The European Journal of Finance

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rejf20

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To cite this article: Paul P. Momtaz (2021) The Pricing and Performance of Cryptocurrency, The European Journal of Finance, 27:4-5, 367-380, DOI: 10.1080/1351847X.2019.1647259

To link to this article: https://doi.org/10.1080/1351847X.2019.1647259

Published online: 28 Jul 2019.

THE EUROPEAN JOURNAL OF FINANCE
2021, VOL. 27, NOS. 4–5, 367–380
https://doi.org/10.1080/1351847X.2019.1647259

The Pricing and Performance of Cryptocurrency

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ABSTRACT
This paper examines the performance of cryptocurrencies issued in initial coin offerings (ICOs) over a three-year period after the initial exchange listing. Average (median) ICO underpricing amounts to 15% (3%), even though 4 out of 10 ICOs destroy value on the first trading day. Liquidity, market capitalization, and high-low price ratios predict returns. Long-run buy-and-hold returns are positive for the mean and negative for the median. For holding periods between one and twenty-four months, the median ICO depreciates by 30%. Evidently, there is substantial positive skewness in the cryptocurrency market. Further, a *size effect* emerges from the data as an empirical regularity: Large ICOs are more often overpriced and underperform in the long run.

ARTICLE HISTORY
Received 13 June 2018
Accepted 25 June 2019

KEYWORDS
Initial coin offering; token sale; token offering; cryptocurrency; blockchain; smart contracts

JEL CLASSIFICATIONS
G24; G32; K22; L26

Initial coin offerings (ICOs) are an innovative way to raise external finance for projects yet to be developed. Although the ICO market is still in its infancy, its size is already substantial. As of October 2018, ICO projects have raised more than $21 billion, with a market capitalization ten times as high resulting from substantial aftermarket demand in cryptocurrencies. Originally a financing mechanism for entrepreneurial firms, the scope of ICOs has rapidly expanded beyond its original purpose. One example is the ICO of Venezuela's national cryptocurrency, the *petro*. Another example are recent mega-ICOs such as the one of *EOS* that raised $4.2 billion, exemplifying that ICOs are also viable in the large-cap segment. In fact, Amsden and Schweizer (2018) show that the ICO market already exceeds the entire venture capital industry in Europe. The soaring development of the ICO market has already attracted more than 600 institutional investors, with growing attention from entrepreneurial firms, the broad investment management community, regulators, and academic finance.

ICOs are smart contracts on a blockchain designed to raise external finance. They implement *self-executing contracts* of the following type: If investor i sends fiat currency or another cryptocurrency in the amount of x to capital-raising firm j, then investor i receives amount y of the newly issued tokens from firm j in exchange, where x/y is the exchange rate that has been fixed a priori in the smart contract (Momtaz 2019). The main innovation is the complete *disintermediation* of the financing process. ICOs allow firms and investors to keep all the profits from the transaction to themselves. Although there are obvious benefits (see Howell, Niessner, and Yermack 2018), ICOs also bear substantial potential for moral hazard resulting from asymmetric information (Momtaz 2018b). Hence, empirical questions of significant practical and theoretical relevance are how ICOs are priced, how they perform in the long run, and whether there are robust predictors of pricing and performance. However, there is no systematic evidence on these questions.

The purpose of this paper is to fill this gap. Using a comprehensive sample of more than 1400 ICOs since 2013, I document several stylized facts about the pricing and performance of cryptocurrencies. The findings for

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the short-run performance are as follows: Mean (median) ICO underpricing amounts to 15% (3%). However, 40 out of 100 ICOs are overpriced. Initial returns on the first trading day are related to several factors, i.e. liquidty (+), market capitalization (−), and high-low price ratios (+).

For longer investment periods ranging from one week to three years, buy-and-hold (abnormal) returns (BH(A)R) are significantly positive (negative) for the mean (median) ICO. In fact, BHR for the median ICO is relatively stable at −30% for holding periods between one and twenty-four months, suggesting that most ICOs destroy a considerable amount of value. Consistent with this observation, 65 out of 100 ICOs have destroyed value after the first month of trading. Moreover, the factors of the short-run performance, i.e. liquidity, market capitalization, and high-low price ratios, do not consistently predict the long-run performance. Overall, the results document substantial positive skewness in the return distribution of ICOs. Therefore, the whole-sample measures have to be interpreted with caution and a look at the return distribution is necessary.

Additionally, in the spirit of Fama and French (1992), the sample is sorted into cross-sectional portfolios to provide a more detailed picture of the data skewness and how it affects the pricing and performance of ICOs. The empirical regularity emerging in this exercise is, inter alia, a significant *size effect*. Large firms are more often overpriced, which explains why aggregate money left on the table in nominal terms is negative for some time periods even though average underpricing is always positive. The size effect prevails in the long run. Large ICOs underperform substantially.

This study makes several important contributions to the emerging literature on cryptocurrencies. First and foremost, the finding of substantial value destruction by the median ICO in the long-run suggests that the economics of complete disintermediation may not be optimal. The smart contracts behind ICOs often fix the total token supply, factually precluding subsequent coin offerings by the same firm. As a consequence, ICO firms play 'one-shot games', in which they try to maximize gross proceeds – a classic moral hazard problem. Institutional investors may provide a valuable service to the ICO market. Institutional investors, unlike retail investors, can provide screening and monitoring, thereby remedying asymmetric information issues. In this role, the involvement of institutional investors in a specific ICO may entail a *certification effect*, which signals ICO project quality to the market. In fact, the ICO market has begun to recognize the value-added by institutional investors, rewarding them with steep discounts often in the amount of 25% and more. Hence, a major implication of the empirical findings presented in this study is that there might be substantial wealth gains for sophisticated investors from filling the vacuum created by the absence of trusted intermediaries in the ICO market.[1]

Additionally, this study can also serve as a foundation to inform and inspire regulators and policy-makers, and current and future research on ICOs and cryptocurrency. Three concurrent papers are closely related to my study. Dittmar and Wu (2018) look at the performance of ICOs versus non-ICO cryptocurrencies and find that the former outperform the latter. Hu, Parlour, and Rajan (2018) examine measures of common variation for secondary market returns on 222 cryptocurrencies and find they are all strongly correlated with Bitcoin performance. Liu and Tsyvinski (2018) examine the risk-return trade-off only of the three largest cryptocurrencies and show that it is distinct from those of stocks, currencies, and precious metals. My study is the first to provide systematic evidence of the long-term performance of all listed cryptocurrencies on all major token exchange platforms.

Moreover, several studies examine the short-term success of ICOs such as underpricing (Kostovetsky and Benedetti 2018; Momtaz 2018c) and the funding amount raised (Fisch 2019).[2] It is not clear, however, to what extent short-term success in ICOs is related to the long-term performance of cryptocurrencies. Drobetz, Momtaz, and Schroeder (2019) are the first to examine to what extent first-day returns predict long-term performance, but their primary focus is on how investor sentiment affects ICOs. Furthermore, Shams (2019) examines the covariation of cryptocurrency returns and Li and Yi (2019) are the first to shed initial light on an emerging factor structure of cryptocurrency returns. Additionally, a number of studies examines the role of information disclosure in whitepapers (Florysiak and Schandlbauer 2018; Momtaz 2018b), although with mixed findings. For example, Howell, Niessner, and Yermack (2018) find that information disclosure is positively related to ICO success, whereas Blaseg (2018) finds no significant effect. Another research branch compares how tokens issued in ICOs compare to traditional securities (Chod and Lyandres 2018; Lyandres, Palazzo, and Rabetti 2018; Malinova and Park 2018).[3]

The remainder is organized as follows: Section 1 provides some background on ICOs and the market evolution, Section 2 describes the data, variable construction, and summary statistics, Section 3 presents the empirical results, and Section 4 concludes.

1. Initial coin offerings: some background

An initial coin offering (*ICO*), also called *token sale* or *token offering*, is an event in which a firm issues a digital currency (i.e. *tokens* or *coins*), in exchange for other digital currencies or legal tender.[4] The digital currencies are based on blockchain technology, which is a decentralized ledger with a publicly available and verifiable record of the transaction history. Excellent overviews of the technology are presented in Böhme et al. (2015), Yermack (2017), and Howell, Niessner, and Yermack (2018). Importantly, most issued tokens do not represent equity shares. Instead, it is a currency that can be used as a means of payment for products and services of the issuer that will be offered in the future (so-called utility tokens).[5] Nevertheless, because the token supply is fixed, platform growth increases the price of tokens, which has attracted many investors. Athey et al. (2016) report that most of the volume in the largest digital currency, Bitcoin, is driven by speculative trading activities.

The life cycle of a digital currency begins with its idea. Almost as soon as a vision and management team have formed, the project is marketed, a whitepaper (the 'ICO prospectus') is prepared, and team members go on road show. An important step in this phase is to make sure that the token will fail the *Howey Test*, which ensures that it is regarded to be distinct from a traditional security and hence can operate in an almost unregulated environment. Some projects undertake pre-ICOs to raise funds for the actual ICO. The ICO is usually organized on the *Ethereum* blockchain, which provides an easy-to-use interface to create the tokens and conduct the exchange transactions. In fact, the creation of tokens takes only a few minutes, and some ICOs raise their desired funds in the same period of time. For example, a project for a new web browser, called *Brave*, raised $35 million within the first 30 seconds. After the successful ICO, it takes the median firm only 42 days to get listed on a token exchange platform. A comprehensive overview of this process is outlined in Momtaz (2018c).

The evolution of the ICO market began in early 2014; very few ICOs emerged prior. I show the ICO market evolution proxied for by the cumulative number of ICOs in Figure 1. The graph shows that the ICO market grew

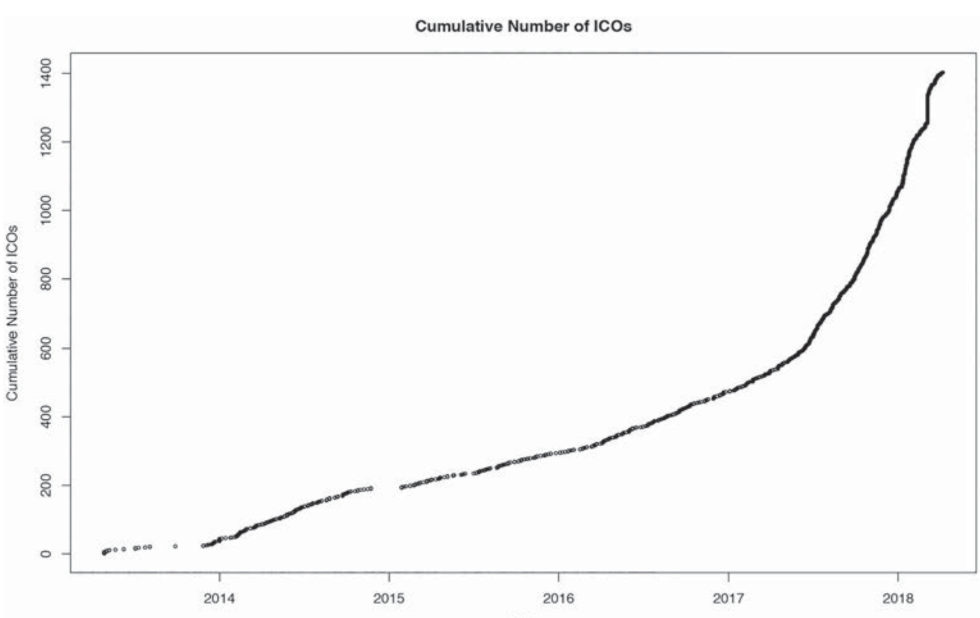

Figure 1. The Evolution of the ICO Market.

almost at a constant rate until middle-2017. In the beginning of the second half of 2017, the ICO market soared in terms of the number of ICOs. This structural break appears to have been initiated by the ICO of Tezos, the largest ICO at that time, raising more than $230 million. The increase in the number of ICOs came along with a substantial increase in total market capitalization and trading volume.[6]

2. Variable construction, data, and summary statistics

2.1. Variable construction

Following the IPO underpricing literature (Chambers and Dimson 2009), I assume that an issuing firm wishes to maximize the ICO gross proceeds and aims to establish a liquid market that will attract potential platform users and is necessary to get listed on a token exchange platform. ICO underpricing is then defined as the average first-day raw returns denoted by $\overline{Ret.}$ or $\bar{R}$ and is calculated as the sum over all digital currencies i of the closing and opening price difference over the opening price of the first-day of trading divided by the number of digital currencies n:

$$\overline{Ret.} = \overline{R} = \frac{1}{n}\sum_{i=1}^{n}\frac{P_{i,1} - P_{i,0}}{P_{i,0}} \tag{1}$$

Raw buy-and-hold returns (BHR) are used for the long-term performance of ICOs, which are more precise than geometric averages such as cumulative abnormal returns used in long-term studies (MacKinlay 1997).[7] The BHR are computed in the same way as the first-day raw returns but with the first-day closing price being replaced by the closing price after the focal holding period:

$$\overline{BHR_\tau} = \frac{1}{n}\sum_{i=1}^{n}\frac{P_{i,\tau} - P_{i,0}}{P_{i,0}} \tag{2}$$

The raw returns are adjusted using a market capitalization-weighted benchmark. The crypto-market capitalization-weighted benchmark has the advantage of being unbiased by the presence of extreme daily returns of some very small digital currencies. Indeed, some currencies have yielded daily returns of more than 300% on some days, suggesting that an equal-weighted benchmark might produce deceptive results. I define average abnormal returns as $\overline{AR}$ and define them as the mean of all first-day raw returns corrected by my market benchmark. The market benchmark is calculated as the sum of the products of the market capitalization of digital currency j on day t over the total market capitalization on day t and the daily raw return of digital currency j on day t:

$$\overline{Abn.\ Ret} = \overline{AR} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{P_{i,1} - P_{i,0}}{P_{i,0}} - \sum_{j=1}^{n}\frac{MC_{j,t}}{\sum_{j=1}^{n} MC_{j,t}} \cdot \frac{P_{j,t} - P_{j,t-1}}{P_{j,t-1}}\right] \tag{3}$$

Similarly, average buy-and-hold abnormal returns ($\overline{BHAR}$) for holding period τ are defined as the mean of BHR less the market return.

$$\overline{BHAR_\tau} = \frac{1}{m}\sum_{i=1}^{m}\left[\frac{P_{i,\tau} - P_{i,0}}{P_{i,0}} - \sum_{j=1}^{n}\frac{MC_{j,t}}{\sum_{j=1}^{n} MC_{j,t}} \cdot \frac{P_{j,t} - P_{j,t-\tau}}{P_{j,t-\tau}}\right] \tag{4}$$

Finally, a volatility estimate based on the realized variance of BHR is computed as follows:

$$Realized\ Variance\,(BHR_\tau) = \frac{1}{m-1}\sum_{i=1}^{m}\left[BHR_{i,\tau} - \overline{BHR_\tau}\right]^2 \tag{5}$$

Table 1. Summary statistics.

Variable	*N*	Mean	St. Dev.	Q1	Median	Q3
Raw returns	1403	0.148	0.491	−0.043	0.015	0.196
Abnormal returns	1397	0.150	0.494	−0.064	0.029	0.216
High/Low ratio	1403	1.031	6.420	0.125	0.310	0.735
Liquidity	1367	2635.589	17,481.658	1.474	24.685	287.895
Market capitalization	559	39,372.864	382,010.037	17.819	177.660	2492.570
Gross proceeds	559	37,841.758	351,242.369	16.714	151.213	2494.594
Money left on the table	559	2370.503	50,612.842	−10.003	0.109	38.330

Notes: The sample consists of 1403 ICOs with time-series return data. However, *coinmarketcap* provides data on market capitalization only for 559 observations.

2.2. Data

The data set consists of all digital currencies available from the *coinmarketcap* database between 2013 and April 2018. In particular, it contains information on the closing prices, market capitalization, trading volume, and the highest and lowest daily prices. *Coinmarketcap* is the most comprehensive publicly available data source.[8] Nevertheless, there are some outliers, which, upon manual checks, are confirmed to be wrong and are hence removed from the dataset. To be sure, I also winsorize the data at the 1% level because the correctness of some extreme values cannot be verified. This results in a final sample of 1,403 digital currencies.

2.3. Summary statistics

Table 1 presents the summary statistics for the different first-day return measures,[9] realized variance, liquidity, market capitalization, gross proceeds, and money left on the table. The average first-day raw (abnormal) returns are 14.8% (15.0%). This is about twice the magnitude reported in a related study that uses a smaller sample of ICOs (Momtaz 2018c). However, the median returns are comparable, ranging from 1.5% to 2.9% for first-day raw and abnormal returns, respectively.

The liquidity measure indicates once more that the sample is significantly positively skewed. The mean first-day trading volume is $2.6 million, while the Q3 estimate amounts only to $0.3 million. Similarly, the average first-day market capitalization is $39.37 million, while the corresponding Q3 estimate is only $2.5 million. The average (median) firm in the sample reports ICO gross proceeds of $37.8 million ($0.15 million) and leaves money on the table in the amount of $2.4 million ($0.0001 million).

2.4. Skewness

The discrepancy between mean and median values evident in Table 1 suggests the presence of substantial positive skewness. As a consequence, whole-sample measures should be interpreted with caution. Relying exclusively on whole-sample measures might be misleading. Therefore, results are always reported for mean and median values. The comparison of these two measures of central tendency allows a more meaningful interpretation of the data. Additionally, the results section below presents analyses based on quartile portfolios.

3. Empirical results

3.1. First-day returns, aggregate ICO proceeds, and money left on the table

This section briefly describes some (partly untabulated) stylized facts about the initial financial performance of ICOs. Supporting results are provided in Table 2. As shown in Figure 1 above, the number of ICOs exponentially increased in H2/2017, however, the return distribution seems largely time-invariant. Although the average *first-day returns* vary by year to some extent, regressing first-day returns on the date yields an insignificant coefficient. The average raw (abnormal) first-day return amounts to 14.8% (15.0%), with corresponding median of 1.5% (2.9%). The mean-median ratio again reflects the highly skewed return distribution in the cryptocurrency market. An interesting observation is that about 4 out of 10 ICOs report negative first-day returns.

Table 2. First-day returns, aggregate gross proceeds, and money left on the table.

	No.of ICOs	*First-day returns in %* Raw returns	Abnormal returns	Aggregate gross proceeds (in $ million)	Aggregate money left on the table (in $ million)
2013	36	0.279* (0.037**)	0.468** (0.296**)	1738.114	−10.197
2014	156	0.189** (0.02*)	0.216** (0.056**)	129.883	129.525
2015	102	0.029 (−0.001)	0.032 (−0.008)	3.8	−0.076
2016	179	0.023 (−0.001)	0.024 (−0.002)	50.36	8.045
2017	583	0.204** (0.043**)	0.184** (0.039**)	17,102.396	1209.346
2018	347	0.122** (0.014*)	0.137** (0.038**)	2128.99	−11.531
Total	1403	0.148** (0.015**)	0.15** (0.031**)	21,153.543	1325.111

Notes: This table presents first-day raw and crypto-market capitalization-weighted abnormal returns, aggregate gross proceeds, and money left on the table by year. The calculation of the return measures is described in Section 2. I show average estimates and the medians, with the latter being shown in parentheses. Aggregate gross proceeds are defined as the sum of all gross proceeds in a given year, where gross proceeds are defined as the market capitalization before the first-trade takes place. Money left on the table is defined as the product between the return measure in each row and gross proceeds. ** and * stand for statistical significance at the 1% and 5% level, respectively.

Aggregate gross ICO proceeds, defined as the sum of the market capitalization at the first instance after a digital currency is admitted to public trading, increased exponentially in H2/2017, showing the same pattern as the cumulative number of ICOs. This seems to be initiated by the *Tezos* ICO, the by-far largest ICO at that time, raising $232 million. The dramatic increase is illustrated in Amsden and Schweizer (2018) who show that the aggregate market volume of *alt-coins* (i.e. all cryptocurrencies except Bitcoin) increased from $2.4 billion to $373 billion in 2017 alone, exceeding the entire European venture capital industry. Interestingly, the cumulative funds raised in ICOs, as of October 2018, amount to $21.3 billion, whereas the aggregate market volume exceeds that amount by a factor > 10. This implies that much of the value comes from aftermarket demand.

Aggregate money left on the table, defined as the product of gross proceeds and underpricing, offers another interesting insight. Even though I observe positive underpricing in all sample years since 2013, money left on the table is significantly negative in three out of six sample years. This observation suggests a considerable *size effect*. There were some large ICOs that were actually overpriced and hence destroyed investor value in absolute terms. An overview of empirical results in support of these remarks is provided in Table 2.

3.2. Long-term performance, realized variance, and sharpe ratios

This section aims to provide first evidence on the long-run performance of ICOs. For that purpose, I compute BHR and BHAR for holding periods from one week to three years after the listing.

The long-term return measures offer interesting initial insights. The results are shown in Table 3. Beginning with the unadjusted BHR, the sample averages suggest that ICOs perform very well in the long run. After the first month, BHR amount to 25.1%, which is doubled by the end of the second month. After the end of the first three years of trading, digital currencies have on average increased in value by about 207%, 829%, and 1600%, respectively.[10]

However, the median measures tell a completely different story. In fact, after the first month of trading, the median ICO has decreased in value by about 30% and remains at that level. This suggests that the positive mean returns are driven by some large outperformers.

Furthermore, buy-and-hold abnormal returns (BHAR) that are adjusted by a market capitalization-weighted benchmark shed some light on the opportunity costs in the ICO market. After the first month of trading, the average BHAR amounts to −4.9%, and further decrease to −1590% after the first year of trading. While this estimate appears astronomically high, it simply expresses the fact that some very large digital currencies such as

Table 3. ICO performance and volatility over the long run.

		Buy-and-hold returns	Buy-and-hold abnormal returns	Volatility
	# ICOs	Mean (Median)	Mean (Median)	Mean (Median)
1 Week	1387	0.206**	0.198**	0.192**
		(−0.094**)	(−0.023)	(0.033**)
1 Month	1316	0.251**	−0.049	0.197**
		(−0.285**)	(−0.264**)	(0.039**)
2 Months	1172	0.493**	−0.4**	0.21**
		(−0.329**)	(−0.356**)	(0.043**)
3 Months	1010	0.81**	−0.699**	0.216**
		(−0.25**)	(−0.575**)	(0.048**)
6 Months	772	1.554**	−3.436**	0.273**
		(−0.259**)	(−1.534**)	(0.056**)
1 year	495	2.073**	−15.903**	0.43**
		(−0.367**)	(−2.939**)	(0.078**)
2 Years	302	8.294**	−41.813**	0.406**
		(−0.305*)	(−0.533**)	(0.062**)
3 Years	190	16.001**	−37.991**	0.605**
		(0.113)	(−1.136**)	(0.049**)

Notes: This table presents buy-and-hold returns in raw form and in adjusted form, where the adjustment is based on a crypto-market capitalization-weighted benchmark. The calculation of the return measures is described in Section 2. This table also presents volatility estimates based on the realized variance as described in Section 2. I show average estimates and the medians, with the latter being shown in parentheses. ** and * stand for statistical significance at the 1% and 5% level, respectively.

Bitcoin and Ethereum dramatically outperformed the sample ICOs.[11] For these reasons, I focus my following analysis on BHR instead of BHAR.

The volatility, as measured by the realized variance, appears to be relatively stable in the first three to six months. The estimates for these holding periods range from 19.2% to 27.3%. Only cryptocurrencies that are traded for a year or longer show evidence of higher volatility levels between 40.6% and 60.5%. This can to some extent be related to the fact that the ICO market is highly sensitive to adverse industry effects such as regulatory initiatives, government bans, and other market events such as the new Facebook advertisement policy prohibiting the promotion of ICOs, as shown in Momtaz (2018c).

I also examine the *risk-adjusted* profitability of ICOs by comparing the distribution of Sharpe Ratios for different investment horizons. Figure 2 presents boxplots which locate the median and give an indication of the distribution of Sharpe Ratios of individual ICOs for each holding period. As expected, the distribution of Sharpe Ratios widens over the lengths of the different holding periods. Average Sharpe Ratios for every holding period are included as well. The average Sharpe Ratios are clearly below the commonly agreed 'success threshold' until the end of the second month, which is marked by a Sharpe Ratio of 1.08. For longer holding periods, the Sharpe Ratios increase continuously to values of 3.16, 13.02, and 20.57 for one-year, two-year, and three-year holding periods, respectively.

3.3. Portfolios sorts

3.3.1. First-day returns

To examine whether there are systematic differences in the pricing of these ICOs, ICOs are sorted into portfolios based on liquidity. Howell, Niessner, and Yermack (2018) show that liquidity is an important success factor for blockchain-based platforms that raise capital in ICOs. Intuitively, the value of these platforms increases in the number of users, and hence liquidity should be positively related to platform value and ICO success. To complement this view, I also discuss results from cross-sectional portfolios based on market capitalization and high-low ratios. The results are shown in Table 4.

The differences between the liquidity-based portfolios are statistically and economically significant. The Q1-portfolio has the smallest first-day returns. They are positive, and their mean (median) ranges from 5.6% to 5.8% (0% to 0.4%). The difference between the highest quartile and the lowest quartile is significant at the 5%

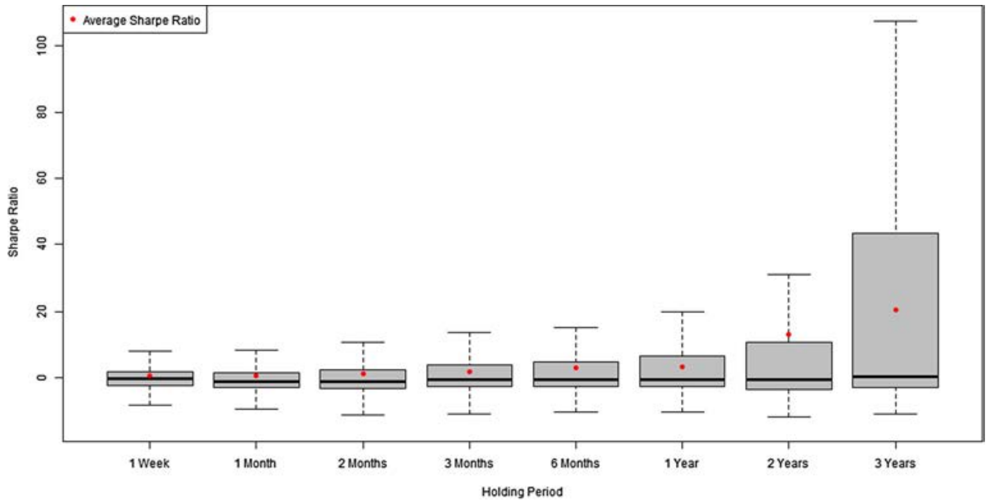

Figure 2. Sharpe Ratios. This figure shows boxplots of the Sharpe Ratios. The average Sharpe Ratios are computed based on the average buy-and-hold returns for the holding period and the square root of the average realized variance for the holding period.

level and amounts to 7.2% for first-day mean raw returns and to 4.2% for first-day median raw returns. There are two potential explanations for the positive return-liquidity relation. One explanation is that underpricing may be used as a knock-on effect to create liquidity, which positively affects platform value (Aggarwal, Krigman, and Womack 2002; Momtaz 2018c). The other is that there might be an ex post 'hot market' for some

Table 4. Portfolio analysis of first-day returns.

		Mean		Median	
	#ICOs	Raw returns	Abnormal returns	Raw returns	Abnormal returns
Liquidity					
Q1	342	0.056*	0.058*	0.000	0.004
Q2	342	0.176**	0.167**	0.024**	0.031**
Q3	341	0.219**	0.216**	0.036**	0.051**
Q4	342	0.128**	0.133**	0.03**	0.037**
Q4−Q1		0.072*	0.075*	0.03**	0.033**
(Q4+Q3)−(Q2+Q1)		0.115*	0.124*	0.042**	0.053**
Market capitalization					
Q1	140	0.16**	0.171**	0.006*	0.022**
Q2	140	0.194**	0.213**	0.023	0.034
Q3	139	0.109**	0.135**	0.014	0.053**
Q4	140	0.092**	0.086**	0.000	−0.003
Q4−Q1		−0.068	−0.085	−0.006	−0.025
(Q4+Q3)−(Q2+Q1)		−0.153*	−0.163*	−0.015	−0.006
High/Low ratio					
Q1	351	0.002	0.000	0.000	−0.002
Q2	351	0.027**	0.026**	0.015	0.019*
Q3	350	0.098**	0.111**	0.067**	0.086**
Q4	351	0.464**	0.462**	0.290**	0.327**
Q4−Q1		0.462**	0.462**	0.290**	0.329**
(Q4+Q3)−(Q2+Q1)		0.533**	0.547**	0.342**	0.396**
Total	1403	0.148**	0.15**	0.015**	0.031**

Notes: This table presents mean and median first-day raw and crypto-market capitalization-weighted abnormal returns for different portfolios based on the quartiles sorted by liquidity (trading volume), market capitalization, and high-low ratios. For example, Q1 under liquidity consists of all ICOs, which ranked in the lowest 25% based on liquidity. The calculation of the return measures is described in Section 2. The estimates are tested for statistical significance, where the means are tested with a t-test and the medians are tested with a sign test. ** and * stand for statistical significance at the 1% and 5% level, respectively.

ICOs (Derrien 2005; Yung 2008). The sample data does not allow to formally test which explanation of the liquidity-return relation dominates, leaving room for future research.

Furthermore, portfolios sorted by market capitalization provide evidence of a size effect. While the returns for all portfolios are significantly positive, smaller ICOs in the first and the second quartile offer significantly higher first-day returns. In fact, the difference between the first two (Q1 and Q2) and the latter two quartiles (Q3 and Q4) is 15.3% for mean raw returns and 16.3% for mean abnormal returns, which is statistically significant.

In additional analyses, I examine the performance of portfolios based on high-low ratios. The high-low ratio compares the highest and lowest prices of the first trading day. In efficient markets, the information revealed on the first ICO trading day should be indicative of the project's quality as well as its performance in the future (Ljungqvist 2007). Indeed, I find highly significant effects for the portfolios based on the high-low ratio. The higher the ratio, the larger the first-day returns. The average ICO in the Q4-portfolio generates 46.2% more first-day returns than the average ICO in the Q1-portfolio. Pooling the lower two portfolios and the upper two portfolios, the difference is even higher, amounting to statistically significant 53.3%. The results are equally true for median first-day returns, albeit less pronounced.[12]

3.3.2. Buy-and-hold returns (BHR)

Do these portfolio effects persist over the long run? To answer this question, I track the performance of the same portfolios over a period of three years. The results for the liquidity-based, market capitalization-based, and high/low ratio-based portfolios are shown in Tables 5–7, respectively.

In short, the long-term performance of the *liquidity* portfolio provides inconclusive results. All portfolios perform similarly up to the sixth month of public trading. The Q1-portfolio's performance increases, while the other three portfolios remain at comparable levels. In fact, in year three, all portfolios except Q1 returned between 1000% and 1200% to their early investors. The lack of a linear relationship between the four portfolios is surprising, and precludes a robust interpretation of the evidence. Overall, the results cast doubt on the widely-held view that initial platform liquidity is a solid predictor of long-run platform value.

Turning to the portfolios based on *market capitalization*, the size effect emerges from the data after the first year of public trading. The difference in BHR after the first sixth months of trading between the larger half of ICOs and the lower half in my sample is −276.2%. For shorter trading periods, the differences are mostly insignificant. This suggests that the market seems to learn about the ICO project quality over the first year and forms expectations, that end up being correct given that the difference sharply increases after two and three years of trading. The interpretation is consistent for both mean and median returns.

Table 5. Liquidity-based portfolio analysis of buy-and-hold returns (BHR).

	1 Week	1 Month	3 Months	6 Months	1 Year	2 Years	3 Years
#ICOs	1387	1316	1010	772	495	302	190
Panel A: Mean performance based on buy-and-hold returns (BHR)							
Q1	0.206**	0.193*	0.609**	1.484**	2.9**	11.446**	27.609**
Q2	0.664	0.245	0.268	1.544	1.513	−0.572*	10.321*
Q3	0.361*	0.871**	0.744*	0.67	1.101	0.206	12.352*
Q4	0.174*	0.298*	0.704**	1.19**	0.571	1.22	11.667**
Q4−Q1	−0.032	0.105	0.095	−0.294	−2.329**	−10.226**	−15.942*
(Q4+Q3) − (Q2+Q1)	−0.335	0.731	0.571	−1.168	−2.741**	−9.448**	−13.911*
Panel B: Median performance based on buy-and-hold returns							
Q1	−0.103**	−0.276**	−0.315**	−0.333**	0.187	1.417**	1.802**
Q2	−0.115	−0.608	−0.655*	−0.653	−0.411	−0.82	9.464
Q3	−0.113	−0.291*	−0.527*	−0.659*	−0.764**	−0.806**	0.069
Q4	−0.099*	−0.222**	−0.231*	−0.174	−0.771**	−0.853**	−0.163
Q4−Q1	0.004	0.054	0.084	0.159	−0.958**	−2.27**	−1.965
(Q4+Q3) − (Q2+Q1)	0.006	0.371	0.212	0.153	−1.311**	−2.256**	−11.36

Notes: This table presents mean (Panel A) and median (Panel B) buy-and-hold returns (BHR) for different portfolios based on the quartiles sorted by liquidity (trading volume). For example, Q1 under liquidity consists of all ICOs, which ranked in the lowest 25% based on liquidity. The calculation of the return measures is described in Section 2. The estimates are tested for statistical significance, where the means are tested with a t-test and the medians are tested with a sign test. ** and * stand for statistical significance at the 1% and 5% level, respectively.

Interestingly, the portfolios based on the *high-low ratio* reverse the first-day signal in the long run. The first-day returns are increasing in the high-low ratio. If the ICO market is relatively efficient, the information revealed on the first-day should be indicative of the underlying ICO project value and hence predict the future performance. However, this is not the case. The first-day signal is already partially reversed after the first week of public trading, and disappears thereafter. This suggests that first-day signals in the ICO market are poor predictors of future performance.[13]

3.4. Nominal value creation vs. destruction

This section sheds some light on the extent to which ICOs create and destroy value in absolute terms (results untabulated). About 40% of all ICOs destroy value on the first day of trading. In fact, this fraction increases

Table 6. Market capitalization-based portfolio analysis of buy-and-hold returns (BHR).

	1 Week	1 Month	3 Months	6 Months	1 Year	2 Years	3 Years
#ICOs	1387	1316	1010	772	495	302	190
Panel A: Mean performance based on buy-and-hold returns (BHR)							
Q1	0.328**	0.348*	0.52	1.605**	2.219**	9.094**	25.847**
Q2	0.452**	0.623**	0.751**	1.729**	1.829**	3.115*	18.84**
Q3	0.192*	0.412*	0.658*	0.187	0.258	1.005	8.299
Q4	0.143	0.208	0.574**	1.916**	1.028	−0.388	3.729
Q4−Q1	−0.185	−0.14	0.054	0.311	−1.191	−9.482**	−22.118**
(Q4+Q3) − (Q2+Q1)	−0.445*	−0.351	−0.039	−1.231	−2.762**	−11.592**	−32.659**
Panel B: Median performance based on buy-and-hold returns							
Q1	−0.059	−0.32**	−0.412**	−0.392**	−0.025	0.377	2.054**
Q2	−0.095	−0.212*	−0.304	−0.37	−0.671	−0.586*	0.382
Q3	−0.099	−0.272**	−0.535**	−0.715**	−0.852**	−0.859**	−0.698*
Q4	−0.114*	−0.223**	−0.107	0.09	−0.158	−0.695*	−0.459
Q4−Q1	−0.055	0.097	0.305*	0.482**	−0.133	−1.072**	−2.513*
(Q4+Q3) − (Q2+Q1)	−0.059	0.037	0.074	0.137	−0.314**	−1.345**	−3.593**

Notes: This table presents mean (Panel A) and median (Panel B) buy-and-hold returns (BHR) for different portfolios based on the quartiles sorted by market capitalization. For example, Q1 under market capitalization consists of all ICOs, which ranked in the lowest 25% based on market capitalization. The calculation of the return measures is described in Section 2. The estimates are tested for statistical significance, where the means are tested with a t-test and the medians are tested with a sign test. ** and * stand for statistical significance at the 1% and 5% level, respectively.

Table 7. High/Low ratio-based portfolio analysis of buy-and-hold returns (BHR).

	1 Week	1 Month	3 Months	6 Months	1 Year	2 Years	3 Years
#ICOs	1387	1316	1010	772	495	302	190
Panel A: Mean performance based on buy-and-hold returns (BHR)							
High/Low ratio							
Q1	0.147*	0.135	0.654**	1.638**	3.252**	6.528**	10.822*
Q2	0.086	0.197*	0.781**	1.534**	1.646**	13.48**	10.819*
Q3	0.115**	0.271**	0.819**	1.467**	1.68**	7.107**	29.119**
Q4	0.474**	0.388**	0.952**	1.567**	1.564**	7.824**	10.761**
Q4−Q1	0.327**	0.253	0.298	−0.071	−1.688*	1.296	−0.061
(Q4+Q3) − (Q2+Q1)	0.356**	0.327	0.336	−0.138	−1.654	−5.077	18.239
Panel B: Median performance based on buy-and-hold returns							
Q1	−0.106**	−0.24**	−0.213**	−0.18*	0.258	−0.089	0.164
Q2	−0.147**	−0.34**	−0.18	−0.168	−0.085	−0.315	−0.152
Q3	−0.092*	−0.289**	−0.291**	−0.37*	−0.565*	−0.382	1.007
Q4	0.022	−0.252**	−0.239**	−0.433**	−0.588**	−0.372*	0.046
Q4−Q1	0.128**	−0.012	−0.026	−0.253	−0.846**	−0.283	−0.118
(Q4+Q3) − (Q2+Q1)	0.183*	0.039	−0.137	−0.455	−1.326**	−0.35	1.041

Notes: This table presents mean (Panel A) and median (Panel B) buy-and-hold returns (BHR) for different portfolios based on the quartiles sorted by high/low price ratios. For example, Q1 under high/low price ratios consists of all ICOs, which ranked in the lowest 25% based on high/low price ratios. The calculation of the return measures is described in Section 2. The estimates are tested for statistical significance, where the means are tested with a t-test and the medians are tested with a sign test. ** and * stand for statistical significance at the 1% and 5% level, respectively.

substantially for longer holding periods, and is more pronounced for BHAR compared to BHR. For example, for a holding period of one month after the listing, 65 of 100 ICOs destroy coinholder value.

Looking at the average (median) value destruction and creation after one month of trading based on BHR, the average (median) firm in the subsample of firms that destroys value has destroyed \$14.2 million (\$0.09 million). This compares to an average (median) value creation in the subsample of ICO projects that create value of \$23 million (\$0.16 million). However, the value destruction is more pronounced when I use BHAR for the calculation. This reflects the fact that BHR adjusted by a cryptocurrency market capitalization-weighted index incorporates the opportunity costs of not investing in extreme outperformers in the sample. Therefore, BHAR provide a somewhat biased estimate of investment opportunities.

Finally, there is mixed evidence on whether the ICO market creates or destroys value in aggregate terms. ICOs that are traded three months or less have destroyed more aggregate value than they have created. Value destruction by ICOs after three trading months amounts in total to \$1.18 billion (aggregate value destruction – aggregate value creation; \$6.74 billion – \$5.54 billion). However, ICOs that remain in my sample for longer holding periods than three months create value in aggregate. For example, the aggregate value creation by ICOs with a holding period of one year amounts to \$3.56 billion.

3.5. Potential avenues for further research

These results should be viewed as an initial set of robust empirical regularities of the long-run performance of ICOs. Many interesting determinants of long-run returns known in the IPO literature might be applicable to ICOs as well and provide interesting avenues for future research as more and more data become available. While the exploration of other determinants is beyond the scope of this paper, a few potential directions are worthwhile to be mentioned: First, it appears highly relevant to better understand to what extend founders' human and social capital characteristics affect the long-run performance of ICOs (see, for initial work, An et al. 2019; Fisch 2019). Several studies show that founders' characteristics are an important determinant of the growth of start-up firms (Colombo and Grilli 2005, 2010; Ahlers et al. 2015). In the spirit of Leland and Pyle (1977), token retention by the founders may be a credible signal of ICO quality and predict long-term success (Vismara 2016; Davydiuk, Gupta, and Rosen 2018) as well as pre-issuance debt as a signal of governance (Epure and Guasch 2019). Other potentially relevant founder characteristics documented in the IPO literature include demographics (Farag and Mallin 2018), intellectual capital (Alcaniz, Gomez-Bezares, and Ugarte 2017), and affiliation with prestigous institutions (Colombo, Meoli, and Vismara 2019). Second, 'waiting periods' until firms choose to go public oftentimes reflect prior beliefs about post-IPO expected cash flows and might therefore also be a viable proxy in the uncertainty-plagued ICO context (Colaco, De Cesari, and Hegde 2018). Similarly, 'waiting periods' between offering and listing may be associated with pricing effects (Chan, Wang, and John Wei 2004). Third, ICOs are designed to spur the growth of global platforms, and hence platform internationalization might have an affect on long-term success (Schwens et al. 2018). Fourth, the ICO market is subject to continuing regulatory uncertainty with many uncoordinated interventions such as the bans in China and South Korea that entailed substantial market reactions (Momtaz 2018c). These exogenous events might prove relevant as natural experiments to draw causal inferences related to long-term ICO success (see, for related stock market, VC, and IPO studies, Hou and Howell 2012; Fiordelisi and Galloppo 2018; Liu et al. 2019). Sixth, ICO firms face several issuance design options such as the implementation of bounty programs, airdrops, lock-up provisions (Howell, Niessner, and Yermack 2018) that may affect the pricing and performance of ICOs in the same way as in other corporate financing contexts (e.g. in IPOs, Yang and Hou 2017).

4. Conclusion

This paper has provided the first systematic evidence of the pricing and performance of ICOs. The results show that there is significant ICO underpricing and factors such as liquidity, market capitalization, and high-low price ratios are related to differences in initial returns on first tradings days. However, 40% of all ICOs are overpriced.

Analyses of the long-run performance of ICOs yield several major results. Buy-and-hold returns are significantly positive for the mean ICO, whereas significantly negative for the median ICO. In fact, the median ICO destroys value of about 30% for holding periods between one and twenty-four months. In line with this, 65% of all ICOs trade at a discount after the first month of trading. Moreover, the factors predicting ICO short-run performance do not consistently predict ICO long-run performance. However, there is a significant *size effect*. Large firms are more often overpriced and underperform in the long run.

Several important implications of practical significance emerge from these findings. There are limits to the degree of disintermediation in financial markets. Complete disintermediation may not be sustainable. On the one hand, this calls for policy-makers and regulators who have yet to propose a regulatory framework for the ICO market. On the other hand, it suggests that institutional investors may fill the vacuum created by the absence of trusted intermediaries. Institutional investors can provide screening and monitoring services that add economic value. The involvement of institutional investors may then signal ICO project quality and attract more investors. Consequently, institutional investors can expect to profit from their role as *certifying entity*.

Many interesting questions about this soaring market are left to future studies. Promising avenues for future research may include a thorough investigation of the determinants and implications of the empirical return distribution in the ICO market documented herein.

Notes

1. See, for a recent study on the role of venture capital funds in ICOs, Fisch and Momtaz (2019).
2. A number of additional studies looks at the valuation of tokens (Catalini and Gans 2017, 2018; Felix 2018). Others focus on specific aspects of cryptocurrency trading such as the amount of speculation, among many others (Dwyer 2015; Yelowitz and Wilson 2015; Athey et al. 2016; Ciaian, Rajcaniova, and Kancs 2016; Athey, Catalini, and Tucker 2017). A number of studies looks at specific success determinants in ICOs such as CEO loyalty (Momtaz 2018d), emotions (Momtaz 2018a), and trust (Rhue 2018). Yermack (2017) provides a thorough discussion of the corporate governance implications of blockchain technology, and Cong and He (2018) look also at blockchain technology and smart contracts. Li and Mann (2018) develop a theory of ICOs and platform building.
3. Many of the existing studies are limited in that they examine small samples that reflect only a small portion of all ICOs. A comprehensive overview of the ICO market is presented in Momtaz, Rennertseder, and Schroeder (2019).
4. See Momtaz (2019) for a comprehensive introduction to ICOs.
5. Tokens can be classified into three types: 1. Cryptocurrencies are general medium of exchanges such as Bitcoin. 2. Security tokens are equity shares and hence subject to securities regulation. 3. Utility tokens represent by far the greatest share of all issued tokens and are essentially vouchers that can be redeemed for an ICO project's products and services once developed.
6. Momtaz (2018c) and Drobetz, Momtaz, and Schroeder (2019) illustrate the ICO market evolution also in terms of market volume and liquidity.
7. See, for a recent discussion of the computation of abnormal returns in applied finance, Melia, Song, and Tippett (2019). Also, note that market-adjusted BHR, as computed here, may perform better than those estimated from an OLS market model when dealing with 'thin markets' (Dissanaike et al. 2018; Drobetz and Momtaz 2019). Some cryptocurrency clearly trade in thin markets.
8. A significant limitation of the *coinmarketcap* data is, however, that it does not provide fundamental data on the tokens such as the proportion of tokens held by the issuing entity or the number of platform adopters. Moreover, the overlap with other data sources that provide fundamental data is very limited (e.g. there is an overlap of only 20% with *ICObench*), and hence restricts the possible scope of this study.
9. It is noteworthy that first-day returns reflect the returns on the first-day a cryptocurrency is tracked in the *Coinmarketcap* database, but this does not necessarily reflect the first day of trading. I thank one of the anonymous referees for pointing this out. However, *Coinmarketcap* covers all major token exchanges and hence the first day of trading should correspond in most of the cases to the first day a token is tracked on *Coinmarketcap*.
10. The long-run returns are not driven by a very few coins. For example, more than 40% of all sample coins have long-run returns > 100% over an investment horizon of three years.
11. I also adjust BHAR using an equal-weighted market benchmark. This results, however, in very inconsistent estimates given that some digital currencies had daily returns exceeding 300% at some days.
12. Interestingly, the high-low ratios are not indicative of underlying ICO project quality, as discussed below. The high-low ratio outperformers on their first trading day become underperformers in the long run (see next subsection). I also observe significant differences between portfolios based on volatility. High-volatility ICOs have higher first-day returns. For example, the Q4-portfolio creates 8.7% more value on the first trading day than the Q1-portfolio. When we compare the pooled portfolio of Q3 and Q4 to the pooled portfolio of Q1 and Q2, we see a much more pronounced and highly significant difference of 16.2%. These results are untabulated but available upon request.
13. Portfolios based on realized variance are evidence of returns increasing in risk. However, the results are weaker with increasing holding periods. Given the sharp increase in the Sharpe Ratios reported above, this evidence is expected.

Disclosure statement

No potential conflict of interest was reported by the author.

Funding

I gratefully acknowledge financial support for this research project from the Price Center for Entrepreneurship and Innovation at UCLA.

References

Aggarwal, Rajesh K., Laurie Krigman, and Kent L. Womack. 2002. "Strategic IPO Underpricing, Information Momentum, and Lockup Expiration Selling." *Journal of Financial Economics* 66: 105–137.

Ahlers, Gerrit K. C., Douglas Cumming, Christina Günther, and Denis Schweizer. 2015. "Signaling in Equity Crowdfunding." *Entrepreneurship: Theory and Practice* 39: 955–980.

Alcaniz, Leire, Fernando Gomez-Bezares, and Jose Vicente Ugarte. 2017. "Efficiency in Initial Public Offerings and Intellectual Capital Disclosure." *The European Journal of Finance* 23: 1129–1149.

Amsden, Ryan, and Denis Schweizer. 2018. "Are Blockchain Crowdsales the New 'Gold Rush'? Success Determinants of Initial Coin Offerings." Working paper.

An, Jiafu, Tinghua Duan, Wenxuan Hou, and Xinyu Xu. 2019. "Initial Coin Offerings and Entrepreneurial Finance: The Role of Founders' Characteristics." *The Journal of Alternative Investments* 21: 26–40.

Athey, Susan, Christian Catalini, and Catherine Tucker. 2017. *The Digital Privacy Paradox: Small Money, Small Costs, Small Talk*. Technical report. National Bureau of Economic Research.

Athey, Susan, Ivo Parashkevov, Vishnu Sarukkai, and Jing Xia. 2016. *Bitcoin Pricing, Adoption, and Usage: Theory and Evidence*. Technical report.

Blaseg, Daniel. 2018. "Dynamics of Voluntary Disclosure in the Unregulated Market for Initial Coin Offerings." Working paper. University of Frankfurt.

Böhme, Rainer, Nicolas Christin, Benjamin Edelman, and Tyler Moore. 2015. "Bitcoin: Economics, Technology, and Governance." *Journal of Economic Perspectives* 29: 213–238.

Catalini, Christian, and Joshua S. Gans. 2017. "Some Simple Economics of the Blockchain." Working Paper 22952. National Bureau of Economic Research.

Catalini, Christian, and Joshua S. Gans. 2018. "Initial Coin Offerings and the Value of Crypto Tokens." Working Paper 24418. National Bureau of Economic Research.

Chambers, David, and Elroy Dimson. 2009. "Ipo Underpricing over the Very Long Run." *The Journal of Finance* 64: 1407–1443.

Chan, Kalok, Junbo Wang, and K. C. John Wei. 2004. "Underpricing and Long-term Performance of IPOs in China." *Journal of Corporate Finance* 10: 409–430.

Chod, Jiri, and Evgeny Lyandres. 2018. "A Theory of ICOs: Diversification, Agency, and Information Asymmetry." Working paper.

Ciaian, Pavel, Miroslava Rajcaniova, and d'Artis Kancs. 2016. "The Economics of Bitcoin Price Formation." *Applied Economics* 48: 1799–1815.

Colaco, Hugh M. J., Amedeo De Cesari, and Shantaram P. Hegde. 2018. "The Waiting Period of Initial Public Offerings." *The European Journal of Finance* 24: 363–390.

Colombo, Massimo G., and Luca Grilli. 2005. "Founders' Human Capital and the Growth of New Technology-based Firms: A Competence-Based View." *Research Policy* 34: 795–816.

Colombo, Massimo G., and Luca Grilli. 2010. "On Growth Drivers of High-Tech Start-Ups: Exploring the Role of Founders' Human Capital and Venture Capital." *Journal of Business Venturing* 25: 610–626.

Colombo, Massimo G., Michele Meoli, and Silvio Vismara. 2019. "Signaling in Science-Based IPOs: The Combined Effect of Affiliation with Prestigious Universities, Underwriters, and Venture Capitalists." *Journal of Business Venturing* 34: 141–177.

Cong, Lin William, and Zhiguo He. 2018. "Blockchain Disruption and Smart Contracts." Technical report. National Bureau of Economic Research.

Davydiuk, Tetiana, Deeksha Gupta, and Samuel Rosen. 2018. "Decryptoing Signals in Initial Coin Offerings: Evidence of Rational Token Retention." Available at SSRN 3286835.

Derrien, Francois. 2005. "Ipo Pricing in 'Hot' Market Conditions: Who Leaves Money on the Table?" *The Journal of Finance* 60: 487–521.

Dissanaike, Gishan, Wolfgang Drobetz, Paul P. Momtaz, and Jörg Rocholl. 2018. *How Does the Enforcement of Takeover Law Affect Corporate Acquisitions? An Inductive Approach*. Working paper. University of Cambridge.

Dittmar, Robert F., and Di Andrew Wu. 2018. "Returns to Initial Coin Offerings: An Empirical Examination." Available at SSRN 3259182.

Drobetz, Wolfgang, and Paul P. Momtaz. 2019. "Corporate Governance Convergence in the European M&A Market." *Finance Research Letters* in press.

Drobetz, Wolfgang, Paul Momtaz, and Henning Schroeder. 2019. "Investor Sentiment and Initial Coin Offerings." *The Journal of Alternative Investments* 21: 41–55.

Dwyer, Gerald P. 2015. "The Economics of Bitcoin and Similar Private Digital Currencies." *Journal of Financial Stability* 17: 81–91.
Epure, Mircea, and Martí Guasch. 2019. "Debt Signaling and Outside Investors in Early Stage Firms." *Journal of Business Venturing* in press.
Fama, Eugene F., and Kenneth R. French. 1992. "The Cross-Section of Expected Stock Returns." *the Journal of Finance* 47: 427–465.
Farag, Hisham, and Chris Mallin. 2018. "The Influence of CEO Demographic Characteristics on Corporate Risk-Taking: Evidence from Chinese IPOs." *The European Journal of Finance* 24: 1528–1551.
Felix, Thijn. 2018. *Underpricing in the Cryptocurrency World: Evidence from Initial Coin Offerings*. Technical report.
Fiordelisi, Franco, and Giuseppe Galloppo. 2018. "Stock Market Reaction to Policy Interventions." *The European Journal of Finance* 24: 1817–1834.
Fisch, Christian. 2019. "Initial Coin Offerings (ICOs) to Finance New Ventures." *Journal of Business Venturing* 34: 1–22.
Fisch, Christian, and Paul P. Momtaz. 2019. "Venture Capital and the Growth of Start-Up Firms: Evidence from Blockchain Data." Working paper. UCLA.
Florysiak, David, and Alexander Schandlbauer. 2018. "The Information Content of ICO White Papers." Available at SSRN 3265007.
Hou, Wenxuan, and Sydney Howell. 2012. "Trading Constraints and Illiquidity Discounts." *The European Journal of Finance* 18: 1–27.
Howell, Sabrina T., Marina Niessner, and David Yermack. 2018. *Initial Coin Offerings: Financing Growth with Cryptocurrency Token Sales*. Technical report. National Bureau of Economic Research.
Hu, Albert, Christine A. Parlour, and Uday Rajan. 2018. "Cryptocurrencies: Stylized Facts on a New Investible Instrument." Working paper. UC Berkeley.
Kostovetsky, Leonard, and Hugo Benedetti. 2018. "Digital Tulips? Returns to Investors in Initial Coin Offerings." Working paper. Boston College.
Leland, Hayne E., and David H. Pyle. 1977. "Informational Asymmetries, Financial Structure, and Financial Intermediation." *The Journal of Finance* 32: 371–387.
Li, Jiasun, and William Mann. 2018. "Initial Coin Offering and Platform Building." Working paper. UCLA.
Li, Jiasun, and Guanxi Yi. 2019. "Toward a Factor Structure in Crypto Asset Returns." *The Journal of Alternative Investments* 21: 56–66.
Liu, Bo, Jerry Cao, Sofia Johan, and Tiecheng Leng. 2019. "The Real Effect of Liquidity Provision on Entrepreneurial Financing: Evidence from a Natural Experiment in China." *The European Journal of Finance* 25: 568–593.
Liu, Yukun, and Aleh Tsyvinski. 2018. *Risks and Returns of Cryptocurrency*. Technical report. National Bureau of Economic Research.
Ljungqvist, Alexander. 2007. "Ipo Underpricing." *Handbook of Corporate Finance: Empirical Corporate Finance* 1: 375–422.
Lyandres, Evgeny, Berardino Palazzo, and Daniel Rabetti. 2018. *Are Tokens Securities? An Anatomy of Initial Coin Offerings*. Technical report.
MacKinlay, A. Craig. 1997. "Event Studies in Economics and Finance." *Journal of Economic Literature* 35: 13–39.
Malinova, Katya, and Andreas Park. 2018. *Tokenomics: When Tokens Beat Equity*. Working paper.
Melia, Adrian, Xiaojing Song, and Mark Tippett. 2019. "Subtle is the Lord, But Malicious He is Not: The Calculation of Abnormal Stock Returns in Applied Research." *The European Journal of Finance* 25: 835–855.
Momtaz, Paul P. 2018a. "CEO Emotions and Underpricing in Initial Coin Offerings." Working paper. UCLA Anderson.
Momtaz, Paul P. 2018b. "Entrepreneurial Finance and Moral Hazard: Evidence from Token Offerings." Working paper. UCLA Anderson.
Momtaz, Paul P. 2018c. "Initial Coin Offerings." Working paper, UCLA Anderson.
Momtaz, Paul P. 2018d. "Initial Coin Offerings, Asymmetric Information, and CEO Loyalty." Working paper. UCLA Anderson.
Momtaz, Paul P. 2019. "Token Sales and Initial Coin Offerings: Introduction." *The Journal of Alternative Investments* 21: 7–12.
Momtaz, Paul P., Kathrin Rennertseder, and Henning Schroeder. 2019. "Token Sales: A Revolution in Corporate Finance?" *Journal of Financial Transformation* in press.
Rhue, Lauren. 2018. "Trust is All You Need: An Empirical Exploration of Initial Coin Offerings (ICOs) and ICO Reputation Scores." Working paper. Wake Forest University.
Schwens, Christian, Florian B. Zapkau, Michael Bierwerth, Rodrigo Isidor, Gary Knight, and Rüdiger Kabst. 2018. "International Entrepreneurship: A Meta–analysis on the Internationalization and Performance Relationship." *Entrepreneurship Theory and Practice* 42: 734–768.
Shams, Amin. 2019. "What Drives the Covariation of Cryptocurrency Returns?" Working paper.
Vismara, Silvio. 2016. "Equity Retention and Social Network Theory in Equity Crowdfunding." *Small Business Economics* 46: 579–590.
Yang, Tianna, and Wenxuan Hou. 2017. "Venture Capital Trusts and the Expiration of IPO Lock-Up Provisions." *The European Journal of Finance* 23: 211–242.
Yelowitz, Aaron, and Matthew Wilson. 2015. "Characteristics of Bitcoin Users: An Analysis of Google Search Data." *Applied Economics Letters* 22: 1030–1036.
Yermack, David. 2017. "Corporate Governance and Blockchains." *Review of Finance* 21: 7–31.
Yung, Chris. 2008. "Cycles in the IPO Market." *Journal of Financial Economics* 89: 192–208.