Initial Coin Offerings:

Financing Growth with Cryptocurrency Token Sales

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Abstract

Initial coin offerings (ICOs) have emerged as a new mechanism for entrepreneurial finance, with parallels to initial public offerings, venture capital, and pre-sale crowdfunding. In a sample of more than 1,500 ICOs that collectively raise $12.9 billion, we examine which issuer and ICO characteristics predict success, measured using real outcomes (employment and issuer failure) and financial outcomes (token liquidity and volume). Success is associated with disclosure, credible commitment to the project, and quality signals. An instrumental variables analysis finds that ICO token exchange listing causes higher future employment, indicating that access to liquidity has important real consequences for the enterprise.

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1 Introduction

Initial coin offerings (ICOs) are a new method of raising capital for early stage ventures, an alternative to more traditional sources of start-up funding such as venture capital (VC) and angel finance. In an ICO, a blockchain-based issuer sells cryptographically secured digital assets, usually called tokens. Explosive growth in the ICO market has attracted interest from entrepreneurs, investors, and regulators. According to one estimate, between January 2014 and December 2018 ICOs raised over $28 billion, and at least 15 individual ICOs to date have taken in more than $100 million.[1] At the same time, the market has become notorious for scams, jokes, and frauds. This paper asks which venture and ICO process characteristics predict real and financial success for ICO issuers, focusing on whether the market exhibits dynamics consistent with existing theoretical literature about entrepreneurial finance and, more recently, about ICOs.

ICOs can provide more security, liquidity and transparency than conventional financing instruments. These features potentially mitigate costs of asymmetric information and agency problems that have long deterred arms-length retail investment in early stage private ventures (Hall and Lerner 2010). These frictions have made fundraising difficult for those entrepreneurs who are located outside VC hubs or lack elite professional networks (Chen et al. 2010). While these frictions may represent unavoidable risks of start-up ventures, they might also arise due to inefficient aspects of market design or overly burdensome regulation, problems that many ICOs have openly tried to address.

We define three types of digital assets. The first is a general-purpose medium of exchange and store of value cryptocurrency, such as Bitcoin; these are often termed coins. The second is a security token, which represents a conventional security that is recorded and exchanged on a blockchain to reduce transaction costs and create a record of ownership. The third is a utility token, which gives its holder consumptive rights to access a product or service.[2] Utility tokens comprise the largest and most well-regarded ICOs and are the primary focus of

[1] See https://www.coinschedule.com/stats.

[2] These are our definitions, not an industry standard, and we do not view the categories as mutually exclusive. For example, Ether (the token of the Ethereum blockchain) is a utility token, but its widespread circulation has led it to become also a store of value. An emerging class of so-called stablecoins, such as Tether, arguably belong to both the first and second categories. Other papers have developed taxonomies of ICO that can be elaborate. See, for example, Zetzsche et al. (2017)and Lo and Medda (2019).

our paper, although our data includes numerous tokens in all categories. Utility token ICOs somewhat resemble crowdfunding pre-sales of products on platforms such as Kickstarter. Perhaps a closer analogy is selling tradable ownership rights to stadium seats before a sports or entertainment venue is built, a practice that goes back to the 19th century.[3] While utility tokens can be simple "corporate coupons" that give the holder the right to an issuer's product or service, the most well-known ICOs employ them as the means of payment in a new marketplace. In this case, we can extend the analogy to suppose that the unbuilt stadium's games were to be played (or at least watched) by people in the grandstands.

Why should a platform have its own token instead of accepting payment using conventional fiat currency? Proponents argue that blockchains with native tokens permit disintermediation of Internet marketplaces such as Uber or Facebook. In these traditional models, the developing firm's control over the platform enables it to extract a large share of the platform's surplus, and this control also raises concerns over the developer's use of transacting party data. In the blockchain token model, platform management is decentralized, and value accrues to the token holders (who may include the platform developers). The token's value is often expected to increase with the value of the decentralized network. This correspondence enables three features, though not every ICO makes use of all three. First, the token can reward the network creators without giving them control after the network has launched. Second, token buyers can fund the platform's development, speculating on the long-term value of the service it will provide in the future. Third, like concert tickets, food stamps, or stock certificates, the token's value is tied to access to a future good or service, creating customer commitment.

We study a sample of 1,519 geographically dispersed ICOs, for which we gather data on a wide range of characteristics, such as whether the token has utility value, previous VC financing, and founder professional backgrounds. The amount raised in the ICO is

[3] The practice of raising capital from prospective customers by selling ownership rights for future seats in an unbuilt arena dates back at least to Royal Albert Hall in London in the 1860s (we thank Bruce Grundy for this reference). Others trace the practice to the time of the Reformation or even earlier, when European church construction began to be financed by the advance sales of pews that were owned in perpetuity by their sponsors and could be re-sold for profit. See http://anglicanhistory.org/misc/freechurch/fowler_pews1844.html. For utility tokens to have value, the issuer must commit to a cap on the total supply, and this is easily done in a sports arena or church where adding new seats is physically difficult. Smart contracts can impose these limits for ICO tokens.

public information for 551 ICOs, which collectively raised the equivalent of $12.9 billion. We analyze ICO process characteristics for a subsample of 450 successful offerings that subsequently traded on secondary market exchanges for at least 90 days. Our descriptive statistics document design tradeoffs faced by ICO issuers, who must balance objectives not unlike those for initial public offerings (IPOs) of equity securities: target proceeds, fraction of total token supply sold, pricing mechanism, distribution method, lock-ups and set-asides, token rights, and choice of secondary market exchange. Our detailed benchmarks of data in these areas, nearly all hand-collected from original sources, represent one contribution of our study.

We study the operational progress of ICO issuers by tracking the failure rate of the companies in our sample through November 2018 and, for those firms still operating at that time, by analyzing their employment as reported by individuals on LinkedIn. As most of the ICO issuers in our sample raised funds in 2017 or early 2018, their headcount in late 2018 indicates progress toward commercializing an issuer's product or service.

A significant predictor of survival and employment is whether a token has apparent utility value, which has strong relevance for current policy debates over whether ICO tokens are investment securities in disguise, or whether they represent an innovation that enables a new venture to raise funds in a way that promotes future product adoption and loyalty, while also offering liquidity. Additional factors associated with ICO success reflect longstanding theories in corporate finance about the importance of reducing information asymmetry and the use of bonding and certification strategies to reduce agency costs. We find that ICO issuers have lower failure rates and higher future employment when the issuer makes voluntary disclosures via a white paper, when the white paper provides a budget for the use of ICO proceeds, when the issuer's executive team has a lockup (vesting) period for sale of its ICO tokens, when some tokens are reserved in an incentive pool, when the issuer has successfully raised VC funding in the past, and when the CEO or founder has professional experience as an entrepreneur (and to a lesser degree, experience in computer science).

Our financial outcomes require that a token has listed on an exchange. To connect the samples used in the real outcome and financial analyses, and also to understand better the role of listing itself, we conduct two exercises. First, we examine factors that predict listing.

These largely parallel those that predict survival and employment. Second, noting that listing is itself an interesting characteristic, with a strong connection to token liquidity, we instrument for listing to assess its effect on employment.[4] Specifically, we use price changes in the Ethereum Classic (ETC) token around the time of an ICO, focusing on periods when Bitcoin prices are high (see Section 4.1.2 for details). The IV estimate, which is about four times the OLS estimate, finds that listing increases future employment by 232 percent.

We also assess which characteristics exhibit significant associations with secondary market liquidity and trading volume. From the perspective of an early stage investor, liquidity represents a central benefit of ICOs relative to conventional financing instruments (Metrick and Yasuda 2011). Liquidity also reflects market depth and interest in a token. Sockin and Xiong (2018) show that token trading enables information aggregation from potential customers about demand for a platform's service, and they conclude that an individual's decision to join a token-based platform depends positively on the token's trading volume. However, the liquidity of ICOs may have a dark side if issuers' ability to cash out quickly undercuts their incentives to build successful businesses, or if investors do not have incentives to monitor intensively (Chod and Lyandres 2018). Therefore, it is important to study the dynamics of liquidity after the ICO. Consistent with the previous analysis of real outcome predictors, we find that liquidity and trading volume are higher for tokens that offer voluntary disclosure in a white paper, credibly commit to the project through insider vesting restrictions, and signal quality via prior VC investment and past entrepreneurial success of the CEO. The results indicate that in this nascent sector, information asymmetry leads to economic mechanisms that are similar to standard entrepreneurial financing settings.

Further analysis shows that ICO design choices and social media promotion have a large effect on both operating and financial measures of ICO success. For example, success is associated with token sales that use dynamic pricing mechanisms, that promote transparency and crowdsource development by publicly posting source code on Github, and that have large Telegram user groups. We categorize the issuers into 12 sectors and find that success along both real and financial dimensions is associated with business models related to advertising

[4] We could not identify suitable instruments for the other issuer and ICO process characteristics.

and rewards, tokenizing real assets (e.g., putting real estate or art on a blockchain), and new blockchain protocols (creating a new blockchain rather than attaching the token to the Ethereum or another existing blockchain). In contrast, asset management and other crypto financial services are if anything negatively associated with success. These results shed light on where the market has perceived opportunities for value creation.

This paper contributes to a nascent literature describing the economics of digital assets. As of early 2019, the subset of this literature focused on ICOs includes more than 100 working papers. We relate our findings to recent ICO theory papers, including Li and Mann (2018), Sockin and Xiong (2018), and Cong, Li and Wang (2018a). For example, the importance of utility value to success and the prevalence of token pre-sales are consistent with the ways that ICOs resolve cross-side and same-side coordination failures in Li and Mann (2018).

Our detailed investigation of token liquidity complements a number of other recent empirical studies. Deng, Lee and Zhong (2018) study the post-ICO Github-based technological development of token issuers, making it the only paper to date besides ours that examines real outcomes for ICO issuers. Among recent papers studying financial market outcomes, the most similar are Bourveau et al. (2018), who conduct a large-sample investigation using the Amihud (2002) illiquidity statistic as the main dependent variable, and Florysiak and Schandlbauer (2018), who study token trading volume in the weeks subsequent to a successful ICO. Related work investigates ICO financial market success measured as an indicator for obtaining an exchange listing for the token. These papers include Amsden and Schweizer (2018), De Jong et al. (2018), Lyandres et al. (2018), and Boreiko and Vidusso (2018). Other papers study topics that resemble the empirical literature on IPOs, focusing on variables such as token underpricing, investor returns, and the amount raised in the ICO, topics that we do not consider in our study.[5] Ofir and Sadeh (2019) provides a literature review of this fast-growing subject area.

One reason that ICOs have proliferated so quickly is that in their most basic form they

[5] On token underpricing, see: Benedetti and Kostovetsky (2018), Chanson et al. (2018), Dittmar and Wu (2018), Drobetz et al. (2018), Felix (2018), Stastny (2018), and Momtaz (2019). On investor returns, see Benedetti and Kostovetsky (2018), Chanson et al. (2018), Dittmar and Wu (2018), Drobetz et al. (2018), Hu, Parlour and Rajan (2018), Lu (2018), Momtaz (2018b), Stastny (2018), and Yuryev (2018). On the amount raised, see Adhami, Giudici and Martinazzi (2018), An et al. (2018), Ante et al. (2018), Blaseg (2018), Burns and Moro (2018), Feng et al. (2018), Fenu et al. (2018), Fisch (2018), Guske and Bendig (2018), Johnson and Yi (2019), Lee et al. (2018), Momtaz (2018a), Momtaz (2018c), Rhue (2018b), and An et al. (2018).

impose almost no costs on the issuer. This contrasts with IPOs, where explicit underwriting and legal costs comprise a significant fraction of the funds raised (Ellis, Michaely and O'Hara 2000). IPOs also have less quantifiable costs, importantly the cost of disclosure, the ongoing regulatory burden, and the possibility that a high stock price will attract product market competition (Maksimovic and Pichler 2001). In our discussion and analysis below, we draw parallels and highlight differences between ICOs and three forms of more conventional finance: equity crowdfunding, venture capital, and IPOs. The literature in financial economics about these instruments illuminates mechanisms that may be important for ICOs. These comparisons highlight connections between our paper and the broader entrepreneurial finance literature, especially work on new vehicles for financing and alternative contracting structures including Kaplan, Sensoy and Strömberg (2009), Hochberg (2011), Mollick (2014), and Bernstein, Korteweg and Laws (2017).

The rest of the paper is organized as follows. Section 2 provides an overview of the ICO market, including regulation, theoretical work, and a detailed description of our hand-collected data. Section 3 discusses the motivations for entrepreneurs to issue ICOs instead of relying on more traditional sources of capital. Section 4 contains our analysis of token success. Section 5 concludes the paper. An Appendix presents a case study of one of the more successful ICOs to date, Filecoin, whose sponsor provided us with confidential data about its token sale for use in this study.

2 The ICO market

ICOs are a phenomenon of the worldwide networks of open blockchains and distributed ledgers that began with the 2009 launch of Bitcoin and now include thousands of digital assets.[6] These novel databases provide decentralized record-keeping that cannot be retroactively edited and use cryptographic functions that link records, enable rapid verification of data, and prevent hacking. Early blockchains such as Bitcoin and Litecoin were designed as simple payment systems, and they also provide an archival function

[6] See Flood and Robb (2017) for an account of the historical antecedents that led to the launch of cryptographic tokens by Nakamoto and others.

because text can be appended to ordinary transactions. The advent of more sophisticated blockchains such as Ethereum and EOS has enabled a much wider range of applications, including insurance contracts, voting schemes, and contingent investment products. ICOs are a fundraising mechanism in which a new token is sold to investors and prospective users. Most tokens sold in ICOs are "smart contracts" within the Ethereum blockchain, though some are the units of account in new blockchain protocols.

In order to explore what predicts ICO success – the primary aim of this paper – it is important to first understand the features of this new market. This section begins by discussing the legal status of ICO tokens. The subsequent sections describe the data that we use in this paper and explain the economic content and institutional practice behind the variables we collect.

2.1 Legal status of ICO tokens

Cryptographic assets challenge regulators in the U.S. and elsewhere with basic problems such as how to account for them as part of a company audit. For ICO tokens, one question is whether the issuance of tokens creates income tax liability for the promoter or for investors who buy and later re-sell them. Another is whether some tokens are commodities, which would imply further compliance obligations. Finally, some token issuers may be construed as money transmitters, a status which in the U.S. implicates cumbersome state-level registration and compliance.[7]

The most important legal question surrounding ICO tokens is whether they have the status of securities, which would trigger various compliance requirements that could create cost, risk, and delay for issuers. In the U.S., the four-part *Howey* test, which originated in a 1946 Supreme Court case, governs whether an investment scheme qualifies as a security.[8] How

[7] See a memo published by a leading law firm at https://www.clearygottlieb.com/-/media/files/alert-memos-2018/us-regulators-continue-scrutiny-of-virtual-currencies-and-icos.pdf, which details how token issuers could variously be covered by the U.S. securities, commodities, and/or money transmission laws, which may have overlapping effects and are not mutually exclusive.

[8] SEC v. W.J. Howey Co., 328 U.S. 293 (1946). Rohr and Wright (2017) provide a detailed analysis of the relevant caselaw and its potential applications to blockchain-based tokens. More broadly, a significant body of legal scholarship has begun to emerge around these issues, including many papers that make proposals for optimal regulation of ICOs. See Brummer et al. (2018), Burilov (2018), Chiu (2018), Chiu and Greene (2018), Dambre (2018), Dell'Erba (2018), Enyi and Le (2017), Gurrea-Martínez and Remolina (2018), Holoweiko (2018), Preston (2017), Robinson (2017), Sherman (2018), and Zhang et al. (2018).

U.S. courts interpret the 73-year-old *Howey* precedent in the context of modern technology will have worldwide implications, because U.S. securities laws are often followed at least informally by many other countries.[9] Two parts of the *Howey* test seem to be satisfied by most if not all token sales: whether an investment of money is made by the ICO purchaser, and whether the ICO investment is part of a common enterprise among numerous purchasers. Uncertainties arise from the other two branches of the test: whether the success of the enterprise depends on the efforts of a third-party promoter, and whether a purchaser has an expectation of a financial return, such as capital gains. Virtually all tokens are issued by promoters, but after launch many tokens are governed not by a management team but instead by a computer algorithm on a decentralized public network. This was recognized by the U.S. Securities and Exchange Commission's (SEC)'s Director of the Division of Corporate Finance in a June 2018 address, in which he opined that the Ether token on the Ethereum blockchain, viewed as one of the first-ever ICOs, no longer meets the criteria to qualify as a security due to its lack of centralized control.[10] If the token buyer intends to use the token as a customer, he may not be motivated by an expectation of financial profit. However, many ICOs have no apparent utility purpose (47 percent of our sample), and non-utility tokens are almost certainly securities under *Howey*.

The SEC created a Strategic Hub for Innovation in Financial Technology in October 2018 to "serve as a resource for public engagement on the SEC's FinTech-related issues," and in April 2019 that group published a memorandum that enumerated criteria for "whether offers and sales of a digital asset are securities transactions" under *Howey*.[11] On the same day, the group issued a No-Action letter opining that the tokens of one issuer, Turn-Key Jet, were not subject to the securities laws. The commission has also brought a handful of high-profile enforcement actions against select token issuers, such as the Airfox and Paragon settlements announced in November 2018, and these cases have tended to have extreme fact patterns that leave little ambiguity about whether the underlying tokens qualify as securities (Rhue

[9] Regulation of ICOs internationally is studied by Barsan (2017), Chohan (2017), Kaal and Dell'Erba (2017), Shroff and Venkataraman (2017), Blemus (2017), Collomb et al. (2018), Hacker and Thomale (2018), Kaal (2018), Klöhn et al. (2018), Koeppl and Kronick (2018), Pilkington (2018), Flood and McCullagh (2019), and Maas (2019).

[10] See https://www.sec.gov/news/speech/speech-hinman-061418.

[11] See https://www.sec.gov/corpfin/framework-investment-contract-analysis-digital-assets.

2018a). Further test cases of these principles seem inevitable in the near future, given the intensity of the SEC's scrutiny of ICOs. SEC Chairman Walter J. Clayton took an extreme position in a February 2018 U.S. Senate hearing, stating that "I believe every ICO I've seen is a security," but the decision for any individual ICO ultimately belongs to the federal courts and not to the SEC. Congress also has the opportunity to supersede *Howey* and clarify the future regulation of ICOs through legislation.

Some issuers have responded to the threat of U.S. securities regulations by selling rights to tokens as explicit securities to accredited investors under established registration exemptions, which requires extensive know-your-customer due diligence. Since late 2017, some ICOs have taken place under the Simple Agreement for Future Tokens (SAFT) framework, which was introduced by Cooley (a law firm) and Protocol Labs, the company responsible for Filecoin (see Appendix). SAFT issuers enter into an investment contract for the future delivery of tokens – essentially a forward contract – once a platform is developed and becomes functional. The tokens delivered in the future are meant to be products that are subject not to securities laws, but instead to the ordinary consumer protection and tax laws of the U.S. and various states. Whether federal agencies and courts will adopt the regulatory stances anticipated by the SAFT framework is a question for the future.

Other countries have adopted a wide variety of regulatory stances toward ICOs. These range from blanket prohibitions (China, South Korea) to relatively accommodating safe harbors (Singapore, Switzerland). Whether a country can enforce its tax and securities laws against an ICO issuer is not always obvious, because public blockchains, including Ethereum, operate everywhere and are not anchored physically in any particular jurisdiction. An issuer that markets tokens to U.S. investors has U.S. compliance obligations even if the issuer is located abroad, leading some issuers to declare their ICOs off-limits to U.S. residents (this is the case for 19 percent of our sample). However, bringing a foreign issuer into a U.S. court might be impossible. Also, the pseudo-anonymous nature of public blockchain addresses makes excluding U.S. buyers difficult. The geographic distribution of ICOs appears to reflect emerging international regulatory competition between countries seeking to attract a portion of the fast-growing market (see Figure 1). For example, 92 ICOs in our sample are located in Singapore.

2.2 Market overview

We create a large, unique dataset of ICOs and their characteristics. Data are hand collected from issuer websites and white papers, as well as news articles, ICO aggregator and tracker websites, LinkedIn, Github, Twitter, and Telegram.[12] We use our data in Section 4 below in our investigation of ICO success factors. As shown in Table 1, Panel 1, we begin with a sample of all 1,519 unique ICOs listed on the TokenData website as of April 2018. At the start of our data collection in the summer of 2017, TokenData was recognized as the most prominent and respected website among several that tracked the growing roster of ICOs.[13] We merge the ICOs from TokenData with daily trading data from CoinMarketCap, which is the most comprehensive and credible source of trading data for digital assets, with indices featured in the data feeds provided by NASDAQ, Bloomberg Terminal, Thomson Reuters, and others. CoinMarketCap aggregates daily data from those public exchanges that charge trading fees. Exchanges without fees permit issuers or other stakeholders to generate false volume, where a trader (or its bots) trades back and forth with itself. Two examples illustrate CoinMarketCap's coverage, as of March 2019. Price and volume data for the token Blocktix, which has a $0.9 million market cap, comes from two exchanges, Bittrex and HitBTC. Data for EOS, one of the top five tokens with a market cap of $3.5 billion, comes from 94 exchanges.

Table 1, Panel 1 shows that of the 1,519 ICOs, 1,265 were completed.[14] Figure 2 shows the number of ICOs and the U.S. dollar value equivalent of amount raised by quarter. It indicates that our sample ends before the overall market bubble concluded in the first half of 2018. We observe the amount raised for 551 ICOs and convert it when necessary to U.S.

[12] The data were collected by a team of more than a dozen research assistants and spot-checked.

[13] Some ICO listing websites have biased samples because they charge payments for including the tokens in their rosters. Deng et al. (2018) (footnote 7) discuss the benefits and limitations of many ICO aggregators. They note that TokenData is one of three websites "that have the most comprehensive coverage and provide the most thorough list of deal characteristics" and that TokenData covers the largest number of ICOs. Amsden and Schweizer (2018) (footnote 32) make a similar observation about the comprehensiveness of TokenData's coverage. In a recent analysis of ICO white papers, The Wall Street Journal used TokenData as one of its three sources of a sample of 3,291 documents. See https://www.wsj.com/graphics/whitepapers/. One of the other sites used by the Journal, ICOBench, had only just launched and had limited coverage at the time of our data collection.

[14] Completed means that the ICO was not canceled and that the tokens were actually sold (or given away in the case of airdrops). TokenData categorizes all ICOs as completed, active, or failed. We use their failure indicator and spot check for accuracy.

dollars (Table 1, Panel 2). This variable has a mean of $23 million, a median of $8.5 million, and a maximum value of $4.2 billion for the EOS token sale (the next highest is Tezos, at $230 million). We do not use amount raised as a success metric because raising more money than needed for development has potential downsides, such as unwanted publicity and the agency problems that arise when the founders have a large cash cushion. These issues are recognized in the VC literature (Gompers 1995).

Roughly half of the completed ICOs ultimately listed on an exchange. Some crypto exchanges are centralized, such as Poloniex and Binance, and others are decentralized (peer-to-peer), such as ShapeShift and EtherDelta. They vary in approaches to approving tokens for listing. For example, Circle, which runs the Poloniex exchange, considers dozens of factors including: "Does the project encourage rational participation by investors?" and "Is the team transparent with company developments, operations, and hiring?"[15] In 2017 it was reported that many exchanges charged listing fees ranging as high as $1 to $3 million.[16] By comparison, listing a registered equity security on a traditional exchange such as NASDAQ costs $125,000 to $300,000. Some exchanges charge token-specific listing fees depending on factors such as expected daily volume.

Panel 2 of Table 1 indicates that nine percent of ICO issuers have previously received VC equity financing. Anticipating that portfolio companies may raise additional funding through ICOs, some VCs now include rights to future tokens as a standard term sheet clause.[17] As the relationship between the VC and ICO markets matures, they function as complements in some circumstances and substitutes in others. Instances where issuers previously raise equity VC or include VCs as token buyers include Kik, Blockstack, and Filecoin. In contrast, the founder of Pillar explicitly described its ICO as a substitute for VC.[18]

[15]See https://www.circle.com/marketing/pdfs/en/circle-asset-framework.pdf.

[16]See https://www.bloomberg.com/news/articles/2018-04-03/crypto-exchanges-charge-millions-to-list-tokens-autonomous-says.

[17]Based on author conversation with a Union Square Ventures founding general partner, and https://www.coindesk.com/ico-investors-seek-veto-power-future-token-sales. The National Venture Capital Association has added a protective provision to its model term sheet that gives investors a veto over token, cryptocurrency and blockchain related offerings. See https://nvca.org/pressreleases/nvca-unveils-updated-model-legal-documents.

[18]Digital identity company Pillar's founder unsuccessfully sought VC before raising $25 million in an ICO. See http://www.wired.co.uk/article/what-is-initial-coin-offering-ico-token-sale.

2.3 Prevalence of utility tokens

Utility tokens confer consumptive rights, unlike equity. Using issuer white papers and other public information, we assessed whether each token's issuer intended the token to have utility value. Table 1, Panel 2 indicates that 53 percent of ICOs in our sample sell tokens with intended utility value. Utility tokens typically do not carry rights to the future cash flows of the issuer or platform, except to the degree the token's value is intrinsically tied to the network's value. There are exceptions; for example, ICONOMI tokens come with the rights to a portion of fees paid to the network. The most common right for utility token holders is the right to use the token to access services. For example, the Basic Attention Token (BAT), which was sold in an ICO that raised $35 million in 24 seconds, will be the only means for users, advertisers and publishers, to transact for attention on the Brave Internet browser.

Token holders sometimes have platform governance rights, like equity shareholders. At one extreme, token holders set the overall business strategy. An example is TheDAO (a "decentralized autonomous organization"), which became famous for a hacking event that precipitated a hard fork of the Ethereum blockchain in 2016. More commonly, token holders have limited governance roles, such as adjudicating disputes. Token holders may also have the right to play a role in creating and securing blocks through a proof-of-stake system where, as with company stock, voting power is determined by token holdings. The smart contracts that create ICO tokens can invest them with state-contingent privileges similar to those in VC contracts, which sometimes give an entrepreneur more control in good states of the future, and the investor more control in bad states.

2.4 Pre-sales

Our data show that for 43 percent of ICOs, the issuer segments the market by conducting a pre-sale before the public ICO. This resembles how IPO issuers have often previously sold private equity to VCs and other stakeholders. ICO pre-sales serve multiple functions. One is to fund the costs of promoting the ICO itself. A second is to certify the issuer, particularly if well-known experts or institutions participate. A third is to determine demand and the appropriate price, which is analogous to the book-building part of the IPO process (Sherman and Titman 2002, Derrien and Womack 2003).

Pre-sale buyers usually receive discounts. These are akin to the lower prices that conventional early stage equity investors receive in exchange for taking on more risk, providing value-added services, and signaling quality to the market (Hellmann and Puri 2002). Li and Mann (2018) rationalize the pre-sale as one mechanism to resolve the coordination failure that emerges in the case of what they call a "same-side network effect during the ICO." This is a traditional network effect, in that the value of being a user depends on there being a sufficient number of other users on the platform. Pre-selling discounted tokens can help the issuer approach the needed critical mass of participants.

2.5 White papers and other bonding devices

The failure rates of ICOs have attracted scrutiny from regulators, and a number of empirical studies document evidence of fraud (Hamrick et al. 2018, Li et al. 2018, Liebau and Schueffel (2019), Cohney et al. 2018). Even if an ICO occurs without market manipulation such as "pump and dump" schemes, no legal safeguards prevent the issuer from absconding with the proceeds, nor is there accountability via audits or oversight through corporate governance of promoters' use of proceeds. More generally, ICO token buyers do not have legally enforceable residual claims due to absence of regulation.

We therefore expect that certification, disclosure, and bonding mechanisms are important for ICO success. Variables relevant to these mechanisms are listed in Table 1, Panel 2. Eighty-six percent of issuers publish a white paper, a voluntary disclosure document similar in spirit to an IPO prospectus. However, in the absence of regulation their contents vary dramatically. Most describe how the token will be used, including its benefits to holders and how its blockchain architecture will operate. Beyond the white paper, issuers typically conduct public relations campaigns to promote tokens.

Table 1, Panel 2 shows that 43 percent of issuers set tokens aside to incentivize platform development through a foundation, bounty, or endowment. There is a vesting schedule for tokens assigned to insiders in 22 percent of ICOs, and a budget for use of the proceeds in 42 percent. Vesting periods for founders help align developer incentives with those of token buyers. Brav and Gompers (2003) find that this commitment device to alleviate moral hazard problems is the best explanation for the 180-day lockups of insider shares that exist in the IPO market. A few ICO issuers, including Golem, have tied token lock-ups to specific development milestones. Other lock-ups are hard-coded set-asides to incentivize future network contributors. For example, Bancor set funds aside for a market maker that is charged with maintaining price stability, and from which funds cannot be removed for a pre-specified period.

2.6 Founder backgrounds

ICO issuers are sometimes firms and sometimes simply a group of developers. We are able to identify a lead individual in the form of a founder or CEO for 1,016 of the ICOs, summarized in Table 1, Panel 3 Of these, 96 percent of founders are male, a distribution that is even more skewed than the share of VC-backed entrepreneurs who are male, which Gompers and Wang (2017) find to be about 90 percent post-2010. LinkedIn information about previous jobs is available for 963 ICOs. Among these, 29 percent of founders/CEOs have backgrounds in the crypto community, which includes having worked at a blockchain-based company. Thirty-three percent have backgrounds in financial services, and 48 percent in computer science. If the founder/CEO claims on LinkedIn to have previously founded a company, we assign him an entrepreneurship background, which applies to 58 percent of the sample (these classifications are not mutually exclusive).

2.7 Location

We identify the issuer's headquarters office location for 1,296 tokens, and the map in Figure 1 illustrates that issuers are located or partially located in 60 countries. The top five countries are identified individually; the U.S. and Russia lead, with 214 and 105 ICOs, respectively. The dollar amounts raised by country roughly correlate with the number of ICOs. The U.S. leads, with Switzerland, Singapore, Russia, China, and Israel following (in order).

ICOs may facilitate entrepreneurial finance in countries with less mature regulatory systems such as Russia and China. ICOs often employ self-enforcing, state-contingent contracts that enable arms-length investors to have some degree of trust without relying on enforcement by weak government institutions.[19] Lerner and Schoar (2005) examine private equity contracts across countries and find that in low-enforcement countries with socialist backgrounds or civil law traditions, it is most common for private equity investors to purchase majority equity ownership. The cost of this may inhibit optimal development of vibrant entrepreneurial ecosystems in these markets.

Location also raises the issue of jurisdiction for legal purposes. An ICO issuer that successfully removes its tokens from the jurisdiction of the securities laws may create income tax or value-added tax liability. To reduce potential income tax liability, some token issuers have routed their ICOs through non-profit foundations, while others have located in tax havens such as the Cayman Islands or Zug, Switzerland, which has come to be known as the Crypto Valley. However, Huang et al. (2018) find that tax considerations are less important than lenient securities regulation in attracting ICOs to individual countries.

2.8 Detailed data on ICO processes

When launching an ICO, the issuer typically makes tradeoffs among a set of economic variables with parallels to IPO decision points: target proceeds, fraction of total token supply sold, pricing mechanism, and distribution method, among others. To study the ICO process in depth, we hand-collect data on the 450 exchange-listed tokens that had traded on an exchange for at least 90 days as of April 2018. The summary statistics for these variables about ICO processes and social media interactions represent an important contribution of our study, and they appear in Table 2.

In most ICOs, a prospective buyer sends payment to the blockchain address of the issuer. Payment usually occurs in cryptocurrency, most commonly Ether since the majority of ICOs occur on the Ethereum blockchain. Table 2, Panel 1 shows that 66 percent of ICOs in our data accept Ether. Orders are filled through automated, pre-established smart contracts. These dictate, for example, how to ration tokens when the offer is over-subscribed. The issuer has no control over the ICO process once the smart contract launches. As offers are accepted, the contract sends tokens to the blockchain addresses of successful buyers, while refunds are conveyed to addresses of unsuccessful buyers.

[19]For a skeptical alternative view, see the analysis in Venegas (2017) and Cohney et al. (2018).

Data in Panel 1 of Table 2 indicate that the Ethereum blockchain dominates the token market, with 73 percent of tokens using the ERC20 smart contract. ERC20 refers to an off-the-shelf Ethereum protocol that standardizes issuance, distribution, and control functionality of tokens. Knowing that a token is ERC20 compliant provides information about its reliability and interoperability with other systems. ERC20 tokens can be specialized to a platform's needs. For example, the issuer may want to bar some class of agents from spending its token. The Waves blockchain is a distant second, hosting five percent of the ICOs in our sample. Fifty-one percent of ICOs disclose a fundraising goal. We are able to ascertain whether this goal is achieved for 419 token offerings, and of these, 52 percent meet their goal. Fourteen percent of ICOs give tokens away for free, a strategy for building interest known as an airdrop.

More than three quarters of ICOs place a cap on the number of tokens sold (the number sold is akin to the public float in an IPO). Some capped sales have been grossly oversubscribed, creating an incentive to buy just as the sale starts, which can lead to blockchain congestion and high transaction fees. In an uncapped ICO, buyers do not know what share of total supply a token represents. Fourteen percent of issuers may issue more tokens after the ICO, expanding the total supply (this parallels IPOs, where issuers can conduct secondary equity offerings). On average 53 percent of total token supply is sold in an ICO, including both capped and uncapped deals. ICOs sometimes occur essentially instantaneously, while at the other extreme some have lasted for multiple years. The average duration is 40 days. These statistics are in Table 2, Panel 1.

Most ICOs in our data sell tokens on a fixed price and first-come, first-served basis. Thirty-three percent of ICOs use dynamic pricing, where the price changes during the ICO in a pre-determined way. Nine percent have a price that is sensitive to demand (i.e., changes during the ICO in a way that reflects demand), and five percent use an auction mechanism.[20] For example, Gnosis and Viva used auctions in which the number of tokens sold was unknown and depended on the lowest successful bid. The infrequency of auction mechanisms may

[20]Cerezo Sánchez (2017) is one of the few papers to date that considers the optimal design of an ICO auction. To the extent that breathless coverage and pricing mechanisms that benefit early buyers create a "fear of missing out" and attract investors who lack knowledge about the intricacies of blockchain technology, there is abundant opportunity for scams. See https://www.theatlantic.com/technology/archive/2017/05/cryptocurrency-ponzi-schemes/528624/.

seem puzzling to economists, as auctions are an efficient way to allocate a scarce resource. Auctions are also rare among IPOs (Kutsuna and Smith 2003). Their rarity among ICOs suggests that rather than regulatory institutions, inertia, or other features of the complex IPO process explain their rarity; this appears to be a fruitful avenue for future research.

2.8.1 Github and social media characteristics

Publishing source code is a powerful form of transparency, which also leverages the wisdom of the crowd to identify bugs and improve quality. Github is the dominant web-based repository hosting service for computer code. We identify a main repository containing the token contract for 301 ICOs, or 67 percent of detailed sample of 450. As shown in Table 2, Panel 2, the average main Github repository has more than 2,000 commits (revisions), 11 branches (pointers to specific versions), 30 releases (official new versions of the software), and 49 contributors (people who are not organization members but contribute to the project). We use the number days from the last commit as a proxy for ongoing engagement with the software; a higher number of days implies less user engagement.[21]

Token issuers use social media to communicate with stakeholders primarily on two platforms, Telegram and Twitter. Telegram is a cloud-based messaging application with a focus on security and speed. Accounts are tied only to phone numbers. Telegram's own source code is publicly available and, to some degree, open-source. As a result of this and perceived independence from large companies and governments, it has become a preferred platform for the crypto community. Eighty-three percent of the ICOs in our sample have a Telegram group, and among this subset, the average group has more than 5,000 members (Table 2, Panel 2). Ninety-seven percent of the sample has an official Twitter account, which has on average 22,200 followers.

[21]Specifically, this is the number of days between the last commit prior to April 11, 2018 and April 11, 2018.

2.8.2 ICO industry sectors

We assign each issuer to one of 12 industry sectors, shown in the left column of Table 3.[22] The largest category is Non-Crypto Marketplaces and Services, with 18 percent of issuers. One example in this category is Paragon, which raised $70 million to build "a community dedicated to the worldwide legalization and systematization of cannabis" and later became a high-profile target of SEC enforcement in November 2018. The second largest sector is Asset Management / Other Crypto Financial Services, with 15 percent of issuers. One example in this category is Bloom, a platform for identity attestation, risk assessment and credit scoring that raised $41 million. An interesting category is Smart Contract Creation, with 5 percent of issuers. An example of a smart contract ICO is Agrella, which raised $29 million and plans to enable users to create and manage legal agreements that automate obligation fulfillment (e.g. payment).

To explore what types of ventures use ICOs instead of traditional financing, we collect data from the CB Insights database on startups using blockchain technology that receive seed or VC investment. We are able to assign most of the VC-backed startups into one of the 12 ICO sectors, and data reflecting these assignments appear on the right side of Table 3. Two sectors are much better represented among VC-backed startups than among ICO issuers: Payments and Wallets, and Enterprise, Health and Identity. This reflects more frequent orientation of VC-backed blockchain startups toward businesses rather than consumers.

We also categorize the VC-backed startups as either having a business-to-business model or a business-to-consumer model. We find that 43 percent have a business-to-business model, while essentially all ICO issuers in our sample target atomized consumers and are usually building two-sided marketplaces (see the theory in Garratt and van Oordt 2019). These differences indicate selection by start-ups into different types of financing. Enterprise-focused blockchain startups such as Digital Asset Holdings are more likely to fund themselves with VC, while decentralized, consumer-focused platforms are more likely to issue tokens, as they may not be well suited to conventional equity and debt instruments.

[22]Sector categories were developed on the basis of detailed analysis of a subset of 60 ICOs, and researchers then applied these categories to the whole sample.

2.9 ICO success measures

This paper aims to establish predictors of success in the ICO market. We focus on two types of information to evaluate whether an ICO is successful: the operational progress of each token's parent organization and the trading performance of each token. The first real outcome success measure is employment, defined as individuals who identify as employees of the issuer on LinkedIn as of November 2018. Table 4 shows that the mean of this variable is 12.6, and the median is 3. Second, we use an indicator for whether the ICO issuer has failed by November 2018, which is the case for 30 percent of the sample (Table 4).[23]

We use two measures of financial market success, which require the token to have listed on an exchange. The first is liquidity, which is an advantage of ICOs compared to conventional financing instruments such as the preferred stock used in VC contracts. Liquidity proxies for market depth and interest, which is useful for new ventures that typically lack operating histories. A number of ICO theory papers further help to motivate our choice of liquidity as a measure of ICO success. For example, Sockin and Xiong (2018) point out that token trading enables information aggregation from potential customers about demand for a platform's service. Lee and Parlour (2018) focus on ICOs as a type of crowdfunding with a resale market. The liquidity in the resale market (which is facilitated by speculators) means that consumers need not charge the firm a liquidity premium as they do in conventional crowdfunding.

Our primary liquidity measure is price impact, based on the standard illiquidity measure for low-frequency trading data (see Amihud 2002 and Amihud, Mendelson and Pedersen 2006). This statistic, shown in equation 1, gives the volume needed to move the price by 1 percent. We take the average of this statistic over the last five days:

$$Illiquidity_t = \frac{1}{5} \sum_{t=t-5}^{t} \frac{\left|\log\left(\frac{p_t}{p_{t-1}}\right)\right|}{p_t volume_t} \tag{1}$$

Earlier research shows this statistic to perform well in measuring price impact with daily data (Goyenko et al. 2009, Hasbrouck 2009). For ease of interpretation, we negate the log of this illiquidity measure and term it liquidity.

[23]We classify an ICO as failed if the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists (if it ever did).

We also use the trading volume of each token ($p_t volume_t$). This is the 24-hour U.S. dollar volume over the past five days. In traditional asset markets, agents have nothing to learn by observing trading volume. However, in crypto asset markets volume imparts important information, because consumers' decisions to join token-based platforms depend positively on token trading volume. Sockin and Xiong (2018) conclude that "any fundamental analysis of the cryptocurrency should look beyond prices and to volumes as an anchor." However, frequent allegations about inflated "fake" volume totals on certain crypto exchanges provide a reason to be cautious about interpreting empirical work that relies too heavily on volume data without studying other success measures as well.

Table 4 shows summary statistics for liquidity and volume measured seven, 28, 140, and 168 days after the start of trading (the latter three correspond to one, 5, and 6 months). Our regressions use 140 days, but the results are not especially sensitive to the time period. Figure 3 contains scatter plots of our liquidity and volume measures over time and shows that both have increased steadily, albeit with wide dispersion. In Table 5, we compare ICO token liquidity to that of NASDAQ stocks and find that after controlling for volatility, volume, and price in a Fama-MacBeth regression, ICO tokens are 7 percent less liquid than a conventional benchmark.[24]

3 Advantages of ICOs

As a new finance instrument, what do ICOs offer that other entrepreneurial finance methods do not? That is, why would a venture use an ICO rather than a traditional instrument? This section discusses six advantages of ICOs: (i) financing the development of decentralized networks; (ii) securing commitment from future customers and gauging their demand; (iii) establishing immutable, non-negotiable governance terms; (iv) providing rapid liquidity; (v) hastening network effects; and (vi) reducing transaction costs. Explaining these advantages

[24]We compare ICO tokens to NASDAQ stocks between January 2015 through November 2018. Table 5, Panel 1 shows that NASDAQ stocks have much higher liquidity and lower standard deviation than ICOs. We test whether this reflects basic characteristics of the assets in the following regression, where t denotes a week and i an asset: $Liquidity_{i,t} = \alpha + \beta ICO_i + \gamma_1 Volatility_{i,t-1} + \gamma_2 Volume_{i,t-1} + \gamma_3 log(Price_{i,t-1}) + \varepsilon_{i,t}$. The weekly estimates are averaged in Fama-MacBeth format. Table 5, Panel 2 shows that after controlling for volatility, volume, and price, the ICO indicator coefficient is -1.2, implying that ICO tokens are 7 percent less liquid than a conventional benchmark.

provides context for what "success" means, the question that we consider empirically in Section 4 below.

3.1 Financing development of decentralized networks

Instead of value accruing to network sponsors or intermediaries, as is the case with equity-funded startups such as Facebook and Google, it is possible for a blockchain network's value to accrue to its token holders, who are diffuse future contributors and users of the blockchain. Popper (2016) points out that this can remunerate creators of content for open source applications, which have traditionally relied on volunteer work (e.g. Wikipedia and Unix). That is, an ICO compensates initial developers without giving them more control of the network than any other token holders (Canidio 2018). After the network launches, a native token can also incentivize platform helpers, such as validators.

A utility token faces a tension between two adverse outcomes. On one hand, the ability of an ICO to jump-start network effects may be undermined if token holders perceive more value from holding rather than using the tokens. On the other hand, if a utility token's value does not rise with the network's value, there is no reason to hold it at all, and extremely high velocity will put downward price pressure on the token. While the technology is still evolving, one approach to resolving this tension is a token whose value is tied to work that maintains the network. To illustrate, consider Augur, a decentralized prediction market that has been functional since 2016. Betting and payouts are conducted using Ether. Augur's token, REP, is used to identify the true outcome for any market in a decentralized manner. Suppose a market exists to guess whether the Patriots will win the 2019 Super Bowl. After the game ends, Augur's oracle process will come to consensus about whether the Patriots won. Anyone can stake REP to report on the outcome. The reporter receives her REP back plus a portion of the reporting fee if her report is the same as the majority. The fee is a function of how much has been staked and is also set such that the overall market capitalization of REP is at least five times the value of open interest in markets. If her report deviates from the crowd's, she loses her tokens, which elicits honest reporting. With higher demand, more revenue accrues to reporters, who then are willing to stake more for the right to report. A significant fraction of tokens is locked up at any given time through these stakes, preventing excess velocity.

It is possible for a token to both be used to "work" for the network and also be used by customers. An example is the Filecoin network, described in the Appendix. There, customers are not expected to hold tokens for long. Instead, the service providers hold tokens and are therefore more likely to participate in platform governance. This is similar to producer-owned cooperatives, such as the farmer-owned agricultural co-ops discussed in Hansmann (1996). The result is that, in theory, the value of the token will scale neither too fast nor too slow with the network's value.

3.2 Securing commitment from future customers

A second advantage of ICOs is that they permit a venture to raise financing from future users, similar to the pre-sale of goods via crowdfunding. This contrasts with conventional equity, where investors have claims on future cash flows and are generally distinct from intended customers. Raising capital from customers could potentially redistribute network growth gains from financial intermediaries such as VCs to developers and consumers. It also helps to promote the brand among consumers and provide the issuer with an early signal about demand (Demers and Lewellen 2003, Catalini and Gans 2018). Some have therefore heralded ICOs as a means to "democratize" access to investment opportunities in new ventures.[25] However, conventional institutional investors such as hedge funds and VCs are purchasing an increasing share of tokens, especially in the most sought-after ICOs, raising concerns that utility tokens are held mostly by speculators rather than future customers.

In Li and Mann (2018)'s model, users purchase tokens to make a credible commitment to use the platform. It is precisely because the token is worthless outside of the platform that its purchase offers a credible commitment to spend the token later on the platform. Their theory also suggests the presence of speculators does not detract from the ability of utility tokens to resolve coordination problems; speculators would only purchase tokens if they believed that the tokens would ultimately be held and spent by platform users. An alternative theoretical

[25]For example, Sam Altman, the president of Y Combinator, a well-regarded startup accelerator in Silicon Valley, said in 2017 that "We are interested in how companies like Y Combinator can use the blockchain to democratize access to investing." See https://www.coindesk.com/y-combinator-sam-altman-icos-bubble/.

justification for speculation appears in Cong et al. (2018b). They argue that an important aspect of ICOs is expected price appreciation, which helps to accelerate adoption and network effects by making token ownership attractive to potential early users.

3.3 Establishing immutable governance terms

A third advantage of ICOs arises from the credible commitments that an issuer makes to token scarcity and governance through the immutable token creation contract. Once the token contract and platform are launched, the platform can exist independently of the issuer. Catalini and Gans (2018) consider utility tokens that will serve as the medium of exchange on a platform and have no governance or future cash flow rights. However, their model raises several concerns about ICOs as a fundraising mechanism. Similar to the theory in Canidio (2018), they argue that the ability to issue tokens in the future (i.e., earn seigniorage revenue) creates commitment problems.

3.4 Providing rapid liquidity

ICOs provide start-up investors with early liquidity, because the tokens are easily transferable. Liquidity increases dramatically if the token is listed on a cryptocurrency exchange, where it is tradable for other cryptocurrencies or for fiat currency. The liquidity feature of tokens differs sharply from the preferred equity used in VC or the pre-sale contracts used in crowdfunding. Instead, this benefit is a key parallel between IPOs and ICOs (Zingales 1995). Liquidity is not guaranteed, however; as shown in our data, 47 percent of ICO tokens never become exchange-traded, and even if the token is listed, its liquidity may prove to be low or non-existent.

3.5 Hastening network effects

Another benefit of ICOs is that tokens hasten network effects. Token holders are motivated to help the platform succeed either by using tokens directly or contributing (e.g. finding bugs or adding features). This advantage highlights the dynamic aspect of token value, emphasized in the model in Cong et al. (2018a), where expected token price appreciation leads more users to join the platform. Bakos and Halaburda (2018) model the sale of platform-specific utility tokens in an ICO as useful if pre-selling the token can help solve a coordination problem among prospective users – i.e., to jump-start one-sided network effects. The incentive to pre-join in order to benefit from token appreciation is an important differentiating feature of ICO models relative to conventional network effects.

Establishing network effects quickly is particularly important in this setting, because decentralized applications are often easily imitated. Of course, token holders may hoard their tokens if they expect their value to appreciate. Platforms therefore often have mechanisms for issuing tokens in the future or releasing existing supply from a reserve inventory.

3.6 Reducing transaction and regulatory costs

A final benefit of using a token on the platform instead of fiat currency is lower transaction costs, especially when agents exist in multiple countries. Other conventional currency services, such as the need for a common unit of account or the desire of the issuer to collect seigniorage, could be accomplished without a native token. Indeed, low transaction costs alone do not motivate a native token, as the platform could alternatively use Bitcoin or Ether.

Relatedly, thus far a benefit of conducting an ICO is that the transaction and regulatory costs have been essentially zero, in striking contrast with IPOs, which impose large underwriting and legal costs. Disclosure has also been entirely voluntary, in contrast to the large amount of disclosure required for listed, public companies. However, increasing regulatory scrutiny of the sector appears to have made the low regulatory burden a fleeting phenomenon, and ICO issuers now frequently use token sale strategies that explicitly acknowledge the instrument is sold as a security and aim to comply with existing securities laws (see Section 2.1).

4 Analysis of ICO success factors

We study the factors associated with ICO success using variants of Equation 2:

$$Success_{i,t} = \alpha + \beta' \mathbf{X_i} + \gamma BTCPrice_t + \tau_t + Sector_i + Country_i + \varepsilon_{i,t} \tag{2}$$

We regress success measures on a vector of characteristics $\mathbf{X}_i$, which are generally not time-varying. All except the social media variables are observed before the start of trading. We include the price of Bitcoin and fixed effects for the calendar quarter that the ICO started (τ_t), both of which help to control for market sentiment. Finally, our main models also include indicator variables for industry sectors and for the top nine countries by number of ICOs, as well as an indicator for being dispersed across at least five countries. There are some ICOs for which we were unable to identify a country or sector, so the models with these fixed effects have slightly smaller samples. Standard errors for the regression estimates are clustered by the quarter in which each token begins trading.

4.1 ICO characteristics and issuer real outcomes

We begin our analysis of ICO success factors by studying how the future employment and failure rates of ICO issuers are associated with important characteristics of the parent organizations and their top managers.

4.1.1 Issuer and founder/CEO characteristics

The first three columns of Table 6 show estimates from OLS regressions in which the log of one plus future employment is projected on proxies for issuer quality, transparency, and credibility. Like most of our regression models, Column 1 includes fixed effects for calendar quarters in which each ICO starts, to control for time-series shocks that affect ICOs at their start date. The second column of Table 6 adds sector and country fixed effects. In Column 3, we use fixed effects for the week of ICO start rather than the quarter, to show that the main results are not driven by time variation within a specific quarter. Similar regressions with the probability of issuer failure are in Columns 4-6. Column 4 estimates a logit model, which drops fixed effect groups without successes, so the sample is slightly smaller. Standard errors for the regression estimates are clustered by the quarter in which each ICO starts.

The first row of Table 6 shows that token utility value predicts issuer success. For example, the coefficient of 0.131 in Column 2 implies that utility tokens are associated with a 14 percent increase in employees.[26] This result is consistent with theory. First, Li and Mann (2018) argue that ICOs can create economic value if the issuers sell utility tokens that promote network effects on a new platform. Second, Cong et al. (2018a) focus on how network effects interact with token price dynamics. They argue that tokens can help accelerate network adoption when the value of the network increases in its number of users. While they do not explicitly discuss utility tokens, the dependence of token value on the size of the user base suggests that the token is used as a medium of exchange or to purchase a product/service. Third, Lee and Parlour (2018)'s model, in which an ICO is essentially a means of crowdfunding, requires the token to have utility value. The positive correlation between utility value and real outcomes is also relevant to the regulatory debate about ICOs (see Section 2.1), as some observers argue that utility tokens should not be regulated as securities.

Voluntary disclosure is also associated with success. Publishing a white paper and a budget for use of proceeds both predict higher employment and lower risk of failure (Table 6). The importance of disclosure that is not required by law speaks to the longstanding academic debate about the effectiveness of voluntary vs. mandatory disclosure. For public securities offerings in the U.S., disclosure has been required since the 1933 and 1934 securities acts, but critics view these rules as costly and inflexible (e.g. Easterbrook and Fischel 1984). If disclosure were voluntary, according to this critique, companies would still choose to release information to the market, but each issuer would tailor its releases to its own needs and circumstances, potentially increasing the volume and variety of information reaching the market. The diverse and extremely frequent white paper disclosures by the ICO issuers in our sample seem to reflect this type of outcome. Our results suggest that ICO issuers are mindful of the importance of transparency, consistent with literature on IPOs showing that

[26] When the dependent variable is logged, and coefficients are greater than 0.1, the correct percent interpretation is $100 * (e^{\beta} - 1)$.

attempts to reduce information asymmetry or agency costs make fundraising more successful (Healy and Palepu 2001, Loughran and Ritter 2002).

We find strong evidence that bonding to reduce agency costs is relevant to success. Indicators for setting aside an incentive pool of tokens and using insider vesting schedules always have the expected signs and are uniformly significant. Most importantly for bonding, vesting is associated with 34 percent more subsequent employees (Table 6, Column 2). Relatedly, prior VC investment in the issuer is among the strongest and most significant predictors of future employment, as it predicts a 71 percent increase in employees (Column 2). This result parallels papers in the IPO literature that have found a positive relation between VC backing and post-IPO success, such as Baker and Gompers (2003) and Hochberg (2011). Catalini and Gans (2018) note that a challenge for the ICO model is that the issuer may raise insufficient capital to cover its costs of development. They suggest this latent funding need helps explain why ICO issuers sometimes raise VC before the ICO. Our finding that previous VC strongly predicts success supports their hypothesis, though of course it is also consistent with a variety of other mechanisms, including simply being a proxy for quality. Prior VC reduces the probability of failure by just 6.5 percent, significant at the .01 level (Column 6). The asymmetry between success (employment) and failure is consistent with VCs investing in a highly skewed portfolio, in which there are (hopefully) a few home runs, and many failures (Ewens, Nanda and Rhodes-Kropf 2018).

Finally, the background of the issuer's founder/CEO also matters for operational progress. The strongest result is that entrepreneurial experience is associated with 26 percent more employees (Table 6, Column 2). Like VC, this result is not symmetric; it has no relationship with failure. Experience in computer science differs: it predicts a 10 percent increase in employment, and a 3.5 percent decrease in the probability of failure, both highly significant at conventional levels (Columns 2 and 6). Evidence in other studies shows that the quality of a startup's founding team is the most important factor in attracting early stage angel and VC investment capital (Gompers et al. 2016, Bernstein, Korteweg and Laws 2017, Howell 2019), and our results show that founder quality affects ICO capital raising as well.

4.1.2 Exchange listing and future employment

The results thus far show relationships between issuer characteristics and real outcomes. In the following section, we consider financial outcomes, which are conditional on the token listing on an exchange. To bridge the two analyses, we examine factors that predict listing on an exchange. Further, noting that listing is itself an interesting characteristic, with a strong connection to token liquidity, we instrument for listing and demonstrate that it causally affects future employment. (We found no instruments for the other issuer and ICO process characteristics.)

First, in Table 7, we show estimates of variables that predict listing; in general, the results are similar to Table 6. Utility token, incentive pool, insider vesting, VC backing and computer science founder experience predict listing. Second, we estimate a two-stage least squares model. The instrument for token listing is price changes in the Ethereum Classic (ETC) token around the time of an ICO.[27] As noted above, the large majority of ICOs occur on the Ethereum blockchain and also accept Ether (ETH) as payment. One barrier to being listed on an exchange is the high fees that exchanges charge for the opportunity. These have been reported to range from $500,000 to $1 million, and they appear to correlate with market sentiment. Since issuer wealth is tightly tied to ETH, high ETH prices may predict the ability or willingness to pay to list on an exchange. This relationship should be most pronounced when listing fees are high. To proxy for high exchange fees, we use the period in which market sentiment (i.e., the crypto bubble, measured with Bitcoin prices) was at its highest, from November 2017 to April 2018. We segment the sample into high and low Bitcoin price groups.

ETH itself as an instrument raises a concern about the exclusion restriction, which would require that ETH price movements cannot independently affect employment. The ETH

[27]We measure the change in ETC prices as the 90th percentile of ETC prices between 23 and 43 days after the start of an ICO, relative to the average ETC price 30 days before the start of the ICO. In this case, 23- and 43-day cutoffs are the 25th and 50th percentiles for how long it takes for tokens in our dataset to list on an exchange. The results are not very sensitive to selecting other thresholds. The analysis includes 1,404 ICOs for which we can calculate the ETC price change. This is smaller than the 1,519 in the overall sample because there are 50 tokens issued before ETC was available and 65 without a start date. Of the 1,404, 570 eventually became listed on an exchange, and 834 did not. For the post-ICO price, we use the 90th percentile to capture the spikes in prices. Again, our results are similar if we use the 75th or the 95th percentiles, for example.

price is partially driven by ICO activity, because so many ICOs are ERC20 tokens and accept payment primarily in Ether, as explained in Section 2.8. We therefore use a different cryptocurrency, ETC. ETC was created in 2016 as a controversial hard fork from ETH. It is strongly correlated with ETH because of their common design and shared heritage. While market conditions on the ETH blockchain are an important factor in launching ICOs, the market conditions on the ETC blockchain have little or no relevance, since no tokens are hosted there. Therefore, the IV requirements of relevance condition and the exclusion restriction are likely to be satisfied when using ETC price changes as the IV.

Table 8 shows 2SLS estimates for a model in which employment (specifically, log of one plus future employment) is the dependent variable, and token listing is the independent variable of interest. We also include the key issuer characteristics as controls. Columns 1-3 show results for the entire sample, Columns 4-6 for the high Bitcoin price group, and Columns 7-9 for the low Bitcoin price group. In each case, the first column shows the naive OLS relationship between listing and employment. The second and third columns contain the first and second stages of the two-stage least squares IV estimation, respectively. In the overall sample, listing is associated with a 29 percent increase in the number of employees, significant at the .01 level. In the first stage, ETC price changes robustly predict listing, but the magnitude is small and the F-statistic is smaller than the weak instrument rule-of-thumb threshold of 10. In the second stage, we observe a large coefficient of 1.6, but it is not significant. In the high bitcoin price group, as expected we observe a much stronger first stage, with an F-statistic of 13. In the second stage, the coefficient of 1.2, significant at the .1 level, indicates that listing causes a 232 percent increase in the number of employees (Column 6). This is almost four times the size of the OLS estimate in Column 4, which implies a 60 percent increase.

The larger IV effect indicates that the subset of listings sensitive to the ETC price lead to higher employment than the average ETC price increase captured by the OLS regression. This could reflect endogeneity that biases the OLS result downward. Alternatively, the local average treatment effect for compliers with the instrument may be larger than the population average treatment effect. As Jiang (2015) explains, this can lead to a larger IV effect even if the exclusion restriction is satisfied. In our context, it seems possible that some issuers are very strong or very weak and will have good or bad outcomes regardless of whether their token lists or not. The IV captures the marginal issuers, whose listing status is sensitive to the ETC price. Their future success depends more on the liquidity enabled by exchange listing.

We believe this result is among the more important ones in the paper, as it indicates that when a token sold in an ICO succeeds in being listed on a cryptocurrency exchange, the liquidity and reputation benefits of listing causally increase issuer employment, indicating that it helps to build real economic activity in the crypto sector. In related work, Amsden and Schweizer (2018), De Jong et al. (2018), Boreiko and Vidusso (2018) and Deng et al. (2018) study listing predictors, and also find that disclosure and VC backing are associated with listing.

4.2 Liquidity and trading volume

We study financial measures of success – token liquidity and volume – in Table 9, using the same specifications as in Table 6. Four variables strongly predict liquidity and volume, while the others do not at all. First, voluntary disclosure through a white paper positively predicts both liquidity and volume. For example, Column 2 implies that having a while paper is associated with a 500 percent increase in liquidity. We also find positive, highly significant estimates for insider vesting schedules and the prior raising of venture capital by token issuers. These estimates are consistent with the importance of the issuer taking bonding and certification steps to reduce the costs of asymmetric information. Finally, founder entrepreneurial experience is associated with an 84 percent increase in liquidity, and a 67 percent increase in volume (the other professional backgrounds have no significant effects). In general, these results are consistent with our findings in Table 6 about which characteristics matter for future employment and ICO completion.

Two other papers use a version of the Amihud (2002) illiquidity statistic. Bourveau et al. (2018) finds that illiquidity is higher when the white paper is opaque and the management team lacks a record of past success, both results similar in spirit to ours. Lyandres et al. (2018) also study token liquidity but estimate only narrow regression models focused on social media (see Section 4.5 below) and market characteristics. Florysiak and Schandlbauer (2018), the only other paper to have examined ICO trading volume, finds almost no significant associations between volume and a range of explanatory variables related to the quality of white paper disclosures.

4.3 Operating sectors

Table 10 presents regression estimates of associations between our four measures of ICO success, based on both operational progress and financial market depth, and indicator variables for the 12 industry sectors introduced in Table 3 above. Based upon these estimates, two of the less popular sectors stand out as the ones most significantly associated with successful ICOs: the advertising and loyalty rewards tokens, listed in the top row of the table, and tokens issued by organizations developing new blockchain protocols. We also find that tokenizing real assets has a strong positive relationship with employment, and a negative relationship with failure. This likely is linked to the increasing apparent viability of what is often called the "security token" business model (Kharif 2019).

Our result that new blockchain protocols are among the most robust predictors of all of our success proxies appears to support the model in Chod and Lyandres (2018), which focuses on the tradeoff between diversification and monitoring from the perspective of a potential investor. The authors compare the ICO model to the conventional VC model; while VC investors are poorly diversified, they can monitor the venture closely and thus reduce underinvestment induced by agency conflicts (since the entrepreneur chooses the investment level after raising money). Their model predicts that an ICO will dominate VC when the issuer's payoffs are highly right-skewed. We do not have a direct measure of issuer uncertainty, but it seems likely that issuers building new blockchain protocols (rather than issuing an ERC-20 token that is part of the Ethereum blockchain) have more right-skewed payoffs.

This is because new blockchain protocols usually intend to be the infrastructure for diverse applications. They may be riskier investments than tokens tied to a narrow product or service, but their potential for value creation seems much larger, because they can become the infrastructure for potentially widespread and diverse applications. Whereas value has not accrued to the infrastructure layer of the Internet, the tie between the token and the network in a blockchain ensures that the two have correlated value, at least in theory. The potential of a new blockchain is like the value that Facebook created as the underlying network, relative to the value of applications such as games that developers have built for use on Facebook. Consistent with the hypothesis that new blockchain protocols are likely to be better suited to ICOs than to VC, Table 3 shows that they comprise six percent of ICOs compared to two percent of VC-backed blockchain startups, a difference that is highly significant.

4.4 ICO design choices

We study the importance of ICO design features in Table 11, again using all four of our dependent variables related to both operational progress and market liquidity. The independent variables are mostly from the subsample of 450 tokens that trade for at least 90 days, as of April, 2018, after achieving an exchange listing. Due to the costs and time required for data collection, most of these variables have not appeared in other ICO empirical papers except for the pre-sale indicator, which is used as a control variable by many authors.

One of the most consistent and also unsurprising results is that ICOs which accept ETH tokens as payment – about two-thirds of the sample – are associated with higher trading volume and liquidity as well as higher future employment. The large majority of this subgroup would use the ERC20 token template, a design choice that many potential investors are likely to find reassuring due to its wide adoption in the marketplace. ICOs with dynamic pricing, in which the sale price escalates during the transaction, also are associated with better liquidity, trading volume, and future employment at the issuer. The pre-sale indicator is associated with higher future employment, and surprisingly, tokens that attempt to bar U.S. investors seem to be more successful on several fronts.

At the bottom of Table 11, we add estimates for additional variables related to the amount raised in the ICO and use these variables in an alternative regression model of future employment. All of these variables are available only for 254 observations out of our detailed sample of 450 ICOs. Token issuers that raise greater amounts (as measured in the USD equivalent) are able to have more staff on their payrolls as of late 2018, and the same is true of those token issuers that have the shortest elapsed time between ICO completion and token listing.

4.5 Social media

In Table 12 we analyze the importance of social media as a factor in ICO success. Publishing code on Github and having a Telegram group are strongly associated with all four success measures. For example, posting code on Github increases employment by 72 percent, and decreases the probability of failure by 11 percent. We find more limited evidence in support of the importance of Twitter, although the number of Twitter followers of the issuer is positively associated with its future employment.

We gather detailed data about Github for subsample of 236 tokens for which the ICO's source code is posted on Github. Most of the Github variables exhibit no significant associations with future employment. An exception is the negative and significant relationship between days from last commit and future employment. A longer time since the last revision indicates that the code is not being actively worked on, and this may signal that the issuer is abandoning or not prioritizing the project.

5 Conclusion

This paper studies the market for ICOs, which grew rapidly from mid-2017 through mid-2018 and emerged as a vibrant alternative channel for start-up financing. We study a sample of more than 1,500 ICOs that collectively raise the equivalent of $12.9 billion. Our dataset, which includes hand collected data about ICO design features and offering mechanisms, provides new insights into how the market operates and the design tradeoffs faced by ICO issuers.

We examine ICO success in two dimensions, whether the ICO issuer makes operational progress, as measured by future employment and an indicator for failure of the venture, and whether the ICO token achieves wide market adoption, as measured by liquidity and trading volume. Tokens designed with a utility feature enabling the access of future products and services appear to be the most successful in helping the issuer avoid failure and achieve higher levels of future employment. Other variables related to voluntary disclosure, bonding, and certification are also associated with future ICO success, and an instrumental variables analysis shows that successful ICO listing helps cause higher levels of future employment. Market adoption is also higher for ICO issuers that engage in similar types of disclosure and bonding. Promotion of ICO ventures through Github and Telegram social media platforms is associated with both operational success and financial market adoption.

Our paper contributes to a rapidly growing literature about ICOs. While some ICO success factors reflect classical corporate finance predictions about the importance of reducing information asymmetry and engaging in bonding, others tend to support new theoretical models that illuminate ICOs' unique potential to promote customer adoption and loyalty while raising capital from a new class of investors.

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Table 1: ICO issuer characteristics

Panel 1: Sample summary

	N
Total sample	1,519
Completed ICO	1,265
Listed on exchange	671

Panel 2: Issuer characteristics

	N	Mean	S.d.	Min	Median	Max
Amount raised (USD millions)	551	23.34	181.40	0.00	8.52	4234.28
Days from ICO start to first trading date	595	54.42	82.13	0.00	44.00	1071
Token has apparent utility value	1,519	0.53				
Had a pre-sale	1,519	0.43				
Had a white paper	1,519	0.86				
Incentive set aside	1,519	0.43				
Founder token vesting schedule	1,519	0.22				
Had a budget for use of proceeds	1,519	0.42				
Venture capital-backed	1,519	0.09				
Stated goal to raise	1,519	0.51				

Panel 3: Issuer founder/CEO characteristics

	N	Mean
Male	1,016	0.96
Professional background in crypto	963	0.29
Professional background in financial services	963	0.33
Professional background in computer science	963	0.48
Professional background in entrepreneurship	963	0.58

Note: This table contains summary statistics about issuers for all the ICOs in our data. Where the sample is smaller than 1,519, data were not available for the remaining ICOs. Panel 1 enumerates our whole sample, the number that completed (i.e., ICO was not canceled mid-sale), and the number that listed on a cryptocurrency exchange. Panel 2 describes key characteristics we collected about issuers. Panel 3 contains characteristics of the CEO or lead founder of issuers. Data were gathered from issuer websites, technical white papers, news articles, and LinkedIn.

Table 2: Token and ICO process characteristics

Panel 1

	N	Mean	S.d.	Min	Median	Max
Token on Ethereum blockchain	450	0.73				
Token on Waves blockchain	450	0.05				
Airdrop (token price was $0)	450	0.14				
Capped (limit on number tokens sold)	450	0.76				
US investors barred	450	0.19				
Future token creation	450	0.14				
Dynamic pricing (price changes during ICO)	450	0.33				
Sensitive pricing (price changes during ICO reflect demand)	450	0.09				
Auction pricing	450	0.05				
Accepted USD as payment	450	0.10				
Accepted Euros as payment	450	0.03				
Accepted Bitcoin as payment	450	0.41				
Accepted Ether as payment	450	0.66				
Accepted XRP as payment	450	0.02				
Accepted Litecoin as payment	450	0.09				
Accepted Waves as payment	450	0.04				
Met goal if had stated goal	419	0.52				
Amount raised less stated goal, if any (USD mill)	419	-8.45	36	-279	0	160
Fraction total token supply sold in ICO	283	0.53	0.32	0.00	0.54	1.00
Duration of ICO in days	366	40.10	89.58	0.00	28.0	948
Number of currencies accepted	358	2.07	1.76	1.00	1.00	15.0

Panel 2: Issuer Github and social media characteristics

	N	Mean	S.d.	Min	Median	Max
Has Github source code repository	450	0.67				
Number of repositories	301	15.56	33.64	0.00	6.00	399.00
Main repository: Number of commits (000s)	301	2.02	6.38	0.00	0.18	92.73
Main repository: Number of branches	301	10.95	30.91	0.00	3.00	361.00
Main repository: Number of releases	301	29.63	96.05	0.00	0.00	1291.00
Main repository: Number of contributors	301	49.5	144.7	0.00	5.00	2041.00
Main repository: Days between last commit and April 11, 2018	288	262.88	448.17	0.00	111.00	3233.00
Has Telegram group	450	0.83				
Number of Telegram group members (000s)	356	5.07	9.30	0.01	2.03	88.34
Has Twitter page	450	0.97				
Number of Twitter followers (000s)	430	22.26	53.46	0.01	6.76	741.00

Note: This table contains summary statistics about the token and ICO process. Data were gathered for a subset of 450 ICOs that listed on an exchange and traded for at least 90 days as of April 2018. Data for Panel 1 were gathered from issuer websites, technical white papers, news articles, and LinkedIn. Panel 2 contains data about the issuer's Github presence and about the issuer's social media presence, gathered from Github, Telegram, and Twitter. Github is a web-based repository hosting service for, primarily, computer code. Repositories contain public source code about a project. The main repository contains the token/ICO contract. The platform enables open source development, version control, and broad-based collaboration. The remaining rows include only those ICOs with a Github source code repository. Telegram is a cloud-based mobile and desktop messaging application with a focus on security and speed. Accounts are tied only to phone numbers. Its "group" chats permit 100,000 members, and enable simple message broadcasting. Telegram's own source code is publicly available and, to some degree, open-source. As a result of this and perceived independence from large companies and governments, it has become a preferred platform for many in the crypto community.

Table 3: Exchange-traded ICO issuer sectors and VC-backed blockchain startup sectors

	ICO issuers				VC-backed blockchain startups					
	Total #		Amount raised		Total #		Amount raised		P-values	
	N	Share	N	Ave $	N	Share	N	Ave $	Shares	Amt raised
Ads, rewards	51	0.05	31	18.6	20	0.03	16	4.45	0.07	0.01
Asset mgmnt & other crypto fin services	174	0.15	92	20.2	132	0.19	109	4.04	0.05	0.00
Data storage/computing	67	0.06	41	18.5	38	0.05	30	4.53	0.65	0.03
Enterprise, health, identity	73	0.06	26	12.3	112	0.16	83	3.52	0.00	0.00
Gaming, entertainment, messaging	153	0.14	65	9.26	31	0.04	23	15.2	0.00	0.43
New blockchain protocol	67	0.06	40	126	17	0.02	15	20.7	0.00	0.55
Non-crypto marketplace/service	206	0.18	101	11.9	41	0.06	27	6.69	0.00	0.20
Payments, wallets	106	0.09	46	20.2	194	0.28	165	4.85	0.00	0.00
Prediction markets and gambling	23	0.02	15	8.44	5	0.01	3	6.23	0.03	0.70
Smart contract creation	56	0.05	28	18.4	11	0.02	7	1.18	0.00	0.22
Tokenizing real assets	46	0.04	13	11.3	9	0.01	7	2.32	0.00	0.22
Trading and crypto exchanges	106	0.09	41	15.4	89	0.13	67	3.86	0.03	0.00
Unknown/Other	392		12	12.3	72		58	7.06		0.38
All	1519		551	23.3	771		610	5.40		0.02

Note: The left columns of this table describe sectors of ICO issuers. The sector categories were determined after researching a subset of sixty ICOs in detail. Data for the issuers is gathered from white papers and websites. The right part of the panel, "VC-backed blockchain startups", includes the 771 blockchain startups that received seed or VC investment as of April, 2018. They have been assigned where possible to one of the 12 sectors. No sector applied for 72 ("Other"). "$ amt raised" indicates the amount of financing in nominal U.S. dollars. Data for the VC-backed startups is from CB Insights. "N with amt raised" is the number of issuers where we observe the amount raised.

Table 4: ICO Success Measures

	N	Mean	S.d.	Min	Median	Max
Employment (as of Nov 2018)	1519	12.60	35.24	0.00	3.00	716.00
Issuer failed (as of Nov 2018)	1519	0.30				
Log liquidity at 7 days	669	12.54	3.54	-0.16	12.81	20.94
Log liquidity at 28 days	665	12.58	3.79	-0.32	12.88	21.62
Log liquidity at 140 days	623	12.89	4.20	1.41	13.54	22.45
Log liquidity at 168 days	613	12.82	4.34	-0.49	13.29	22.41
Log volume at 7 days (mill USD)	669	11.07	3.03	0.15	11.10	19.10
Log volume at 28 days (mill USD)	667	10.79	3.22	-0.41	10.73	18.90
Log volume at 140 days (mill USD)	624	10.84	3.55	-0.69	11.16	19.47
Log volume at 168 days (mill USD)	614	10.80	3.63	-1.79	10.81	19.99

Note: This table contains continuous variables summarizing the proxies for ICO success. Employment is the number of people who identify themselves as employees on LinkedIn as of November 2018, or the number of people listed as employees on the website where no LinkedIn profile was available. We classify an ICO as failed if the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists. Liquidity is the negative of the Amihud price impact (illiquidity) measure averaged over the past five days. Volume is the total 24-hour US dollar trading volume averaged over the past five days. Both are available only for tokens listed on an exchange, and sample sizes vary depending on the number of tokens that have been trading for the specified number of days.

Table 5: Comparison of ICO and NASDAQ Liquidity

Panel 1: Summary statistics

	N	Mean	S.d.	Min	Median	Max
Log liquidity NASDAQ	2,146,418	18.22	2.97	4.80	18.36	28.85
Log liquidity ICOs	271,602	12.55	4.49	-1.79	13.02	33.59
Difference of means		5.67***				

Panel 2: Fama-MacBeth regression

	(1) Log Liquidity
ICO	-1.216***
	(0.052)
$\text{Volatility}_{i,t-1}$	-0.125***
	(0.008)
$\text{Volume}_{i,t-1}$	0.000***
	(0.000)
$\text{Log Price}_{i,t-1}$	1.267***
	(0.014)
Observations	491180
R^2	0.53

Note: This table compares the liquidity of NASDAQ stocks and exchange-traded ICOs. Liquidity is the negative of the Amihud price impact (illiquidity) measure averaged over the past five days. We use daily data for all NASDAQ stocks from Jan 2015 - November 2018, and daily data from our sample of 671 exchange-traded ICOs. Panel 2 shows results from a weekly Fama-MacBeth regression, where "ICO" is an indicator for the asset being an ICO token rather than a NASDAQ stock. Standard errors are in parentheses. ${}^{*}p < 0.10$, ${}^{**}p < 0.05$,${}^{***}p < 0.01$

Table 6: Relationship Between Issuer Characteristics and Real Outcomes

	Employment			Failed		
	OLS	OLS	OLS	OLS	Logit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Utility value	0.126**	0.131*	0.148**	-0.043**	-0.799***	-0.028
	(0.050)	(0.065)	(0.074)	(0.017)	(0.241)	(0.018)
White paper	0.346**	0.339**	0.408**	-0.077**	-0.394	-0.093***
	(0.159)	(0.149)	(0.171)	(0.030)	(0.277)	(0.027)
Incentive pool	0.270***	0.245***	0.235***	-0.088***	-1.194***	-0.083***
	(0.074)	(0.076)	(0.077)	(0.015)	(0.348)	(0.018)
Insider vesting	0.266***	0.290***	0.287***	-0.030**	-0.915**	-0.027**
	(0.092)	(0.074)	(0.088)	(0.014)	(0.415)	(0.011)
Budget	0.206	0.200	0.193*	-0.064***	-0.778***	-0.054**
	(0.120)	(0.127)	(0.102)	(0.021)	(0.301)	(0.021)
VC equity	0.626***	0.537***	0.591***	-0.082***	0.000	-0.065***
	(0.141)	(0.138)	(0.133)	(0.013)	(.)	(0.013)
Male	-0.021	0.026	0.083	0.053	0.500	0.031
	(0.282)	(0.239)	(0.163)	(0.034)	(0.660)	(0.040)
Crypto exper.	-0.182	-0.209	-0.149	-0.010	-0.274	-0.014
	(0.142)	(0.147)	(0.139)	(0.019)	(0.265)	(0.015)
Finance exper.	0.018	-0.016	0.016	0.000	-0.177	0.018
	(0.078)	(0.093)	(0.069)	(0.015)	(0.238)	(0.016)
Comp. sci. exper.	0.127***	0.108**	0.092	-0.033***	-0.730***	-0.035***
	(0.038)	(0.042)	(0.091)	(0.011)	(0.165)	(0.009)
Entrep. exper.	0.232***	0.229**	0.217***	-0.017	-0.274	-0.014
	(0.077)	(0.081)	(0.078)	(0.017)	(0.343)	(0.016)
Observations	960	939	960	960	826	939
R^2	0.180	0.226	0.253	0.148		0.177
Pseudo R^2					0.225	
Quarter Start FE	Y	Y		Y	Y	Y
Sector & Country FE		Y				Y
Week Start FE			Y			

Note: This table contains regression estimates of the relationship between issuer characteristics and real outcomes. The dependent variable in Columns 1-3 is the log of one plus number of employees, which is the number of individuals that identify as being employed by the issuer on LinkedIn as of November, 2018. The dependent variable in Columns 4-6 is an indicator for whether the issuer failed, which means that the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists. Utility value indicates that the token is intended to have consumptive value. The following five variables are issuer and token contract characteristics. "Incentive pool" means that a fraction of tokens are set aside to compensate future external developers or contributors to the network. The final five variables refer to the issuer's main founder or CEO, if it has one. Quarter/week start fixed effects control for the calendar quarter or week in which the ICO began. Sector fixed effects control for each of 12 mutually exclusive sectors. Country fixed effects control for the nine most common countries as well as a dummy for the issuer being dispersed across more than five countries. Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Relationship between Issuer Characteristics and Listing Status

	Listed		
	OLS	Logit	OLS
	(1)	(2)	(3)
Utility value	0.047***	0.289*	0.044*
	(0.016)	(0.166)	(0.021)
White paper	0.054	0.281	0.027
	(0.055)	(0.268)	(0.052)
Incentive pool	0.100**	0.523***	0.109**
	(0.045)	(0.190)	(0.041)
Insider vesting	0.178***	0.916***	0.183***
	(0.028)	(0.184)	(0.031)
Budget	0.030*	0.138	0.030
	(0.015)	(0.111)	(0.021)
VC equity	0.104**	0.571***	0.109**
	(0.048)	(0.206)	(0.040)
Male	-0.021	-0.031	0.002
	(0.097)	(0.568)	(0.102)
Crypto exper.	0.023	0.202	0.032
	(0.026)	(0.308)	(0.031)
Finance exper.	0.003	0.029	-0.002
	(0.011)	(0.183)	(0.007)
Comp. sci. exper.	0.039**	0.264	0.040*
	(0.017)	(0.231)	(0.020)
Entrep. exper.	0.014	0.124	0.015
	(0.037)	(0.303)	(0.040)
Observations	939	900	960
R^2	0.237		0.211
Pseudo R2		0.150	
Quarter Start FE	Y	Y	Y
Sector & Country FE			Y

Note: This table contains regression estimates of the relationship between issuer characteristics and listing. The dependent variable is an indicator for the issuer listing on an exchange. The first five variables are issuer and token contract characteristics. "Incentive pool" means that a fraction of tokens are set aside to compensate future external developers or contributors to the network. The final five variables refer to the issuer's main founder or CEO, if it has one. Quarter/week start fixed effects control for the calendar quarter or week in which the ICO began. Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Effect of Listing Status on Future Employment (IV using ETC)

	Entire Sample			High BTC price			Low BTC price		
	OLS	2SLS		OLS	2SLS		OLS	2SLS	
		1st stage	2nd stage		1st stage	2nd stage		1st stage	2nd stage
	Employment	Listed	Employment	Employment	Listed	Employment	Employment	Listed	Employment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Listed	0.254***		1.576	0.471***		1.211*	0.158		1.554
	(0.075)		(1.050)	(0.115)		(0.714)	(0.100)		(1.362)
Δ ETC Price		0.035***			0.253***			0.028**	
		(0.012)			(0.070)			(0.012)	
Utility value	0.254***	0.125***	0.083	0.134*	0.064**	0.083	0.399***	0.176***	0.144
	(0.063)	(0.022)	(0.152)	(0.076)	(0.030)	(0.092)	(0.097)	(0.031)	(0.270)
White paper	0.270***	0.046	0.214*	0.403**	0.128*	0.303	0.215*	0.022	0.190
	(0.099)	(0.035)	(0.118)	(0.181)	(0.072)	(0.210)	(0.120)	(0.039)	(0.133)
Incentive pool	0.118	0.199***	-0.147	0.129	0.113**	0.054	0.127	0.233***	-0.202
	(0.081)	(0.028)	(0.228)	(0.120)	(0.048)	(0.143)	(0.106)	(0.034)	(0.340)
Insider vesting	0.330***	0.218***	0.044	0.227*	0.215***	0.064	0.378***	0.221***	0.071
	(0.085)	(0.030)	(0.245)	(0.129)	(0.051)	(0.204)	(0.111)	(0.036)	(0.321)
Budget	0.343***	0.094***	0.219*	0.424***	0.073	0.381***	0.284***	0.085**	0.165
	(0.080)	(0.028)	(0.132)	(0.117)	(0.047)	(0.128)	(0.106)	(0.035)	(0.164)
VC equity	0.707***	0.160***	0.497**	0.478***	0.211***	0.322	0.822***	0.112**	0.668***
	(0.110)	(0.039)	(0.206)	(0.159)	(0.063)	(0.221)	(0.147)	(0.048)	(0.219)
Pre-sale	0.277***	-0.061**	0.363***	0.286**	-0.003	0.289**	0.263***	-0.062**	0.357**
	(0.074)	(0.026)	(0.106)	(0.114)	(0.046)	(0.118)	(0.095)	(0.031)	(0.139)
Stated goal to raise	0.412***	0.119***	0.254*	0.546***	0.103**	0.475***	0.331***	0.123***	0.159
	(0.076)	(0.027)	(0.150)	(0.118)	(0.047)	(0.139)	(0.097)	(0.032)	(0.198)
Observations	1404	1404	1404	464	464	464	940	940	940
R^2	0.301	0.308	0.146	0.391	0.246	0.336	0.272	0.364	0.118
F-Stat		8.71			12.94			5.98	
Year Start FE	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table contains OLS and 2SLS regression estimates of the effect of an ICO being listed on an exchange on labor outcomes. The dependent variable in Columns 1, 3, 4, 6, 7 and 9 is the log of one plus number of employees, which is the number of individuals that identify as being employed by the issuer on LinkedIn as of November, 2018. The dependent variable in Columns 2, 5, and 8 is an indicator for listing on a cryptocurrency exchange. Δ ETC Price is defined as the 90th percentile of ETC between 23 and 43 days after an ICO is started, divided by the average ETC price in the 30 days before the ICO start date. Days 23 and 43 cutoffs are the 25th and the 50th percentile difference between the ICO start date and the first trading date for the ICOs that have become listed on an exchange. *High BTC price* is defined as months in which Bitcoin price was above $10,000 at least once (December, 2017 - March, 2018). All other time periods are defined as *Low BTC price*. Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Relationship Between Issuer Characteristics and Financial Outcomes

	Liquidity		Volume	
	(1)	(2)	(3)	(4)
Utility value	-0.109	-0.027	-0.035	0.033
	(0.260)	(0.259)	(0.243)	(0.231)
White paper	2.027***	1.798***	1.451**	1.234***
	(0.596)	(0.528)	(0.507)	(0.413)
Incentive pool	0.297	0.234	0.227	0.113
	(0.373)	(0.541)	(0.238)	(0.362)
Insider vesting	1.348***	1.216***	1.155***	1.041***
	(0.275)	(0.323)	(0.275)	(0.277)
Budget	0.135	0.261	0.096	0.230
	(0.320)	(0.356)	(0.249)	(0.276)
VC equity	2.255***	1.842***	1.777***	1.411***
	(0.167)	(0.304)	(0.210)	(0.338)
Male	-0.693	-0.570	-0.711	-0.617
	(0.663)	(0.815)	(0.426)	(0.603)
Crypto exper.	-0.260	-0.345	-0.208	-0.284
	(0.406)	(0.310)	(0.287)	(0.210)
Finance exper.	-0.046	-0.074	-0.154	-0.186
	(0.469)	(0.324)	(0.342)	(0.250)
Comp. sci. exper.	0.336	0.135	0.238	0.071
	(0.265)	(0.229)	(0.184)	(0.151)
Entrep. exper.	0.666**	0.612**	0.574**	0.516*
	(0.252)	(0.286)	(0.236)	(0.248)
Observations	546	538	547	539
R^2	0.234	0.291	0.229	0.287
Quarter Start FE	Y	Y	Y	Y
Sector & country FE		Y		Y

Note: This table contains regression estimates of the relationship between issuer characteristics and financial outcomes. The dependent variable in Columns 1-3 is log liquidity, and the dependent variable in Columns 4-6 is log volume. Both are measured at 140 days from the first trading date; see Section 2.3 for details. Utility value indicates that the token is intended to have consumptive value. The following five variables are issuer and token contract characteristics. "Incentive pool" means that a fraction of tokens are set aside to compensate future external developers or contributors to the network. The final five variables refer to the issuer's main founder or CEO, if it has one. Quarter start fixed effects control for the calendar quarter or week in which the ICO began. Sector fixed effects control for each of 12 mutually exclusive sectors. Country fixed effects control for the nine most common countries as well as a dummy for the issuer being dispersed across more than five countries. Standard errors are in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Relationship Between Issuer Sector and Outcomes

	Employment (1)	Failed (2)	Liquidity (3)	Volume (4)
Ads, rewards	0.491***	-0.169***	1.147***	0.854**
	(0.133)	(0.047)	(0.285)	(0.354)
Data storage/computing	-0.089	-0.120*	0.940	0.871
	(0.186)	(0.067)	(0.880)	(0.755)
Enterprise, health, identity	-0.109	-0.013	1.494**	1.383**
	(0.217)	(0.038)	(0.690)	(0.571)
Gaming, entert., messag.	-0.117	-0.105**	-0.021	0.253
	(0.100)	(0.050)	(0.658)	(0.515)
New blockchain protocol	0.816***	-0.182***	3.559***	2.997***
	(0.154)	(0.028)	(0.680)	(0.634)
Payments, wallets	0.025	-0.061	1.264**	1.145**
	(0.084)	(0.059)	(0.486)	(0.512)
Prediction mkts and gambl.	-0.052	-0.116*	1.756*	1.338
	(0.331)	(0.066)	(0.905)	(0.867)
Smart contract creation	0.100	-0.133**	-0.146	-0.169
	(0.090)	(0.058)	(0.821)	(0.635)
Tokenizing real assets	0.345**	-0.214***	-0.606	-0.601
	(0.130)	(0.039)	(0.745)	(0.620)
Trading, Crypto exchs.	0.069	-0.093**	0.352	0.504
	(0.090)	(0.042)	(0.639)	(0.610)
Asset mgmnt, crypto fin servi.	-0.153*	-0.079	0.200	0.154
	(0.084)	(0.051)	(0.378)	(0.349)
Observations	1124	1124	602	603
R^2	0.175	0.107	0.239	0.262
Quarter Start FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y

Note: This table contains regression estimates of the relationship between issuer sectors and outcomes. Each ICO is assigned to one of 12 mutually exclusive sectors. The excluded dummy is "other". The dependent variable in Column 1 is the log of one plus number of employees, which is the number of individuals that identify as being employed by the issuer on LinkedIn as of November, 2018. The dependent variable in Column 2 is an indicator for whether the issuer failed, which means that the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists. The dependent variable in Column 3 is log liquidity, and the dependent variable in Column 4 is log volume. Both are measured at 140 days from the first trading date; see Section 2.3 for details. Quarter start fixed effects control for the calendar quarter or week in which the ICO began. Country fixed effects control for the nine most common countries as well as a dummy for the issuer being dispersed across more than five countries. Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Relationship Between ICO Characteristics and Outcomes

	Employment			Failed	Liquidity	Volume
	(1)	(2)	(3)	(4)	(5)	(6)
Capped	0.198	0.196	-0.396	-0.151***	0.566	0.422
	(0.211)	(0.217)	(0.546)	(0.043)	(0.655)	(0.503)
Barred to US	0.370	0.453**	0.362	-0.027	0.964**	0.958**
	(0.247)	(0.165)	(0.361)	(0.024)	(0.378)	(0.350)
Pre-sale	0.206**	0.135*	0.157	-0.052	0.718	0.626
	(0.083)	(0.077)	(0.118)	(0.033)	(0.586)	(0.424)
Had goal to raise	0.150	0.178		-0.003	-0.158	-0.029
	(0.144)	(0.146)		(0.024)	(0.236)	(0.162)
Airdrop (free)	-0.173	-0.391*	-0.320	-0.042	0.427	0.373
	(0.187)	(0.197)	(0.201)	(0.043)	(0.581)	(0.449)
Dynamic pricing	0.325***	0.283*	0.184***	-0.051	0.695**	0.655**
	(0.102)	(0.161)	(0.056)	(0.032)	(0.272)	(0.253)
Demand-sensitive pricing	-0.204	-0.305	-0.300	0.069	-0.768	-0.615
	(0.319)	(0.207)	(0.332)	(0.052)	(1.015)	(0.930)
Auction pricing	0.173	0.188	0.338***	-0.036	0.464	0.338
	(0.240)	(0.176)	(0.076)	(0.084)	(0.907)	(0.753)
Future token creation	0.214	-0.123	-0.101	-0.012	0.816	0.627
	(0.280)	(0.238)	(0.327)	(0.048)	(0.596)	(0.482)
Accept USD	0.222	0.367*	-0.167	-0.061	0.161	0.329
	(0.204)	(0.182)	(0.366)	(0.048)	(0.490)	(0.338)
Accept EUR	-0.220	0.244	0.138	0.126	-1.108*	-1.467**
	(0.839)	(0.811)	(0.868)	(0.113)	(0.628)	(0.594)
Accept BTC	0.183	0.174	0.162	-0.048	1.358**	1.148***
	(0.254)	(0.200)	(0.326)	(0.063)	(0.489)	(0.373)
Accept ETH	0.596**	0.456**	0.732**	-0.078	1.931***	1.528***
	(0.246)	(0.210)	(0.328)	(0.076)	(0.352)	(0.257)
Accept XRP	0.740***	0.683*	1.192***	-0.061	0.561	0.852
	(0.175)	(0.379)	(0.123)	(0.119)	(0.922)	(0.906)
Accept LTC	-0.684*	-0.474	-0.663	0.005	-0.945**	-0.910**
	(0.347)	(0.401)	(0.391)	(0.037)	(0.446)	(0.318)
Accept WAVES	-0.309	-0.374*	-0.130	-0.056	-2.913***	-2.198***
	(0.290)	(0.181)	(0.361)	(0.077)	(0.947)	(0.669)
Raised USD (Mill)			0.018***			
			(0.005)			
Met to raise goal			-0.057			
			(0.203)			
Fraction tokens sold			0.039			
			(0.329)			
Duration (days)			0.001			
			(0.002)			
Days ICO start to list			-0.003**			
			(0.001)			
Observations	450	432	254	450	439	440
R^2	0.245	0.320	0.276	0.224	0.278	0.311
Quarter Start FE	Y	Y	Y	Y	Y	Y
Sector & Country FE		Y				

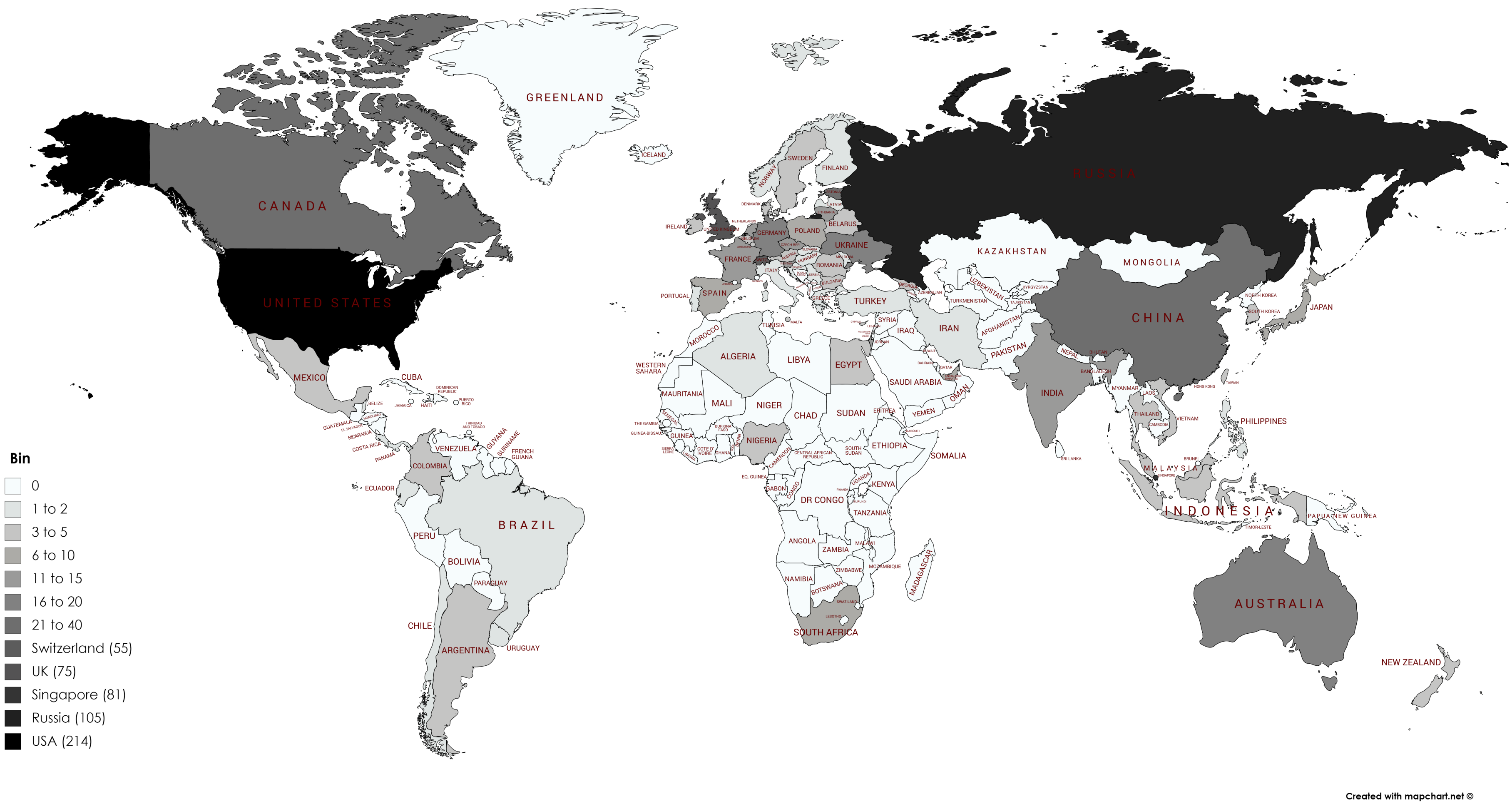
Note: This table contains regression estimates of the relationship between ICO process characteristics and outcomes. We collect process data for a subset of 450 ICOs that had traded on an exchange for at least 90 days as of April, 2018. The dependent variable in Columns 1-3 is the log of one plus number of employees, which is the number of individuals that identify as being employed by the issuer on LinkedIn as of November, 2018. The dependent variable in Column 4 is an indicator for whether the issuer failed, which means that the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists. The dependent variable in Column 5 is log liquidity, and the dependent variable in Column 6 is log volume. Both are measured at 140 days from the first trading date; see Section 2.3 for details. Quarter start fixed effects control for the calendar quarter or week in which the ICO began. Sector fixed effects control for each of 12 mutually exclusive sectors. Country fixed effects control for the nine most common countries as well as a dummy for the issuer being dispersed across more than five countries. Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Relationship Between Issuer Github, Social Media Characteristics and Outcomes

	Employment			Failed	Liquidity	Volume
	(1)	(2)	(3)	(4)	(5)	(6)
Code on Github (GH)	0.643***	0.535***		-0.107***	2.069***	1.733***
	(0.141)	(0.161)		(0.030)	(0.582)	(0.444)
Twitter account	0.413**	0.170		0.056	0.949	0.512
	(0.155)	(0.203)		(0.099)	(0.744)	(0.848)
Telegram group	0.673***	0.633***		-0.203***	2.109***	1.794***
	(0.192)	(0.191)		(0.059)	(0.575)	(0.493)
Telegram members (000s)			0.002			
			(0.008)			
Twitter followers (000s)			0.010***			
			(0.003)			
GH repositories (000s)			1.157			
			(4.658)			
GH commits (000s)			-0.010			
			(0.033)			
GH main rep branches (000s)			2.394			
			(3.150)			
GH main rep releases (000s)			-0.653			
			(0.540)			
GH main rep contrib. (000s)			-0.505			
			(1.397)			
GH months from last commit			-0.028***			
			(0.005)			
Observations	451	433	236	451	440	441
R^2	0.230	0.296	0.259	0.211	0.255	0.286
Quarter Start FE	Y	Y	Y	Y	Y	Y
Sector & Country FE		Y				

Note: This table contains regression estimates of the relationship between issuer Github and social media variables and outcomes. See Table 2, Panel 2 for an explanation of these characteristics. We collect these characteristics for a subset of 450 ICOs that had traded on an exchange for at least 90 days as of April, 2018. The dependent variable in columns 1-3 is the log of one plus number of employees, which is the number of individuals that identify as being employed by the issuer on LinkedIn as of November, 2018. The dependent variable in column 4 is an indicator for whether the issuer failed, which means that the issuer does not have an active website, the token is not listed on CoinMarketCap, and Internet searches yield no other indication that it still exists. The dependent variable in column 5 is log liquidity, and the dependent variable in column 6 is log volume. Both are measured at 140 days from the first trading date; see Section 2.3 for details. Quarter start fixed effects control for the calendar quarter or week in which the ICO began. Sector fixed effects control for each of 12 mutually exclusive sectors. Country fixed effects control for the nine most common countries as well as a dummy for the issuer being dispersed across more than five countries. Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

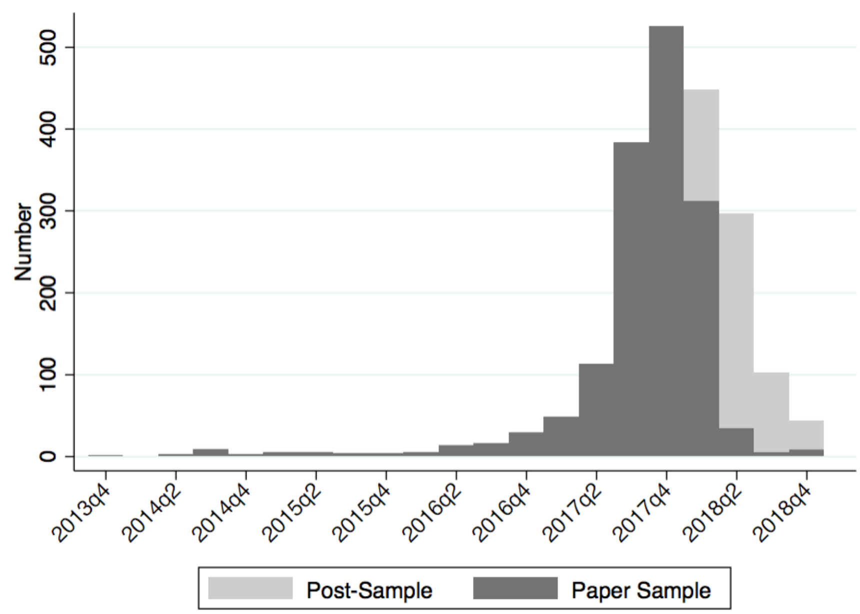
Figure 1: Number of ICOs by Country



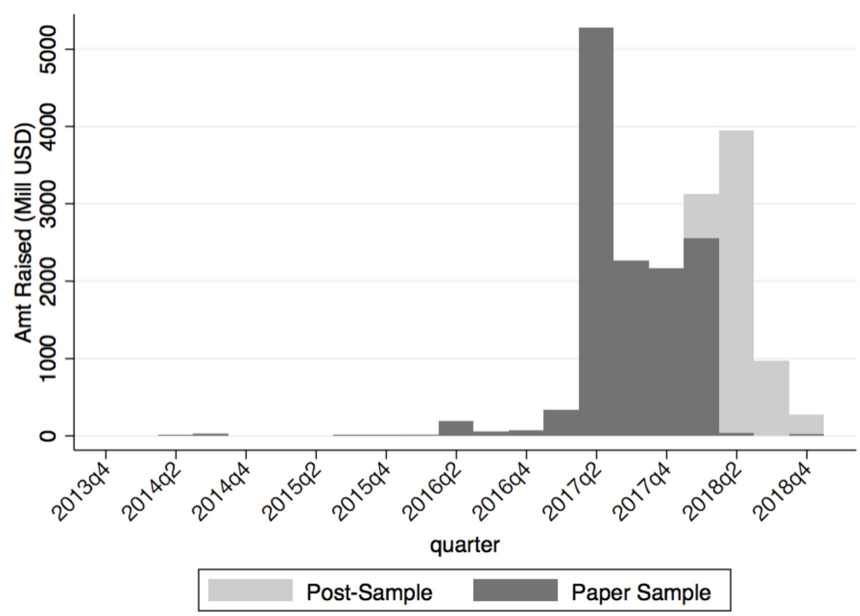
Note: This figure shows the location of ICO issuers in our sample, which includes all ICOs in TokenData from 2014-18. We observe location for 1,055 of the ICOs, based on issuer websites and other public material. Of these, 73 are dispersed across at lease five countries and are not shown. The remaining 982 are included in the figure, except for the Cayman Islands (3 ICOs), Curacao (1), Cyprus (1), Gibraltar (1), Marshall Islands (1), Saint Kitts (1). Countries are grouped by bins of their number of ICOs. The top five countries are shown separately.

Figure 2: Number of ICOs and Amount Raised by Quarter

Panel A: Number of ICOs



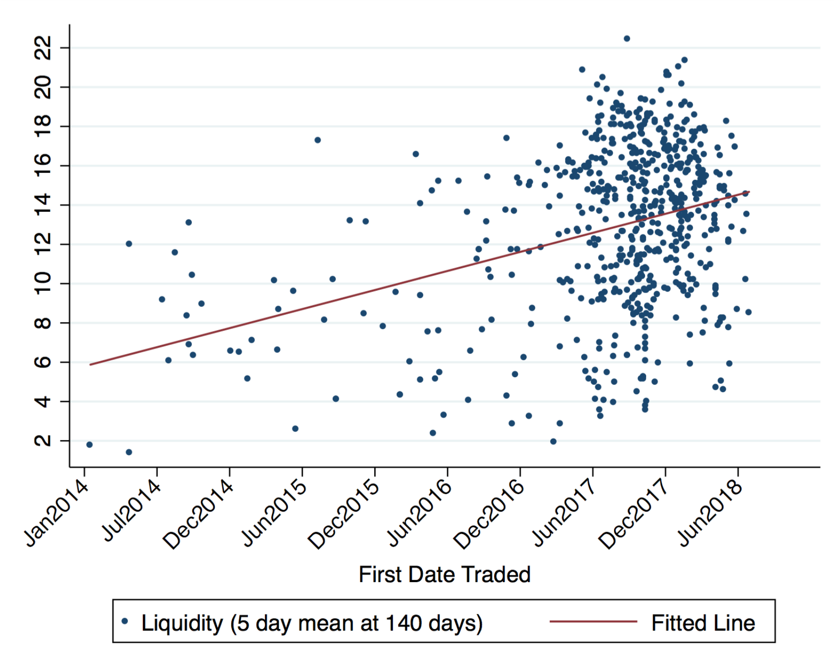
Panel B: Raised Amount



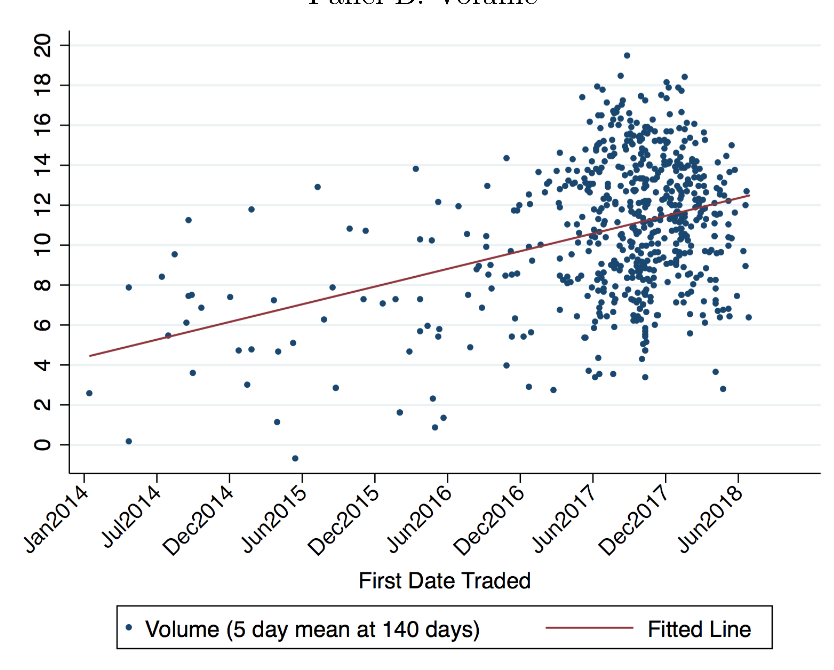
Note: This figure shows the total quarterly amount raised and number of ICOs. Dark bars represent our sample, while light bars represent ICOs appearing in TokenData (our baseline source for the ICOs) after our sample ends. The light bars help to illustrate the market development. Panel A shows a bar chart of the number of ICOs that begin in each quarter. The dark bars include all 1,519 ICOs in our sample is 1,519, while the light bars include 531 ICOs outside our sample. The amount raised is only available for 551 of the ICOs in our sample, and these are included in the dark bars of Panel B. The light bars in Panel A comprise 249 ICOs outside our sample for which amount raised is observed.

Figure 3: Liquidity and Volume at 5 Months

Panel A: Liquidity



Panel B: Volume



Note: This figure shows the liquidity and volume measures we use 140 days (5 months) after the start of trading. Panel A shows liquidity, the negative of the log Amihud price impact (illiquidity) measure averaged over the past five days. Panel B shows volume, the log total 24-hour US dollar trading volume averaged over the past five days. All exchange-traded tokens that traded for at least 140 days are included, which comprises 624 ICOs from 2014-2018.

Filecoin Case Study Appendix

Filecoin, which raised more than $200 million in its 2017 ICO, is a project of Protocol Labs, Inc., a Delaware corporation headquartered in San Francisco. The company kindly shared with us confidential transaction-level data on an anonymized basis, permitting us to study the prices paid by different types of investors, as well order sizes, means of payment, vesting schedules and related information. To our knowledge, this is the first such data made available for academic research.

Protocol Labs is building a new blockchain (the Filecoin protocol) to host a peer-to-peer decentralized storage market. The storage infrastructure is called InterPlanetary File Storage (IPFS), another project of Protocol Labs. Decentralized storage is an alternative to incumbent cloud storage providers such as Dropbox, Amazon and Google. Filecoin's advocates perceive market power, vulnerability to cyber-attacks, and centralization of control over others' data as drawbacks to these centralized services. The Filecoin protocol will be completely automated, so that once the network goes live, Protocol Labs will have no direct control, although the company will own a large amount of FIL tokens that will allow it indirectly to influence the Filecoin storage market.

Filecoin's token, which uses the symbol FIL, is a utility token that will provide access to this marketplace as the only means of customer payment for storage services. Storage providers (known as storage miners) will earn FIL by storing digital files for clients. FIL is also a work token, because storage miners must post FIL as collateral in order to pledge their storage power and be eligible to match with clients. A second type of producer, a retrieval miner, responds to requests for files by rapidly retrieving and reassembling them. Filecoin has a number of competitors, including Golem, Storj, Sia, Elastic, and SONM. One way that Filecoin distinguishes its business model is that its prices are based on a competitive bidding process among storage miners. Filecoin contends that its model is the only one to offer incentive compatible storage with cryptographic guarantees for users.

The Filecoin ICO was capped at 200 million FIL tokens, representing 10 percent of the ultimate supply of 2 billion tokens. Of the remaining tokens, 15 percent are retained by Protocol Labs for research, engineering, business development, marketing, and other purposes, five percent are held by the Filecoin Foundation for long-term network governance and public use data preservation (e.g., storing government climate data), and 70 percent are reserved for miner rewards. The ICO did not sell FIL, but rather rights to future FIL through a SAFT, an investment vehicle that attempts to comply with SEC regulations (see Section 2.1).[28] Only accredited investors could participate, allowing Filecoin's ICO to be exempt from U.S. securities laws. CoinList, a new platform for SEC-compliant token sales, managed the ICO. CoinList is an AngelList spinoff that emerged from collaboration with Protocol Labs for the Filecoin sale. It likely helps reduce information asymmetry, just as reputable underwriters do in IPO markets (Loughran and Ritter 2002).

Filecoin conducted a pre-sale to offer discounts to select investors, which ended on August 1, 2017.[29] Participants in Filecoin's pre-sale included investors who had previously purchased equity in Protocol Labs, including Union Square Ventures. Other participants were VCs such as Sequoia Capital and Andreessen Horowitz, accredited advisors and individual investors, and Protocol Labs employees. The public sale followed soon after the pre-sale and lasted from August 10 to September 7.

In the pre-sale, Filecoin raised approximately $52 million from 150 investors. Pre-sale FIL tokens were offered at $0.75, but investors could obtain discounts for agreeing to vesting (lock-up) periods, leading to an average price paid of $0.57. In the public sale, the price charged for each token was determined by a dynamic formula, whereby the price would equal the total dollar amount raised up to that point divided by $40 million. Therefore, the public token sale began at a price of $1.30 ($52 million divided by $40 million), and the FIL subscription prices increased continuously thereafter. Again, discounts were offered to buyers who agreed to vesting periods. The escalating price over time during the public sale

[28]See the Filecoin Private Placement Memorandum: https://coinlist.co/assets/index/filecoin_index/Protocol%20Labs%20-%20SAFT%20-%20Private%20Placement%20Memorandum-bbd65da01fdc4a15219c49ad20fb9e28681adec9fae744c41cccd124545c4c73.pdf.

[29]While we use the term "ICO" throughout this paper for simplicity, and the Filecoin project appears in all rankings of top ICOs, Protocol Labs did not use the ICO term to describe its token sale. Protocol Labs termed its pre-sale the "Advisor Sale", and what we call its ICO, the company referred to as a "Public Sale." We use the terms "pre-sale" and "ICO" to be consistent with the language elsewhere in the paper.

maximized the final price at the sale's conclusion, creating a high-water reference point for the market. This is similar to the common practice of using the price per share in the most recent equity financing round (e.g., a VC Series D) to value a startup, a practice that can lead to overvaluation (Gornall and Strebulaev 2017).

Filecoin's public sale raised $153.8 million from more than 2,100 investors in over 50 countries, of which $135 million came in the first hour. Under the terms of the public sale, all buyers in the first hour were ultimately charged an identical price of $2.43 per token, which was the weighted average first-hour sale price after adjusting for vesting discounts. The equalization of first-hour prices was done to avoid a rush in the first minutes of the sale, because Protocol Labs feared investors would not read the documentation accompanying the purchase process in an effort to benefit from the lowest prices. The pre-sale and registrations for the public sale helped gauge demand for the public sale, which the issuer had underestimated. After the first hour, the price increased gradually over the remaining four weeks of the public sale. Buyers after the first hour paid a vesting-adjusted weighted-average price of $4.61 per token. Table A.1, Panel 1 summarizes this information. It shows that the pre-sale buyers paid much lower prices than the buyers in the public sale, especially those who bought in the later stages. Token buyers could pay in U.S. dollars, Bitcoin, Ether, or Zcash.[30] Figure A.1 shows the amount raised in each currency for the three offer periods. Pre-sale investors paid mostly in U.S. dollars, while public investors paid mostly in Ether. Very few paid in Bitcoin or Zcash. The majority of funds were raised in the first hour of the public sale. In Table A.1, Panel 3, we show information about the purchases made by members of the Protocol Labs core team, advisors, and venture capital investors. Six members of the Protocol Labs core team and nine angel and VC investors who had previously invested in Protocol Labs equity also invested during the pre-sale. One core team member and one VC participated in the public sale. Core team members invested an average of $40,800 each, while the VCs on average purchased more than $1.7 million worth of tokens each.

[30] Estimates of the amount raised depend on the exchange rates used. We use the daily U.S. dollar closing price of each cryptocurrency on CoinMarketCap. Many media reports valued the proceeds of Filecoin's ICO at $257 million rather than $206 million, and the difference represented the appreciation of Ether, Bitcoin, and Zcash obtained by the company during the ICO period.

Price discounts for investors who agreed to different vesting periods are listed in Table A.1, Panel 2. The vesting periods will begin after the network launches. All FIL tokens sold in the ICO are locked up for at least six months after network launch. Pre-sale investors were not given the six month option; their tokens could be locked up for 12, 24, or 36 months, providing discounts of 7.5, 15, and 30 percent, respectively. Figure A.2 shows the distribution of vesting choices for each of the three periods of the ICO. A dramatic difference is apparent between the long vesting schedules agreed to by most of the strategic investors in the pre-sale, and the preference for the shortest possible vesting periods in the public sale.

At the time of this writing, more than 20 months after the start of the Filecoin ICO, the FIL tokens have not yet been delivered to investors. Filecoin futures have traded on Gate.io and Lbank since December 13, 2017, and the futures prices provide an estimate of the value of the underlying FIL tokens. While the FIL futures traded as high as $27.66 each in the crypto bull market of late 2017, prices have retreated to a recent level slightly above $3.00. Even with the sharp decline in prices, mirroring that of the overall crypto market since late 2017, the recent prices of Filecoin imply that its 200 million outstanding tokens have a fair market value of approximately $600 million, substantially more than the $206 million that they sold for in 2017. Consistent with the results of this study, Filecoin's parent company Protocol Labs saw its headcount increase approximately fivefold, from about 20 employees at the time of its ICO in July-September 2017 to about 100 by November 2018, according to conversations with the company's general counsel.

Table A.1: Filecoin

Panel 1: Summary Statistics

	Num Transactions	Avg. num FIL per transaction	Avg. USD per transaction	Median USD per transaction	Avg. USD/FIL
Pre-sale	210	430,554	$246,217	$49,356	$0.57
1st Hour of Public Sale	1,690	33,005	$80,255	$10,000	$2.43
Rest of Public Sale	1,167	3,474	$16,000	$3,480	$4.61

Panel 2: Vesting Discounts in Advisor Sale (Pre-sale) and Public Sale

Vesting period:	6 months		12 months		24 months		36 months	
Portion of ICO:	Pre-sale	Public	Pre-sale	Public	Pre-sale	Public	Pre-sale	Public
Vesting Discount:	N/A	0	7.5%	7.5%	15%	15%	30%	20%
Avg. USD/transaction:	N/A	$58,414	$184,743	$35,970	$277,478	$26,175	$275,841	$61,575

Panel 3: Number of Investors During ICO by Investor Type

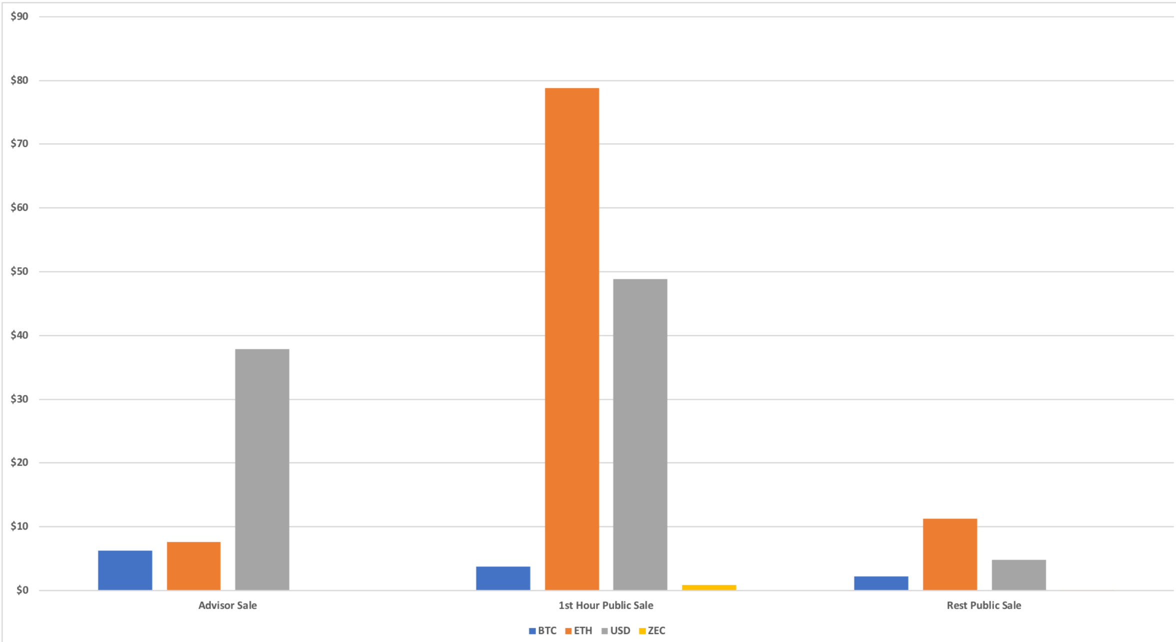
	Core team	Previous PL investors	Others
Pre-sale	6	9	128
1st Hour of Public Sale	0	1	1,358
Rest of Public Sale	1	0	815

Panel 4: Advisor Sale (Pre-sale)

	Avg. Investment in USD
Core team	$40,835
Previous PL investors	$1,786,440
Others	$276,760

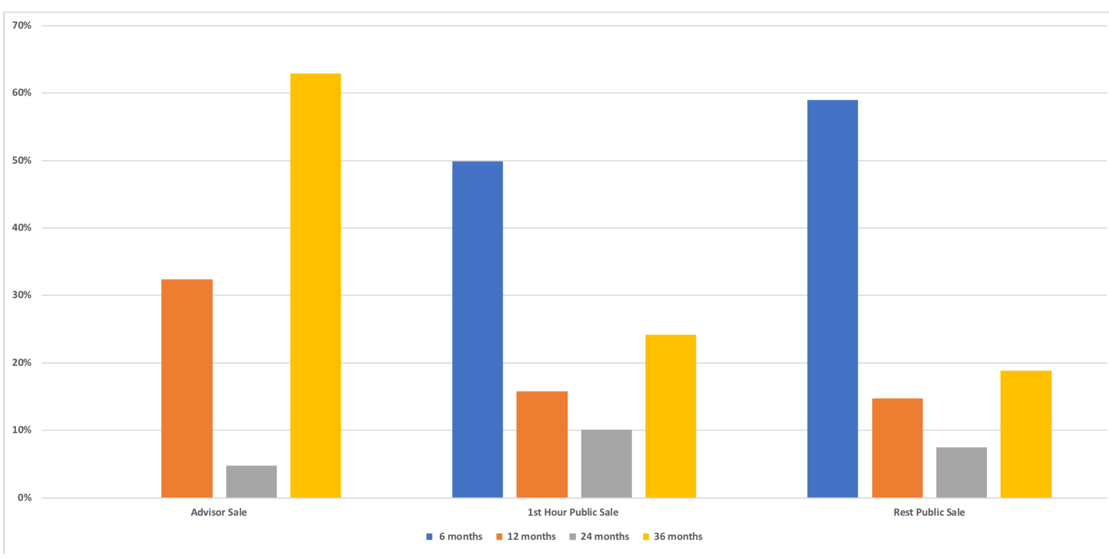
Note: Panel 1 shows summary statistics about the three periods of Filecoin's ICO, which are the pre-sale (Filecoin terms this the "advisor sale"), the first hour of the public sale, and the rest of the public sale. We show the number of transactions (individual purchases), the average number of FIL tokens issued per transaction, the average and median USD paid per transaction, and the average price in USD of a FIL token. Panel 2 shows the discounts offered by vesting horizon; the minimum was six months. For some vesting horizons the discounts also depended on whether the investment was made during the advisor sale or during the public sale. Panel 3 shows the number of investors from two specific groups across the three time periods: Protocol Lab's "core team", which includes founders and critical employees, and previous Protocol Labs investors (including angel and VC investors). Panel 4 shows the average number invested per investor (converted to USD) across the three groups during the advisor sale.

Figure A.1: Filecoin ICO investments by currency (millions of USD)



Note: This figure shows the USD equivalent amount invested during the Filecoin ICO. We separately show the advisor sale, the 1st hour of public sale, and the rest of the public sale. The exchange rates for the 1st hour of the advisor sale are observed on 8/10/2017 at 4 pm EST (the end of the first hour of the public sale). For advisor sale and for public sale, exchange rates are the closing price of the currency on 8/1/2017 and 9/7/2017, respectively.

Figure A.2: Filecoin ICO investor vesting length (months)



Note: This figure shows what percentage of transactions during the three different time periods of the ICO: advisor sale, first hour of public sale, and the rest of the public sale, chose the 6-month, the 12-month, the 24-month, and the 36-month vesting horizon. Note that investors during the advisor sale didn't have the 6-month vesting option.