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Have Low Interest Rates Fueled the Boom of the Initial Coin Offering Market?

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Abstract

This paper evaluates if the boom in the ICO market during 2017 and 2018 was caused by low interest rate environments, adding to the lacking macroeconomic research of ICOs, and to the existing debate of loose monetary policies on the economy. The methodology to test this involved testing interest rates and ICO funds raised using fixed effect regression models to control for country, industry and time, at different levels of aggregation. This paper found evidence of interest rates being correlated with funds raised in the ICO market, but, in most cases, these lacked economic significance, suggesting that monetary policy was not responsible for the rise of this speculative asset class during the period at hand. Nevertheless, unexpected strong evidence and contradictory correlations were found among countries. There was a clear distinction between the negative correlation found in Russia, a developing country with high interest rates, and the positive correlation in UK and Singapore, developed and low interest rate countries. Even though a causal effect cannot be established due to potential omitted variable bias and selection bias concerns, these correlations bring further insights into the effect of interest rates on highly speculative asset classes such as ICOs, and the differences between low and high interest rate environments.

Keywords: ICOs, interest rates, monetary policy, systemic risk, low interest rate environments.

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1. Introduction

The Great Recession of 2008 triggered a set of financial and economic events never seen before such as the surge of Bitcoin, the first cryptocurrency. Since the issuance of Bitcoin, many other entrepreneurs have launched their own blockchain technology in the form of Initial Coin Offerings (ICOs). However, the unregulated market of ICOs entails a potential threat for the economy by increasing systemic risk, and thus the probabilities of a financial crisis. According to Zetsche, Buckley, Arner and Föhr (2019), the growth of the market is the most alarming part, increasing from 228 million in 2016, to 2.6 billion US dollars in 2017and, in the second quarter of 2018, the ICO market raised 45% of the amount raised by the US IPO market[1] (Gan, Tsoukalas & Netessine, 2020).

Given that the ICO market is heavily influenced by the momentum in Bitcoin and Ethereum (C. Masiak, Block, T. Masiak, Neuenkirch & Pielen, 2020), this becomes even more alarming in 2021. As these cryptocurrencies surpassed their 2017 peaks in a rally comparable to the Tulip Mania (Bloomberg, 2020), the ICO market will likely follow, foreshadowing what could possibly be interpreted as an asset bubble. The rising importance of this market, its economical and legal consequences, and the cross-border scope of its use has brought a deep interest from participants across different sectors, such as regulators, investors and academics.

The ICO market is arguably one of the riskiest and most speculative markets up to date due to several market inefficiencies. One of the main problems is the difficulties in regulating this asset class, since it is distinguished as a fast-paced innovative sector, with opaqueness of information in the market and a lack of an appropriate legal framework. Moreover, with the inclusion of new crypto-asset participants in the ICO market, regulators find it troubling to classify each one of these; hence, appropriate regulation is still pending. Additionally, the increasing participation of financial intermediaries such as hedge funds, venture capital firms and even banks, results in a higher systemic risk in the economy and make this market an increasing concern. Nonetheless, some authorities have identified a potential risk in this market and have unsuccessfully tried to deter investors from it. For example, the Securities Exchange Commission (SEC) has issued numerous warnings about the risks of the ICO market, but these had no long term effect.

The lack of an efficient ICO market is also detrimental for issuers and investors seeking to raise or lend capital. On one hand, issuers with profitable projects have trouble signaling the benefits of their venture. On the other, investors fall prey of numerous scams and frauds, which increases the risk of the market and deters many from entering the market. The presence of market inefficiencies such as information

[1] Important to note there are different estimates of the total ICOs total funds raised. Some ICOs do not even report their total funds raised, which makes it hard to know the exact number. The market as a whole is still very opaque and obscure, posing a threat to the reliability of statistics and research.

asymmetry and adverse selection make the market highly speculative, and capital is often misallocated to unprofitable ventures instead of those capable of generating long term value or innovation.

The ICO market is also obscure to academics as there is not extensive research regarding the topic yet. The research is mainly focused in ICOs at an individual level, but there is still very few research regarding the ICO market from a macroeconomic level (Masiak et al., 2020; Moxotó, Melo & Soukiazis, 2021). A better understanding of how macroeconomic variables affect the ICO market might be useful for further policy purposes to effectively regulate this market.

Today, participation in ICOs has become so popular because it offers a high return for investors in comparison to safer asset classes, which are affected by the low interest rates set by the central bank. There is historical evidence that very loose monetary policy has encourages excessive risk-taking, asset bubbles and misallocation of capital. This might lead to hypothesize that the current low interest rate environment in developed economies had a significant effect on the ICO market. Hence, I will explore the main research question throughout this paper:

What is the effect of interbank interest rates in the performance of ICOs?

Knowing if the interest rates have an effect on the ICO market might contribute to the debate of the benefits and costs of low interest rates policies. On one hand, a significant effect might provide more evidence for higher risk-taking behavior in the economies due to low interest rate policies. On the other, it might also provide the central bank with a tool to regulate the ICO market indirectly, and prevent an asset bubble. As this market is still relatively small, it is unlikely to be a decisive factor for choosing a certain interest rate policy. Nonetheless, it could definitely be potential argument to take into consideration, especially if the market keeps growing along with Bitcoin.

In addition, understand the macroeconomic drivers of ICOs might be useful to valuate and classify them. Firstly, there are no established valuation or pricing models for crypto-assets (Cong, Li & Wang, 2020; Hu, Parlour & Rajan, 2019). Understanding macroeconomic drivers might help to quantify the market risks of an ICO, which could be beneficial to develop effective crypto-asset valuation and pricing models. Secondly, regulators currently have problems classifying ICOs because they do not fully understand if crypto-assets behave like currencies, securities or another asset class (Zetsche et al., 2019).

To explore this question, I will divide my paper in the following way. Section II will be a theoretical framework, divided in two main parts, with the objective of further motivating the research question. The first part will summarize and analyze the leading literature regarding ICOs, explaining why are they extremely risky, who are their main investors, why are they so hard to regulate and what are the potential consequences of an unregulated ICO market. The second part will summarize present literature regarding low interest rates and macroeconomic research of ICOs. This part will describe how can low interest rates affect risk taking behavior in financial institutions and individuals, and what are the potential risks of higher risk taking in the economy. In Section III, I will explain the data collection process in detail. I will explain the sources of information, the data collection process, and provide data visualizations with descriptive tables and statistics. In Section IV, I will explain and motivate my methodology in detail, breaking down the main research question into relevant sub questions and elaborating appropriate hypothesis to answer them. I will also explain the methodology to test the hypotheses, along with the pertinent assumptions and limitations. In Section V, I will present the results including relevant graphs, tables and statistical tests, and briefly discuss the findings. In Section VI, I evaluate the limitations of the methodology, the implications of the results on the research question and suggest further research.

2. Theoretical Framework

2.1 Initial Coin Offerings

Initial Coin Offerings are a funding mechanism that raise capital by selling tokens to investors (Fisch, 2019) and they are characterized by using blockchain technology. Some seek to achieve a decentralization of the finance and payment industry, while others include a wide variety of functions along industries as different as entertainment and infrastructure. There is not an established taxonomy of crypto assets, but I will classify them according to Howell, Niessner and Yermack (2019) research paper, who classify them in three non-mutually exclusive domains: currency tokens, equity tokens and utility tokens. The first ones, are meant to be a medium of exchange and a store of value. The second one is an equity token that is recorded on a blockchain, and the third and most common one, referred to as utility tokens, gives the right to consume the product or service provided by the digital asset at hand (Howell et al., 2019).

2.1.1. Benefits of a Healthy ICO Market

In theory, ICO markets could bring several advantages to an economy in terms of innovation by allocating capital to very young and risky ventures that might have difficulty accessing public capital markets, bank loans, or even private equity funds. Important to stress that these benefits can just be reaped in an ideal and efficient ICO market, which is not what happens in practice nowadays.

A healthy ICO market could benefit investors, entrepreneurs and the economy as a whole. For investors, ICOs might give access to highly liquid investments in comparison to other non-public ventures. According to Cumming, Fleming and Schwienbacher (2005) illiquidity is one of the problems for private equity investors as ventures are not easily valuated and sellable. In theory, tokens listed on a crypto exchange provide instant liquidity through blockchain exchanges, which reduces the risk of a venture as investors can quickly cash out. In this way, an efficient ICO market could make private equity investments more liquid, decreasing the risk of this asset class and thus providing capital to many more ventures.

For the entrepreneurs, ICOs enable a committed userbase, a better forecast of demand for their products and lower transaction costs. ICO investors are not only owners, but also future consumers of the venture's product or service, which is not only helpful to easily estimate demand, but also means future customers have an incentive to make the venture successful. Lastly, ICO funding requires less underwriting and legal costs than normal IPOs, highly reducing fees on intermediaries (Howell et al., 2019).

For the economy, ICOs could develop a decentralized network, distribute ownership among stakeholders and allocate capital to a sector that might foster innovation. ICOs can provide the development of a decentralized internet marketplace platform, which is currently monopolized by Top Tech companies such as Amazon, Google or Facebook. An ICO still compensates developers of the platform, but they retain the same control as other token holders, fomenting a decentralized marketplace (Howell et al., 2019). This might make that sector of the economy more efficient as rent-seeking behavior becomes increasingly complex with a decentralized system. Furthermore, ICOs might democratize the governance of companies by easily distributing ownership among stakeholders such as customers, developers and entrepreneurs alike (Chen, 2018). Sharing ownership among stakeholders might help achieving Corporate Social Responsibility, in which the interests of all parties are taken care of in a fair way. Finally, an ideal ICO market can help channel capital to several ventures which cannot acquire funds from exclusive venture capital funds. According to Gompers, Gornall, Kaplan and Strebulaev (2020), less than 1% of considered applicants are selected by venture capital funds, leaving out other potentially innovative ventures.

2.1.2. Why is the ICO Market Currently so Risky?

Even though there is a big potential, the ICO market still faces huge risks and uncertainty. Countries such as China (BBC News, 2017) and South Korea (Bloomberg, 2017) have even decided to ban ICOs completely[2]. The reason behind this are the many inefficiencies, such as frauds, scams and highly speculative behavior, which ultimately harms investment.

Due to the lack of regulation and government intervention, there is a big lack of transparency, which results in information asymmetry. Even though there is no strict regulations regarding their issuance, ICOs are often accompanied by "whitepapers", which are meant to explain the fundamental characteristics of the token at hand to investors. The problem is that these documents are not standardized, and issuers are free to disclose whatever information they want. A study by Zetsche et al. (2019) elaborated a balanced sample of ICOs from many data sources, and found that more than 67% of issuers failed to disclose an

[2] ICO regulation is different from cryptocurrency regulation. For example, South Korea prohibits Initial Coin Offerings but is considered crypto-friendly.

address, an issuer, or a country of origin; 40% did not provide any financial information; 65% did not mention the laws applicable to the venture; and not a single one (0%) of the samples had an external auditor certifying the truthfulness of the data. This lack of information for investors results in a high risk of fraud as entrepreneurs cannot be easily prosecuted by law.

The lack of transparency and accountability has resulted in frauds and scams, jeopardizing the trust in the ICO market. One of the most prominent cases was OneCoin in 2017, which gathered 4 billion US dollars and ended up being a Ponzi Scheme (Business Insider, 2021). Other cases involve deceptive marketing strategies, such as using celebrities or defining funds as "donations", and "pump and dump" schemes caused by the presence of pre-sales and the absence of lock-up periods (Zetsche et al., 2019). As a result of this and more cases, the SEC in the US has issued warnings against the ICO market in numerous occasions (SEC 2013; SEC 2017) and there is evidence that investors are mostly afraid of fraud (Fisch, Masiak, Vismara & Block, 2019). Even though the exact number or percentage of frauds is difficult to estimate due to the opaqueness of the market, it seems like the few scandalous cases are enough to hamper the trust in the market and increase its overall uncertainty.

Finally, these assets tend to be driven by speculation, which further contributes to higher volatility of the market due to bubble behavior . Fisch et al. (2019) interviewed 517 ICO investors and found their prime reason to invest in ICOs was a "future sale of the token at a higher price (at a later point in time)" and not really to get exposure to equity or a profitable project, suggesting the market is driven by speculation and herd-behavior. In addition, Zetsche et al. (2019) found that less 10% of the ICOs had a real function or purpose, further providing evidence for speculation-driven investments.

2.1.3. Why Are They so Hard to Regulate?

A big issue in regulating ICOs is they are very hard to group under a single legal framework because each ICO can be very different from the other. Legal disparities among jurisdictions contributes to further hamper this. In addition, many ICOs are structured in a way to exploit loopholes among distinct jurisdictions and to avoid revealing the real issuer of the crypto-asset. In addition, without appropriate disclosure of the country of origin and issuers, the enforcement of the law becomes almost impossible. (Zetsche et al., 2019). Their lack of regulation has been the main source for the high information asymmetry, lack of trust and uncertainty in the market.

This market may even stay that way because the lack of regulation is partly originated by the ideology behind crypto-assets. This ideology is anarcho-capitalism, a belief in an economy based on individual transactions without any sort of regulation or collective action (Zetsche et al., 2019). This ideology is firstly seen in Bitcoin's whitepaper in 2008, in which the author visualizes a decentralized payment system that did not rely on third party financial intermediaries that might be corrupt (Nakamoto,

2008) . Saying this, some entrepreneurs, investors and stakeholders in cryptocurrencies likely believe in this ideal, and hence have an intrinsic incentive to oppose regulation feverishly.

2.1.4. The Role of Institutional Investors

Many public companies such as PayPal (BBC News, 2020), Tesla (Nuttall, 2021) or Microsoft (Vanian, 2018) currently accept or have accepted Bitcoin as means of payment for their services. Even though these companies are adopting cryptocurrencies, they might be far from penetrating the ICO market. The ICO market is currently plagued with retail investors who generally lack financial knowledge in investing. Nevertheless, financial intermediaries are becoming increasingly active in this market, threatening the economy in the form of higher systemic risk, which can be defined as the risk of a widespread financial instability that jeopardizes the entire financial system to the point where economic growth and welfare can be hindered (European Central Bank, 2009).

In the past decade crypto hedge funds and venture capital funds were the most active financial institutions in the ICO markets. From 2013 to 2017, a total of 110 crypto funds had been established, of which 84 appeared in 2017 alone (Zetsche et al., 2019), probably due to the high momentum of Bitcoin. There is evidence that this trend is also present in current times. In 2021, crypto funds have been poaching executives from top banks, which indicates a very high profitability and growth in this market (Oliver, Fletcher, Szalay & Stafford, 2021). Anyhow, it is important to note that institutional investor backing might also contribute to an improvement of the market. Fisch et al. (2020) found evidence that institutional investors might help reduce information asymmetries and moral hazard through monitoring and screening. In this way, the involvement of financial intermediaries might not necessarily be a negative thing as it could help the ICO market reach efficiency.

Fortunately, banks were heavily regulated after 2009 and their big-scale involvement in the ICO market is unlikely. Thus, a financial crisis as big as the Great Recession is unlikely to be triggered by a burst in this risky market. Nevertheless, the increasing interest of these financial intermediaries in the cryptocurrency market might be alarming. In 2021, investment banks such as Goldman Sacs (Kaminska, 2021), Citi and Bank of New York Mellon (Szalay, 2021) have demonstrated a big interest in cryptocurrencies. The involvement of banks in this asset class can considerably increase the systemic risk.

It is true the ICO market is still at its infancy stage, and it would be highly speculative to say it will trigger a financial crisis. Nevertheless, the astonishing growth rates summarized above may potentially increase the systemic risk of the economy and jeopardize financial stability. In addition, an unregulated ICO market promotes the growth of the black market. Around a quarter of Bitcoin users are involved in illicit activities, and 46% of these are used in illegal transactions (Foley, Karlsen & Putnins, 2019).

Nevertheless, even though most crypto token adoptions described above are related to consolidated cryptocurrencies such as Bitcoin, the evidence can be extrapolated to the ICO markets. As shown in (Masiak et al., 2020), the ICO industry is heavily influenced by the momentum of bigger cryptocurrencies. This makes sense as the adoption of Bitcoin as a medium of exchange, kindles the hope for a wider adoption of other crypto-assets. In this way, there is reason to believe that more financial intermediaries could start investing in ICOs, which are even riskier than consolidated cryptocurrencies.

As explained up to this point, the ICO market is currently suffering from an alarming market failure. The high volatility attracts speculators, and deter the necessary value investors that allocate capital to the ventures that produce real growth and innovation in the long run. In the pursuit of short term gains, speculative investors heavily misallocate capital to unprofitable ventures, resulting in wasted investments and thus, a market that fails to channel funds efficiently.

Regulation still needs to catch up to fix this market failure, but the market is growing at a very fast pace and the involvement of financial intermediaries increases systemic risk. Unfortunately, warnings by the European Securities and Markets Authority (ESMA) and the SEC have proved ineffective (Adhami, Giudici & Martinazzi, 2018). Policymakers might consider an indirect type of regulation tools, at least to make the market less attractive and prevent the ICO market from expanding more. As a consequence, the purpose of this dissertation thesis is to find evidence for a causal effect of interest rates in ICOs and evaluate its potential use as an indirect regulatory tool.

2.2 Interest Rates and ICOs

2.2.1. Macro Level Research

According to the latest literary reviews in ICOs, there is little research regarding determinants of ICOs at a macro level (Masiak et al., 2018; Moxotó et al., 2021). There is some research about the effect of macroeconomic factors (consumption growth, production growth and personal income growth) on the returns of the biggest cryptocurrencies (Bitcoin, Ethereum and Ripple), where no significant effects were found (Liu & Tsyvinski, 2021). Another finding by Huang, Meoli and Vismara (2020) compare ICOs across countries and find that these are more common in countries with advanced digital technology, public equity markets and developed financial systems. They found no significance regarding tax regimes, public debt markets, venture capital or private equity funds.

2.2.2. Low Interest Environments

Since the financial crisis of 2008, interest rates have been at an all-time low. Many economies have even fixed negative nominal interest rates, which can be seen as a “saving tax” in order to boost investment as much as possible. In periods of crises, the high money flow encourages investment by, for example, helping to recapitalize financial intermediaries, who then invest money back in the economy (Chodorow-Reich, 2014). However, there are still debates regarding the implications of low interest rates for prolonged periods of time. In theory, low interest rates may contribute to phenomena such as inflation. Nevertheless, in practice central banks believe there is a low risk of an overheating economy, as inflation has been low in the past decade (Lane, 2020).

Additionally, interest rates might have negative repercussions for the economy as they facilitate the availability of capital, causing overinvestment and misallocation, asset price bubbles and higher debt. As argued by Klein and Pettis (2020), many financial crises are created by credit expansions, which end up financing speculative and risky assets which were not be paid. Some research also suggest that the low interest rate environment might even originate the next financial crises through the formation of bubbles (Farhi & Tirole (2012)).

Furthermore, low interest rates can indirectly affect the economy by changing the behavior of institutions and individuals. At an institutional level, there is evidence for higher risk taking behavior in many financial intermediaries. Delis and Kouretas (2011) found a strong link between short and long term interest rates on excessive risk-taking in European commercial banks. Other studies argue that low short term interest rates soften standards for household and corporate loans (Maddaloni & Peydró, 2011). Mutual funds, pension funds and other financial intermediaries also increased their risk-taking behavior during lower interest rates (Chodorow-Reich, 2014). Another pertinent study recognizes the increased risk behavior, but mentions that it is not significant enough to affect financial stability (Dell'Ariccia, Laeven & Suarez, 2016). According to this line of reasoning, it makes sense that low interest rate environments are pushing financial intermediaries towards riskier assets such as the crypto markets.

There is also evidence from a behavioral change in risk-appetite at an individual level when interest rates are too low in a phenomenon described as "reaching for yield". Lian, Ma and Wang (2018) find how individuals take riskier choices under low interest rate environments under hypothetical and incentive based scenarios. They argue how people's risk and return trade-offs are different under low risk environments due to behavioral biases. This means that not only institutions are affected by low interests, but also individuals. Hence, there is more reason to believe that low interest rates have an effect on ICOs.

Some studies have found an association between low interest rates and growing asset prices (Borio & Zhu, 2012; Sutton, 2002); while others suggest the association is coincidental (Shiller, 2007). Demonstrating if there is an effect of interest rates on the booming market of ICOs is thus important to add to this debate. If there is indeed a positive effect, the central bank might use this as an argument to set a stricter monetary policy. In addition, it might even use this as an indirect regulatory tool to keep investors, especially financial intermediaries, away from the ICO markets, at least till formal regulation catches up.

3. Data Collection

3.1. Initial Coin Offerings Data

Given the opaqueness and informality of the ICO market, no official databases of ICOs can be found. For this experiment, I used ICOBench and Tokens-Economy to extract data regarding dates, industries, countries and funds raised.[3] For funds raised, I compared ICOBench to ICORating and ICOData to check for inconsistencies and missing data. However, most of the data used comes from ICOBench as it has been used in numerous other studies due to its relatively detailed information (Fisch & Momtaz, 2020; Thies, Wallbach, Wessel, Besler & Benlian, 2021; Huang et al., 2019).

I extracted data from the top four countries in the sample from January 1st, 2017 to 31st of December, 2018. The countries include: USA, Singapore, UK and Russia.

3.1.1. Data Modifications and Missing Data

Some modifications were made when found appropriate. For example, some ICOs in ICOBench like EOS, were erroneously classified as American when in reality they are part of the Cayman Islands. EOS has been one of the biggest ICOs to date (4.198 billion US), and severely skewed the data. The finding of this mistake was attributable to (Zetsche et al. 2019).

Similar to Huang et al. (2019), I also cross-checked with other Databases such as ICORating and ICOData. However, contrary to Huang et al. (2019), I did not eliminate non-matching sample as these are often more obscure and opaque ICOs for which less information is available. As found by Fisch (2019), the most opaque ICOs tend to have a poorer performance, and thus, eliminating them would introduce a sample selection bias. Instead, I decided to use an average of the mentioned websites in case there were disparities. The averaging of three websites also increases the reliability of the results.

In addition, I grouped the 29 industries appearing in ICOBench into the industry groups defined by the Global Industry Classification System (GICS), developed by Standard & Poor's and Morgan Stanley Capital International (2020). In Table 1, there is a detailed overview of the reclassification that took place. Two extra industries had to be created: "Other" & "Cryptocurrency". The former includes industries that were not found under any sub-industry classification of the GICS, and the latter includes cryptocurrencies, as it is still unclear if these fall under consumer discretionary goods, financials or information technology (Zetsche et al., 2019). Cryptocurrencies were not included in "Other" as they represent an important subsector of ICOs, being the second largest ICO industry.

[3] Important to note that Tokens-Economy extracts its data from ICOBench. I used this website solely for visualization and data collection purposes. The information in this website matches the one in ICOBench.

Important to note that some ICOs have a diverse range of functions and they can thus fall under many industries. Classifying ICOs is one of the biggest problems as many industry standards are outdated and are uncapable of grouping all the functions of modern ICOs under a single category. Other classification systems, such as the Cryptocurrency Classification Standard (CSS) by Cryx (2018), were considered, but soon discarded due to their lack of reliability.

Furthermore, due to the lack of information of 2019, 2020 and 2021 ICOs, I decided to exclude these years. The three databases presented a lot of ICOs whose funds raised where unknown. For example, only 65% of the 2019 ICOs in ICOBench, the most complete database, lacked information about funds raised. 2015 and 2016 will not be used because there are very few samples per country.

Table 1

Industry Reclassification

ICO Bench	Global Industry Classification System (GICS) Industry Groups
Energy (5)	Energy (5)
Business Services (85); Manufacturing (5); Electronics (1); Infrastructure (23);	Industrials (114)
Art (7); Casino & Gambling (8); Sports (5); Tourism (4); Education (5); Retail (12)	Consumer Discretionary (41)
Health (21)	Health Care (21)
Banking (47); Investment (43)	Financials (90)
Artificial Intelligence (16); Big Data (26); Internet (20); Platform (159); Software (29); Virtual Reality (1);	Information Technology (251)
Media (18); Communication (17); Entertainment (43)	Communication Services (78)
Real Estate (13)	Real Estate (13)
Other (23); Smart Contract (13); Charity (3)	Other (39)
Cryptocurrency (127)	Cryptocurrency (127)
Total 779	Total 779

Notes: Reclassification of samples into the Global Industry Classification System (GICS). Information on ( ) are the number of Observations. "Cryptocurrency" and "Other" were created as these do not fall under a GICS industry. Source: Morgan Stanley Capital International, 2020. *Global Industry Classification Standard Methodology.*

3.1.2. Potential Sample Selection Bias

Important to note, however, that these databases might still have a big sample selection bias. According to Zetsche et al (2019), a total of 55% of ICOs fail to disclose the real funds raised. For this experiment, I collected 1394 samples between 2017 and 2018, of which 507 had to be eliminated due to lack of information about funds invested. In addition, Zetsche et al. (2019) also mentioned that ICOBench overrepresents utility tokens (96%), reducing the external validity of my dataset, which can only represent one out of three types of crypto-assets. Fisch et al. (2020) also uses ICOBench mainly but mentions the website tends to delete failed ICOs. Hence, my samples represent those relatively "transparent", successful utility token ICOs. The results of this experiment might not be extrapolated further.

3.2 Interest Rates Data

For interest rates, I will use the interbank rates of each respective country. In some cases, the data was easily available, in others, web scrapping was used. For the United States, I used the US interbank rate collected from the Federal Reserve Economic Data (2021). For Russia, I used the interbank interest rate (MIACR), collected from the Bank of Russia (2021). For the United Kingdom, I used the London Interbank Offer Rate (LIBOR), extracted from the Federal Reserve Economic Data (2021). For Singapore, I used the Singapore Overnight Rate Average (SORA) extracted from the Monetary Authority of Singapore (2021). This rate was used because no data could be obtained for daily Singapore Interbank Offer Rate (SIBOR). Even though the interbank rates are sometimes different from the central bank rates, they are more relevant because they include several banks that ultimately lend capital and are the main agents in money production. Important to clarify that these rates are strongly affected by the central bank rates. For forward guidance dates and information, I used the official website of the Board of Governors of the Federal Reserve System (2018), which is the official website of the US Federal Reserve System.

4. Methodology

As mentioned in the introduction, the central question of research is: **What is the effect of interbank interest rates in the performance of ICOs?** I will break down this question in two other sub questions:

1. Is there a difference in ICO performance amongst countries and industries?
2. Is there a correlation between the average ICO performance and interbank interest rates?
3. Is there a correlation between ICO performance and interbank interest rates at an aggregate level?

For the following questions, I will target the Top four ICOs-issuer countries (USA, Singapore, UK and Russia) from 2017 to 2018. Important to clarify that I will use funds raised as a proxy for ICO performance. Hence, these words will be used interchangeably.

Prior to answering the sub-questions and their respective hypotheses, I will group the ICOs by country and industries and make descriptive statistics to visualize if there is a difference in performance over 2017 and 2018. This will serve as an introductory and visual description, which will help to better understand the performance, proxied by total funds raised, of ICO industries and countries through time. As no statistical analyses will be done for this part, no official conclusions could be drawn for this part.

To answer the second and third sub-questions, I will use two econometric models with the objective of evaluating if there is a significant correlation between interest rates and funds raised by ICOs. In both models, I will control for country, industry and time to get rid of potential omitted variable bias. The main difference between both models is the unit of observation, in which the first model (Model 1) will evaluate the ICOs at an individual level, while the second model (Model 2) will do so at an aggregate level. In addition, I will complement each model with its respective Difference in Difference graph visualization, which will try to provide further evidence for a causal effect of interest rates on funds raised.

4.1. Variables

4.1.1. Dependent Variable: Funds Raised

My dependent variable for both models will be a logarithmic transformation of total funds raised, measured at the end date of each ICO. This transformation seems pertinent because the ICO total funds data is positively skewed considering most ICOs in my sample raised less than 10 million US dollars. In addition, the data also suffers from positive kurtosis due to the few outliers that raised more than 100 million US dollars. This can be better appreciated visually in Appendix A.

As seen in Table 2, skewness and kurtosis decrease after the transformation. Even though the data still presents significant kurtosis, a logarithmic transformation eliminates skewness and better approaches a normal distribution. The following transformation allows solves the problem mentioned and allows to include periods with no ICOs.

$$funds_i = \log(1 + Total\ Funds\ Raised_i)$$

Table 2

Summary statistics of dependent variable before and after logarithmic transformation.

Statistics	Before (1)	After (2)
Mean	11.966 (19.064)	1.900 (1.776)
Distribution		
Min.	0	0
25th Percentile	1.37	0.863
Median	6.010	1.947
75th Percentile	15.177	2.784
Max.	257	5.553
Skewness	5.858***	0.089
Kurtosis	59.775***	2.140***
Number of Observations	779	779

Notes: Summary statistics of Funds Raised by released ICOs, before and after the logarithmic transformation. Column (1) shows Funds Raised in Million USD before transformation. Column (2) shows Funds Raised after logarithmic transformation log(1+funds raised). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01. Information on ( ) are the standard errors.

4.1.2. Independent Variable: Interbank Interest Rates

For both models, I will use each country's interbank interest rates from the sources discussed in Section 3. Model 1 will use the daily interbank interest rates occurring when the ICO was concluded. Nevertheless, as Model 2 will aggregate the ICOs at a monthly level, a monthly average interest rate will be used in this case. This variable will take the name of *interests* throughout both models.

As seen in Figure 1, the UK, Singapore and the US have very similar interest rates, oscillating between 0.5% and 2%. Although these countries are implementing a low interest environment, they have not reached negative rates, contrary to Russia, the only developing country, with relatively more volatile and higher interest rates. This phenomena is present in developing countries, where monetary policy is used to boost money demand and prevent further depreciation of their currency. Having three low interest rate and one high interest rate countries can be useful to analyze the effect of different interest rate policies on ICO funds raised.

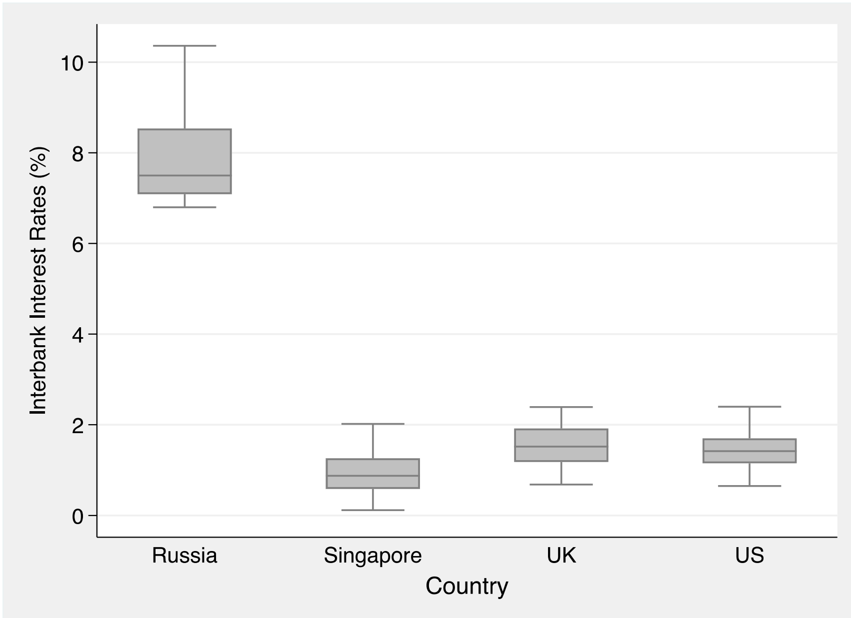

Figure 1. Distribution of Interbank Interest Rates, 2017-2018.

Important to note that the investors of ICOs may be influenced by previous interest rates, which might introduce a spurious relationship. For example, just as an IPO, an ICO occurs throughout of period of time, in which different daily interest rates take place.

4.1.3. Control Variables: Country, Industry and Time.

For both models, I will firstly control for country, then I will proceed to include industry and finally time. I collected data from the Top four ICO countries, which are US, Singapore, UK and Russia. To control for these I will use country fixed effects, which will take the name of *country*. As seen in Huang et al. (2019), country-specific characteristics influence the number of ICOs, so there is also reason to believe they also have an effect on their performance. In addition, the characteristics of each country also has an effect on the monetary policy, and thus, on the interest rates. Controlling for country could be enough to control for other macroeconomic variables which probably affect treatment and dependent variables such as inflation and GDP.

Secondly, I will control for industry using industry fixed effects. This control variable, under the name of *industry*, has the purpose to further control for other time-invariant and industry-specific characteristics that might cause endogeneity. The ten studied industries can be found in Table 1

Additionally, I will control for time in both models. Interest rates are time-dependent as they fluctuate with business cycles. ICO funds raised could potentially depend on time as well given that they depend on Bitcoin and Ethereum (C. Masiak et al., 2020), which are themselves correlated with time (Baur, Cahill, Godfrey & Liu, 2019). In both models, I will control for time at the monthly level as ICOs are too volatile at a daily level, giving rise to the time variable *year-month.* To control for these, both models will use fixed effects categorical dummy variables for country, industry and time. More details about the model are provided in Sections 4.3 and 4.4

4.2. Is There a Difference in Funds Raised Amongst Countries and Industries?

Although this question will be explored qualitatively and no conclusions can be drawn, it will help to visualize the data at hand and serve as an introductory framework and complementary evidence for the main research question. It is firstly important to know if there is a difference between countries and industries, and then assess if interest rates are drivers of these differences.

Firstly, finding if there is a difference among countries might not only contribute to the missing macroeconomic research, and also to understand if there are differences of ICOs funds raised among countries. For this point, I will provide visualizations of total and average funds collected per country through each month of 2017 to 2018. For the former, total funds will be analyzed in gross numbers, while the latter will use a logarithmic function to better approach a normal distribution. Furthermore, I will analyze the behavior of the American and Russian ICOs, along with their respective interest rates, as a qualitative evidence for the effect of interest rates on funds raised. The reasons for choosing these countries are explained in Section 4.5.

Secondly, analyzing industries can also broaden the understanding of macroeconomic determinants of ICOs, and provide further evidence for differences within industries. Finding no difference could mean that industries are irrelevant for investing in ICOs, suggesting investors do not use ICOs for a purpose or function, but only as mere vehicles for speculation. This would in turn provide evidence for the high risk behavior in the market. Just as in the country analysis, this visualization will also use total and average funds collected per industry through each month of 2017 to 2018, using gross funds for the former and a logarithmic transformation for the latter.

4.3. Is There a Correlation Between the Average ICO Performance and Interbank Interest Rates?

To answer this question, I will explore the following main hypothesis:

Hypothesis 1: There is a significant negative effect of interest rates on funds raised by released ICOs at an individual level.

The motivation for this hypothesis is that lower interest rates induce risk taking behavior in investors, fueling the funds allocated to highly speculative ICOs. Each ICO will be taken as given, and the objective is to see if the average released ICO receives higher funds in low interest rate environments. In other words, I hypothesize there is an inverse relationship between interest rates and ICO funds raised.

In response to the hypothesis at hand, I will do a fixed effects regression, referred to as Model 1, to see the effect of interest rates on funds raised. As explained above, the period under analysis is 2017 and 2018, and the model will control for country, industry and monthly time. Even though a causal relationship cannot be established through this methodology, it might be useful to find if there is an association.

Model 1 will gradually include three types of fixed effects. At first, the regression will only include country fixed effects but will add industry and time fixed effects, originating the second and third variations of the model, respectively. The purpose of this is to see how interest rate coefficients and significance are affected by the introduction of new fixed effects. Model 1 and its three variations will be represented by the following three equations:

$$funds_i = \beta_0 + \beta_1 interest_i + \sum_{C=1}^{C} \beta_C \, country_C + \varepsilon_i \, ,$$

$$funds_i = \beta_0 + \beta_1 interest_i + \sum_{C=1}^{C} \beta_C \, country_C + \sum_{I=1}^{I} \beta_I \, industry_I + \varepsilon_i \, ,$$

$$funds_i = \beta_0 + \beta_1 interest_i + \sum_{C=1}^{C} \beta_C \, country_C + \sum_{I=1}^{I} \beta_I \, industry_I + \sum_{M=1}^{M} \beta_M \, year - month_M + \varepsilon_i$$

In this model, *funds* represents the logarithmic transformation, described in Section 4.1.1., of funds raised per ICO (dependent variable), and the *interest* variable is the daily interbank interest rates (independent variable). In addition, $\sum_{C=1}^{C} \beta_C \, country_C$ represents country fixed effects, $\sum_{I=1}^{I} \beta_I \, industry_I$ represents industry fixed effects and $\sum_{M=1}^{M} \beta_M \, year - month_M$ represents monthly fixed effects. Lastly, β_0 represents the constant and ε_i the error term.

4.3.1. Assumptions

In order to ensure a consistent and unbiased estimator, I assume there is no correlation between the interest rates and the error terms, which could occur due to simultaneous causality, measurement error or omitted variable bias. Firstly, simultaneous causality is highly unlikely because the ICO market is still at its infancy stage and it is very unlikely that it has an effect on monetary policy. Secondly, measurement error is not a concern either, given that all the interbank interest rates were collected from reliable sources, such as the central banks of each respective country. Thirdly, and most importantly, there might be non-observable variables influencing both the treatment and dependent variable at hand, threatening the conditional independence assumption. There might be omitted variables such as international regulations, which might be bias Model 1, even after controlling for country, industry and time fixed effects. As a result, even though simultaneous causality and measurement errors are unlikely, no causal relationships can be drawn from this regression due to potential endogeneity.

Another assumption is homoscedasticity and the absence of autocorrelated residuals. A problem with my data is the clustering of samples belonging to the same country because they share the same interest rate policy. For example, Russian ICOs are clustered around the 8-10% range because those ICOs are exposed to that monetary policy. However, this will be solved by using clustered standard errors at the *country-year-month* level.

4.3.2. Robustness and Standard Errors

Model 1 will use clustered standard errors, which make the standard errors more conservative (Abadie, Athey, Imbens and Wooldridge, 2017), because there are both experimental and sampling design reasons to cluster. The former occurs because interest rates are not randomly assigned to each ICO, but they depend on the country and time period in which the ICOs took place. For the latter, the data on this methodology is based on samples from the top four ICO issuing countries around 2017 and 2018, and I want to extrapolate the results to the broader populations of ICOs across other countries and periods of time. For these reasons, the most logical way to account for this is to use cluster standard errors at the *country-year-month* level.

Abadie et al. (2017) mentions that clustered standard errors are only advisable if there is heterogeneity in treatment effects. In this experiment, interest rates will probably affect each ICOs in a different way, depending on its industry, country and time period in which it took place. As a result, treatment is heterogeneous and using cluster standard errors is appropriate for this fixed effect regression.

To test robustness, I will also apply this model to individual countries. It might be interesting if the relation holds for every country, or just for some. However, I will not use *year-month* controls as these would absorb all monthly variation in interest rates.

4.4. Is there a correlation between ICO performance and interbank interest rates at an aggregate level?

Even though Model 1 explains the effect of interest rates on funds raised, it is still unclear what would be the effect of an ICO on funds raised for a given industry, at a given country and at a specific period in time. Important to clarify that, if there are no ICOs at a given industry, for a given country at a period in time, funds raised will be taken as zero. To answer this question, I will explore the following hypothesis.

Hypothesis 2: There is a significant negative effect of interest rates on funds raised by ICOs at an aggregate level.

The main difference between Model 1 and Model 2 are the units of observation. While Model 1 takes each individual ICO as unit of observation, Model 2 aggregates the ICOs into specific industries, at a specific country, during a specific month. For example, funds raised are aggregated into units such as "Singapore, Tech industry, during January, 2017". As funds raised were aggregated into months, interest rates were averaged, and a single monthly average interest rate was used per unit of observation. To explain this relationship, I will use the following model:

$$funds_{it} = \beta_0 + \beta_1 interest_{it} + \sum_{C=1}^{C} \beta_C \, country_C + \varepsilon_{it} \, ,$$

$$funds_{it} = \beta_0 + \beta_1 interest_{it} + \sum_{C=1}^{C} \beta_C \, country_C + \sum_{I=1}^{I} \beta_I \, industry_I + \varepsilon_{it} \, ,$$

$$funds_{it} = \beta_0 + \beta_1 interest_{it} + \sum_{C=1}^{C} \beta_C \, country_C + \sum_{I=1}^{I} \beta_I \, industry_I + \sum_{M=1}^{M} \beta_M \, year - month_M + \varepsilon_{it}$$

Just as in Model 1, *funds* represents the logarithmic transformation, described in Section 4.1.1., of funds raised per ICO (dependent variable), and the *interest* variable is the daily interbank interest rates (independent variable). In addition, $\sum_{C=1}^{C} \beta_C \, country_C$ represents country fixed effects, $\sum_{I=1}^{I} \beta_I \, industry_I$ represents industry fixed effects, and $\sum_{M=1}^{M} \beta_M \, year - month_M$ represents monthly fixed effects. Lastly, β_0 represents the constant and ε_{it} the error term. The only difference is that this is a panel data fixed effects regression.

The same assumptions, standard errors and robustness tests described in Section 4.3.1. and Section 4.3.2., respectively, will also hold for Model 2. Moreover, to further check for robustness, I will use the same model, but using an *interest* and second lags ($interest_{t-1}$ and $interest_{t-2}$, respectively) to account for the problem described in Section 4.1.2, in which investors might be affected by the interest rates when the ICO was raisings funds, not only by the ending period ones. As described in (Howell et al., 2019), the average ICO lasts 40 days, so testing for two lags should be enough. This will not be done for Model 1 because data is on a non-continuous daily basis, and using a 40 day lags would not yield accurate results. As a last robustness check, I will also test for aggregation levels at the *country* and *year-month* level.

4.5 Difference in Difference Complement

For both Model 1 and Model 2, I will use a multiple period Difference in Difference (DID) approach comparing two countries in order to find evidence for a causal effect of interest rates on ICO performance. A DID approach is helpful to control for non-time-varying differences between the two nations, and allows to visualize the evolution of a variable before and after a specific event. Ideally, this method involves testing the difference of the change in the treatment group and control groups after the treatment took place. However, given the unavailability of samples, I will not provide formal statistical tests, but only use this approach as a complement for Model 1 and Model 2 in the form of visualizations.

To measure ICO performance, I analyzed the average funds raised of American (Treatment) and Russian (Control) ICOs before and after a forward guidance shock in the US. Interbank interest rates remain relatively constant before the forward guidance period and have a sudden increase after the forward guidance. These countries were chosen because they are the most different nations among the Top four ICO issuing countries, and their ICO markets are more likely to be segmented. If markets are not segmented, the Russian-based ICOs will also be affected by the interest rate changes and thus, both countries will have the same post-treatment trend.

The period chosen was based on the forward guidance occurring on the 13th of June of 2018, in which the Federal Open Market Committee (FOMC) announced an interest rate increase due to lower unemployment and higher economic activity (Board of Governors of the Federal Reserve System, 2018). As a result, the Fed increased the interest rates a day after (14th of June of 2018) from 1.7% to 1.9%. From the 22nd of March of 2018 to the forward guidance period, interbank interest rates remain relatively stable at 1.7%, giving an 84-day window of time to test if both countries have the same pre-treatment trend. This is necessary to ensure there is no time-varying differences between countries that may bias the results. Furthermore, interest rates remain stable at 1.9% till the 26th of September of 2018 during the post treatment period. This 105-day time frame will be used to test if there is a significant effect in the difference of both trends after the interest rate change.

The period mentioned above also has its limitations. Firstly, this forward guidance resulted in a very small increase in fed rates of just 20 basis points. This change might be irrelevant for investors and thus, their decision to invest in ICOs might not change at all. In addition, there is a small post-treatment period of around 3 months, which might not be enough for investors to process the information of an interest rate change. Given that many ICO investors are retail investors, this is a latent possibility. Other forward guidance periods were considered, but I was limited by the availability of ICO samples and the presence of other monetary policies affecting interest rates at the same time than forward guidance.

From the 22nd of March of 2018 to the 26th of September of 2018, there are a total of 231 samples, of which 162 are American and only 69 are Russian. However, some samples have to be eliminated because there was no information of ICO funds raised or because they started before the 22nd of March, indicating that their investors are influenced by interest rates prior to the examination period. For example, I will exclude ICOs started in January even if they finish during April because their investors might be influenced by the monetary policy from January and February. This reduces my samples to a final of 48 American and 23 Russian ICOs. Given the shortage of samples, I could only divide the DID periods into two pre-treatment, and three post-treatment periods. A detailed breakdown of the periods in specific dates and sample numbers, can be found in Appendix C.

Some assumptions of this methodology were briefly touched upon above. However, it is important to stress the reason and importance of each one in more detail. Firstly, this methodology assumes there is a market segmentation between the US and Russia, which means that Americans will be partially deterred from entering the Russian ICO market due to market frictions such as cultural differences and capital flow restrictions between both countries. This is supported by Howell, et al (2019), who found that a considerable portion of issuers exclude their ICOs from US investors due to regulatory concerns. Nevertheless, this assumption might not hold in reality given that ICOs are obscure by nature and an issue country is often not even available in the white papers; transactions are quickly made online, which facilitates capital movements; and they are driven by speculation, which means that investors might not care at all about the country of issuance. Chang (2019) found that crowdfunding campaigns overcome country barriers thanks to the internet. Even though the results were not tested on ICOs, there might be a similar effect.

Secondly, I assume US and Russian ICOs have the same pre-treatment trend. This would mean that there are no other time-varying differences between both countries and a proper causal effect can be established. Hence, I am also assuming there are no other time-varying effects between both countries in the pre-treatment period. This can be tested visually by comparing both countries through the pre-treatment period. However, because I excluded those samples that stared before March 22nd, there are fewer pre-treatment periods, posing a serious limitation to this methodology.

Thirdly, I assume there is no other monetary policy tool implemented by the central bank apart from the forward guidance. According to the relatively steady interest rates during the sample periods mentioned, I can assume this is the case.

5. Results

5.1. Performance of Industries and Countries in 2017 and 2018

5.1.1. Countries

Before analyzing the effect of interest rates, it is relevant to visualize the data per country and industry. Figure 2 summarizes the monthly total ICO funds raised per country during 2017 and 2018. Interestingly, the US has its peak during 2017 and falls during 2018, while the rest of the countries display more activity in the first half of 2018 and then fall again during the second half.

The decline of ICO funds raised can be explained by Bitcoin's crash soon after 17th of December of 2017, in which it lost 45% of its value in a single trading week (The Guardian, 2017). This was followed by negative news, such as one of the biggest hacks in crypto exchanges up to date in January 26 of 2018 (Forbes, 2018), and the banning of ICO advertisements by Facebook, Twitter and Google at the end of March of 2018 (Das, 2018), which ultimately shattered the confidence in Bitcoin, an asset that lost 80% of its value by the end of 2018. Even though Bitcoin's price can explain, as proposed by C. Masiak et al. (2020), the decline in US ICOs, it cannot fully account for the increase of funds raised in other countries during the first half of 2018. This may suggest there are other inherent factors affecting the ICO market.

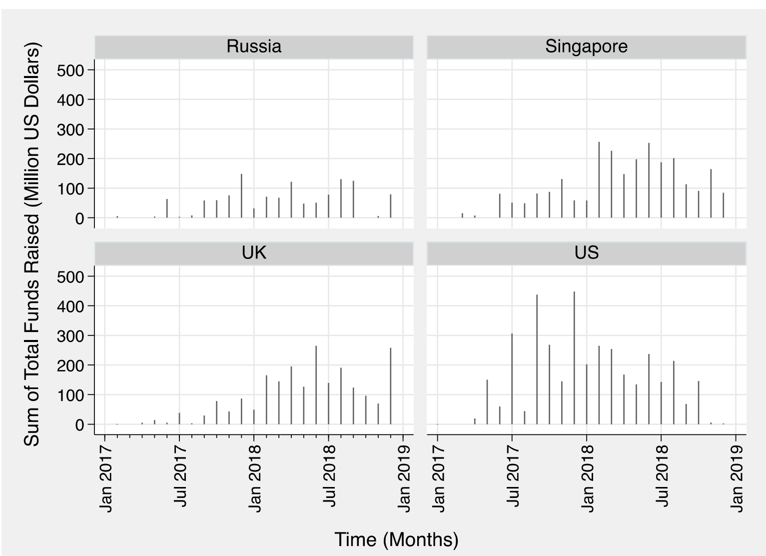

Figure 2. Total Funds Raised per Month per Country, 2017-2018.

The highest performing countries are, US, Singapore, UK, and finally Russia. Similar to Huang et al. (2020), these countries are those with ICO-friendly regulations (Singapore), developed financial systems (US, UK) and advanced digital technologies (US, Singapore). Russia is the only outlier as they do not have these characteristics, but their high performance in ICO markets might be attributed to their high human capital in mathematical sciences, as speculated by Huang et al. (2020).

Nevertheless, it is important to note that Huang, et al. (2020) results are computed using number of ICOs, not total funds raised. It is logical that those countries with more ICOs will also have higher funds raised as more ICOs will generally mean more funds, irrespectively of how good these perform. As seen in Figure 3, with the exception of some months, all countries have a very similar performance per ICO they release, which suggests that the country characteristics described above might only have an effect on the number of ICOs, but not on the average performance of these.

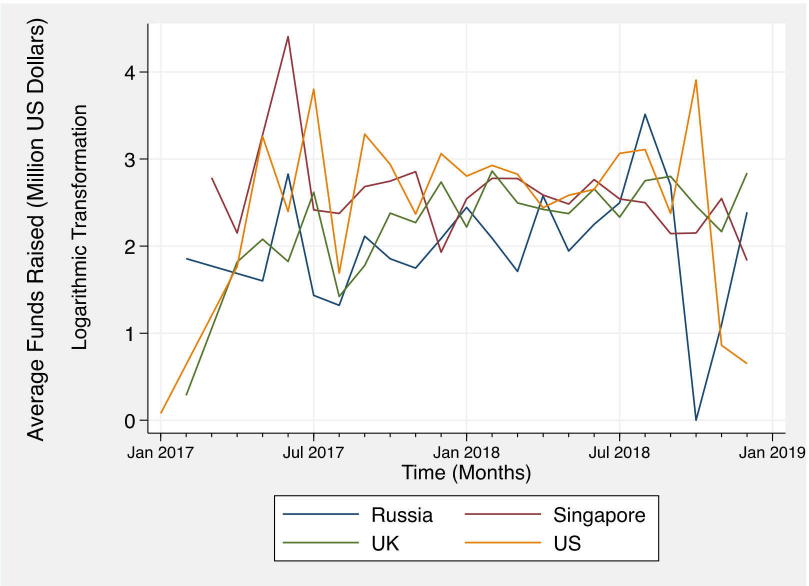

Figure 3. Average Funds Raised per Month per Country, 2017-2018.
Notes: Funds Raised follow the transformation log(1+ funds raised).

As seen in Figure 4, the rise in US interest rates coincided with a fall in ICO funds raised. The same relationship is seen in Russia, where falling interest rates seem to be correlated with rising ICO funds. As seen by the dashed line, Bitcoin's first crash had an initial effect on both countries, but in Russia's case, the funds rose again, while American ones kept decreasing. Even though no conclusions can be drawn, these two graphs suggest that interest rates had a role in ICO performance, which would be consistent with higher risk taking behavior caused by lower interest rates (Lien et al., 2019). However, as seen in Appendix C, this negative correlation is not that clear among other countries, suggesting it is a mere coincidence.

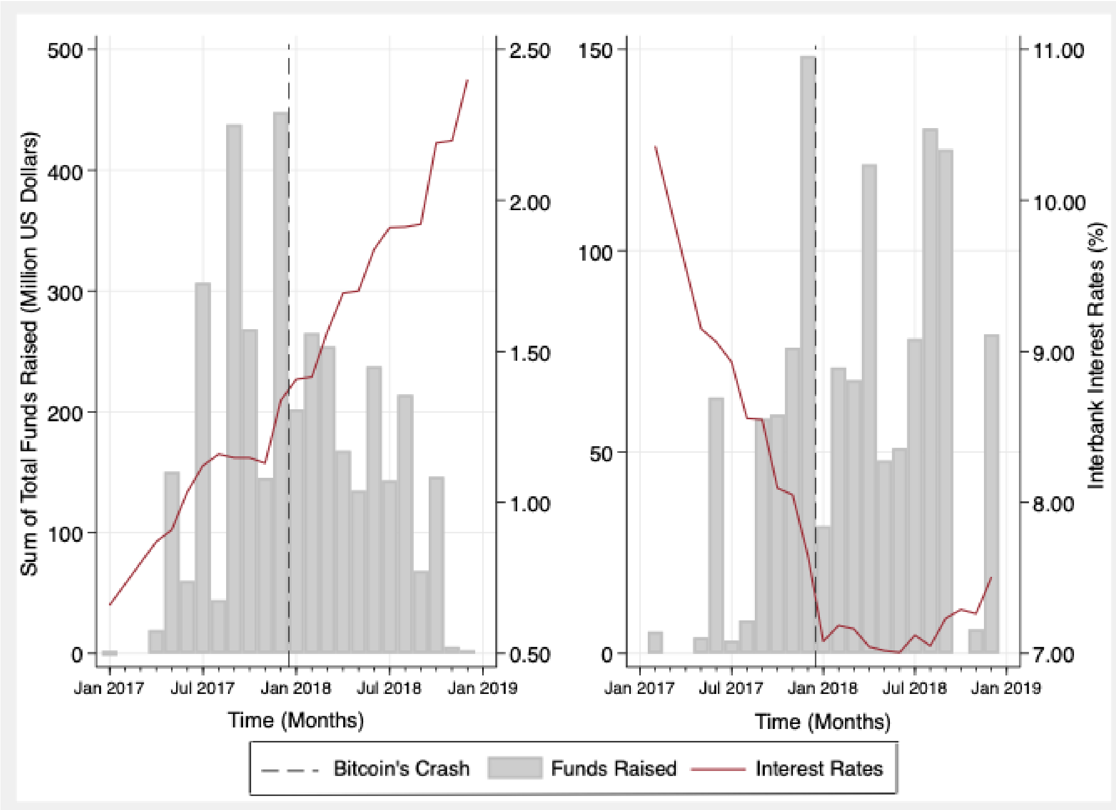

Figure 4. US Funds Raised per Month with US interbank Interest Rates (left); and Russian Funds Raised per Month with MIACR Interest Rates (right), 2017-2018.

5.1.2. Industries

As seen in Figure 5, Information Technology, Cryptocurrencies, Financials and Industrials are the most profitable industries among all. These are also the industries with the highest number of ICOs. Surprisingly, Energy, Health Care, Communication Services, Consumer Discretionary, Financials and Other have their highest peak after Bitcoin's crash. The first two of these did not even exist prior to 2018. This might also indicate that there are other drivers for ICOs other than Bitcoin.

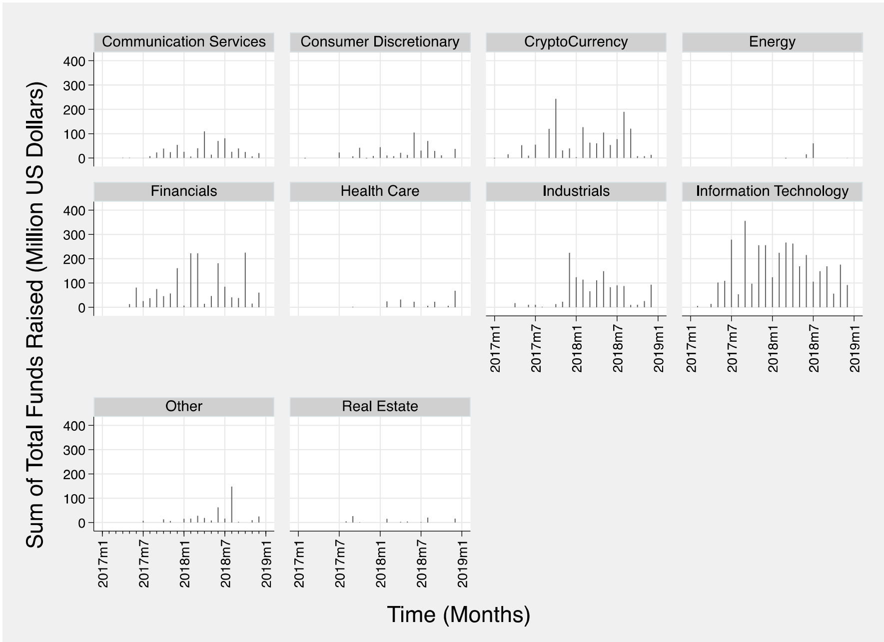

Figure 5. Total Funds Raised per Month per Industry, 2017-2018.

There does not seem to be an industry of ICOs which consistently outperforms the others. ICO in industries such as Information Technology, Cryptocurrencies, Financials and Industrials clearly raise more funds than others, but, when analyzed at an individual basis, it is not entirely clear if these differences remain (Figure 6). This differs from IPOs, which are influenced by industry characteristics (Akhigbe, Johnston & Madura, 2006).

The lack of differentiation among industries could suggest that most ICOs are merely objects of speculation as investors are not searching for specific functions provided by the blockchain, also supported by Fisch et al. (2019). This is also seen by Zetsche et al. (2019), who also found that most ICOs have no purpose at all, irrespectively of their industry. If this is true, industries are not different amongst each other because investors simply do not care about the function ICO, making it highly speculative and risky.

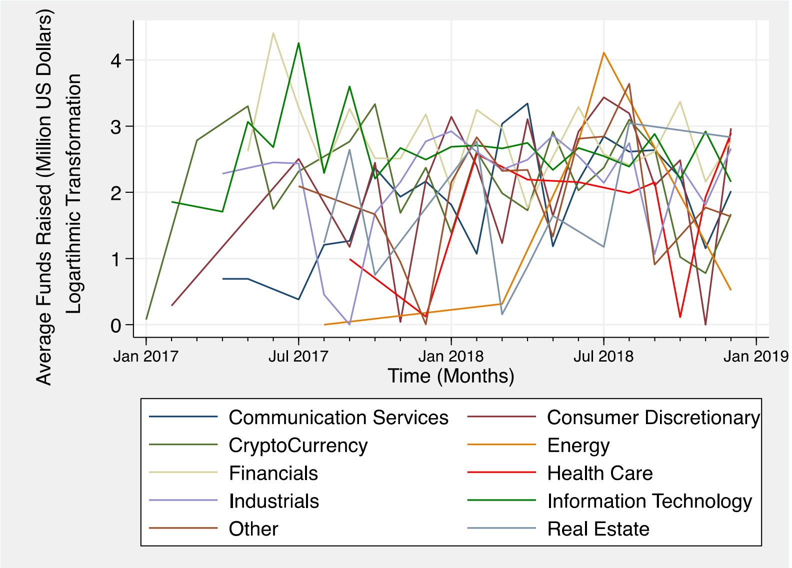

Figure 6. Average Funds Raised per Month per Industry, 2017-2018.

Notes: Funds Raised follow the transformation log(1+ funds raised*).*

5.2. Effect of interests rates on funds raised of an average ICO.

5.2.1. Statistical Analysis

As seen in Table 3, there are no significant effects of interest rates on funds raised and adding *industry* and *year-month* controls does not make a difference. Hence, we cannot confirm the first hypothesis formulated in Section 4.3. Considering these results are small and the standard errors also are, it can be safely established that the coefficient is a tightly estimated zero. Even if we take the bottom of the confidence interval from the lowest p-value coefficient (Column 1), an extra standard error decrease in interest rates would lead to a small economic effect of 0.025 log-point increases in funds raised, way below the 25th percentile of the distribution (Table 2). Hence, it can be concluded that interbank interest rates are not correlated with the funds raised of the average released ICO.

Table 3

Fixed Effects Regression of Interest Rates on Average ICO Funds.

	Country Fixed Effects (1)	Industry Fixed Effects (2)	Year-Month Fixed Effects (3)
Interest Rates	-0.038 (0.103)	-0.027 (0.102)	0.012 (0.089)
Country Fixed Effects	YES	YES	YES
Industry Fixed Effects	NO	YES	YES
Year-Month Fixed Effects	NO	NO	YES
Constant	2.028 (0.269)***	1.999 (0.270)***	1.901 (0.242)***
Adj. R^2	0.016	0.046	0.063
Observations	779	779	779

Notes: Observations are log (1+ funds raised) in Million USD of released ICOs. The model controls for country, and gradually, for industry and year-month using fixed effects. Column (1) are the results of the model when using *country* fixed effects. Column (2) includes country and adds *industry* fixed effects. Column (3) includes *year-month* fixed effects in addition to country and industry fixed effects. The three regressions used clustered standard errors at the *country-year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

Important to note that the relationship between interest rates and funds raised is indeed significant for some countries when analyzed separately. As seen in Appendix D.1., UK and Singapore present significant effects of interest rates. UK is positive and slightly significant at the 10% level when accounting for *industry* fixed effects, and Singapore is negative and slightly significant at 10% with no fixed effects and significant at 5% with *industry* fixed effects. Nevertheless, even if we assume the coefficient is at the bottom of the confidence interval, we can only see a -0.578 log points decrease in average funds raised, also below the 25th percentile of the data, which makes this coefficient economically insignificant. The rest of non-significant coefficients are also tightly estimated around zero for all countries.

5.2.2. Difference in Difference

Furthermore, the Difference in Difference Approach in Figure 7 does not seem to provide evidence for a causal effect either. None of the trends seem to be affected by the spike in interest rates, suggesting that there is no effect of interest rates on funds raised for the average ICO.

However, this methodology might have limitations. There seems to be different time trends prior to the forward guidance, which might be biasing the results due to different time-varying characteristics between countries. As both countries are following a similar trend even several periods after, this might also suggest that the market segmentation assumption does not hold, as indicated by (Chang, 2019). In addition, the lack of samples and available pretreatment as seen in Appendix B, reduces the reliability of these results.

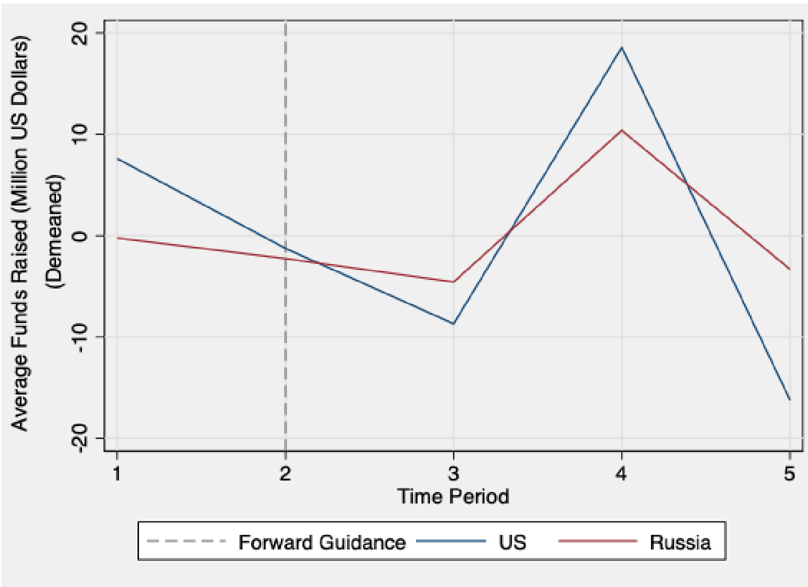

Figure 7. Difference in Difference of Average Funds Raised in American and Russian ICOs.
Notes: Funds Raised are demeaned for better comparisons between countries.

5.2.3. Answer to sub-question

In answer to the research sub-question, no significant relationship was found when analyzing ICOs at the individual level. In most cases, interest rates estimates were tightly estimated zeros, and, even though there was a significant relationship in the UK and Singapore, these lacked any economic significance. Furthermore, the Difference in Difference approach did not provide evidence for an effect either. Hence, it can be concluded that there is no evidence supporting an effect of interbank interest rates on the funds raised by the average ICO released into the market.

5.3. Effect of interests rates on funds raised at a determined industry, country and time period.

5.3.1. Statistical Analysis

As seen in Table 4, there are no significant effects of interest rates on funds raised at first, but adding country, industry and year-month controls makes coefficients positive and highly significant at the 1% level. Nevertheless, considering the coefficient is very small, and the standard errors also are, this effect is economically insignificant. Assuming the effect is at the top of the 95% confidence interval, the economic effect is just 0.210. Thereby, even though there is a significant correlation between interests and funds raised at this level of aggregation, this coefficient is not economically significant.

Table 4

Fixed Effects regression of interest rates on ICO funds per country, industry and year-month.

	Country Fixed Effects (1)	Industry Fixed Effects (2)	Year-Month Fixed Effects (3)
Interest Rates	0.138 (0.118)	0.121 (0.116)	0.154 (0.042)***
Country Fixed Effects	YES	YES	YES
Industry Fixed Effects	NO	YES	YES
Year-Month Fixed Effects	NO	NO	YES
Constant	0.572 (0.349)	0.624 (0.344)*	0.525 (0.123)***
Adj. R^2	0.011	0.243	0.372
Observations	960	960	960

Notes: Observations are log (1+ funds raised) in Million USD, aggregated at the *country-industry-year-month* level. The model controls for country, and gradually, for industry and year-month using fixed effects. Column (1) are the results of the model when using country fixed effects to control for country. Column (2) includes country and adds industry fixed effects. Column (3) includes time at a monthly level fixed effects in addition to country and industry fixed effects. The three regressions used clustered standard errors at the *country-year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

As in Model 1, the relationship between interest rates and funds raised is different for each country. As seen in Appendix E.1., every country except for the US display highly significant coefficients of interest rates under both scenarios. Important to note that Russia presents negative coefficients while UK and Singapore present positive ones. Only coefficients for UK and Singapore carry economic significance.

5.3.2. Robustness Tests

To test for robustness, two period lagged interest rates were added to the regression model. Given that ICOs are open for a period of time, funds raised registered in one month might have been affected by past interest rates as well. For this reason, Model 2 was run using up to two lags of interest rates. However, as seen in Appendix E.2., past interest rates are not significant.

In addition, the data was tested at other forms of aggregation. tested at the country and year-month form of aggregation with *country* and *year-month* fixed effects. As seen in Appendix E.3., interest rates are not significant at this form of aggregation. This was also tested for countries separately, as seen in

Appendix E.4., where all countries except for the US present highly significant effects at 1% and all coefficients present economic significance. As seen in D.1. and E.1., there is also evidence for different behavior in Russian ICOs than in UK and Singaporean ICOs.

5.3.3. Difference in Difference

Very similar to the Difference in Difference approach in Section 5.2.1.1., interest rates do not seem to affect total funds raised either. However, this methodology also suffers from the limitations already explained in Section 5.2.1.

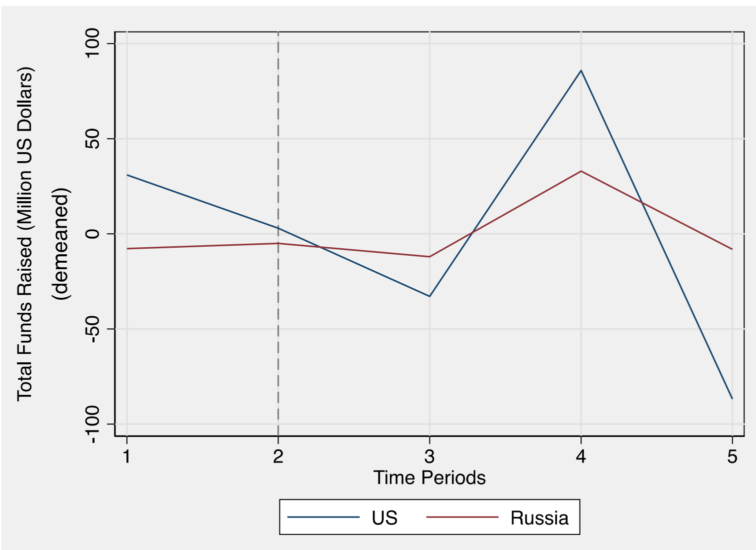

Figure 8. Difference in Difference of Total Funds Raised in American and Russian ICOs.

Notes: Funds Raised are demeaned for better comparisons between countries.

5.3.4. Answer to sub-question

In answer to the research sub-question, a highly significant correlation was found when analyzing ICOs in a specific country, industry and time period. However, the effect was only economically significant for UK and Singapore when analyzed separately. Robustness tests confirm the significant correlation of interest rates in specific countries such as the UK, Singapore and Russia. In addition, there is strong evidence for opposite correlations in high interest rate countries and low interests ones. This contradiction might be attributed to different behavior under low interest rate environments, as supported by Lian et al. (2019). Nonetheless, a causal effect cannot be established as the Difference in Difference approach does not provide evidence for this, and endogeneity cannot be discarded. There might be other non-observable characteristics which affect the top four countries differently.

6. Conclusion

The results used to answer the first hypothesis was a tightly estimated zero. The second hypothesis is refuted as the correlation between interests and funds raised was positive. Tse, Rodgers and Niklewski (2014) also found a positive correlation between interest rates and housing prices even though they agree it goes against common financial theory.

The aforementioned findings were not economically significant, which has several policy implications. On one hand, this is a positive thing given that most of developed countries have implemented a low interest rate policy during the last decade. On the other, this indicates that the central bank could not effectively regulate the ICO market indirectly through interest rate monetary policies. The increasing involvement of institutional investors, and the growing popularity of the ICO market remains a pressing issue for regulators as it could become a threat to financial stability.

Nevertheless, important findings were found when analyzing countries individually. When evaluating average released ICOs, there were significant correlations for Singapore and the UK when analyzed separately. The same trend holds for data at the aggregate level, where even Russia’s correlation becomes significant as well. Interestingly, interest rates in Russia, the only high interest country, had a negative correlation, while UK and Singaporean ones presented a positive one. This might provide evidence of different investment behavior under low interest rate policies, as suggested by Lian et al. (2019).

Sutton (2002) also found a positive effect of interest rates and house prices in the UK from 1980 to 2000, suggesting the positive correlation is not a coincidence at least for the UK. However, the study also found negative correlations for US, Canada, Australia, Netherlands and Ireland, which might indicate that positive correlations are something present in UK only and not in every low interest country.

Important to clarify that a causal effect cannot be established and the correlations might be purely coincidental. As seen in Figure 4 and Appendix C.1., funds raised by the UK, Singapore and Russia seem to follow a similar trend, but Russia is the only country whose interest rates are decreasing, suggesting the reason why their effect was negative was because their interest rates happened to be decreasing during 2017 and 2018. In addition, as seen Figure 1, Figure 4 and Appendix C.1, the US and UK follow an almost identical distribution and trend of interbank rates, but their funds raised behave differently, probably because of other non-observed characteristics that affected their ICO market differently. If interest rates truly had a causal effect, American and UK ICOs would more likely follow a similar trend. As a result, a correlation might be established at this level of aggregation, but more research needs to be done to find a causal effect. To test this, it would be necessary to gather samples from other periods of time and including other high interest rate countries.

The biggest limitation of this research, which is also present in most ICO papers, is the obscurity of the market and the lack of reliable data which causes sample selection bias. The three databases used for this paper often showed different results in countries, industries, funds raised and even dates. For example, as also seen in Zetsche et al. (2019), around half of ICOs fail to disclose the funds they raised, and the three websites I used do not disclose most failed or fraudulent ICOs. As a result, my sample is likely to have a sample selection bias given that fraudulent, unsuccessful and untransparent ICOs are not represented.

Additionally, these results might not be extrapolated to other risky assets, countries, time periods, and not even to all ICOs. Firstly, this experiment only uses samples from the Top four issuing countries, of which three are developed and low interest rate countries, and only one is a developed, high interest nation. Thus, using a sample with more developing countries is necessary to arrive to a stronger conclusion. Secondly, this experiment only analyzes the data from 2017 to 2018, mainly because of lack of information from other years, and thus, this phenomena might not hold for other years, such as 2020 and 2021. Thirdly, this experiment uses ICOs which are displayed in ICOBench. According to Zetsche et al.(2019), this website consists of 96% of utility tokens, so the results might fail to represent other types of tokens such as equity or currency tokens.

Hence, further research needs to be done including high interest rate countries, other time periods and with a more balanced ICO database. A potential experiment could be to compare the effect of interest rates after the COVID-19 pandemic in 2020, where interest rates were dropped considerably, and the cryptocurrency market rose. It might also be relevant to evaluate the effect of other variables such as the returns in debt, equity and cryptocurrency markets on the ICOs.

7. Appendixes

Appendix A. Distribution of Dependent variable Funds Raised

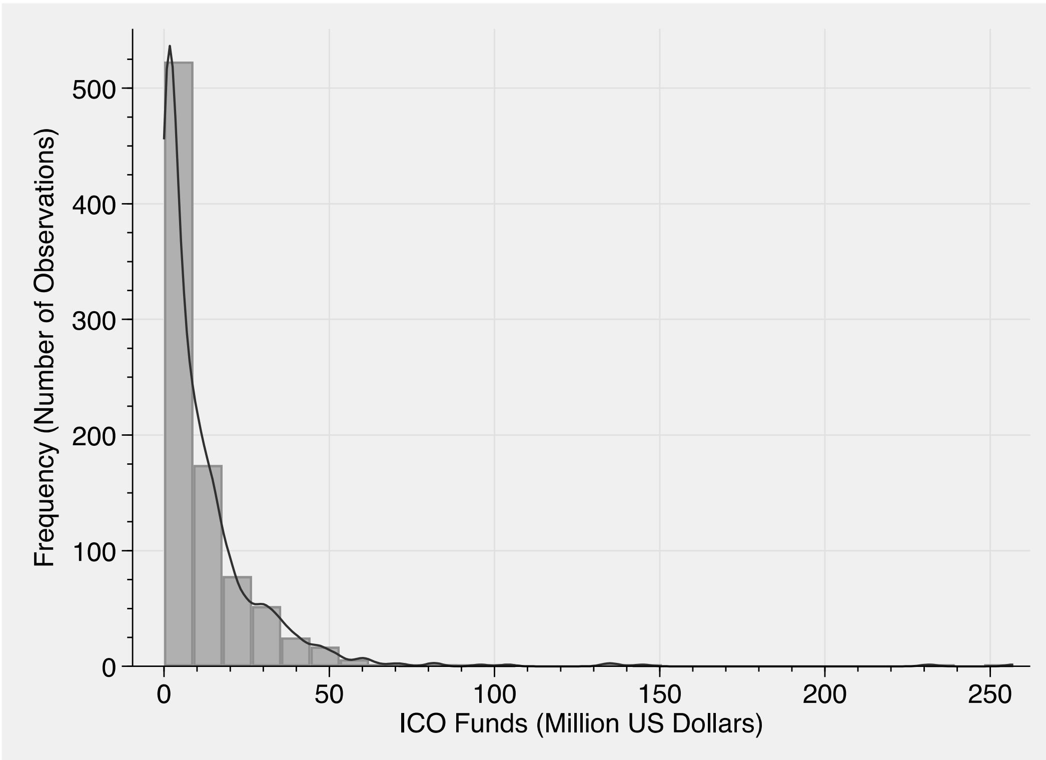

Figure A.1. Distribution of ICO Raised Funds.

Notes: Figure demonstrating the frequency distribution of the funds raised by 779 ICOs from January 2017 to December 2018. It can be seen how the data presents positive skewedness towards 0 and positive kurtosis. Even though most samples collect less than 10 million US dollars, there are outliers with more than 100 million US dollars, with the largest ICO collecting 257 Million US dollars.

Appendix B. Difference in Difference methodology in detail

Table B.1

Period Division in Difference in Difference Approach

Period	Dates (1)	Observations (2)
1	12/04 – 12/05	Russia (1); US (5)
2	13/05 – 13/06	Russia (3); US (6)
Treatment	**14/06**	N/A
3	14/06 – 14/07	Russia (2); US (7)
4	14/07 – 14/08	Russia (3); US (5)
5	15/08 – 15/09	Russia (3); US (6)

Notes: Column (1) includes the dates in which the periods were divided. All dates took place in 2018. Column (2) includes the observations found in that country for that given range. The row in bold letters is the treatment date in which interest rates changed (one day after the forward guidance took place).

Appendix C. Other Country Visualizations

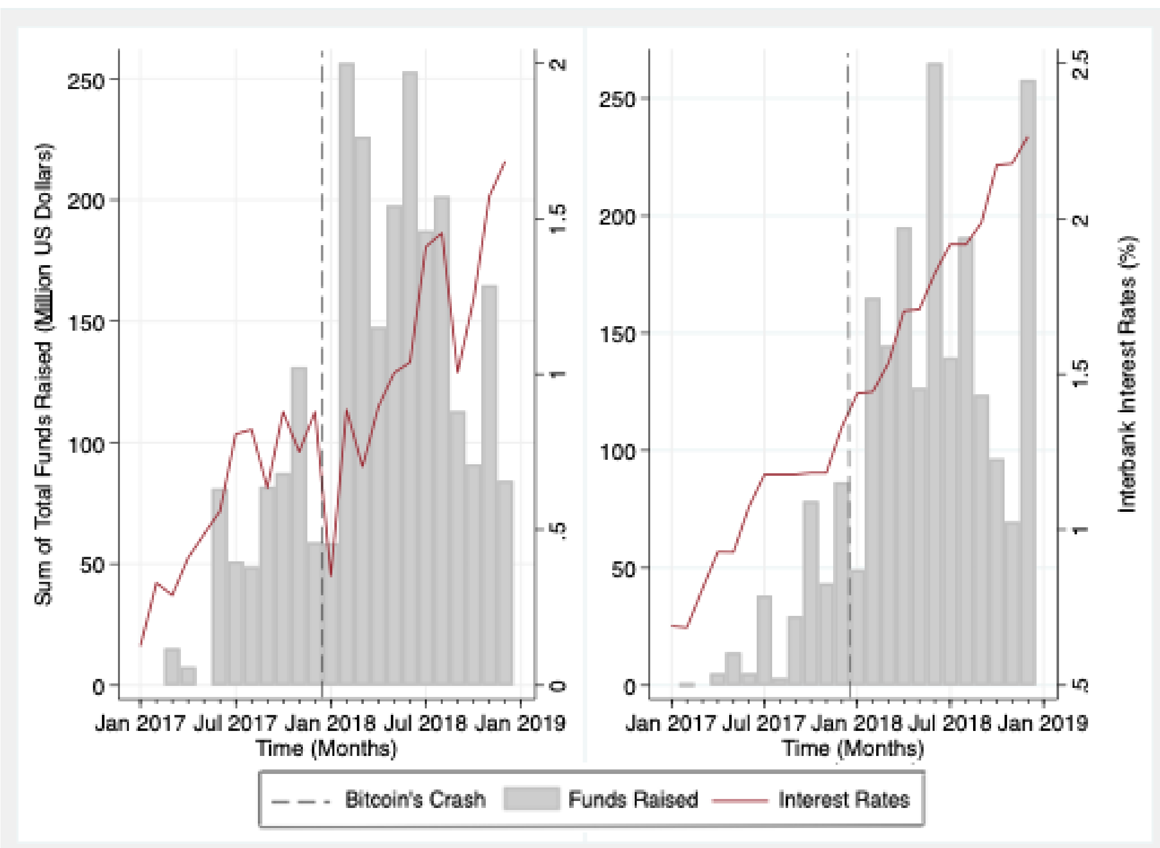

Figure C.1. UK Funds Raised per Month with LIBOR Interest Rates (left); Singapore Funds Raised per Month with SORA Interest Rates (right), 2017-2018.

Appendix D. Robustness Tests For Model 1

Table D.1.

Fixed Effects Regression of Interest Rates on Average ICO Funds, per Individual Country.

		No Fixed Effects (1)	Industry Fixed Effects (2)
US			
	Interest Rates	-0.047 (0.302)	0.063 (0.311)
	Constant	2.119 (0.440)***	1.958 (0.458)***
	Adj. R^2	-0.004	0.027
	Observations	226	226
Russia			
	Interest Rates	0.006 (0.160)	0.021 (0.161)
	Constant	1.537 (1.246)	1.423 (1.268)
	Adj. R^2	-0.007	-0.004
	Observations	150	150
UK			
	Interest Rates	0.335 (0.239)	0.349 (0.200)*
	Constant	1.387 (0.412)***	1.363 (0.338)***
	Adj. R^2	0.006	0.060
	Observations	185	185
Singapore			
	Interest Rates	-0.292 (0.142)*	-0.299 (0.134)**
	Constant	2.333 (0.159)***	2.349 (0.156)***
	Adj. R^2	0.0104	0.0475
	Observations	218	216
Country Fixed Effects		N/A	N/A
Industry Fixed Effects		NO	YES
Year-Month Fixed Effects		NO	NO

Notes: Observations are log (1+ funds raised) in Million USD of released ICOs, analyzed separately by country. There are no controls at first, but industry fixed effects are gradually included. Column (1) are the results of the model without using fixed effects. Column (2) includes industry fixed effects. Column. The two regressions used clustered standard errors at the *year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

Appendix E. Robustness Test For Model 2.

Table E.1

Fixed Effects Panel Regression of Interest Rates on ICO Funds per Industry per Year-Month, per Individual Country

		No Fixed Effects (1)	Industry Fixed Effects (2)
US			
	Interest Rates	0.326 (0.367)	0.305 (0.372)
	Constant	0.683 (0.516)	0.711 (0.528)
	Adj. R^2	0.005	0.249
	Observations	240	240
Russia			
	Interest Rates	-0.303 (0.062)***	-0.305 (0.063)***
	Constant	3.160 (0.551)***	3.174 (0.559)***
	Adj. R^2	0.063	0.287
	Observations	240	240
UK			
	Interest Rates	1.210 (0.202)***	1.206 (0.206)***
	Constant	-0.776 (0.241)***	-0.770 (0.246)***
	Adj. R^2	0.152	0.353
	Observations	240	240
Singapore			
	Interest Rates	1.277 (0.207)***	1.111 (0.224)***
	Constant	0.016 (0.197)	0.155 (0.228)
	Adj. R^2	0.121	0.362
	Observations	240	240
Country Fixed Effects		N/A	N/A
Industry Fixed Effects		NO	YES
Year-Month Fixed Effects		NO	NO

Notes: Observations are log (1+ funds raised) in Million USD, aggregated at the *industry-year-month* level, analyzed separately by country. There are no controls at first, but industry fixed effects are gradually included. Column (1) are the results of the model without using fixed effects. Column (2) are the results of the model using industry fixed effects. The two regressions used clustered standard errors at the *year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

Table E.2.

Fixed Effects Panel regression of Lagged Interest Rates on ICO Funds per Country, Industry and Year-Month.

	Country Fixed Effects (1)	Industry Fixed Effects (2)	Year-Month Fixed Effects (3)
Interest Rates	0.293 (0.246)	0.271 (0.240)	0.161 (0.061)***
L1. Interest Rates	-0.052 (0.280)	-0.046 (0.274)	0.057 (0.085)
L2. Interest Rates	-0.193 (0.193)	-0.195 (0.190)	-0.086 (0.156)***
Country Fixed Effects	YES	YES	YES
Industry Fixed Effects	NO	YES	YES
Year-Month Fixed Effects	NO	NO	YES
Constant	0.845 (0.343)**	0.895 (0.339)**	0.597 (0.156)***
Adj. R^2	0.016	0.249	0.369
Observations	951	951	951

Notes: Robustness test results for Model 2, a fixed effects panel regression to test the effect of interbank interest rates with two month-lagged values on ICO funds raised. Observations are log (1+ funds raised) in Million USD, aggregated at the *country-industry-year-month* level. The model controls for country, and gradually, for industry and month using fixed effects. Column (1) are the results of the model when using country fixed effects to control for country. Column (2) includes country and adds industry fixed effects. Column (3) includes time at a monthly level fixed effects in addition to country and industry fixed effects. The three regressions used clustered standard errors at the *country-year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

Table E.3.

Fixed Effects Panel Regression of Interest Rates on ICO Funds per Country per Year-Month.

	Country Fixed Effects (1)	Year-Month Fixed Effects (2)
Interest Rates	0.110 (0.359)	0.196 (0.189)
Country Fixed Effects	YES	YES
Year-Month Fixed Effects	NO	YES
Constant	3.379 (1.091)***	3.125 (0.571)***
Adj. R^2	0.008	0.660
Observations	96	96

Notes: Observations are log (1+ funds raised) in Million USD ICOs, aggregated at the *country-year-month* level. There are no controls at first, but time fixed effects are gradually included. Column (1) are the results of the model with country fixed effects. Column (2) are the results of the model with time fixed effects in addition to country fixed effects. The two regressions used clustered standard errors at the *country-year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

Table E.4.

Fixed Effects Panel Regression of Interest Rates on ICO Funds per Year-Month, per Individual Country.

	No Fixed Effects (1)
US	
Interest Rates	1.032 (1.106)
Constant	2.678 (1.668)
Adj. R^2	0.024
Observations	24
Russia	
Interest Rates	-1.063 (0.237)***
Constant	11.633 (1.940)***
Adj. R^2	0.396
Observations	24
UK	
Interest Rates	3.056 (0.488)***
Constant	-0.763 (0.763)
Adj. R^2	0.659
Observations	24
Singapore	
Interest Rates	2.753 (0.777)***
Constant	1.653 (0.808)*
Adj. R^2	0.411
Observations	24
Country Fixed Effects	N/A
Industry Fixed Effects	NO
Year-Month Fixed Effects	NO

Notes: Observations are log (1+ funds raised) in Million USD ICOs, aggregated at the *year-month* level, analyzed separately by country. Column (1) are the results of the model. The two regressions used clustered standard errors at the *year-month* level, which are shown by the numbers in ( ). * represents the data is significant with a p-value of 0.1-0.05, ** that it is significant with a p-value 0.01-0.05, and *** that it is significant with p-values smaller than 0.01.

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