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Forks and airdrops in cryptomarkets: Investment opportunities or thin air?

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Declaration of Authorship

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Prague, May 9, 2019

Petr Hotovec

Abstract

Cryptocurrencies present a relatively new field of study where not much research has been done on the effects of announcements on cryptocurrency returns. This thesis examines the effect of hard fork and airdrop announcements on cryptocurrency returns using the event study methodology. Fork and airdrop announcements are studied on 22 cryptocurrencies from the top 100 cryptocurrencies ranked by their market capitalization and the results show that average abnormal returns are not statistically significant on the day of the announcement which is in stark contrast to most of the evidence from the stock markets and implies market inefficiency due to a 2 day lag before average abnormal returns become statistically significant. Our interpretation of the results is that information on cryptocurrencies are very confusing and unreliable and investors wait for their confirmation, hence the two day delay.

Keywords	cryptocurrency, airdrop, hard fork
Title	Forks and airdrops in cryptomarkets: Investment opportunities or thin air?

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Abstrakt

Kryptoměny představují relativně novou oblast výzkumu, kde zatím neproběhlo mnoho studií událostí, které by zkoumaly vliv oznámení novinek na kryptoměnové výnosy. Tato práce zkoumá vliv oznámení hardforků a aidropů na kryptoměnové výnosy za užití metodologie event study. Forky a aidropy jsou zkoumány na 22 kryptoměnách z první stovky kryptoměn dle tržní kapitalizace. Výsledky ukázaly, že průměrné abnormální výnosy v den oznámení nejsou statisticky signifikantní, což je v silném kontrastu s většinou studií zkoumajících akciové trhy a ukazuje to na neefektivitu kryptoměnového trhu, jelikož abnormální výnosy jsou statisticky signifikantní až s dvoudenním zpožděním od oznámení. Výsledky jsme interpretovali tak, že informace na kryptoměnových trzích jsou velice zmatečné a nespolehlivé a z toho důvodu investoři vyčkávají na jejich potvrzení, což se projevuje dvoudenním zpožděním.

Klíčová slova	kryptoměna, airdrop, hard fork
Název práce	Forky a airdropy na kryptotrzích: Investiční příležitost nebo investice do vzduchu?
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Acronyms

BTC Bitcoin

ETH Ethereum

BZX Bitcoin Zero

PRL Oyster Pearl

SHL Shell

ICO Initial Coin Offering

DAO Decentralized autonomous organization

SEO search engine optimization

TOP100 first one hundred cryptocurrencies ranked by market capitalization

SEC U.S. Securities and Exchange Commission

BCH Bitcoin Cash

Bachelor's Thesis Proposal

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Proposed topic	Forks and airdrops in cryptomarkets: Investment opportunities or thin air?

Research question and motivation The thesis will analyse forks and airdrops as investment opportunities. A hard fork (or sometimes hardfork), as it relates to blockchain technology, is a radical change to the protocol that makes previously invalid blocks/transactions valid (or vice-versa). Forks have emerged in summer 2017 as a positive fundament driving the price of coins and tokens. An airdrop for a cryptocurrency is a procedure of distributing tokens by awarding them to existing holders of a particular blockchain currency. I will analyse the effects of forks on the sample of coins which underwent it. My goal is to find whether there is a positive effect of announced fork on the coin and estimate when is the best time to sell the coin, whether it is before the fork or after the fork along with the new airdrop. As far as I am concerned I am about to be the first to study this completely new topic.

Contribution Effects of forks and airdrops on price of cryptocurrencies have not been studied on academic level so far, therefore my thesis will be a pioneer. Since airdrops and fork emerged very recently, there is finally enough data to study the topic. The results of my work will show when is it most profitable to sell the forking cryptocurrencies. Whether before or after the fork/airdrop and when exactly. I believe I will be able to find whether the raise in price of coins which are about to fork is caused by the fork itself or if it is caused by random speculation.

Methodology I will use data from coinmarketcap and various cryptocurrency exchanges, like binance, bittrex, kucoin, cryptopia and others. In my thesis I will analyze the price evolution of each cryptocurrency after the announcement of fork until certain point in time after the fork. I will also try to compile as many supportive data as I could including the reach of news about the fork and public reactions, for

example number of likes that a facebook group dedicated to the coin got, or the number of twitter and reddit followers.

Outline

1. I plan to structure my thesis in 5 sections. In the beginning I will describe my topic, then comment on how I chose the data for my model, run the model and then decribe what the data showed me.
2. 1) Introduction to forks/airdrops, cryptocurrencies
3. 2) Data summary, comment on data
4. 3) Data analysis
5. 4) Outcome analysis
6. 5) Conclusion

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Chapter 1

Introduction

Cryptocurrencies are a relatively new topic on the scientific field. There have already been studies measuring whether cryptocurrencies are a gambling asset, studying pumps and dumps, measuring seasonality, or testing whether cryptocurrencies are a good tool for portfolio diversification. However as far as we are concerned, little to no effort was put in studying events' effect on cryptocurrency prices. In our thesis we are focusing on two similar yet different events and their effect on cryptocurrency returns - forks and airdrops. To our best knowledge, we are the first who study this topic. In order not to repeat ourselves when we want to mention forks and airdrops together, we sometimes refer to them as to "the events of interest" in our thesis.

Each of the events is a very broad category and it is sometimes very difficult to distinguish between them even for experienced cryptocurrency enthusiasts. Forks are events whose occurrence is natural to cryptocurrencies built on the blockchain technology and whose economic potential was perceived only recently. Airdrops were invented as a marketing tool in 2014 (Christensen 2019). Moreover some of the events may either be planned, or may take place randomly. In the thesis we will try to estimate the effects of the events of interest on cryptocurrency returns, using daily data on prices from coinmarketcap web page and event data from our own research which is based on the data from coinmarketcal - largest online cryptocurrency events calendar.

Since there is very little scientific literature on these events, second chapter of the thesis is focused on a description of each of the events of interest. In the third chapter of the thesis, we perform the literature review focused on the possible methods we can choose and on the relevant cryptocurrency literature. In the fourth chapter, we describe our data and present the criteria we set in

order to create our dataset. Fifth chapter of the thesis is focused on methodology and in the sixth chapter we present and comment on the results. In the seventh and final chapter of the thesis we provide conclusion of our results.

Chapter 2

Theoretical background on forks, swaps and airdrops

On the following pages we will try to describe the basic terminology and functionalities of blockchain and distributed ledger technology with a focus on terms necessary to understand forks, airdrops and swaps. We try to make the text understandable for readers without any prior knowledge of blockchain and cryptocurrencies, therefore we do not go into much technical detail and we try to explain the process of forks and airdrops as understandable as possible since purpose of this thesis is to examine the events of interest' effects and not to provide a technological overview. As a result of that, we often make simplifications and we do not fully exhaust all the variations and use cases of the events, which we deem impossible anyway, due to very dynamic progress in the whole field. We have no doubt that readers who would read the text within few months from publication might find the technological overview outdated and obsolete. Before we start describing the events itself we should first provide some basic theoretical overview on cryptocurrencies that is necessary to fully understand the topic of the thesis.

2.1 Blockchain

According to Bitcoinwiki, which is an independent project with around 6200 articles on cryptocurrencies, "Blockchain[1] is a transaction database shared by all nodes participating in a system based on the coin's protocol. A full copy of a currency's block chain contains every transaction ever executed in the

[1]It is also possible to spell it as block-chain or block chain

currency. With this information, one can find out how much value belonged to each address at any point in history. Every block contains a hash of the previous block. This has the effect of creating a chain of blocks from the genesis block to the current block. Each block is guaranteed to come after the previous block chronologically because the previous block's hash would otherwise not be known. For any block on the chain, there is only one path to the genesis block. Coming from the genesis block, however, there can be forks."(Bitcoinwiki 2018a). Blockchain can therefore be interpreted as a way how to reliably and securely pass information from point A to point B relying on a decentralized pool of computers instead of central authority. Cryptocurrencies are built on the blockchain technology.

2.2 Wallet

Antonopoulos describes wallet as a user interface: "Coin's blockchain is a protocol that can be accessed using a client application that speaks the protocol. A "bitcoin wallet" is the most common user interface to the coin's system, just like a web browser is the most common user interface for the HTTP protocol"(Antonopoulos 2014)(pp.13). Without the use of wallets, common users, who lack the necessary technological background, would not be able to be able to access their cryptocurrency funds.

2.3 Private key

Private key is the most important code every cryptocurrency user has. It is the key which unlocks the funds in wallets. It is especially important for investors participating in hardforks, because they shall insert their private key to a new wallet which interacts with the new blockchain of the newly created coin. According to Frankenfield's article on investopedia: "A private key is a sophisticated form of cryptography that allows a user to access his or her cryptocurrency. A private key is an integral aspect of bitcoin and altcoins, and its security make up helps to protect a user from theft and unauthorized access to funds."(Frankenfield 2018)

2.4 Coin

Coin, for instance Bitcoin, is a cryptocurrency type which operates independently of any other platform. In other words a coin has its own platform which is called blockchain. Coin is any cryptocurrency which operates on its own blockchain. In the literature we may find references to coins, altcoins, cryptocoins and various other terms. Citowise on his blog addresses the difference between these terms: "There is no difference between a coin and a cryptocoin or altcoin; coin is just an abbreviation of cryptocoin. Altcoins simply refers to coins that are an alternative to Bitcoin. The majority of altcoins are variants of Bitcoin, built using Bitcoin's open-sourced, original platform with changes to its underlying codes, therefore creating a brand new coin with a different set of features."(CITOWISE 2018)

2.5 Token

In comparison to coins, tokens don't operate independently, they do not use their own blockchain. Tokens require another platform such as Ethereum to exist and operate (CITOWISE 2018). Token is not a coin, it is just a conventional functionality unit created according to the existing blockchain standards, like ERC20. In other words, the company issues a contract on an external blockchain (like Ethereum) that serves as fuel for in-platform operations. The main and basic difference between a coin and a token is that the coin acts as digital money with its own blockchain. Coins have their own infrastructure to sustain transactions. Tokens, in turn, are a conditional unit based on the existing blockchains and used for functionality purposes (Atomicwallet 2019). According to Frankenfield's article on investopedia, "Terms like cryptocurrency, altcoins, and crypto tokens are often erroneously used interchangeably in the virtual currency world. Technically, they are all different terms. Cryptocurrency is the superset, and altcoins and crypto tokens are its two subset categories."(Frankenfield 2019)

In our work we distinguish between the terms cryptocurrencies, tokens and coins. If we refer to coins, we only refer to cryptocurrencies which operate on their own blockchain. By tokens, we refer to cryptocurrencies which do not operate on their own blockchain. Cryptocurrency serves as a superset in our thesis, so referring to cryptocurrencies means we refer both to coins and

to tokens. This distinction is very important, because some of our events of interest may occur only on coins or on tokens.

2.6 Mining

According to Bitcoin wiki, "mining is the process of adding transaction records to Bitcoin's public ledger of past transactions (and a 'mining rig' is a colloquial metaphor for a single computer system that performs the necessary computations for 'mining'). This ledger of past transactions is called the blockchain as it is a chain of blocks. The blockchain serves to confirm transactions to the rest of the network as having taken place. Bitcoin nodes use the blockchain to distinguish legitimate Bitcoin transactions from attempts to re-spend coins that have already been spent elsewhere."(Bitcoinwiki 2018b). In simple terms, miners are the ones who confirm the authenticity of cryptocurrency transactions and update the blockchain with the new information.

This overview and definitions shall be sufficient in order to understand the following text on hard forks and airdrops. In the following sections, we will explain and define our events of interest. This thesis examines the effects of hard fork and airdrop announcements on cryptocurrency returns, therefore it is essential to understand what a hard fork and airdrop is. Economic idea why should hard forks and airdrops affect returns is similar for each of the events. Both events shall increase investor's balance of cryptocurrency at the moment the event takes place. Therefore we would expect the investors to view the events positively and positively react to events' announcements.

2.7 Fork

Price might be affected by soft forks, hard forks[2] and airdrops. In the beginning we have to first post ourselves a question which forks are we going to consider to be our events of interest. Frankenfield in his investopedia article explains hard fork in a following manner: "Hard fork itself (or sometimes hardfork), as it relates to blockchain technology, is a radical change to the protocol that makes previously invalid blocks/transactions valid (or vice-versa). This requires all nodes or users to upgrade to the latest version of the protocol software. Put differently, a hard fork is a permanent divergence from the previous version of

[2]We call this section fork. There are several kinds of forks. In the thesis we will mostly focus on hardforks, which can be spelled both hard fork or hardfork

the blockchain, and nodes running previous versions will no longer be accepted by the newest version. This essentially creates a fork in the blockchain: one path follows the new, upgraded blockchain, and the other path continues along the old path. Generally, after a short period of time, those on the old chain will realize that their version of the blockchain is outdated or irrelevant and quickly upgrade to the latest version"(Frankenfield 2019). Therefore hardfork is basically any kind of change to blockchain which makes the previous version of blockchain and nodes incompatible with the new one. If all the miners and node providers comply to change, old blockchain cease to be used and the whole community moves to the new chain. This broad definition of hardfork is not the hardfork we should be interested in, since it does not necessarily leads to a creation of a new coin, therefore investors should not necessarily see this broadly defined hardfork as an investment opportunity, because they get no "free money[3]" for holding the coins during hardfork's snapshot. We shall be interested in only those hardforks that lead to a blockchain split, leading to establishment of two separate functioning blockchains that would both exist further. Only this kind of hard fork provides the incentive to purchase the coin pre-fork in order to get an extra coin after the hardfork.

Hardforks have been integral part of cryptocurrencies since the foundation of Bitcoin and they have always been used to implement major changes or upgrades to blockchain. Probably the first well documented, crucial, controversial and widely discussed hard fork occurred on cryptocurrency Ethereum after the June 2016 DAO exploit, which enabled hackers to siphon off one third of the DAO's funds using vulnerability in the DAO code. Part of the community argued it was an unacceptable fraud and the stolen funds should be reversed, other part argued that the lack of central authority and interference is essential principle of Ethereum and the funds shall not be reversed, because the reversal would go against cryptocurrency ethical principles of no central authority intervention. The situation thus lead to a hard fork of Ethereum blockchain, the majority of the community opted for the funds reversal, so they were able to keep the original name and symbol (Ethereum (ETH)) and the part of the community, which did not agree with the interference, created a new coin, Ethereum Classic (ETC).

This hardfork, although very important, did not cause the shift in cryptocurrency community's view on forks and therefore shall not mark the begin-

[3]Hard forks and airdrops are often called "free money". See (Malwa 2018) or (Nielsen 2017)

ning of the data analysis. It was the first widely discussed fork which affected price, but the fork itself was not viewed as an investment opportunity, but as a measure to overcome a catastrophe which, along with Mt.Gox hack, was probably one of the darkest events and biggest fails in the short history of cryptocurrencies. We believe we should start our analysis of forks with another, probably the most discussed hardfork (until the Craig Wright's fight over Bitcoin Cash against Jihan Wu and Roger Ver), which lead to the establishment of hard forks as an investment opportunity from the investors' population perspective. The hardfork which changed the perception of forks was undoubtedly the Bitcoin Cash hard fork which occurred on 1st of August 2017, just two months prior to the big bull run of 2017, that lead to an introduction of Bitcoin and blockchain to wider population.

Sometimes you may come across a fork referred to as "knife". It refers to forks during which snapshots are taken from multiple blockchains. We came across this term in GravityCoin's discord channel. GravityCoin team did a fork and created Bitcoin Zero (BZX). BZX forked from GravityCoin (then hexxcoin) blockchain, therefore it shares GravityCoin's technology, but a snapshot of Bitcoin's (BTC) blockchain was also taken and BZX was awarded both to holders of Bitcoin and GravityCoin. This process of forking one coin and awarding the newly created coin to both the holders of coins on original blockchain and to holders of other coins is referred to as "knife" by some people in the cryptocurrency community. However the term may die out or be replaced by some other. Every month, new versions and types of forks are being developed/used and terms which are used today may not be used tommorow.

2.8 Airdrops

Along with forks, we also analyse the effects of airdrops on cryptocurrency returns. Airdrops are as well as hardforks also referred to as "free money" in the cryptocurrency community. We have always wondered if the name airdrop was chosen due to its nomen/omen relation to what an airdrop is, because the whole idea of an airdrop is to distribute tokens for free to people who either own certain amount of a cryptocurrency - those are called holder airdrops, or to people who fill up a telegram form, post a tweet or perform various other deeds - the so called bounty airdrop. Malwa (2018) in his hackernoon article explains the origins of bounty aidrops "A while ago Token Start ups realized that there is a lot more value when their token is held on as many wallets as possible. More

coins lead to more interest and exposure, which in turn greatly increases the Trading Volume of a particular coin when it gets listed on an exchange.Then came up with an indigenous solution - Airdrop. And no, I am not referring to the software update here. Participating in an Airdrop is simple. You discover, or are informed of an Airdrop, fill out a telegram form, give your Ethereum (or relevant coin) wallet address, and Voila ! Free Tokens in your wallet a few weeks from then. What is it also does is create marketing waves in the crypto ecosystem. People start discovering and talking about "free" tokens, and the word spreads around the community about that particular Token. The word reaches thousands of people, and the cost of advertising - zero. Compared to an ICO, which initially involves a Private Sale (basically the rich getting richer), followed by a Public sale, where small time investors purchase tokens for ETH or BTC. An Airdrop takes away the payment bit of this process, instead giving more value towards informing people of their offering, and giving every one the chance to own some tokens."(Malwa 2018).

As described by Malwa (2018), there are many different kinds of airdrops. In the dataset we used, all airdrops were holder airdrops in which holders of major coins, like Neo or Waves were given other cryptocurrencies based on their balance at the moment of airdrop. Malwa (2018) provides a nice example how a holder airdrop occurs "The shell, or SHL is a utility token. Shells are used to pay for connectivity and Dapp operation across the Oyster meshnet, whilst Oyster Pearl (PRL) are used for static data retention on the tangle.To be eligible for the Airdrop, all you need to have are the Oyster Pearl tokens. This will be the only way to attain SHL, it will not be offered in a token sale. Every 1 PRL held on the blockchain will be airdropped 1 SHL. The total supply of SHL will match the total supply of PRL (after the 10m PRL coin burn event)." (Malwa 2018). The result of such an airdrop is identical to a result of a hardfork but there is no effect on the blockchain structure of the coin which makes holder eligible for an airdrop. In the Shell case, holders of Oyster Pearls received Shells, without Oyster Pearl team having to do anything. There was no change to the Ethereum blockchain (on which both Pearl and Shell run), if the holders of Oyster Pearl wanted to get their Shells, they just claimed them using ERC20 wallet.

This is a major difference between a fork and an airdrop. In case of an airdrop, investors usually don't have to download any special wallet, which is a necessity in order to claim a coin after hardfork, because hardfork splits the blockchain and if an investor wants to operate with both the old and the new

coin after chainsplit, he or she needs to use two different wallets - two different blockchain interfaces.

The process of claiming airdrops is nicely described on a page dedicated to airdrops - airdrops.io: "The claim process for airdrops differs from project to project. Some 'holder drops' will drop tokens automatically into the wallets of users who own a specific coin. Other projects are snapshot- based, and can only be claimed by users who held the required token during the "snapshot", which is a record of token holders taken at a specific time/block."(airdrops.io 2019)

2.9 Swaps

Cryptocurrency may be airdropped both to a coin and a token, but hardfork may only occur on coins. Readers may be curious if some equivalent to a fork exist for token, therefore, although not being analyzed in the thesis, a short section on swaps is included in the overview. Swaps functionality is to provide interaction between coins and tokens. You may imagine a swap to be similar to a company conversion (e.g. from limited liability company to corporation). Gutteridge (2018) provides a good overview on swaps: "A token swap is a process by which one cryptocurrency is exchanged for another at a predetermined rate. Unlike selling one coin to buy another, a token swap is the replacement of one coin for another, so it means that you are required to exchange the old coin for the new one, or you will lose value. A token swap is not a simple rebranding, as that can happen without the participation of anyone holding the coin. With a rebranding, tokens might change names or have their ticker symbol switched to something else, but with a token swap, the underlying blockchain that supports the token is being changed entirely, and holders are compelled to take some kind of action."(Gutteridge 2018).

Swaps usually happen when a token wants to move to a different blockchain-mainnet. Swap is often connected with significant changes to token's functions. Tokens usually migrate in order to improve their possibilities in evolving new utilities and functions as in the case of NKN token swap from NEP-5 to ERC-20[4]. Another occasion for swaps is when token wants to move to its own blockchain as was the case of EOS or vice versa - if a coin is to become a token on a host blockchain as was the case of Bela coin.

[4]NEP-5 and ERC-20 are protocols on which tokens operate. NEP-5 is built on NEO and ERC-20 is built on Ethereum

The question we want to answer in this thesis is whether fork and airdrop announcements affect the returns on cryptocurrency. We deem the above introduction chapter sufficient in order to facilitate the reader's understanding of the following chapters.

Chapter 3

Literature review

Literature review in the case of forks and airdrops shall be conducted in two sections. First section shall review the existing literature on cryptocurrencies related to our topic and second part should review the possible methodology.

3.1 Review on existing literature on cryptocurrencies

There has been a lot of literature on cryptocurrencies concerning mostly Bitcoin. Lot of academic literature is dedicated to determining Bitcoin's value and to searching for what affects Bitcoin's price. Cheah & Fry (2015) published a paper verifying that Bitcoin has no fundamental value which was contrary to Kristoufek (2015), who found that standard fundamental factors, such as usage in trade, money supply and price level, play a role in long term Bitcoin price. Cheah & Fry (2015) paper brought lot of controversy and inspired many academics to analyze what brings value to cryptocurrencies.

One of the sources of argued fundamental value is the Metcalfe's Law which states that the effect of communications network is proportional to the square of the number of connected users to the system, which was elaborated by Alabi (2017) who analyzed Bitcoin, Ethereum and Dash network and showed that networks were fairly well modeled by Metcalfe's Law and presented a model that showed value of cryptocurrency to be proportional to the exponential of the root of the number of users participating in the network.

Positive relation between financial returns on Bitcoin and the use of the Bitcoin network was confirmed by Koutmos (2018) who showed that when comparing the bidirectional linkages between returns and transaction activity,

contribution of return shocks to transaction activity is quantitatively larger in magnitude. However in cryptocurrency community, the act of flooding bitcoin network with transactions is viewed as one of the tools to manipulate price due to Bitcoin notoriously small block size (Bitcoinwiki 2016). Civitarese & Mendes (2018) used cointegration tests to reject long-term relations between number of transactions, wallets, unique addresses and prices.

Apart from studies based on number of users in the network, other studies find hype as one of the drivers of Bitcoin price, forecasting Bitcoin price with Google Trends data (Dastgir *et al.* 2019) which is a continuation of previous research done by Kristoufek (2013), who discovered that interest in Bitcoin measured by search queries on Google Trends and frequency visits on Wikipedia pushes price further atop if the prices are above trend, and if they are below the trend, then the growing interest pushes the prices even deeper.

For the purpose of our work, we shall mostly consider the literature concerning the efficiency of the cryptocurrency markets. Several authors study the presence of weak market efficiency, which means that past information including volume, earnings and price movement data do not affect asset price and can't predict its future direction, focusing mostly on Bitcoin. Bitcoin market inefficiency is studied by Kristoufek (2018), who finds market inefficiency studying USD and CNY Bitcoin markets, although he states that efficiency is improving in periods of after bubble consolidations. Similar result using different approach is stated by Urquhart (2016), who finds market inefficiency over the full tested sample period, but some of the employed statistical tests suggest Bitcoin returns are random. Civitarese & Mendes (2018) studied a determinant to the semi-strong form of market efficiency, specifically the usage of public information in cryptocurrencies price variations and discovered that release of information regarding code failures brings negative abnormal returns, whilst news are quickly explored by market participants.

Semi-strong efficiency of Bitcoin market was tested by Vidal-Tomás & Ibañez (2018) who examined the impact of news on Bitcoin and concluded the inefficiency of Bitcoin market. They found that Bitcoin only responds to its negative news in the Mt.Gox and Bitstamp market and to positive news in the Bitstamp market. Bitcoin does not react to monetary policy news, which, authors assumed, is an evidence of absence of any kind of control on Bitcoin. Interestingly, Vidal-Tomás & Ibañez (2018) conclude with a warning to investors to be aware that trading Bitcoin means trading an asset that cannot be controlled by the central banks, which they view as a flaw. However the idea of

creating an electronic payment system based on cryptographic proof instead of trust without any central authority is a keystone of the whole cryptocurrency ecosystem and could be considered the main principle of Bitcoin as described by Nakamoto (2008) in Bitcoin whitepaper.

Interesting link between efficiency and market liquidity is discovered by Brauneis & Mestel (2018), who measure liquidity and find that efficiency is positively related to liquidity. Liquidity which is tightly collected to market volume is a very tricky thing on cryptocurrency markets and anyone who ever attempted to trade especially lower market cap cryptocurrencies have probably witnessed, that reported volumes are very far away from reality, as was confirmed by a report from Bitwise (2019) which was published by the end of March 2019.

Since the majority of studies on market efficiency suggests that cryptocurrency markets are getting more efficient in time, based on either bigger market depth or post-bubble efficiency, it seems reasonable to test if cryptocurrency markets efficiently react to positive news.

3.2 Literature review on possible methodology

Although hardforks and airdrops emerged only very recently and thus can be considered a very young market event, they could be to some extent compared to company conversions, divisions, spin offs or stock splits. In an economic sense, the events of interest are something between marketing move, CEO/other valuable member of the board replacement, main product update (e.g. new car announcement), company division, hostile takeover, company spin off and stock split. Based on whether our event is a hard fork or airdrop, hostile or voluntary, planned or accidental, it can resemble many or none from the above mentioned stock market events.

After studying the existing literature on the role of above mentioned events on stock prices of listed companies, we came to a conclusion that forks and airdrops might be compared to spin offs and stock splits. We dismissed the literature on marketing effects because it was based on quantitative analysis of resources spent on marketing(Raghubir *et al.* 2010), which is not applicable on analysis of forks and airdrops and it seemed a rather new field of research to us.

We also dismissed the literature on the effects of change in CEO because it was focused only on change in one person who has a significant control on

firm's financial and other decisions, which is in contrast with the decentralized ecosystem of cryptocurrencies (Beatty & Zajac 1987). From the events we study in this thesis it would only very remotely resemble a hardfork. CEO replacement would fit for some forks which lead to a split of teams where only one team prevail with their coin but these cases are not very frequent and it would be hard to identify them, mainly because we do not know if the other team is about to give up/exit scam right after the fork. Announcement of new product was omitted because it would fit on many other announcements in the cryptocurrency community and is not, in principle, similar to airdrop and hardfork.

Therefore we were left with two fields with which to be inspired when building up our model and that was stock splits and company spin offs. "A spin-off occurs when a company distributes all of the common shares it owns in a controlled subsidiary to its existing shareholders, thereby creating a separate public company."(Miles & Rosenfield 1983). If we substitute stocks for a newly created cryptocurrency and shareholders for cryptocurrency holders, we would not be far away from the description of planned hard fork which includes new coin creation.

Stock splits are well described as a form of corporate action during which existing shares are divided into multiple shares. The number of shares outstanding increases but the total value of the shares remains equal to the pre-split amounts, due to no extra added value (Chen J. 2019). One of the main reasons why stock splits take place is the effort to boost stock's liquidity. More stocks means smaller nominal value for each, therefore it is easier to trade them. However there is no such issue on cryptocurrency markets, since it is not necessary to buy the whole cryptocurrency, but we may buy its fraction (e.g. 1 satoshi[1]). Both the definition of spin off and stock split are reasonably close to what effect does a fork and an airdrop have on investors' cryptocurrency assets.

Spin offs and stock splits methodologies are focused on measuring the effects of announcements on stock prices. The methodology to study spin offs and stock splits is built on a classic event study as introduced by Fama *et al.* (2003) study on adjustment of stock prices to new information which steps are generalized and elaborated by MacKinlay (1997). There is not much literature in cryptocurrency field that would examine the effects of events on cryptocurrency returns. One of the studies we found is an event study, examining the effects of 51% attacks on cryptocurrency price by Shanaev *et al.* (2018) which

[1]one satoshi is one hundred millionth of a single bitcoin (0.00000001 BTC)

uses methodology based on MacKinlay (1997), setting an estimation window of 50 days and event window of 12 days and using market model to estimate abnormal returns for 13 events. The study discovered a robust and statistically significant price reaction on the attack date and provided an early conceptualisation of fundamental risk factor associated with investing into cryptocurrency markets. Shanaev *et al.* (2018) suggest an event study on hardforks executed by parts of the community as an analogy to hostile takeovers in the realm of blockchain.

Based on the review of academic literature on stock splits and spin offs and the consequent search for event studies in the field of cryptocurrencies, we came to a conclusion to make the thesis in form of an event study.

Chapter 4

Data description

In this section we present the data sources we used in our thesis. The chapter is separated into four sections, in the first two sections, we describe the sources of our data. In the third section, we explain the criteria based on which we selected a sample, and in section four we discuss the issues which are connected with data on cryptocurrencies.

4.1 Data from coinmarketcap

Data used in the thesis came from 2 sources. Data on daily cryptocurrency prices were obtained using R software package 'crypto' which downloaded daily data on all 2106 cryptocurrencies tracked by www.coinmarketcap.com (coinmarketcap) on March 11th 2019. Data were collected for days between 27th of August 2017 and March 11th 2019. For a cryptocurrency to be listed on the coinmarketcap site, it must meet the following criteria: "Must fit the definition of a cryptocurrency. Must be traded publicly, and actively traded on at least two (2) exchanges that are supported on CoinMarketCap (if the cryptocurrency is an exchange-based token only traded on its own exchange, we may add it given that off-platform withdrawals are possible). Note that these are only necessary conditions and meeting them does not guarantee a listing."(coinmarketcap 2019). Therefore the coinmarketcap database offers certain kind of reliability due to the fact that the page does perform certain level of control and does not list fake projects. Coinmarketcap will hence provide the basis for our data analysis because the data they provide is open source and easily accessible.

Data downloaded from coinmarketcap included the variables row, slug, sym-

bol, name, ranknow, open, close, high, low, market, spread and volume. Variable row measured the observation's position in the dataset, row 1 being an observation of Bitcoin on 27th of August 2017. Slug variable serves as a unique identifier for each cryptocurrency and it is given to each cryptocurrency by coinmarketcap. For example, for Bitcoin, the slug variable is 'bitcoin'. Symbol variable is a short identifier for each cryptocurrency. For example for Bitcoin, its symbol is 'BTC'. However, symbol is not a unique identifier, because it is not chosen by the cryptocurrency exchanges or by coinmarketcap, but by cryptocurrency team which registered its cryptocurrency on coinmarketcap. Ranknow is a variable which ranks cryptocurrencies according to their market capitalisation on 11th of March 2019. Bitcoin having the highest market capitalisation has ranknow 1, OBXcoin, having the lowest market capitalization, has rank 2106. Open, close, high and low marks daily opening and closing price. High shows daily high, while low shows daily low. Market variable measures daily market capitalization for each cryptocurrency. "Market Capitalization is one way to rank the relative size of a cryptocurrency. It's calculated by multiplying the Price by the Circulating Supply. Market Cap = Price X Circulating Supply."(coinmarketcap 2019). Spread shows the daily 'volatility premium' for each cryptocurrency and it is counted as daily high-daily low. Volume variable measures daily trading volume from all the exchanges on which cryptocurrency is traded excluding exchanges with no trading fees, where it is impossible to measure the extent of fake volume.

After downloading the data, we exported them in a .csv format which we later exported to statistical software Stata MP 13 where the analysis was performed.

4.2 Data from coinmarketcal

Probably the most demanding part in obtaining the data was obtaining the data on the events of interest dates. We were lucky to find a web page called coinmarketcal which, as it name suggests, serves as a cryptocurrency calendar offering information on coins and tokens. We contacted the page support and we were told they collect data on 2500 cryptocurrencies, and there is a possibility to add an event by anyone who visits the page. Every added event is then published and the community votes if the event is true or fake. Quality of information is controlled by website's team and community voting. The page administrators then construct a confidence index, which shows the likelihood of

an event happening, scaling between 0-100 %, based on the number of positive and negative votes refined with other criteria (e.g. if the event has been added by the official team).

Along with coinmarketcal there are several other web pages tracking upcoming events in the cryptocurrency world, but they lack the qualities of coinmarketcal. Coinmarketcal is a sovereign in google search. On 9th March we typed following commands in google: 'cryptocurrency calendar', 'cryptocurrency events', and a link to www.coinmarketcal.com popped up first. Coinmarketcal popped up on the first google search page, which means top 10, after typing: 'upcoming forks', 'upcoming airdrops'. Joachims *et al.* (2017) showed, that around 68 % of internet users view the web page which is ranked first in google search and more than 40 % of users open the web page which is ranked first by the google searching engine. Therefore the fact, that coinmarketcal popped up first in several searches all focused on obtaining information on cryptocurrency events, provides us with a high likelihood that people who intend to obtain information about upcoming events prefer the page over other pages.

Coinmarketcal (www.coinmarketcal.com) is a general calendar focused on a variety of events including announcements in general, coin burns, new partnerships, AMA and several other events, where Airdrops and Forks/Swaps stand for only two separate categories. This is, in our opinion based on basic knowledge of SEO, the reason why coinmarketcal does not pop up as first in the google mechanism, when we ask specifically for forks and airdrops, because there are other specialised webs which focus only on airdrops, for example cryptocal (www.cryptocal.com) or airdrops.io (www.airdrops.io). However, these webs at the time of our data research on 9th of March 2019 either do not work properly, do not feature much data (cryptocal) or do not provide enough specific data such as fork/airdrop announcement date or date of addition to the calendar, and lack reliability/peer review system(airdrops.io). We could go more in depth in this analysis, but to conclude, the reason why we chose coinmarketcal over other data sources is the fact that other pages providing information on cryptocurrency events lack the qualities of coinmarketcal, be it understandability, cleanliness of information, web design or the level of error.

As a mean of choosing the right calendar app from which to draw information on forks and airdrops, we also decided to run a small survey for which we used the facebook group "bitcoinoví gambleři a spekulanti", where we created a small survey asking: "What web page do you use to track cryptocurrency news,

notably hardforks and airdrops?"[1]We originally gave our respondents three choices: www.coinmarketcal.com, www.cryptocal.io and www.coincalendar.info. Respondents had an option to suggest a new answer. Respondents had the opportunity to cast one vote for each of the options. From the 30 respondents that took part in the survey, all of them voted for www.coinmarketcal.com, with no new answer suggested, both www.cryptocal.io and www.coincalendar.info had zero votes.

Bitcoinoví gambleři a spekulanti is a huge Facebook group consisting of over 15,000 members. It is a page where most of the Czech and Slovak newcomers to cryptocurrency learn their first lessons, as well as where experienced software engineers debate the nature of Segwit2x. Therefore we believe posting the question on cryptocurrency events calendar gave us a relevant result.

After identifying coinmarketcal as the best aggregate source of information on forks and airdrops, we intended to use the event date as a dummy variable for event of interest occurrence, and addition to coinmarketcal date as a dummy variable for event of interest announcement. We randomly chose 4 events and checked the correctness of the announcement date and of the supposed event of interest occurrence date and the event creation matched the actual event announcement and the expected date of event occurrence matched the actual date when an event of interest occurred.

4.3 Sample selection

However, after running some analysis on the data taken from coinmarketcal, we performed another data check. We found out there are huge inaccuracies in both the information on dates when an event is supposed to take place and on announcements. Some of the event information were absolutely wrong. Most notably the announced hard forks often suffered from postponing which was not reflected by the data. For example the Ethereum's Ether zero hardfork was postponed multiple times, and the event date marked by coinmarketcal was several days off the real date. Other issues from the dataset included misspecification of announcements, some announcements that were supposed to be fork announcements were actually 'new partnership announcements', etc.

[1]This is the author's translation, the question was originally posted in Czech: "Jakou stránku používáte ke sledování kryptoměnových novinek, zejména forků a airdropů". The questionnaire was deleted after few days, because the page administrators considered it off-topic

Another issue was that some of the events especially for the lower market cap cryptocurrencies had very low reliability albeit its relatively high confidence vote, for example an airdrop announcement was based on a 'chat moderator' response in a Discord discussion without any 'more official' announcement to follow, such as in the case of Uservice cryptocurrency. Facing the above mentioned problems we decided to create our own dataset of events. We used coinmarketcal as the base of our research and we assumed that all the major announcements were featured on the coinmarketcal page.

One of the problems in cryptocurrency ecosystem is the information noise. By using coinmarketcal as a base for our search, we were able to track down announcements which were spread wide among investors, thus we avoided including events which had no effect on the cryptocurrency because nobody read them. Since every event on the page includes a link to the source of the announcement and a 'proof' which is usually a screenshot of internet discussion or Twitter announcement, we were able to track the majority of announcements in the TOP100 cryptocurrencies and manually create the actual date of announcement variable. We decided to limit our research on TOP100 cryptocurrencies for following reasons.

4.3.1 List of reasons for limiting sample on TOP100 cryptocurrencies

(1) Cryptocurrencies from TOP100 are reasonably known among the community, therefore events of interest have enough confidence votes on coinmarketcal. There is higher likelihood that all the events of interest will be captured in the research if it is limited to TOP100.
(2) Cryptocurrencies in TOP100 usually offer better quality information. Generally, cryptocurrencies in TOP100 have relatively professional whitepapers and the teams, which stand behind them, act professionally to some extent. The lower in market capitalization we descend, the more chaotic, with some exceptions like GravityCoin, it gets. Vaguely formulated announcements and contradicting information is almost a standard in lower market capitalization projects ranked 1000 and higher. Low market capitalization projects often have very small community where a few dozens people are active, so there is likely not much effect of an announcement, if nobody, apart from few people who

have already expected an announcement to be made, read it.[2]
(3) Smaller market capitalization means easier manipulation. As mentioned in the literature review, fake volume is no secret to anyone who ever traded low market cap cryptocurrencies. On most of the exchanges, it is possible to manipulate price quite easily by selling high volumes of cryptocurrency you own, thus activating stop losses of other market participants, creating panic and then buying lower than you sold. Discord chats are full of panicking people when the price is falling, and fuelling their fears by creating fake accounts and painting cryptocurrency's future black is a popular way how to make people sell (See GravityCoin's Discord general chat). Low market capitalization cryptocurrencies do not have the volume and capitalization to withstand attempted market manipulation. As an example may again serve GravityCoin. On 28th of April, approximately 1800 dollars worth of GravityCoin (8784 coins) were enough to cause a 99% drop in price on Crex24 exchange, which is one of the two exchanges GravityCoin is listed on.
(4) In smaller market cap cryptocurrencies, investors can easily get in private contact with cryptocurrency developers. Although it brings many benefits, it makes an event study difficult, because the possibility of massive information leakage is huge. Unfortunately, materials we collected on the topic of information leakage resulting from direct private communication with the developing teams can't be used in the thesis, because we did not obtain permission from all the participating parties.
After reducing the sample to TOP100 cryptocurrencies according to their market capitalization on 11th of March 2019, the events, which were recorded on coinmarketcal, were examined and out of 144 coinmarketcal events, which were marked either as forks, swaps or aidrops, 30 were considered to meet the following criteria.

4.3.2 List of event of interest selection criteria

(1) Event had more than 100 confidence votes. This criterion simply means that more than 100 people voted on coinmarketcal to confirm the event's validity. This criterion shall ensure that event's announcement was successful in persuading investors that the event would occur. It eliminated many airdrops

[2]See for example GravityCoin's Discord or Twitter:
(https://discordapp.com/channels/427145912964612097/430792058371047454)
(https://twitter.com/GravityCoin_GXX)

which were supposed to drop cryptocurrencies to Bitcoin, but community did not deem them interesting or valid.
(2) Event was the event of interest. Swaps were discarded, forks which included only a software update, but did not included the creation of a new coin, were discarded. Only airdrops and hard forks which included creation of a new coin were kept in the dataset.
(3) Event had a functioning link to the announcement source. If it did not have a functioning link, the screenshot of the proof was used and we tried to trace the source of the announcement. If neither link to the source or 'proof' was working, we tried to search the cryptocurrency's social media for the source of announcement. Only events announcement of which was checked and verified were kept in the dataset.
(4) Event announcement must have been clear. In cases, when the announcement was in the form of a reply in the middle of Discord's or other social media chat, which was not followed by any 'more official' announcement, such events were dropped.
(5) Only the events which were planned and 'friendly' were kept in the dataset. This filter did not filter out cryptocurrencies which would not be already filtered out by the requirement of at least 100 confirmation votes. For example Bitcoin Cash/ Bitcoin SV fork would be dropped based on this criterion. However, it was already dropped based on the low confidence vote. This fork was hostile and nobody on the cryptocurrency forums and media was sure, whether it would actually take place. Therefore it received such a low amount of votes, despite the fact that Bitcoin Cash was in top 10 biggest cryptocurrencies by the time of the fork and it was widely known among the community and had many supporters (Bitcoinist 2018). Following cryptocurrencies were included in the dataset:

Bitcoin	Litecoin	EOS	Bitcoin Cash	Stellar
Binance Coin	Tron	Monero	NEO	Ethereum Classic
Waves	Dogecoin	DigiByte	Bitshares	Nano
Pundi X	Siacoin	Golem	Electroneum	WAX
WaltonChain	Zcoin			

Table 4.1: Cryptocurrencies events of which were included in the dataset

4.4 Inherent issues with information on cryptocurrencies

After applying the above criteria and collecting a sample of 30 events on 22 cryptocurrencies, there were still considerable issues to solve. One of the issues was information leakage. There are various social media where the announcements are made and identifying the principal sources of information to which community reacts might be problematic. Some cryptocurrencies have a very strong Telegram group, other cryptocurrencies have a large Discord community. Some rely on Facebook. We found out that a Telegram announcement could be on a different date than Discord's or Twitter's. We always included only the announcement which occurred first. Enlarging our event window to include 2 days preceding the event's announcement appears to solve the problem of information leak and possibly missed earlier announcements.

Although criteria on selecting the events of interest were strict, we deemed them necessary due to difficult nature of cryptocurrency environment. As described in the literature review and methodology section, the thesis is built as an event study based on MacKinlay (1997), who provides an overview on how to conduct event studies on financial markets.

Information are treated differently on the regulated stock markets of publicly listed companies and on the cryptomarkets. Papers on stocks work with stock splits of publicly listed companies, which are heavily regulated in the U.S.A. as an aftermath of Great Depression. The regulatory agency supervising the markets and enforcing, among other statutes and laws, the Securities Exchange Act of 1934, Securities Act of 1933, the Trust Indenture Act of 1939, the Investment Company Act of 1940, the Investment Advisers Act of 1940, the Sarbanes-Oxley Act of 2002, is the SEC (U.S. securities and exchange commission) (Beattie 2018). SEC among its many responsibilities ensures that there is no price manipulation and investors are not misled. Great example of this supervision is Elon Musk's tweet from 7th of August 2018 which stated that Musk considers taking Tesla private at $420 (Musk 2018), which later lead to a more than 10% increase in price of Tesla stock. E.Musk was then charged with securities fraud for misleading tweets (SEC 2018). This situation is in very stark contrast to what happens at the cryptocurrency markets.

Best example of how price manipulation and fake news is still an inherent part of crypto-markets is shown by the case of John McAfee and Craig Wright

(Dr.Faustus on Twitter). John McAfee, who became one of the most powerful cryptocurrency influencers after stating: "if not, I will eat my dick on national television."(McAfee 2017) as a reaction to comments which opposed his declaration that Bitcoin will reach the price of 500 000 dollars in 2020. McAfee then ran a pump and dump scheme profiting from his popularity on Twitter, which was partially secured by the immense popularity of "I will eat my dick" tweet which went viral(Xu & Livshits 2018).

Craig Wright on the other hand is not very popular in the cryptocurrency community, he was even given nickname 'Fakesatoshi' as a mockery for his declaration that he is the real Satoshi Nakamoto, founder of Bitcoin. Craig Wright stands behind Bitcoin Satoshi Vision that forked from Bitcoin Cash in November 2018. C.Wright and his statements[3] on dumping Bitcoins for market price in order to fund the so called 'Hash wars' caused panic on the markets and coincided with the drop of Bitcoin's price under, until then firm, price of 6000 dollars.

Along with market manipulation, cryptocurrency markets are also very confusing, especially for people who are new to the community. Best example of confusion on the crypto-markets regarding access to information is the most famous rank nr. 1 coin - Bitcoin(BTC).

All regular activity in Bitcoin is organized by public pull request project. Decentralization and free participation in development is a core feature of the whole Bitcoin project, as the bitcoinbook on github states: "By 2016, bitcoin's source code had more than 400 contributors with about a dozen developers working on the code almost full-time and several dozen more on a part-time basis. Anyone can contribute to the code-including you!"(Brown 2019). According to developers' own words, Bitcoin is a free software and any developer can contribute to the project. Everything you need is in the GitHub repository (Bitcoin.org 2018). Because it is an open source project without any central authority and all the changes to blockchain has to be approved by both the miners and the software developers, it is natural, that there are conflicting views on the development which sometimes lead to splitting of the chain(Corvette 2002). In 2017, Roger Ver with the support of the largest Chinese based miner and mining hardware producer Bitmain argued for the necessity of enlarging block size limit from 1 megabyte to 8 megabytes. The disagreement between Roger Ver and the rest of the community lead to the Bitcoin/Bitcoin Cash

[3]Craig Wrights Twitter @ProfFaustus (https://twitter.com/ProfFaustus?) was recently banned, therefore his tweets on market dumping are inaccessible now(Pihl 2019)

fork. In August 2017 Bitcoin forked and split into Bitcoin(BTC), the original chain supported by the community around Bitcoin.org, which is an independent open source project with contributors from around the world, and into Bitcoin Cash(BCH).

Roger Ver and people behind Bitcoin Cash took over domain www.bitcoin.com and after Bitcoin Cash forked, Ver used the site to sell Bitcoin Cash. This was condemned by many people from cryptocurrency community and especially by the developer community (Bitcoin.org) which pinned the following tweet on their official Twitter account: "IMPORTANT: Warn your friends and #Bitcoin beginners to never to use any products or services on bitcoin(.)com. There's a high risk of accidentally buying the BCH or BAB altcoins because their content and marketing is based on creating confusion with the real Bitcoin."(Bitcoin@btc 2018). Roger Ver and BCH supporters were apparently trying to persuade the public into thinking that Bitcoin Cash is the real Bitcoin, although majority of the community considered Bitcoin(BTC) to be the real Bitcoin.

Twitter accounts are another issue. There is a Twitter account with the tick Bitcoin@Bitcoin, that was founded in 2011 and later went silent until January 2018 when it reopened and started posting articles related to cryptocurrencies, mostly copying articles from www.bitcoin.com and supporting the ideas of Bitcoin Cash. Although www.bitcoin.com (the site run by Roger Ver) states it does not control the Bitcoin@Bitcoin account, most of the people in cryptocurrency community thought the contrary. In April 2018, the Bitcoin@Bitcoin Twitter account was suspended from Twitter and the community assumed it was due to reports submitted by supporters of Bitcoin(Bitcoin Core, BTC) on the misleading activities of Bitcoin@Bitcoin, which supported the stance that Bitcoin Cash is the real Bitcoin(Emsley 2018).

We understand we did not make the above paragraphs very clear, but it should have been a demonstration of how messy and confusing sources of information on cryptocurrencies are. There is a Twitter account called Bitcoin@Bitcoin, which writes about Bitcoin referring not to Bitcoin (BTC), but Bitcoin Cash(BCH). There is a web page called www.bitcoin.com which claims it provides information on Bitcoin and it offers to sell Bitcoins to investors, but instead it is all about Bitcoin Cash. Then there are Twitter accounts belonging to different developer groups like Blockstream or Bitcoin.org. It is very hard to know which group is which and what power do they have in directing Bitcoin.

Bitcoin is a decentralized currency, which is both its biggest advantage and

weakness. For investors, it is hard to track the latest news, because there is no central authority similar to the board of directors, which would make clear and true statements on what is going to happen next. Cryptocurrency legal status is another issue which makes the information so chaotic. Comparing cryptocurrencies to firms, there is for example no such thing as a business name or trademark protection, each cryptocurrency can choose its own name or ticker (that was also in our original sample, where ticker (symbol) did not uniquely identify the cryptocurrencies). There are no obligatory procedures regarding decision making as faced by listed companies, no prospectus obligation, no regulation on market manipulation. Since it is not clear whether cryptocurrencies are securities, commodities, or something in between, and there is no clear international regulatory framework, each country regulates them differently. There is therefore no efficient way how to enforce market standards as we know them from security markets. In our opinion, cryptocurrencies as we know the term today will cease to exist and there would be different legal categories for each type of cryptocurrency, similar to the way cryptocurrencies are regulated in Switzerland (FINMA 2018).

For these reasons, it is necessary to check validity of information on cryptocurrency markets and events in particular. In order to be able to perform the analysis, it was first necessary to meticulously study each event if it fulfils the criteria of our events of interest. Based on the data from coinmarketcal, announcements of hard forks with new coin creation and announcements of airdrops were collected for the first 100 cryptocurrencies ranked by their market capitalization and an event study was performed on them.

Chapter 5

Methodology

The question of interest in this paper is whether fork and airdrop announcements affect the returns on cryptocurrencies. Following hypothesis was formed.

> H_0 : Fork and airdrop announcements have no effect on cryptocurrency returns

To test this hypothesis, we will perform an event study. The alternative hypothesis is, that fork and airdrop announcements affect cryptocurrency returns. The methodology is built on Fama *et al.* (2003) study of adjustment of stock prices to new information from 1969 which is a pioneer work on event study methodology. Event study represents a way how to test whether markets are semi-strongly efficient. The methodology is further developed by MacKinlay (1997) who offers a general framework on how to conduct an event study, "Using financial market data, an event study measures the impact of a specific event on the value of a firm. The usefulness of such a study comes from the fact that, given rationality in the marketplace, the effects of an event will be reflected immediately in security prices. Thus a measure of the event's economic impact can be constructed using security prices observed over a relatively short time period."(MacKinlay 1997)(p.13)

Cryptocurrency markets are not stock markets, but there is a reason to believe that an event is reflected if not immediately on cryptocurrency prices, at least faster than on the stock markets since there is nothing like no-trading days on cryptocurrency markets and trading is not even restricted to certain hours, but it is non stop. The basic idea of an event study stays the same, regardless of whether the event of interest is a merger, stock split, or in our case, fork or airdrop, and it is to find abnormal returns related to an event while adjusting for normal returns.

We shall conduct the study following the classical approach:

1) Define the event date, event window and estimation window
2) Estimate the normal returns
3) Compute abnormal returns
4) Aggregate abnormal returns across cryptocurrencies and time
5) Test statistical significance of abnormal returns
6) Test normality of the abnormal returns

There are several models used to estimate normal returns. Normal returns may suffer from misspecification effect which was termed as Hypothesis Problem by (Fama 1991). One of the suggested solutions is to use daily data instead of monthly data (Brown & Weinstein 1985), which perfectly fits on cryptocurrency data which are collected daily. Collins & Dent (1984) and Ball *et al.* (2000) conclude that when daily stock price data are used, the standard parametric events study tests are well specified and exhibit good test power. According to MacKinlay (1997), past research has shown that more important than choosing an optimal method to calculate normal returns is to use the exact event date. Givoly & Palmon (1982) argue for the necessity of exact event date notification, otherwise a wrongly identified event lead to a drastic performance fall of the tests.

5.1 Event date, event window, estimation window

The event date was defined as the date on which the fork or airdrop announcement occurred. Event description and the system of dataset creation were exhaustively described in the data-part of the thesis. The event window was defined as 2 days before to 2 days after the event, as suggested by MacKinlay: "Even if the event being considered is an announcement on given date it is typical to set the event window length to be larger than one"(MacKinlay 1997)(p.19). There is always a trade off between accuracy and potential parameter shifts, so time interval has to be chosen in such a length that it facilitates the use of abnormal returns around the event date and measures both the possible leak of information prior to the event and the adjustment of the market to the new information after the event. Choosing event window longer than one day is a standard which is used in almost all of the event studies and it also solves our problem with possible multiple announcements on different social

media on different dates, which could be considered and measured as information leak. Research usually focuses on period after the event where in the case of stocks the post earning announcement drift has been observed.

Estimation window was chosen to begin 93 days prior to the event and end 3 days before the event. Estimation window of 90 days is in line with existing literature on stock splits and event studies in traditional fields and it's length is almost triple the length of estimation window chosen by (Shanaev *et al.* 2018). It is reasonably long to facilitate us the computation of variance of Cumulative abnormal returns which is described further in the text. Sufficiently long estimation window is necessary to perform the market model estimation of normal returns which are used to compute abnormal returns. Estimation window and event window shall not overlap.

In the thesis, following notation will be used based on the standard set by MacKinlay (1997). Returns will be indexed in event time using t, where $t = 0$ marks the event date, $t = T_1 + 1$ to $t = T_2$ represents the event window, and $t = T_0 + 1$ to $t = T_1$ represents the estimation window. The length of the estimation window is defined as $L_1 = T_1 - T_0$ and $L_2 = T_2 - T_1$. It is necessary to define the time periods because L_1 is part of Variance of cumulative abnormal returns formula, which is necessary for statistical testing.

5.2 Normal returns estimation

Normal returns are investors expectations of cryptocurrency returns when there is no announcement of fork or airdrop. There are several ways to estimate normal returns. In the thesis we choose market model to estimate normal returns, which allows us to estimate normal returns using cryptocurrency market returns. The market model is a linear regression model constructed as:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{5.1}$$

where $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it})$=$\sigma^2_{\varepsilon_i}$
R_{it} is return on cryptocurrency i in time t, R_{mt} is a return on cryptocurrency market index in time t, α_i is the intercept and β_i is the slope parameter. Market index is the index of all cryptocurrencies listed on coinmarketcap. Return on

market index was calculated for each dataset day as

$$R_{mt} = \frac{\sum_{j=1}^{k} market_{jt}}{\sum_{j=1}^{k} market_{j_{t-1}}} - 1 \tag{5.2}$$

where $market_{j_t}$ is the market capitalization of cryptocurrency j on day t. Shanaev *et al.* (2018) use Bitcoin returns as market proxy for market returns. However, we opted for counting the market returns based on returns of all cryptocurrencies listed on coinmarketcap, because we believe it is a better representation of market returns and because Bitcoin is one of the studied coins in the thesis, therefore regressing Bitcoin returns on Bitcoin returns would lead to β coefficient being equal to 1 for Bitcoin's abnormal returns computation, which would not provide a meaningful result.

5.3 Alternative pricing models

5.3.1 Constant mean return model

There are other methods to estimate normal returns. The most simple and common method is the constant mean return model which assumes that expected normal returns differ by company but are constant over time. "Although the constant mean return model is perhaps the simplest model, Brown & Warner (1980) and Brown & Warner (1985) find it often yields results similar to those of more sophisticated models. This lack of sensitivity to the model can be attributed to the fact that the variance of the abnormal return is frequently not reduced much by choosing a more sophisticated model." (MacKinlay 1997)(p.17). However it does not contain any regression, therefore market model was preferred over constant mean return model for its higher complexity.

5.3.2 Market-adjusted return model

Market's return model main advantage is the absence of estimation window, which is not necessary to calculate returns, because the model simply substitutes market returns for expected normal returns. It can be interpreted as a restricted market model, where alpha equals zero and beta equals one for each asset. MacKinlay (1997) recommends to use such models only if necessary, such as in the case of initial public offerings.

5.3.3 Capital asset pricing model

The model incorporates asset's sensitivity to non-diversifiable risk and an expected return of a theoretical risk-free investment asset. It is not used in the thesis, because cryptocurrency environment lacks a risk-free instrument such as treasury bills which are commonly used in stock returns analysis. Someone may suggest stable coins as a risk-free asset, but there are several problems with them. First of all, the idea of stable coins is built on 1:1 fixation to dollar or some other currency. Therefore the expected returns should be zero, because their price shall not, apart from very short periods of time, differ from the price of dollar. However history taught us, that even the most popular stable coin, Tether, had undergone periods in which it's price fell under the "guaranteed" price of 1 dollar. See price data on Tether for 26th April 2017 or 15th October 2018, when Tether's price was around 90 dollar cents. Apart from difficult applicability to cryptocurrency markets, economists are doubtful about benefits of CAPM over Market model, as Brown & Weinstein (1985) argue that CAPM's advantage over market model is questionable due to it's more restrictive nature.

5.4 Abnormal returns

Next step is to calculate the abnormal returns sometimes also referred to as prediction errors. Standard methodology on computing abnormal returns has not changed (Butler & Malaikah 1992). Following the general approach, abnormal returns for every cryptocurrency in our sample for each day of interest in our event window are computed.

$$AR_{it} = R_{it} - E(R_{it}) \tag{5.3}$$

where AR_{it} is an abnormal return on cryptocurrency i on the event date t, R_{it} is a normal return on cryptocurrency which is the actual ex-post return on cryptocurrency i in time t calculated as $\frac{close_t}{close_{t-1}} - 1$. $E(R_{it})$ is the expected normal return on cryptocurrency i on the event date which is proxied by the estimation of normal return from market model. After plugging the market model estimated coefficients in the equation, we get

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \tag{5.4}$$

where AR_{it} represents the percentage change in cryptocurrency price which is above or below the investors expectations. According to MacKinlay (1997), the distribution of the sample abnormal return of a given observation in the event window under the null hypothesis of no event of interest effect on cryptocurrency returns is

$$AR_{it} \sim N(O, \sigma^2(AR_{i_t})) \tag{5.5}$$

In order to be able to perform statistical tests, we need to cross-time aggregate the abnormal returns which is achieved by averaging abnormal returns across all announcements for every event window day.

$$\overline{AR_t} = \frac{1}{N} \sum_{i=1}^{N} AR_{it} \tag{5.6}$$

According to MacKinlay (1997), "Under the null hypothesis, conditional on the event window market returns, the abnormal returns are jointly normally distributed with a zero conditional mean and conditional variance $\sigma^2(AR_{it})''$(p.21), where

$$\sigma^2(AR_{it}) = \sigma_{\varepsilon i}^2 + \frac{1}{L_1}\left(1 + \frac{(R_{mt} - \hat{\mu_m})^2}{\hat{\sigma_m^2}}\right) \tag{5.7}$$

The conditional variance has two components. The first component $\sigma_{\varepsilon i}^2$ is the error variance from market model. The second component represents additional variance caused by sampling error in α_i and β_i. The second component leads to presence of serial correlation in abnormal returns. As MacKinlay (1997) points out, one way how to deal with possible serial correlation is to choose reasonably long estimation window L_1 in order to assume that second component's contribution to the variance of the abnormal return is zero. "As the length of the estimation window L_1 becomes large, the second term approaches zero as the sampling error of the parameters vanishes"(MacKinlay 1997)(p.21). Therefore we can proceed to compute the variance of Abnormal returns for each day in the event window as

$$var(\overline{AR_t}) = \frac{1}{N^2} \sum_{i=1}^{N} \sigma_{\varepsilon i}^2 \tag{5.8}$$

, where $\sigma_{\varepsilon i}^2$ can be approximated by variance of errors from the market model regression. Following test statistic is formed to test the significance of abnormal returns aggregated across cryptocurrencies:

$$\theta_1 = \frac{\overline{AR_t}}{\sqrt{var(\overline{AR_t})}} \tag{5.9}$$

If null hypothesis is rejected, Abnormal returns are significantly different from zero which suggests that forks/airdrops announcement events affect cryptocurrency returns. Aggregating abnormal returns across time, we shall compute cumulative abnormal returns (CAR). CAR is computed by summing up average abnormal returns for any possible interval (t_1, t_2) in the event window.

$$CAR(t_1, t_2) = \sum_{t_1}^{t_2} \overline{AR_t} \tag{5.10}$$

The event windows do not overlap in time. "This assumption allows us to calculate the deviation of the aggregated sample cumulative abnormal returns without worrying about non-zero covariances among stocks" (MacKinlay 1997)(p.27). Some of the issues connected with overlapping events windows and clustering are discussed in (Bernard 1987). Inference about the cumulative abnormal returns (under the null hypothesis of no effect) can be based on $\overline{CAR}(t_1, t_2) \sim N(0, \overline{\sigma}^2(t_1, t_2))$. Therefore the test statistic θ_2 is computed in the following manner.

$$\theta_2 = \frac{\overline{CAR}(t_1, t_2)}{\sqrt{var(\overline{CAR}(t_1, t_2)}} \tag{5.11}$$

, where $var(\overline{CAR}(t_1, t_2)) = \sum_{t=t_1}^{t_2} var(\overline{AR_t}) = (t_2 - t_1)\sigma_{\varepsilon i}^2$

In order to achieve robustness of our analysis we performed a non parametric sign test. Parametric tests are built on the assumption of normally distributed returns which empirically does not hold for stocks, therefore there is a high chance that cryptocurrency returns would also not be normally distributed.

5.5 Sign test

The sign test as its name suggest is based on the sign of the abnormal return and it requires half of abnormal returns to be positive under the null hypothesis as well as independence of abnormal returns across cryptocurrencies. The basic idea is that under null hypothesis it is equally probable that cumulative abnormal returns will be positive or negative, therefore it is expected that number of positive and negative abnormal returns would equal a proportion of 0.5. The test statistic is calculated in the following manner.

$$\theta_3 = \left[\frac{N^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim N(0,1). \tag{5.12}$$

where N is the total number of cases and N^+ is the number of cases where the abnormal return is positive. As MacKinlay (1997) states, the sign's test distributional result is asymptotic.

Chapter 6

Results

6.1 Normality tests

In the methodology section we assumed the abnormal returns and cumulative abnormal returns to be normally distributed. Fama (1976) in his book on foundation of finance states, that stock market evidence shows the distributions of daily returns are fat-tailed relative to normal distribution. Warner and Brown later shows that same holds for abnormal or as they call them - excess - returns(Brown & Weinstein 1985). Therefore we first proceed to perform normality tests in order to test the null hypothesis of normally distributed abnormal returns. First of all we perform a visual test which would give us a first impression on abnormal returns distribution. We used quantile-quantile test which plots two quantiles against each other. Result could be seen on Figure 6.1 for the event day and in the appendix for the other 4 days of interest. Plotting quantiles of abnormal returns distribution on the event day

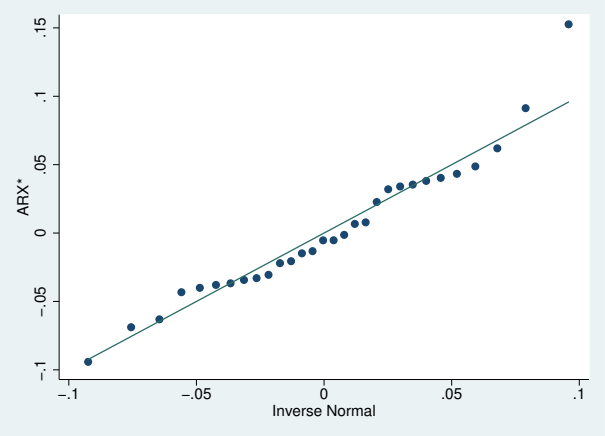

Figure 6.1: Abnormal returns on the event day

against quantiles of normal distribution, we see that the two distributions are only slightly different. Based on the observation we may see that the points display nonlinear shape which implies the violation of the assumption of normally distributed returns. Two statistical tests were performed in order to get more empirical results - skewness and kurtosis test for normality and Shapiro Wilk test.

Variable	PR(Skewness)	PR(Kurtosis)	adj chi2(2)	Prob>chi2
AR day -2	0.020	0.050	7.99	0.018
AR day -1	0.277	0.105	4.03	0.133
AR event day	0.065	0.117	5.57	0.062
AR day +1	0.000	0.000	25.84	0.000
AR day +2	0.083	0.003	9.88	0.007

Table 6.1: Skewness/Kurtosis tests for normality

Skewness-kurtosis test for normality provides ground for us to reject the hypothesis that abnormal returns on day -2, +1 and +2 are normally distributed. However we can't reject the hypothesis of normal distribution for abnormal returns on the event day and on the day -1.

Shapiro-Wilk test for normality Variable	W	V	Z	Prob>z
AR day -2	0.922	2.491	1.887	0.029
AR day -1	0.926	2.355	1.771	0.039
AR event day	0.957	1.362	0.638	0.262
AR day +1	0.731	8.548	4.437	0.000
AR day +2	0.879	3.837	2.781	0.003

Table 6.2: Shapiro-Wilk test for normality

Shapiro-Wilk test offers slightly different results to skewness curtosis test. We can reject the hypothesis that abnormal returns on all event window days are normally distributed apart from abnormal returns on the day of the event announcement. Such a result should advise us to be cautious when interpreting the results from parametric tests and encourages us to compute sign test as well. However, the results imply that we can't reject the hypothesis of normally distributed abnormal returns on the date of event announcement, therefore our parametric tests testing abnormal returns on the announcement day should work well.

6.2 Abnormal returns analysis

The most important part of the results section is the data analysis of aggregated abnormal returns which is essential to answering our research question. There are two parameters of interest, the t-statistic of aggregated abnormal returns which is essential in determining statistical significance of results and the value of abnormal returns as such, which is essential in determining the economic significance of events of interest.

Event day	AR	t-statistics AR	CAR	t-statistics CAR
day -2	-0.007	-0.429	-0.007	-0.429
day -1	-0.011	-0.673	-0.017	-0.780
event day	0.002	0.108	-0.016	-0.574
day +1	0.018	1.176	0.003	0.091
day +2	0.031	1.974	0.034	0.964

Table 6.3: Test statistics of aggregated abnormal returns

Results have shown that the only statistically significant day in our event window is day +2 which shows statistical significance at 5% level. Cryptocurrencies showed no signs of either statistical or economic significance for the announcement day, with average abnormal returns around 0.1% and t-statistics far below any meaningful level, reaching abnormal returns of 1.86% on post announcement day and even 3% two days past the announcement.

This is a surprising result because the event studies on stocks usually reject the null hypothesis on the event day and on day +1, where the t-statistics are the strongest due to immediate reaction of shareholders to the announcement and due to the fact, that some announcements are made after the stock exchange closing hours, hence the investors can react to the announcement on day +1 the soonest. On the contrary, our analysis did not show either the event day or day +1 to be statistically significant. This may seem surprising at first, but the reasoning may be simple.

Cryptocurrency markets are very confusing and there is a lot of information noise. In our analysis we have defined our event date as the date of the announcement and it is possible that investors wait for event confirmation and do not rely on the first announcement due to presence of many fake websites and fake information.

Our interpretation of the results is that forks and airdrops affect cryptocurrency returns not immediately, but with a time lag, which may be caused by the decentralized character of information spread on the cryptocurrency markets. Notably, our sample of coins include only coins from TOP 100 cryptocurrencies, ranked by their market capitalization. These cryptocurrencies have large communities and some of them have a decentralized character as such. Bitcoin, Ethereum and Dogecoin, which have many contributors and influencers might be affected by the information noise the most. Decentralized character of cryptocurrencies, lack of regulation and announcement standards were exhaustively described in the data description section where their effect on information extraction was discussed. Creating the dataset was made difficult by decentralized character of cryptocurrencies, lack of announcement standards, fake news and general confusion. Similar issues are faced not only by us, the researchers, but also by the investors. Therefore it is not surprising to observe a two day lag before the announcement affects price. This interpretation leads to a rejection of the null hypothesis. The graphical representation of average abnormal and cumulative abnormal returns can be seen on figures 6.2, 6.3 and 6.4.

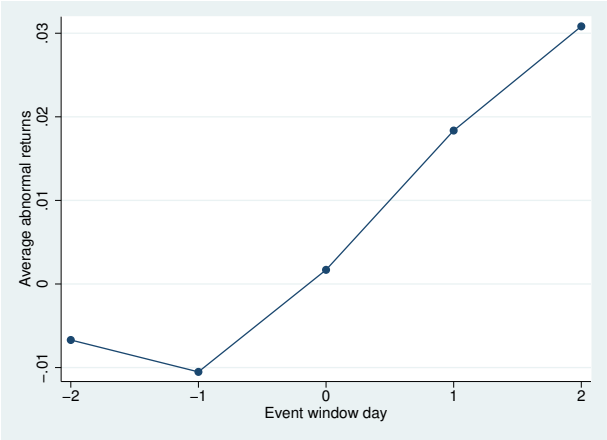

Figure 6.2: Average abnormal returns

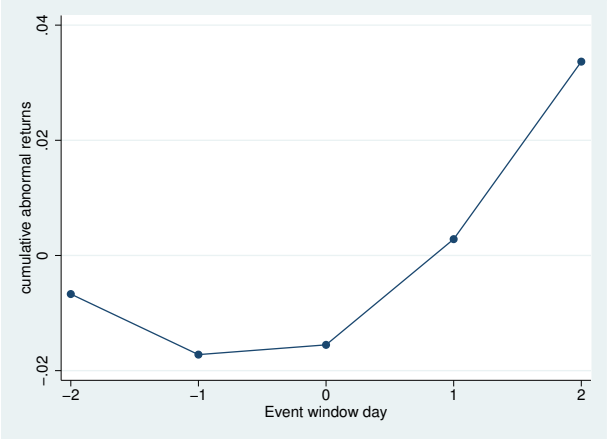

Figure 6.3: Cumulative abnormal returns

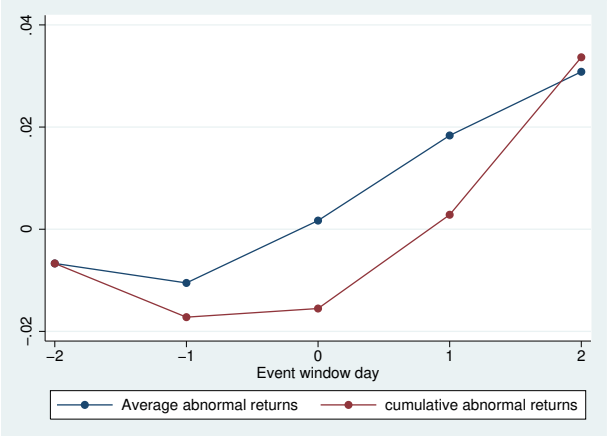

Figure 6.4: AR and CAR combined

Up to this point, average abnormal returns were aggregated across cryptocurrencies and across the whole event window and cryptocurrencies (CAR). Next step is to calculate the Cumulative abnormal returns which are aggregated across cryptocurrencies over other possible intervals in our event window.

event window interval	CAR	t-statistics CAR
days [-1,1]	0.011	0.432
days [0,2]	0.051	1.881
days [1,2]	0.049	2.228

Table 6.4: Cumulative abnormal returns

Cumulative abnormal returns were shown not to be significant for none of the intervals [-2,-1],[-2,0],[-2,1],[-2,2] in the event window as can be seen in table 6.3.

However, cumulative abnormal returns for days in the interval [1,2] are positive and statistically significant on 5% level. Cumulative abnormal returns in the interval [0,2] are significant on 10% level as can be seen in table 6.4. Both intervals [0,2] and [1,2] show high economic significance rewarding quickly reacting investors with cumulative abnormal returns around 5%. Although average abnormal returns aggregated across cryptocurrencies did not show strong evidence to reject the null hypothesis of no effect of fork and airdrop announcements on cryptocurrency returns, cumulative abnormal returns show positive and statistically significant abnormal returns in the post announcement period. This result implies that forks and airdrops announcements indeed affect cryptocurrency returns.

6.3 Non-parametric sign test

Since normality of returns was tested and we concluded that our returns, except for announcement date, are not normally distributed, we performed a non parametric sign test. Results may be seen in table 6.5

Event window days	test statistic
AR day -2	-1.095
AR day -1	-2.923
AR event day	-0.730
AR day +1	-0.365
AR day +2	2.191
CAR[-2,2]	-1.306

Table 6.5: Sign test results

Sign test does not provide any intuition on the economic significance of the results and does not tell us anything about the effect of event window days on the returns, but it shows us whether there is an equal number of positive and negative cases of abnormal returns in each event window day. We reject the null hypothesis of equal number of positive and negative cases for day -1 and day +2. The results of the sign test confirm our results from parametric tests regarding the significance of day +2. Day +2 is the only day in our event window where the number of positive abnormal return cases exceeds the number of negative abnormal return cases. Based on tests of cross currency aggregated abnormal returns, cumulative abnormal returns in the interval [0,2] and [1,2] and on the non-parametric sign test, we may conclude that we found significant abnormal returns on day +2.

Chapter 7

Conclusion

In the thesis we researched whether announcements of hard forks and airdrops affect cryptocurrency returns. Due to very similar economic intuition behind both events, we expected that investors would buy cryptocurrencies for the purpose of getting "free money" during the occurence of both hard fork and airdrop, therefore we treated airdrops and hardforks together. We used classical event study methodology from MacKinlay (1997) and tested a null hypothesis of no airdrop and hardfork announcement effect on cryptocurrency returns which also serves as a test of market efficiency. In the beginning we first defined airdrops and planned hardforks, which include a creation of a new coin, as our events of interest.

Using mostly MacKinlay (1997) methodology we first estimated normal returns using market model and then used normal returns to calculate abnormal returns aggregated across cryptocurrencies and time. We used two parametric tests, on cross cryptocurrencies aggregated abnormal returns ($\overline{AR_t}$), and on cross time and cryptocurrencies aggregated abnormal returns (CAR). We also performed a nonparametric sign test. Our analysis showed that the announcement of hard fork or airdrop does not lead to immediate abnormal returns.

There was a 2 day lag before statistically significant abnormal returns were observed. This lag may be accounted to the poor quality of information on the cryptocurrency markets which is due to the inherent decentralization which is characteristic perk of cryptocurrencies, and due to the lack of regulation regarding information announcements. Another reasoning for the two day lag might be the fact that we observed a relatively small sample of 30 events which took place on 22 cryptocurrencies from the TOP100 cryptocurrencies ranked by market capitalization on coinmarketcap on 11th of March 2019. This restriction

was imposed due to very poor quality of announcements, which we were either unable to track or identify as our events of interest, and due to the presence of market manipulation on lower market capitalization cryptocurrencies.

Based on the performed tests, we did not find evidence of semi-strong efficiency on the cryptocurrency markets. We may conclude that cryptocurrency returns do not immediately react to hard fork and airdrop announcements. We also did not find any positive abnormal returns on days preceding the event. One of the reasoning on insignificance of abnormal returns we may offer, apart from lag caused by market inefficiency, is the theory that our events of interest are not always viewed as significant and/or positive news. Our research focused on TOP100 cryptocurrencies including Bitcoin and 6 other cryptocurrencies from TOP10 cryptocurrencies. We may assume that investors invest in those "high quality" cryptocurrencies for a similar reason investors invest in blue chip stocks, since cryptocurrencies in TOP100 are relatively conservative in comparison to, for example, coins which are ranked in the second thousand. Therefore investors are more likely to invest in cryptocurrencies in TOP100 for the technological features and quality of the cryptocurrency as such and they do not perceive an event during which they would get certain amount of other cryptocurrency as something which should raise value of their portfolio.

For future research, it would be interesting to perform an event study on lower market capitalization cryptocurrencies, some of which, as for example the many times mentioned GravityCoin, were designed to frequently undergo hard forks or airdrops. However, we believe the markets are not yet mature enough for such a study to be possible. Serious lack of regulation concerning announcements and market manipulation, along with low market capitalization, which results in extreme volatility, prevent a meaningful research of lower market capitalization cryptocurrencies.

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Appendix A

QQ plots for event window days

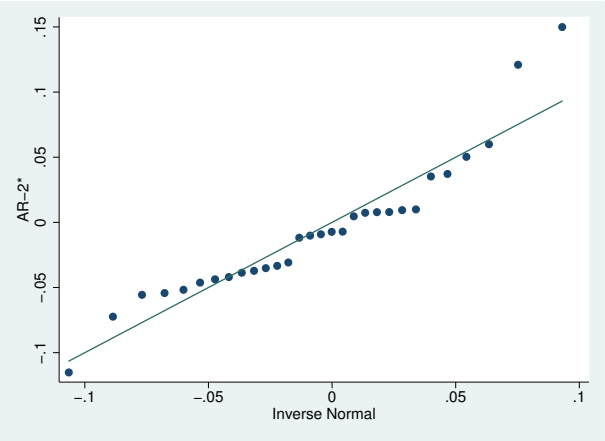

Figure A.1: QQ AR, day -2

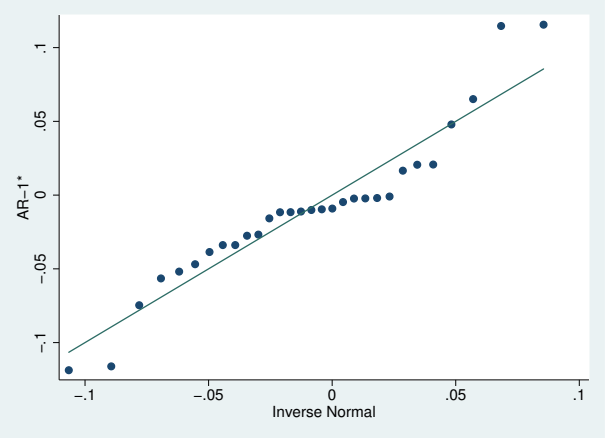

Figure A.2: QQ AR, day -1

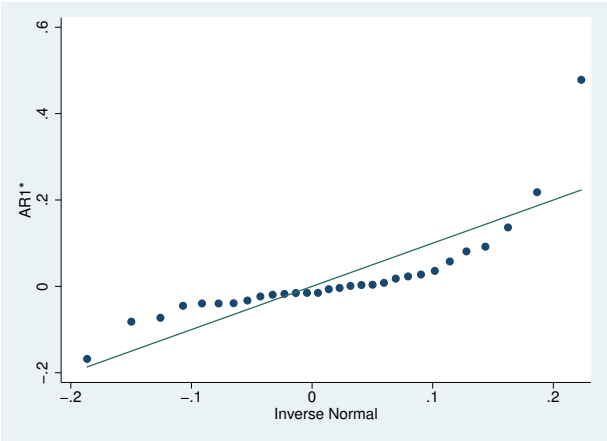

Figure A.3: QQ AR, day +1

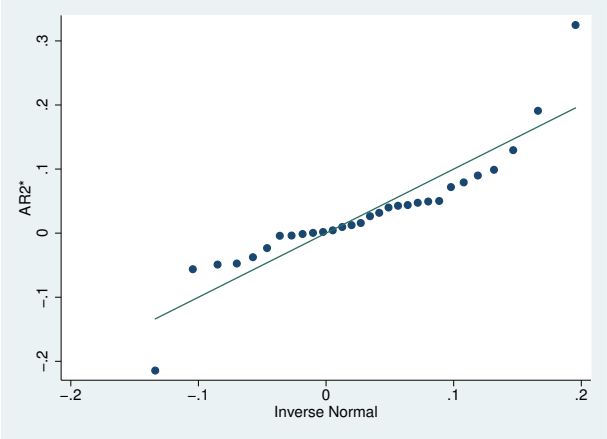

Figure A.4: QQ AR, day +2