectives using different methodological approaches and theoretical foundations. We believe that TSs' idiosyncratic technological and economic characteristics require research between the two opposite poles of techno-skepticism and blockchain enthusiasm to thoroughly understand TSs' positive and negative implications for different stakeholders. In so doing, we can also examine the role of different technology artifacts and their material agencies in shaping the consequences of TSs.

In this spirit, we suggest avenues for future research on TSs building upon dimensions suggested by Risius and Spohrer (2017) and Aral et al. (2013), as summarized in Table 1. The identified research questions touch upon the implications of TSs for 'private and institutional investors', 'society', 'intermediaries', 'technology artifacts', and 'firms and industries'. For each *level of analysis*, we propose research questions related to the activities *design and features*, *measurement and value*, *management and organization*, and *regulations and legal*. It should be noted that a multitude of interesting boundary-spanning research questions emerge at the interface of the different levels of analysis and activities depicted in Table 1. While by no

Table 1 Multidisciplinary research framework on token sales with example research questions

	Design and features	Measurement and value	Management and organization	Regulations and legal
Level of analysis	***How TSs are designed*** *(e.g., token specifications, pricing, blockchain protocol) and the* ***differential effects*** *of TS design and features*	***Added value that TSs provide*** *on the different levels and how it can be appropriated*	***Governance of TSs*** *and the* ***strategies and tactics*** *employed by actors in TSs*	***Policies and legal regulations*** *that (inter-) national policy makers enact regarding TSs*
Private and institutional investors, society *Actors who invest in TSs and the societal consequences of TSs*	How can affordances such as traceability, consensus mechanisms, potential deanonymization, or decentralization affect TS adoption? How do TS design features impact TS investment decisions and TS success? Which TS design features reduce uncertainty and increase venture quality? How do TS design features impact token value and valuation over time? How do pre-sale bonuses affect token valuation in the short, medium, and long term?	Which factors drive TS success? What is the role of the TS teams' human and social capital? How can TS risk be assessed to construct optimal portfolios? What is the relationship between traditional asset classes and crypto tokens? What are the determinants of token liquidity and how does liquidity affect post-TS returns? What are the main drivers of TS profitability in the long term?	How does token-based governance impact venture success? What is the motivation of private and institutional investors to participate in TSs? How will decentralized token-based voting and control rights affect decision outcomes in organizations? Which hybrid startup financing models (e.g., VC and TS) will be most attractive for investors?	How can investor protection be strengthened in a distributed computing environment with trusted intermediaries largely absent? How can fraudulent TSs be identified? How should tokens be treated by financial service authorities (e.g., security or asset)? Which disclosure obligations should be imposed on TS issuers and investors? How effective is the Simple Agreement for Future Tokens (SAFT) for protecting investor rights?
Intermediaries *Intermediary service providers, as well as applications and processes that are hosted within a blockchain environment connecting a service provider and a service consumer*	How can intermediaries enable token exchange across different blockchain protocols? How can smart contracts be designed to be integrated with existing information systems? How can intermediaries help investors evaluate TS design features?	Which intermediary roles and responsibilities are most likely to emerge? What is their added value? How can intermediaries increase the level of trust in smart contracts' algorithms? Will re-intermediation lead to an increase or decrease of the number and size of TSs?	How are activities that are usually enacted by intermediaries shared between different TS actors? Will new intermediaries emerge in the TS context or will established intermediaries (e.g., crowdfunding platforms, VCs) diversify? How will trustees and escrow accounts affect TSs and ventures' governance?	How can intermediaries effectively protect and add value for investors? Does the removal of an intermediary party cause an in- or decrease in the perceived empowerment and control? How can smart contracts be audited by intermediaries?
Technology artifacts *Different blockchain implementations and networks (e.g., Ethereum, Hyperledger), various types of blockchains (e.g., levels of permission), cross-system interactions (e.g., integrating blockchain protocols with each other or into established systems), and social media and networking tools*	How can public and private blockchains be designed and integrated to address security and scalability issues? How can scalability problems be solved (e.g., novel consensus mechanisms, off-chain transactions)? How to establish smart contracts' interoperability across multiple blockchains? How to establish token tradability across blockchains? How do TS features impact the usage of social media and networking tools? What is the impact of TS design on affordance actualization of social media and networking tools?	Which factors determine issuers' selection of a blockchain protocol (e.g., new or established, levels of permission)? What is the effect of the used blockchain protocol for TS success? How does the number of TSs on a blockchain protocol affect its valuation? How do the valuations of native and on-chain tokens correlate? What is the inherent value of social media and networking tools in TSs? Do they impact TS success?	How does blockchain protocols' interoperability affect TS adoption? How can the assessment of smart contracts and blockchain-enabled transactions be simplified? What is the impact of blockchain protocol's ownership on TSs' success? Which impact do consensus mechanisms have on the procedure and outcome of TSs? What is the role of social media and networking tools on token issuers' trustworthiness? How do they impact investment decisions?	How can smart contracts become a widely accepted form of investment agreement? How can unlawful transactions be identified? How should regulators treat native tokens compared to on-chain tokens? To which degree should regulatory bodies set boundaries on possible token designs? How should regulators treat tokens that are associated with physical assets? How can social media and networking tools help to protect investors from fraud?

Table 1 continued

	Design and features	Measurement and value	Management and organization	Regulations and legal
Firms and industries *Organizations and industries that are prone to be affected by TSs or perform TSs themselves*	How can public and private blockchains be integrated to satisfy requirements (e.g., compliance, security, scalability) of financial institutions? How can sensitive data (e.g., investors, financial records) be concealed on permissionless blockchains? How can the trade-off between transparency and privacy be solved from a technical perspective?	Which other use cases exist for peer-to-peer investments on the blockchain (tokenization)? What will the role of established financial institutions be in the TS environment? Which new capabilities are needed by financial institutions to participate? How to design a token model that aligns with the issuer's business model? Are TS-funded ventures more successful than traditionally funded organizations? Why do organizations perform TSs instead of traditional forms of fundraising (e.g., crowdfunding, VC)?	What impact will TSs have on startup and corporate financing (e.g. venture capital firms, private equity)? Under which conditions will established companies use TSs for corporate finance or platform management? What new blockchain-based business models will emerge in corporate finance and investment? How does the token economy affect collaboration in interfirm networks? How do token design and governance optimally align?	How can transaction traceability be used to avoid tax fraud? Does the relationship between token transfer and value follow the same principles as trading volume and price? Which established regulations, e.g. KYC, will be applied in TSs? How do regulations impact TS transaction costs?

means exhausting, we hope that these example research questions will stimulate the IS research community to lead the discussion on TSs and provide guidance for all stakeholders.

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