# Serial and Large Investors in Initial Coin Offerings[*]

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**Abstract**

This study is the first to provide systematic evidence on the investors' behaviour in ICOs, their investment patterns and role in campaigns' success. Using hand-collect data on 472 public token sales, which ran from 2013 to November 2017, we fill the gap in the ICO literature and study more than 370,000 contribution addresses that sent funds to ICOs in bitcoins or ether. We show that participants often invest more than in one campaign, and serial investors contribute earlier, however, they are not more informed and fail to pick better-quality ICOs. In contrasts, larger investors (in particular, large serial investors) not only seem to time the market but also invest in campaigns that raise more funds, are more probable to reach their hard caps and have tokens that are ranked higher following token sales. The results are robust across various classifications of investors by frequency and size of investment.

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*JEL classifications:* G11, G20, K22, M13

## 1. Introduction

Crowdfunding, a new method of funding start-ups through online portals by collecting contributions from many smaller, less-sophisticated investors, has become a valid universal tool to finance projects worldwide, regulated and promoted by many countries (Ordanini et al. 2011; Ahlers et al. 2015). Introduction of bitcoin, subsequent development of more versatile blockchains, and slow reaction of regulating authorities have created even more favourable landscape for attracting funds from internationally dispersed investors. Funding start-ups through Initial Coin Offerings (ICOs) or token sales, a relatively new and complex phenomenon, involves organizations issuing transferable and generally very liquid tokens to investors. As a result, in the ark of the last five years, ICOs have rapidly grown in numbers and volume, becoming a valid alternative to VC funding in blockchain-related industries.

Several authors approached token sales from theoretical perspective and tried to identify the rationale behind this new fundraising method. Catalini and Gans (2017) rely on economic theory to discuss how blockchain technology eliminates the need for a traditional financial intermediary. Cong et al. (2018) study how tokens facilitate transactions among users in decentralized settings and allow them to capitalize on the future growth of promising platforms. Li and Mann (2018) develop a model that show how prior and transparent tokens' distribution through an ICO overcomes later coordination failures during platform operation. Chod and Lyandres (2018) show that an ICO can facilitate risk-sharing without dilution of control and Canidio (2018) studies the interactions induced by ICOs between ex-ante financing and ex-post incentives. Catalini and Guns (2019) illustrate how the ICO mechanism allows entrepreneurs to generate buyer competition for the token, revealing its true value and facilitating coordination among stakeholders due to network effects.

Earlier empirical studies focused on potential determinants of ICO funding success and post-offering tokens performance in the aftermarket. Adhami et al. (2018) collect very basic data on a sample of ICOs run mostly in 2017. Fisch (2019), Amsden and Schweizer (2018), Blaseg (2018), and Cerchiello et al. (2019) use more recent samples and attempt to identify the success factors behind ICOs by looking at the funds raised and token listing status. Howell et al. (2018), Momtaz (2018a, 2018b) and Benedetti and Kostovesky (2018) instead look at post-ICO performance measures of success, such as trading volume, liquidity, first-day underpricing and long-run returns. Boreiko and Vidusso (2019) focus on the role of intermediaries behind successful token sales. An et al. (2019) test the effects of disclosure of founders' background information and founding team's collective human capital on ICO outcomes. Drobetz et al. (2019) examine to what extent the ICO market is driven by investor sentiment, both crypto-related and general capital-market one. Huang et al. (2019) study the geographical distribution of ICOs and show that these take place in countries with developed financial markets and advanced digital technologies.

Finance literature usually differentiates between small retail investors and larger institutional ones, that, due to scale, higher information-processing capabilities, and experience are more informed about the quality of lenders and are assumed to make better investment decisions (Chen et al. 2018). The identity and behaviour of investors play a prominent role in finance (Welch 1992). The investment patterns and portfolio composition of renowned investors are closely watched and followed by many smaller investors (Hagstrom 2000). In initial public offerings, Benveniste and Spindt (1989) theory of bookbuilding assumes that shares are underpriced as a compensation for information revelation of institutional investors that are the ones having valuable information (Boreiko and Lombardo 2011). Similarly, in venture capital (VC) funding, a more experienced VC firm enhances the chance of start-up's success (Gompers

et al. 2010) and serial business angel (BA) investors select better-performing investment targets (Kelly and Hay 1996; Osnabrugge 1998).

Unlike professional investors in traditional capital markets, in the absence of established intermediaries the crowd investors must rely on information provided by the entrepreneurs. This strongly aggravates the issue of information asymmetries and greatly increases the value of the peer investors' activities. Kim and Viswanathan (2013) study how an early investor's experience serves as a credible signal of quality for the other crowd investors. Moritz et al. (2015) conduct an exploratory qualitative study and find out that peer effects do play a major role in equity crowdfunding and the size of the investment is perceived as an indicator of experience or information advantages. Given higher digital visibility of the investment activities, available at the platform level and mostly in reduced form, several studies look at the dynamics of investor behavior in equity crowdfunding. Such a unique setting allows for investigating the role of information cascades and the role of public profile investors in equity crowdfunding (Vismara 2016) or funding dynamics and effect of large investors' participation (Hornuf and Schwienbacher 2017). Fisch et al. (2018) provide the only study so far on the characteristics of the investors in the ICOs and their motivation for funding blockchain start-ups.

Interestingly, no study so far looked at the investors' types, behaviour, and their role in ICO campaigns. Although token sales resemble very much conventional crowdfunding, the former have more flexible terms, more international investor base[1], and are much bigger in size by all dimensions. Indeed, in token sales funding by the crowd is taken to the extreme – our data shows an average number of 1,600 investors per ICO with average funds raised of $9 million.

[1] For example, Airswap (USA) token sale that raised more than $12 million in October 2017, has attracted more than 12,000 participants from 135 countries and German start-up Request Network has raised more than $32 million from more than eleven thousand contributors from 135 countries

Conventional crowdfunding is dramatically smaller and much less internationalized[2]. All this indicate that it is important to understand and learn who and how invests in token sales.

IPO literature shows how later investors mimic the behaviour of previous or more informed investors (Aggarwal et al. 2002, Khurshed et al. 2014, Boreiko and Lombardo 2011). However, studying investor behaviour in standard setting using only public data is virtually impossible. Only with proprietary sets of records something may be learned, like, for example, who invest in pump and dump schemes in Germany (Leuz et al 2017). Crowdfunding platforms do allow some investor-related data collection which is aggregated across time (i.e. daily investments totals) or across individual campaigns. On the contrary, public blockchains' records are publicly available for anyone to see and verify. Moreover, the creation of Ethereum blockchain, smart contracts and Ethereum Request for Comments (ERC) standard allowed for the creation of tokens on Ethereum that can be re-used by other applications, from wallets to decentralized exchanges, and facilitated and favoured the re-usage of single wallets for all the transactions of an individual investor. In fact, ERC-compliant tokens were the choice for the majority of initial coin offerings (ICOs) between 2016-2018.

Bitcoin blockchain information, for example, is used by Foley et al. (2019) to study the extent of blockchain's usage in illegal activities. Similarly, inspection of ICO contribution contracts would shed light on the ICO investors' behaviour. Occasional reports by successfully funded firms, showing the time or size distribution of contributions and investors' background, provide only non-systematic and patchy information on who and how invest in ICOs. This paper is the first to provide systematic evidence of ICO investors' types, their investment patterns and role in campaigns' success. Using self-collect data on 472 token sales, which ran from 2013 to

[2] Vismara (2017) reports the averages of 69 investors and £167,000 fundraising target of 111 campaigns from Crowdcube, UK; Hornuf and Schwienbacher's (2018) sample of 89 campaigns from 4 German crowdfunding platoforms have 293 investors per campaign with an average collected amount of €191,135; Ahlers et al. (2015) sample of Australian crowdsales have an average of 7 investors per campaign.

November 2017, we fill the gap in the ICO literature and provide detailed evidence on investment patterns of all contributing addresses to 83 ICO campaigns that accepted funding in bitcoins (BTC) and 272 campaigns that were primarily funded with ether (ETH).

The pseudo anonymous nature of the blockchain data does not allow us to identify the personal characteristics of the investors but permits reconstructing detailed investment history of each contribution address that is presumably associated with a specific investor. We construct a database of 129,886 contributions from 105,472 individual addresses that sent funds to ICOs accepting BTCs and 498,913 contributions from 264,584 individual addresses to ICOs accepting ETHs. We believe to the first to study the distribution of the investors' contributions and their activity across time, as well as to study whether serial and large investors successfully time the market and pick higher-quality ICOs.

Our main findings are as follows. First, we provide some novel summary statistics along various so-far neglected dimensions for all ICOs and the ones accepting BTC and ETH separately. Given the Bitcoin network architecture[3], it favours using single unique addresses and as a result, it is virtually impossible to reconstruct an individual investor's history of contributions. This is very different for the data coming from Ethereum blockchain that favours re-usage of single address (or wallet) where investor accumulates funds to be send to ICO addresses and receives bought tokens. Around 28% of all identified contribution contracts invested in more than one ICO, with an average number of 3.3 ICO invested in and maximum of 115.

We put forward a hypothesis that such serial investors that invest in more than one ICO have more experience and are better informed about the quality of the projects offering tokens for sale. Alternatively, we split the investor universe by the size of the invested funds and

[3] https://bitzuma.com/posts/five-ways-to-lose-money-with-bitcoin-change-addresses.

hypothesize that larger investors are those that have superior information and are able to choose better projects. Using a range of success measures, we test whether serial investors build up the portfolios of more successful ICOs and fail to find any statistical evidence. It is only the larger serial investors that manage to pick ICOs that collect more funds, attract more contributors, reach their hard-caps, raise more money during the first day of the campaign, and list the tokens on online exchanges. We conclude that given extreme information asymmetry, even experienced ICOs investors do not succeed in selecting better projects and their portfolios are of average quality. We next show that there is strong statistical evidence that serial and larger investor groups invest earlier. However, multivariate analysis indicates that overall, larger serial investors generally invest later in the campaigns.

The rest of the paper is organized as follows. In Section 2, we briefly discuss the ICO investment process. In Section 3, we formulate our research hypotheses about the role of ICO investors, timing of their investment and ability to select better-quality ICOs. Section 4 presents the data set and the econometric methods used. Section 5 discusses main results. The last section provides a number of conclusions.

## 2. ICO investment process

Although still largely unregulated, ICO industry has become a widely used technique to quickly raise funds outside of traditional financial industry. Different from traditional ways of raising funds and also from crowdfunding, there is no intermediary such as an underwriter or crowdfunding platform. Recently, more tokens sales were run not as ICOs but via an online crypto exchange that acted as a trusted intermediary (Initial Exchange Offerings or IEOs). However, this offering type was very infrequent until the end of 2018, and prior token sales were run directly by the founders who communicated all the details for investments to all prospective investors that sent their funds and received ICO tokens on the same wallet they used for investing.

Whereas the first ICOs in 2013-2014 featured only one contribution address, later cases of hacks and security breaches during the ICO campaigns led to some projects (133 or 28 per cent of our sample) to run token sales by setting up an investment portal with mandatory investors' registration and allocating individual contribution addresses. Alternatively, other founders restricted access to contribution address and make it public only during the contribution period and for registered investors. This was aggravated by the recent crackdown by the SEC on the token sales deemed to be securities sales in disguise. Many ICO founders started to delete information about campaigns from their blogs, shutting down set-up token sales portals and closing down ICO communication channels such as Telegram groups. Lastly, some ICOs accumulated collected sums on separate addresses to avoid hacks and thefts, limiting the possibility to identify the investors' contribution history.

Notwithstanding the abovementioned limitations, once the ICO contribution address is known, it becomes a technical issue to collect all contributing addresses and recreate their history of investment into token sales under study, obtaining detailed information about the timing and size of each contribution. Ethereum blockchain data allows us to classify and study ICOs investors' behavior and information cascades similar to crowdfunding research (Colombo et al. 2015; Ahlers et al. 2015; Vismara 2016) with one exception – all blockchain data although public is still *pseudo anonymous*. A public observer can see and trace all transactions of a particular address, theoretically associated with an investor, however, public profile or any other private information is hidden. This is like virtual identity concept used by any physical person to communicate via internet.

## 3. Hypotheses

Signalling literature (Akerlof 1973; Spence 1973, 2002) posits that online crowdfunding markets that are dominated by less sophisticated investors should display severe adverse

selection problem. Increased information asymmetry may be mitigated by credible quality signals from high-quality borrowers (Dranove and Jin 2010). As studied by Block et al. (2018), updates from the founders during the campaign have a significant positive effect on the number of investments and total collected funds. In equity- and other types of crowdfunding the quality of signals is endorsed by the third party, the platform that advertises and runs the campaign. Such endorsements by superior principals (Moritz et al. 2015) is missing in token sales since there is no intermediary between the lenders and borrowers. Boreiko and Vidusso (2019) document that ICO listing and aggregating websites quickly took this niche and provided general information about ICO and even assigned quality ratings that were not very effective at the end to distinguished good projects from bad or even listed the outright frauds at times.

As a result, as shown by Moritz et al. (2015), investors emphasized the positive effect of prior investments made by formal capital providers such as VCs and BAs, given their experience and that they had "skin in the game" (Gorton and Pennacchi 1995). We hypothesize that in token sales such endorsements are even more valuable and formulate our first hypothesis as follows:

*H1. Campaigns with prior funding from BAs and VCs attract more investors who contribute more funds and in general collects funds faster.*

In the absence of the third parties' endorsement, as noted by Moritz et al. (2015) and Vismara (2017), investors consider the signals by observing the behaviour of the others and learning from them (Welch 1992). Based on peer-effects model (Bikhchandani et al. 1992), it might lead to information cascades among investors who ignore their private information and follow the wisdom of the crowd. Alternatively, Scharfstein and Stein (1990) develop a model of irrational herding that would lead to the similar outcome in aggregate investment patterns.

In token sales, the investors not only observe the aggregate funding amount but can scan the contribution contract and see the quantity and size of previous contribution in real time. Although no public profile is available for an individual contribution address as sometimes is the case in equity crowdfunding (Vismara 2017), the potential investors might differentiate between different investor types. First, the size of the investment might serve as an indicator of the perceived degree of professionalism (Moriz et al. 2015). Second, the investment history, i.e. prior experience in investing in token sales, might serve as a signal of informational advantage built up through learning-by-doing process. The finance literature demonstrates that funding by more experienced VCs as well as participation of serial entrepreneurs enhance the chances of success (Gompers et al. 2006). Kim and Viswanathan (2013) provide similar evidence in case of experienced crowdfunding investors. We therefore formulate our second hypothesis as follows:

*H2a. Serial crypto investors contribute funds to more successful ICOs.*

*H2b. Large investors contribute funds to more successful ICOs.*

More informed individuals have less incentive to wait and observe the actions of the peers. As a consequence, they we should observe that they invest earlier in first-come-first-served campaigns with limited number of tokens on sale (in line with arguments related to equity crowdfunding as described in Hornuf and Schwienbacher 2017). We therefore formulate our last hypothesis as follows:

*H3a. Serial crypto investors contribute funds earlier in first-come-first-served ICO campaigns.*

*H3b. Large investors contribute funds earlier in first-come-first-served ICO campaigns.*

## 4. Data and methods

### *4.1. Empirical methods and variables definitions*

To test our hypotheses, we proceed as follows. To identify VC-backed ICOs we have looked at the announcements issued by fundraisers and run Google search to find out if an ICO obtained VC or BA financing prior to the token sale. We included both conventional seed financing rounds any time before the token sale as well as participation of the VCs and BAs in private presales of tokens.

To identify serial investors, we analyse summary statistics of all contributions made to bitcoin and ether contracts and marked contracts that send funds to multiple ICO contribution addresses. We create a *Serial Investor* dummy that is equal to one if the contribution is coming from the addresses that was recorded in more than two ICO and zero otherwise (similar to serial BAs classification adopted by Kelly and Hay 1996 and Osnabrugge 1998). Unfortunately, we cannot exclude the possibility that most sophisticated and experienced investors do use single unique addresses also for investing in ETH. However, we observe that more than a quarter of all investors in our sample re-use a single ETH address and that the average investment size of single-ICO investors is twice as smaller than of the serial ones ($5 thousand vs. $11 thousand). Moreover, it is a common practice of the token sellers to send the tokens to the same contribution address of the investor, therefore, a serial investor would have to deal with a large number of separate wallets to keep his acquired tokens unless all the investment activity is administered from a single address. Such a practice greatly reduces the network fees associated with deposits and mitigates the risk of investors depositing Ethereum tokens to the wrong address. Lastly, we have looked at the number of transactions in all Ethereum addresses in March 2019 and noticed that only less than a third resembled a transitory address (two credit and two debit transactions

at maximum). We therefore conclude that the usage of transitory addresses for ICO investing is rather marginal and does not invalidate our results.

To identify large investors we create four investors categories and associated dummies based on the total funds invested in ICOs – *Small investors, Big investors, Top1% investors, and Whales*. We classify all contribution addresses as *Whales* if their total contribution to all ICOs is bigger than $US1m. Arguably, these very large participants, who are either high-net-worth individuals or institutional investors, represent a core informed-investors group in ICOs. We also selected top one per cent of all the investors by invested funds and labelled them as *Top1%* group. The rest of the accounts was classified as either *Big* or *Small* investor if their total invested funds were above/below the average American household savings account balance in June 2018 of US$16,420[4]. To account for possible interactions of investment frequency and size we also created interactions dummies of *Serial Investor* x *Investor size*.

To test our last hypothesis of serial and large investors participating in more successful ICOs we have to define a successful ICO. Several proxies of campaign success are tested. In crowdfunding, it is usually proxied by the dummy indicating if the projects reach their goals or total number of contributors (Ahlers et al. 2015, Vismara 2016). With token sales, many more measures can be taken to represent ICO's success. We selected the log of total funds raised as the main measure of ICO success. This is an intuitive measure that directly shows the investor's interest and beliefs in the project. Having been used in crowdfunding (Mollick 2014; Ahlers et al. 2015) and VC-funding research (De Clerq and Dimov 2008, Cumming et al. 2005), several scholars (Fisch 2019; Momtaz 2018a) have used this proxy.

[4] Data comes from Magnifymoney.com report based on Federal Reserve and the Federal Deposit Insurance Corp. statistics. Retrieved from https://www.magnifymoney.com/blog/news/average-american-savings.

To test the robustness of the results we also use several other measures of ICO success such as token being listed afterwards, total number of contributors, a percentage of funds contributed within the first day of the campaign and whether the hard cap is reached. The hard cap is an arbitrary maximum financial goal defined by the ICO‘s launchers which can be used as a qualitative dummy variable to define the success of a coin offering. This variable may well indicate fundraising has been a big success, as funds ready to be committed to the project may well exceed the maximum estimate by the founders. Moreover, it might serve as a signal of the founder‘s sensibility and seriousness as well as absence of greed.

For the multivariate analysis, we decided to use the log of total funds raised and listing status of the token as our main proxies of success and to test the robustness of the results against the other measures. We run OLS regressions for total funds raised, number of investors, funds raised during the first day, and logistic regressions for listed and hardcap-reached dummies.

We have selected a wide range of control variables that might influence the ICO dependent variables. Our choice was motivated by the accumulated ICO and crowdfunding literature on measuring ICO success.

To test the hypothesis of more experienced or knowledgeable investors contributing earlier in the campaign we run undated panel OLS regression with time of investment as a regressand and types of investors as explanatory variables. We use firms- and investor fixed effects to account for multiple contributions to the same ICO contracts and from the same investor to several ICOs. Time of investments was calculated as the relative position of individual contributions within the ICO period according to the following formula: (Contribution timestamp – start of campaign timestamp) / (End of campaign timestamp – start of campaign timestamp).

*4.2. Data sample*

To identify all ICOs campaigns we adopt an operational definition that treats an ICO as an *unrestricted* crowdfunded fundraising campaign that sells the new proprietary tokens to *public* investors in exchange for existing cryptocurrencies and fiat money as an option[5]. Given the absence of a coherent and reliable database, the task of constructing a complete list of true ICOs is not easy. We proceed in the following way. The lists from seven of the largest ICO tracking websites as at November 2017 were taken and merged, eliminating the double entries, cancelled or unfinished campaigns with ICO actual end dates until December 31, 2017[6]. The initial list was manually checked for errors and double entries and enlarged by additional ICOs found with textual search for words "ICO", "crowdfunding", "token sales" in Bitcointalk.org forums. Various missing data was filled in using additional sources such as websites of the ICO companies or their archived versions on archive.org; companies' private blogs or hosted on major blogging servers such as Medium.com, Steemit or Dusil; blockchain forums - Bitcointalk, Bitcoingarden, Reddit, Thewiring and Forebits; social media communication channels - Twitter, Facebook, LinkedIn, Tumblr; Github and chat channels as places where developers provided information to the interested parties in a relatively safe and confidential manner– Telegram, Slack, Discord; external news and wire articles.

As a result, the constructed database of 573 deals is a unique source of ICO activity from 2013 that is the most comprehensive and rich in detail as at the moment of writing. We further limit our sample by excluding all private token sales (6 cases), ICOs that were run as jokes[7] or

[5] We exclude the cases were only fiat money are accepted as most of these are usually variations of elaborate frauds or Ponzi schemes not leading to creation of the new cryptocurrency that is traded afterwards.
[6] Smith & Crown, Tokenmarket, Icobazaar, Coinschedule, Hubcoin, Icodata, and Icoprojectrank.
[7] Useless Ethereum campaign in July 2017 or Worthless Ethereum ICO in August 2017 to name just a few.

by dilettante developers without raising any amount of money (22 entries), ad clear fraud campaigns identified by the users before or during the fundraising campaign (73 entries).

Our final sample consists of 472 ICO campaigns. For these ICOs we tried to identify all valid non-empty bitcoin and ether contribution addresses used by the founders to collect investments. We were able to locate BTC or ETH contribution addresses and download the investment statistics for 83 campaigns out of total 237 ones run on Bitcoin blockchain and for 272 campaigns out of 354 ones on Ethereum blockchain.

Table 1 shows summary statistics for full ICO sample and for the BTC- and ETH-run campaigns separately. The data shows that an average ICO in our sample raises $US9 million with one fifth of all raising less than $US100,000. One sixth of all ICOs have obtained some form of seed financing prior to fundraiser and, in general, founders manage to sell only two fifth of the offered tokens while leaving for themselves 14 per cent of the total. Less than a third of the campaigns run private pre-sale rounds, closed or restricted for public investors, with 11 per cent also accepting fiat currencies contributions and almost two thirds of all ICOs offered token price discounts for large or earlier investors. Around 40 per cent used “all-or-nothing” model of fundraising used in crowdfunding by defining a minimum sum needed to proceed with the project (min cap). One in five selected a proportional-sale model where the price and number of allocated tokens is defined only at the end of the campaign by dividing the total funds raised by the number of offered tokens. Around 6 per cent of all used an uncapped sale model, where they were ready to accept any amount of money contributed during the campaign period. Around 45 per cent of all issued token are built on Ethereum blockchain with 12 per cent of all founding teams choosing to run the sale or incorporate the legal entity in jurisdictions that passed ICO-benevolent laws (Singapore, Switzerland, and Estonia). The average fundraising campaign is planned to last 32

days, usually ending earlier by three days and only two thirds of all issued tokens end up being listed on cryptoexchanges[8].

[Insert Table 1 about here]

The data on BTC- and ETH-run token sales and subsamples of ICOs with identified contribution statistics does not show any selection bias. BTC-run campaigns are clustered more at the start of the sample' time period prior to year 2017, when ICOs raised less funds, run more often proportional sales model, were willing to proceed with any amount collected without defined min cap, more aggressively awarded bonus tokens to earlier/larger investors and developed their own blockchains for tokens. ETH-run campaigns, on the contrary are clustered at the end of the sample, larger by size and more often marketing the campaign with published whitepaper, offering bonus tokens less often and choosing Ethereum blockchain not only to raise funds but also to build their tokens on it.

*4.3. Descriptive analysis of investors' contributions*

We were able to locate and obtain the detailed investment statistics for 83 bitcoin and 272 ether contracts. We have downloaded all BTC contracts' data using API calls to blockchain.com Bitcoin blockchain explorer and used a local copy of the full Ethereum blockchain node to download data for ether contribution contracts. The data includes the contributing address with amount sent in either BTC or ETH and timestamp of the transaction. We further removed zero-value transactions, transactions that had an error status and did not come through, all transactions that took place outside of the contribution period or were done from the public wallets of

[8] We treat a token as listed if it is included in the cryptocurrencies' list of Coinmarketcap.com.

intermediaries, such as crypto exchanges[9]. We also manually checked all transactions bigger than $US500,000 and excluded those that were associated with founders (company moving funds from private sales of tokens or presales) or were representing a smart contract address. We cannot rule out the possibility of the final sample still being contaminated with the large transactions coming from organized syndicates pooling resources from individual investors to get better terms or participate in restricted presales of tokens[10]. Still, our sample of 472 ICOs has only 72 campaigns with restriction on minimum investment with an average of $US210 and median of $US12, with only two ICOs having relatively high participation requirement of $US5,000 (Moeda and OmiseGo). Moreover, the ICO pools have become active only towards the end of 2017[11] that is outside of our sample period. Therefore, we proceed by assuming that all the transactions in our sample are coming from individual or institutional investors and not from intermediaries.

Some general statistics about the distribution of investments by individual contracts and aggregated for each ICO is shown in Table 2. The data clearly illustrates Bitcoin blockchain limitation that precludes any coherent analysis of serial investors' behaviour. In fact, less than 0.6% (613) of all contributing addresses invested in more than one ICO.

[Insert Table 2 about here]

Ethereum blockchain data is different. Around 24.3% of all contribution contracts invested in more than one ICO (48,338). With this in mind, we have decided to continue with more detailed analysis of the ICOs subsamples only using available ETH contribution contracts.

[9] For this purpose we constructed a list of all Ethereum addresses associated with known crypto exchanges (around 100 entries).
[10] For more information on ICO pools see Chevalier (2018).
[11] https://hackernoon.com/the-ultimate-list-of-ico-pools-in-the-bear-market-q4-2018-81ffc4df5a9b.

[Insert Table 3 about here]

Table 3 provides descriptive statistics for the sample composition by investor types and quantity of contributions. The first columns show the investment statistics such as average number of ICOs invested, total and average contributions and the time span during which the contribution address has the records of transactions to ICOs in our sample. Larger investors on average have a longer ICO investment history recorded on blockchain, On average, an investor in our sample invests in various ICOs over the span of 43 days, with *Whales* being active over 123 days over the total period under study of 820 days (August 2015 – November 2017 for contribution in ether). Interestingly, the bigger the investor, the earlier she invests (except for *Whales*). *Top1%* group invests on average at approximately 23 per cent of the contribution period (in one week's time from the start) and *Small investors* at around 10 days from the start. This translates into around 3-days difference between the groups, lending some support to the Hypothesis 3

The last four columns of the Table 3 look at various measures of ICO campaign success. As expected, bigger, and presumably more informed, investors seem to contribute to more successful ICOs (except as measured by the total number of contributors). Surprisingly, repeated investors, i.e. those that have long experience in investing in several token sales, seem on average to invest in less successful ones. However, repeated investors do seem to invest on average in tokens that are higher in ranking of the cryptocurrencies published by marketcoincap.com portal. The higher the rank of the cryptocurrency (the smaller is the reported position in the ranking), the larger is the market capitalization of the token, its liquidity and market interest in the project development.

## 5. Results

We test the power of the endorsement of the ICO quality by prior VC or BA investment in Table 4. Here we observe a robust and significant effect of the quality certification by the VC confirming Hypothesis 1. After taking account of various factors that might work lead to success of a particular ICO, such as availability of the project's code in GitHub[12], running token sale in ICO-friendly jurisdiction, granting deep discounts to early backers, and taking account of crypto markets' factors, the presence of VC investment prior to the public sale leads to larger amounts collected, higher participation ratio, faster investment and higher probability of tokens being listed.

[Insert Table 4 about here]

In Table 5 we test whether the peer endorsement effects, even after accounting for VC certification ones, hold. Using the same set of controls plus the VC-investment dummy, we test whether serial and large investor select ICOs that are more successful as measure by our selected proxies. We report the results only for total funds collected and token listing status and do not report the other regressions of serial and larger investors' participation on other success proxies.

[Insert Table 5 about here]

We fail to find support to the claim that serial investors possess superior information about ICOs and make more informed decisions by participating more in more successful ICOs. On the contrary, the experienced investors seem to invest less than non-serial ones in all higher-quality token sales. Faced with severe information problems, investors that contribute to more than two ICO campaign seem not being able to differentiate good from bad projects and their portfolios

[12] We consider only the genuine Github activity and exclude the cases where founders create an empty Github repository or place only the token sale smart contract code with minimal external contributions.

equally likely contain all types of tokens. We therefore reject the hypothesis that investors with records of contributions to multiple ICOs possess superior information about projects' quality and future prospects. However, we find the opposite result for a subgroup of large serial investors that seem to be able to identify and invest in higher-quality projects.

The results of the panel OLS regressions on the timing of investments are reported in Table 6. Univariate regressions show that *serial* and *larger* investors groups (with an exception of *Whales*) do invest earlier in the campaign. Considering an average campaign length of 32 days, it translates into a day difference for *serial* investors and half a day for large contributor groups (*Top1%* and *Big*). The result is unchanged if we run the regression on all types of investor size. To test the preposition that more informed investors are those that not only invest bigger amount but also invest repeatedly into more than one ICO we run the regression with dummies accounting for *serial* investor and investment size, as well as their interaction. Surprisingly, although *serial* investors contribute earlier in the campaign, it is single-investment transactions from *Big* and *Top1%* groups that have time advantage. We explain this finding by observing high competition in many first-come-first-served ICOs in our sample. As a result, *serial* investors have smaller chances to invest earlier in several campaigns in a regular fashion. Overall, we find clear evidence that more knowledgeable investors, either through learning by investing in crypto assets or by being able to invest on a larger scale do invest earlier in crowdfunding campaigns.

[Insert Table 6 about here]

Earlier investments might be explained by desire to receive more discounted tokens due to widespread system of offering large bonuses to earlier investors. Sixty per cent of all ICOs offered substantial bonuses to encourage earlier investment, with maximum bonus size reaching 167% (27% on average) and 70% (11% on average) if we use time-weighted data across total

contribution period. Another possible explanation is that more skilled investors correctly identify higher quality ICOs and invest ahead of the uninformed investors, for which we find partial confirmation in the previous tests.

To test the robustness of the results we used several other proxies of ICO success (not reported here) and looked at the proportion of the number of contributions across all ICOs. We also run the regressions classifying as serial investors all those that invested in more than one (more than five) ICO and as big investors those that contributed more than $50,000 in total. Apart from some coefficients turning out insignificant, in general the results hold – serial investors do not seem to possess superior information about projects, although they time the market and invest earlier in the campaign.

## 6. Conclusions

Blockchain financing with ICOs and token sales, as a new form of crowd financing is now a well-established practice worldwide with start-ups raising a collective of above US$1b monthly in the first half of 2018. In this paper, we have analysed the initial phases of the industry's development from 2013 to November 2017, collecting detailed information on all campaigns or ICO attempts in this period, providing a thorough quantitative analysis of the investor behaviour, and laying the foundation for future research in this area. We document the robust positive effect of superior principle endorsement (VC) on the success of the ICO campaigns. On the contrary, we find out that the serial investors, although investing earlier on average, do not seem to possess the skill to select better ICOs.

We still do not know the exact dynamics of investing activity, how it is differentiated across various types of token sale auctions and the effects of the bonus campaigns on timing and size of investments. Self-compliance and effects of legal tools chosen to ensure smooth token

sales also represent very interesting topics to look at. Finally, the post-ICO lives of the projects and comparative studies of token sales versus more traditional financing methods such as VC and private equity merit special attention. At the end, whatever the prices of cryptocurrencies would be and notwithstanding negative attitude of some national regulators, tokenization and token sales will only develop further.

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**Table 1. Summary ICOs statistics**

| | **Total sample (N=473)** | **Accept BTC (N=237)** | **Known BTC contract (N=83)** | **Accept ETH (N=354)** | **Known ETH contract (N=272)** |
|---|---|---|---|---|---|
| Total funds raised, $US m | **4,165.0** | 1,817.5 | 392.5 | 3,961.3 | 3,398.3 |
| Average funds raised, $US m | **9.0** | 7.9 | 4.1 | 11,4 | 11.6 |
| % collected more $US 50k | **81.8** | 84.4 | 85.6 | 83.3 | 82.7 |
| % collected more $US 100k | **77.2** | 78.5 | 77.9 | 80.5 | 79.6 |
| % with prior VC-backing | **16.7** | 17.3 | 11.5 | 18.6 | 17.0 |
| % with Whitepaper | **89.2** | 84.0 | 79.8 | 94.4 | 95.6 |
| % with Github repository | **59.2** | 58.2 | 64.4 | 58.8 | 61.9 |
| % of total tokens sold | **41.5** | 46.8 | 49.1 | 39.9 | 39.5 |
| % tokens retained by founders | **14.4** | 14.8 | 13.8 | 13/9 | 13.7 |
| % with fiat contributions | **11.0** | 18.6 | 11.5 | 10.2 | 6.8 |
| % with pre-sale stage | **30.7** | 27.8 | 22.1 | 33.9 | 35.0 |
| % with bonus offered | **63.6** | 72.2 | 78.8 | 61.6 | 59.9 |
| % with uncapped sales | **6.1** | 8.0 | 10.6 | 5.6 | 5.4 |
| % with proportional distribution | **17.3** | 27.8 | 39.4 | 10.5 | 9.9 |
| % with defined MC | **41.4** | 33.3 | 29.8 | 44.1 | 45.6 |
| % with Ethereum token | **63.8** | 41.4 | 29.8 | 81,1 | 87.1 |
| % ICO-friendly jurisdiction | **13.7** | 11.4 | 8.7 | 16.7 | 16.0 |
| % run in year 2017 | **79.7** | 66.2 | 47.1 | 92.4 | 92.5 |
| % tokens listed on exchanges | **65.1** | 73.0 | 73.1 | 63.0 | 61.6 |
| N of concurrent ICOs | **69.4** | 41.1 | 22.4 | 87.4 | 93.5 |
| BTC return 1m before, % | **17.7** | 15.8 | 11.7 | 19.6 | 20.2 |
| Average rank on Coinmarketcap | **279** | 325 | 309 | 244 | 235 |
| ICO campaign planned, days | **32** | 35 | 37 | 29 | 26 |
| ICO campaign actual, days | **29** | 33 | 37 | 26 | 25 |

Note: the table shows the selected data for total sample of 472 ICOs and separately for ICOs that accepted either bitcoin or ether as contribution currency and for subsamples with identified contribution contracts. *Total/Average funds raised* are estimated by converting the total/average raised amounts into $US using the actual-end-of-campaign-dates exchange rates. *% with prior VC-backing* show the proportion of ICOs that obtained VC or BA financing before the campaign. *% with fiat contributions* refer to ICOs that accepted contributions not only in cryptocurrencies. *% with pre-sale stage* identify ICOs that prior to public sale run private or restricted sale round for selected investors. *% with bonus offered* show ICOs that featured price discounts for earlier/larger investment. *% with proportional distribution* are ICOs that sold their tokens without a fixed price per token. *% of uncapped* show a proportion of campaigns run without pre-specified hard cap limit. *% with WP* are ICOs that published a White Paper before the campaign's start. *% ICO-friendly jurisdiction* includes ICOs that have chosen Swiss, Singapore or Estonia jurisdiction for running token sales. *Average rank on Coinmarketcap* stands for the relative rank of the ICO tokens in the list of all cryptocurrencies as at 31/12/17.

**Table 2. ICO investors' participation statistics**

| | Mean | Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|---|---|
| BTC contribution contracts (N=83) | | | | | | |
| N of contributions per ICO | 1,565 | 1 | 78 | 392 | 1,455 | 15,189 |
| N of investors per ICO | 1,280 | 1 | 65 | 337 | 1,174 | 15,188 |
| N of ICOs invested in | 1.0 | 1 | 1 | 1 | 1 | 16 |
| Mean contribution, $US | 893 | 0 | 24 | 119 | 522 | 4,360,543 |
| Mean contribution per ICO, $US | 1,070 | 0 | 24 | 126 | 589 | 4,360,543 |
| ETH contribution contracts (N=272) | | | | | | |
| N of contributions per ICO | 1834 | 1 | 80 | 382 | 1,911 | 28,467 |
| N of investors per ICO | 1,610 | 1 | 70 | 344 | 1,675 | 21,312 |
| N of ICOs invested in | 1.65 | 1 | 1 | 1 | 2 | 115 |
| Mean contribution, $US | 4,172 | 0 | 178 | 598 | 1,595 | 10,770,264 |
| Mean contribution per ICO, $US | 4,735 | 0 | 196 | 701 | 1,784 | 10,770,264 |

Note: the table shows the distribution statistics for investors' participation in ICOs accepting contributions in BTC (83 ICOs) and in ETH (272 ICOs). Only transactions within the defined public contribution period are counted. *N of contributions/N of investors per ICO* identify the total number of transactions/unique contribution addresses recorded on blockchain for a campaign. *N of ICOs invested in* shows the statistics on number of ICOs each contribution contract sent funds into. *Mean contribution* and *Mean contribution per ICO* measure the average size of a single contribution and of total funds invested by each contribution contract into each ICOs.

**Table 3. Investment dynamics across investors' types.**

| | N of invested ICOs | Average individual inv., $US | Inv. time span, days | Average inv. Time, % | % of ICOs reaching HC | Token rank | Funds raised, $USm | Average N of investors |
|---|---|---|---|---|---|---|---|---|
| **All investors (264,572)** | **1.6** | **4,734** | **43** | **28.7** | **54.9** | **390** | **28.6** | **7,235** |
| Small (251,504) | 1.6 | 1,305 | 39 | 29.2 | 54.0 | 372 | 28.2 | 7,349 |
| Big (10,424) | 3.5 | 18,946 | 79 | 24.5 | 60.8 | 431 | 30.7 | 6,388 |
| Top1% (2,452) | 3.2 | 156,495 | 105 | 22.9 | 67.0 | 430 | 36.6 | 6,320 |
| Whale (192) | 2.1 | 1,757,500 | 123 | 31.0 | 63.2 | 384 | 38.4 | 5,094 |
| **Non-serial investors (227,857)** | **1.2** | **4,980** | **26** | **31.0** | **56.1** | **437** | **31.7** | **7,898** |
| Small (220,343) | 1.2 | 1,338 | 25 | 31.2 | 55.4 | 431 | 30.8 | 7.913 |
| Big (5,798) | 1.3 | 28,736 | 39 | 24.7 | 71.1 | 559 | 48.3 | 7,720 |
| Top1% (1,563) | 1.2 | 222,540 | 40 | 26.7 | 74.0 | 711 | 54.9 | 7,429 |
| Whale (153) | 1.1 | 2,087,567 | 59 | 38.8 | 55.1 | 504 | 40.9 | 4,721 |
| **Serial investors (36,715)** | **4.7** | **3,215** | **71** | **25.1** | **53.0** | **315** | **23.9** | **6,195** |
| Small (31,161) | 4.4 | 1,067 | 65 | 25.4 | 51.2 | 322 | 23.1 | 6,258 |
| Big (4,1626) | 6.2 | 6,674 | 101 | 24.4 | 57.9 | 333 | 25.7 | 6,012 |
| Top1% (889) | 6.9 | 40,376 | 145 | 21.5 | 64.4 | 345 | 29.8 | 5,908 |
| Whale (39) | 6.1 | 462,626 | 180 | 20.7 | 73.9 | 395 | 35.0 | 5,588 |

Note: the table shows the investment statistics for various groups of investors classified according to number of ICOs participated and investment totals. *Inv. time span* is the time period in days between the first and last investments from each contribution address across all ICOs. *Average inv. time* is the investment time of the contribution relative to the ICO period, where 0% stands for the start of the campaign, and 100% for the end. *% of ICOs reaching HC* refers to the average percentage of ICOs invested by each group that had reached their hard cap. Token rank stands for relative position of the ICO token in the Coinmarketcap ranking as at 31/12/17 with highest position (1) taken by bitcoin. *Funds raised* measure the average funds raised from each investor group. *Average number of investors* shows the average number of contributing addresses across all ICOs for each investor group.

**Table 4. Regressing ICO success proxies on VC participation**

| | Funds invested (1) | N. of investors (2) | Day 1 investment (3) | HC reached (4) | Listed token (5) |
|---|---|---|---|---|---|
| VC-backed (Y/N) | .53** | .79** | .10** | 1.5*** | 1.0** |
| Whitepaper (Y/N) | .79** | .82 | .00 | -.20 | .66 |
| GitHub (Y/N) | .55*** | .87*** | -.01 | 1.0** | .87*** |
| ICO-friendly law (Y/N) | .15 | 1.3*** | .05 | 1.1** | 1.7*** |
| Uncapped sale (Y/N) | .31 | .62 | -.6 | .87 | .28 |
| Bonus tokens (Y/N) | -0.03 | .44** | -.04 | -1.1*** | .02 |
| Presale (Y/N) | .33** | 1.2*** | .09** | .68* | 1.1*** |
| Mincap defined (Y/N) | -0.14 | .30 | .00 | -.18 | .02 |
| ETH-token (Y/N) | .28 | .26 | .10* | .12 | 1.5*** |
| Campaign length, days | -0.14 | -.23** | -.14*** | -0.4** | -.25 |
| ICO market activity | -0.29*** | .27** | -.06*** | -.32* | -.54*** |
| BTC return, pre-ICO | .33 | -1.2** | -.15 | .61 | -1.3 |
| ETH return, pre-ICO | .25 | .85** | .12** | 1.2** | .79* |
| Accepting fiat (Y/N) | .75** | -0.41 | .07 | 1.0 | .28 |
| Year dummies | YES | YES | YES | YES | YES |
| Constant | YES | YES | YES | YES | YES |
| Adjusted/McFadden $R^2$ | .20 | .33 | .22 | .29 | .48 |
| N. of Obs. | 272 | 272 | 272 | 272 | 272 |

Note: the table reports the results of the OLS (1-3) and logistic (4-5) regressions of ICO success proxies against the VC-dummy and a set of control variables. *Funds invested* and *N. of investors* are the total collected contributions converted into $US and number of investors per ICO. *Day 1 investment* measures the percentage of total funds invested in the first 24 hours of the campaign. *HC-reached* is a dummy that equals 1 if the campaign hits a predetermined maximum target. *VC-backed* is the dummy that is 1 if the founders obtained VC or BA financing before the campaign. *Accepting fiat* refers to ICOs that accepted contributions not only in cryptocurrencies. *Presale* identifies ICOs that prior to public sale run private or restricted sale round for selected investors. *Bonus tokens* show ICOs that featured price discounts for earlier/larger investment. *Uncapped sale identifies* campaigns run without pre-specified hard cap limit. *Whitepaper* are ICOs that published a White Paper before the campaign's start. *ICO-friendly jurisdiction* includes ICOs that have chosen Swiss, Singapore or Estonia jurisdiction for running token sales. *ICO market activity* measures the number of the running ICO campaigns at the start of each ICO. *BTC-* and *ETH return* measure one-month prior return from investing in bitcoin or ether. ***, **, * denote the significance of the respective coefficients at 1,5, and 10% levels.

**Table 5. Regressing ICO success proxies on serial and large investor participation.**

| OLS regressions | Funds invested (1) | Funds invested (2) | Funds invested (3) | Listed token (4) | Listed token (5) | Listed token (6) |
|---|---|---|---|---|---|---|
| Serial inv., % of total funds contributed | -1.4*** | | | -1.0* | | |
| Serial inv., % of total contributions | | -.37* | | | -1.8** | |
| Top1% serial inv, % of total funds contributed | | | 1.1* | | | 2.5** |
| VC-backed (Y/N) | .53** | .53** | .51** | 1.0** | .99** | .93** |
| Whitepaper (Y/N) | .67* | .77** | .89** | .55 | .60 | .22 |
| GitHub (Y/N) | .53*** | .54*** | .55*** | .87*** | .87*** | .89*** |
| ICO-friendly law (Y/N) | .17 | .14 | .14 | 1.8*** | 1.8*** | 1.6*** |
| Uncapped sale (Y/N) | .17 | .,27 | .33 | .15 | .04 | .32 |
| Bonus tokens (Y/N) | -.04 | -.04 | -.02 | .00 | .04 | .04 |
| Presale (Y/N) | .32** | .34** | .29** | 1.1*** | 1.2*** | 1.0*** |
| Mincap defined (Y/N) | -.04 | -.12 | -.17 | .01 | .14 | -.60 |
| ETH-token (Y/N) | .24 | .26 | .24 | 1.5*** | 1.5*** | 1.4*** |
| Campaign length, days | -.13 | -.13 | -.14 | -0.3 | -.26 | -.24 |
| ICO market activity | -.23*** | .27** | -.28*** | -.51*** | -.49*** | -.51*** |
| BTC return, pre-ICO | .28 | -.31 | .35 | -1.4* | -1.4* | -1.2 |
| ETH return, pre-ICO | .30 | .27 | .22 | .82* | .85* | .72 |
| Accepting fiat (Y/N) | .54* | .72** | .75** | 0.4 | -.01 | .39 |
| Year dummies | YES | YES | YES | YES | YES | YES |
| Constant | YES | YES | YES | YES | YES | YES |
| Adjusted/McFadden $R^2$ | .25 | .20 | .21 | .25 | .25 | .48 |
| N. of Obs. | 272 | 272 | 272 | 272 | 272 | 272 |

Note: the table reports the results of the OLS (1-3) and logistic (4-6) regressions of ICO success proxies against serial and larger investors variables and a set of control variables. *Serial inv., % of total funds contributed* measures a percentage of funds in each ICO coming from serial investors. *Serial inv., % of total contributions* measures a percentage of number of contributions in each ICO coming from serial investors. *Top1% serial inv, % of total funds contributed* measures a percentage of funds in each ICO invested by a subgroup of top 1 per cent investors who contributed to more than 2 ICOs. All regressands and control variables are defined in Table 5. ***, **, * denote the significance of the respective coefficients at 1,5, and 10% levels.

**Table 6. Panel OLS regressions of the timing of investments**

| **OLS regressions** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
|---|---|---|---|---|---|---|---|
| Serial investor | -0.04* | | | | | | -0.04* |
| Small investor | | 0.01* | | | | | |
| Large investor | | | -0.01* | | | -0.01* | -0.04* |
| Top1% investor | | | | -0.02* | | -0.02* | -0.04* |
| Serial x Big | | | | | | | 0.03* |
| Serial x Top1% | | | | | | | 0.03* |
| Serial x Whale | | | | | | | -0.01 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES |
| Investor FE | YES | YES | YES | YES | YES | YES | YES |
| Constant | YES | YES | YES | YES | YES | YES | YES |
| Adjusted $R^2$ | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 |
| Prob(F-statistics) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| N. of Obs. | 498,913 | 498,913 | 498,913 | 498,913 | 498,913 | 498,913 | 498,913 |

Note: Investor groups are defined in section 4.1. * denote the significance of the respective coefficients at 1%.