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An in-depth analysis of stock prices around IPO lock-up periods

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Abstract

Following an IPO, an average of 80-85% of a company's shares are subject to a lock-up period. When the lock-up period expires the unlocked shares are free for public trading. This paper investigates the effect of the IPO lock-up expiration on the stock returns of US companies between the years 2000 and 2020. Past research of Ofek and Richardson found that IPOs between 1996 and 1998 saw an average 1% - 3% drop in their stock price at the day of the lock-up expiration, even though the event is completely known in advance and observable. This paper finds that for the period 2000 until 2020 there is no significant drop in stock returns on the day the IPO lock-up period expires. There is however a significant drop in stock prices ahead of the lock-up expiration date, with a cumulative abnormal return of -0.94% in the five days prior to the lock-up expiration day. The average bid-ask spread, however, does not allow for arbitrage in the sample. Trading volume increases significantly and stays permanently higher following an IPO lock-up expiration. The results concur with the efficient market hypothesis stating that any possibility to outperform the market is arbitraged away.

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1 Introduction

At an initial public offering (IPO) shares of a private company are offered to the public in an attempt to raise capital from public investors. The amount of shares sold by the owners, however, often contributes to 15-20% of the company (Ofek & Richardson, 2000). The remaining 80-85% of the shareholders are initial investors who are almost always subject to a lock-up period after an IPO. The lock-up period refers to the period following the IPO in which the initial investors are not allowed to sell their shares. The lock-up period in the United States is not regulated by law but is nearly always included in contractual agreements by the underwriters.

Ofek and Richardson (2000) found that, even though the ending of the lock-up period is public knowledge, stock prices drop an average of 1.15-3.29%. They argue that there is however no arbitrage possible as the price drop is difficult to exploit. As the paper was published in the year 2000, and looks at IPOs issued between 1996 and 1998, this difficulty of exploiting the price drop might have diminished with the increasing ease of investing. Furthermore, is the research done in a period of abnormal IPO activity corresponding to the dot-com bubble.

In this paper IPO stock prices are analyzed around the expiration date of their lock-up period. Data is collected of US firms that had their IPO between the years 2000 and 2020. The paper looks at the effect the lock-up expiration has on the stock returns. The paper covers a large timeframe to look into the general effect of the lock-up expiration on the share prices of the stocks. As the research is conducted in the twenty-first century, using a long period of time, the results can be compared to the research done by Ofek and Richardson (2000) regarding the effect in the last years of the twentieth century. It can be determined whether the drop in returns around the lock-up expiration is still present, or whether increased trading easy and easy accessibility to trading tools for the general public have diminished the effect.

The paper focuses mainly on the effect of the excess trading volume of the shares on the returns around the lock-up expiration date. As a large portion of the company's shares are unlocked, it is expected that trading volume increases after the event. Several theories exist regarding the concept of downward sloping demand curves for stocks. If demand curves are downward sloping for stocks, then a supply shock in the form of excess volume would cause prices to fall. However, as the lock-up expiration date is public information, it is expected that

the effect is rationally incorporated into the price at the IPO issuance. The paper furthermore explores the bid-ask spread of the stocks in an attempt to explore possible arbitrage.

As the lock-up expiration date is the date on which the shares of the insiders are first unlocked, it is expected that trading volumes increase. The research data finds that the trading volume of the stocks increases with an average of 64.8% on the first two days following lock-up expiration. This is in line with the assumption that insiders want to sell their shares for risk diversification purposes. Although the excess trading volume recovers after the first day the shares are unlocked, average trading volume of the stocks stays relatively high compared to the period prior to expiration. The research however finds that, contrary to the research conducted by Ofek and Richardson (2000) there is no significant price drop on the lock-up expiration date. In the days leading up to the day of lock-up expiration, significant cumulative abnormal returns are however observed. The three days prior to expiration show cumulative abnormal returns of -0.58% and the five days prior show cumulative abnormal returns of -0.94%. As the cumulative abnormal returns are relatively small, arbitrage is not possible. The research shows that when the average bid-ask spread decreases, the cumulative abnormal returns decrease as well. This indicates that the effect of the lock-up expiration is higher when the bid-ask spread is greater, and the effect of the lock-up expiration diminishes when the bid-ask spread decreases. Therefore, the effect of the lock-up expiration decreases together with its exploitability, showing arbitrage is not possible.

2 Underlying theory

IPO

An initial public offering (IPO) refers to the process of a private venture becoming publicly traded through the issuance of shares. The issuance of shares to the public often results in large capital gains for the venture. Moreover, Ritter and Welch (2002) conclude that apart from financial gains there is almost no reason for a firm to go public. Before a firm goes public it is considered a private company. The shares of a private company are often divided under a relatively small amount of shareholders, often including venture capitalists or angel investors. One of the advantages of an IPO for the initial investors is that once a firm goes public they will be able to sell their shares to the public. Because public investors generally have a more diversified portfolio than the angel investors or venture capitalists, they are on average willing to pay a higher price for the stock (Chemmanur & Fulghieri, 1999). Therefore Black and Gibson (1998) state that an IPO is also an exit for the initial investors.

Underwriters

When a firm decides to go public by means of an IPO, the process is lead by underwriters. IPO underwriters are generally large financial firms such as investment banks and are specialized in the issuance of stock to the public. The underwriters determine the offer price, amount of shares offered at the IPO and the length og the lock-up period of the shares. The initial investors who are holding stock prior to the IPO are not allowed to sell their stake before the expiration of the lock-up period without the consent of the underwriters.

Lock-up Periods

At an initial public offering (IPO) only a relatively small part of a company's shares are sold to the public, namely approximately 15-20% (Ofek & Richardson, 2000). This means that the other 80-85% of the shares is owned by initial investors, and these stocks are nearly always subject to a lock-up period. A lock-up period refers to the time period following an IPO in

which the initial investors are not allowed to sell their shares. The length of the lock-up period can differ as it is not regulated by law, but usually lasts 180 days. Even though the lock-up period is not required by law, it is standard practice that underwriters include the lock-up period as a contractual obligation. This means that for the length of the lock-up period, initial investors are restricted in selling their shares of the company.

The literature regarding the function of the lock-up period varies. Brav and Gompers (2003) find that IPO lock-up periods function as a commitment device to alleviate moral hazard problems. Arthurs, Busenitz, Hoskisson and Johnson (2009) argue that the use of the lock-up period lies in signaling theory. They find that a longer lock-up period acts as a substitute signal to venture capital (VC) and prestigious underwriter backing. A longer lock-up period can function as a signal to investors that a firm is of high-quality. This signaling theory is based on the concept that firms of a lower quality tend to oversell their prospects to quickly raise as much money as they can. A good signal must be difficult or expensive to imitate. The cost of a longer lock-up period lies in the fact that entrepreneurs with a high percentage of ownership cannot sell their stake after the offering. Therefore they have low liquidity and a highly undiversified portfolio. Thus, by allowing a longer lock-up period, entrepreneurs can signal to investors the long-term confidence that they have in their venture. Arthurs et al (2009) furthermore find that for firms suffering from higher uncertainty in the form of a going concern issue, a longer lock-up period can soothe investor concerns and reduce underpricing. This means that apart from the signaling function of a longer lock-up period to outside investors, it is also benevolent to the firm itself in the form of lower underpricing.

The lock-up period is a standard arrangement between the underwriters and the shareholders. The length of the lock-up period is public knowledge and can be found in the S-1 filing with the SEC. This makes the lock-up expiration date for each IPO public knowledge. In the United States there is, contrary to numerous European countries, no legal regulation regarding the length of an IPO lock-up period. This means that underwriters are free in determining the length of the lock-up period, although a period of 180 days is undoubtedly the most common lock-up period length.

Based on the high risk of the high illiquidity and undiversified portfolio of the shareholders, together with the previous literature, the paper hypothesizes that trading volume will increase after the lock-up period expires as a result of insiders selling a large part of their

shares for diversification purposes. However, as the lock-up expiration is a publicly known event, no price arbitrage is expected.

Volume

As the lock-up period ends, a large proportion of a company's shares become available to public trading. This increased trading volume is relevant to the price of the stock. According to the theory of downward sloping demand curves, a higher volume of shares would lead to a lower price per share in an efficient market. Downward sloping demand curves refer to the phenomenon that prices drop if demand increases. The evidence for downward sloping demand curves in asset markets is mixed. On the one hand it is considered that a share price reflects a firm's value and is not dependent on supply and demand. A share price should therefore be determined by a firm's expected cash flows and its cost of capital (Liem, 2006). However other research contradicts this hypothesis, finding that stocks actually do have downward sloping demand curves. Levin and Wright (2006) used an econometric approach to analyse price elasticities of demand for individual stocks. They found that, in accordance with the theory of downward sloping demand curves, stock prices fell after a new share issuance. Also Neumann and Voetmann (2003) researched price changes in stock due to changes in demand for stocks. They too found results consistent with the existence of downward sloping demand curves for stocks.

As the evidence on downward sloping demand curves for stocks is mixed, the expected effect of increased trading volume is hard to predict. But, because the expiration of the lock-up period will result in a significant permanent release of additional shares (an average of 80-85%), the research expects the trading volume to permanently increase after lock-up expiration. If the permanently increased trading volume will influence the stock's returns is difficult to foresee. On the one hand it is expected that stock prices will fall in accordance with the theory of downward sloping demand curves as a result of the excess volume. On the other hand it should be considered that even if the theory of downward sloping demand curves apply for stocks, stock prices should not be influenced by this as the lock-up expiration date is public information. Therefore the paper expects that if trading volume increases as a result of the expiration of the lock-up period, stock prices will not be affected.

Bid-ask spread

The bid-ask spread refers to the difference between the bid price and the ask price of a stock. The bid-ask spread can be thought of as a measure of the supply and demand of the stock and is considered to be the main measure for liquidity in a certain asset market. If the liquidity in a market is high, meaning stocks are bought and sold easily, the bid-ask spread will be relatively small. As the bid-ask spread is the difference between the lowest price a seller is willing to receive and the highest price a buyer is willing to pay, the bid-ask spread is the principal transaction cost of trading. If a market is illiquid, the bid-ask spread is relatively high and trading will be accompanied by high transaction costs. Amihud and Mendelson (2006) find that liquidity of a market affects asset prices and returns. They find that because an investor is averse to the high cost of market illiquidity, asset prices decrease with increased illiquidity as investors want to be compensated for the high trading costs. This paper predicts that there is a negative relationship between the bid-ask spread and the stock prices on the day that the lock-up period of the IPO expires. Also a negative relationship between excess volume and the bid-ask spread is predicted as the increased trading volume will enhance market liquidity. The paper expects that the low bid-ask spread, caused by the increased liquidity, will cause stock prices to increase.

Idiosyncratic Volatility

Idiosyncratic volatility refers to the measure in which the variation in returns of a stock, or group of stocks, cannot be explained by an asset-pricing model. This means that the volatility is inherent to the stock itself. Idiosyncratic volatility is closely related to idiosyncratic risk, also known as unsystematic risk, which dictates the structural risk of an individual stock. Company management and operations can be thought of as examples of idiosyncratic risk. Many researchers say that idiosyncratic risk can be diminished or eliminated by diversifying a portfolio. This is different from systematic risk, which refers to the risk of the market itself. Inflation rates or recessions can be thought of as examples of systematic risk. Contrary to idiosyncratic risk, systematic risk cannot be reduced by diversification.

Aabo, Pantzalis and Park (2017) find a positive relationship between absolute idiosyncratic volatility and asset mispricing. This means that if a stock has a higher volatility, independent of average market volatility, the stock is more likely to be mispriced. Furthermore they find that higher idiosyncratic volatility of a stock leads to a higher level of noise traders. These noise traders are primarily inexperienced traders who trade based on incomplete or inaccurate data, causing artificial market movements based on irrational trading behavior. Because higher idiosyncratic volatility of a stock leads to higher levels of mispricing, this paper expects to see a negative relationship between idiosyncratic volatility and cumulative abnormal returns around the lock-up expiration period. This means that it is expected that the effect of the lock-up expiration is higher for the stocks with higher idiosyncratic volatility as high idiosyncratic volatility is characterized by high mispricing and noise trading.

Efficient Market Hypothesis

The efficient market hypothesis (EMH) is the theory that beating the market is impossible because stocks are already accurately priced and reflect all available information. According to this theory it is impossible to make a profit from any trading strategy. The only way to earn higher returns than the market according to this theory is to buy riskier stocks. According to this theory the price effect of the lock-up expiration event should be incorporated in the share price at the time of the IPO. This means that according to the efficient market hypothesis, excess returns in any way should not be possible at the expiration of the IPO lock-up period. The concept of the efficient market hypothesis was first introduced by the economist Eugene Fama in 1970 who concluded that the efficient markets model holds in most cases (Fama, 1970). However there are a lot of people that argue against the efficient market hypothesis stating that the very existence of active traders demonstrates that outperforming the market is possible. They state that if outperforming the market is impossible, active traders would not exist. As the lock-up expiration date is public information, the efficient market hypothesis states that the event will not influence the stock returns as the information is rationally incorporated into the share price prior to expiration. Therefore the paper predicts that stock returns will not be influenced by the expiration of the lock-up period as the event is already absorbed into the stock price.

3 Previous Research

In the year 2000 Ofek and Richardson conducted a similar experiment regarding the relationship between stock prices and lock-up expiration. However, this research was performed regarding IPOs between 1996-1998. These years formed the height of the so-called dot-com bubble, a stock market bubble between 1995 and 2000 characterized by enormous stock returns. The timeframe of their research is relatively short and is characterized by high volatility in the stock market, especially with regard to IPO prices. During this time the amount of IPOs peaked and there was considerable amount of underpricing. According to research done by Ljungqvist and Wilhelm Jr (2003), IPOs during the dot-com bubble had enormously high levels of underpricing with average first day returns of 73 percent in 1999.

This research aims to find whether or not stock prices drop when their lock-up expiration date expires and whether arbitrage is possible. It builds on the research done by Ofek and Richardson in 2000 but looks at a larger timeframe after the internet bubble. Ofek and Richardson concluded that there was in fact a price drop, but that no arbitrage was possible due to the fact that the price drop was hard to exploit. As trading platforms have developed greatly over the years, factors that make price drops easier to exploit such as the ease to short stocks and information transparency have increased. This paper expects to see increased trading volumes due to the expiration of the lock-up period as a large portion of shares becomes available to trading. Apart from the theoretical availability of the shares, the research expects those freed shares to be sold by the initial investors because of diversification purposes as mentioned earlier. Because of the extra shares traded, increased liquidity is expected which will be reflected in the bid-ask spread. This is based on the assumption that in an efficient market with information transparency arbitrage is not possible. This view is partly consistent with the results presented by the research of Ofek and Richardson (2000), in the sense that arbitrage is still not expected. Due to increased market transparency and trading ease it is expected that the effect of the change in trading volume is absorbed into the stock price beforehand.

4 Data

The sample consists of all United States based firms that issued their IPO between the years 2000 and 2020. Only US stocks were investigated instead of choosing a multinational data set in order to avoid differences in legal regulations regarding the IPO lock-up period. Rules on lock-up periods in Europe are not homogenous with many countries demanding a minimum lock-up period by law. In contrast, the duration of the lock-up period is not regulated by law in the United States. The IPO firms from the United States are collected from the ThomsonOne database, including their individual issue dates and lock-up periods. Via the ThomsonOne database it was determined which US based firms had their IPO between the years 2000 and 2020, and when their individual lock-up periods expired. Also a 9-digit CUSIP identifier, an identifier unique to each firm, was downloaded in order to collect data on these companies via other databases. The firms that did not have a 9-digit CUSIP identifier, or their lock-up period specified by ThomsonOne, were deleted from the sample. In this way a total of 2323 firms met the criteria for further investigation and selection. For each of these firms additional data was collected for the period concerning their individual lock-up expiration date. Via CRSP the daily stock prices as well as the trading volume, returns, company sector, value-weighted index returns, bid price and ask price were collected using the 9-digit CUSIP identifiers. Lastly the data was filtered so that only firms with a lock-up period of 180 days remained. IPOs that had a lock-up expiration date after December 2020 were deleted from the sample. For the prediction of normal stock price behavior, an estimation window as well as an event window were created. Firms that did not have the required amount of observations in trading days for both the estimation window as well as the event window were deleted from the sample. This left the sample with a total of 1431 firms.

A large time period is chosen, twenty years, to get as large a dataset as possible. The dataset starts in 2000 and ends in 2020 and therefore contains multiple major economic events. The year 2000 is still characterized by the dot-com bubble and has a significant larger amount of IPOs than the years that follow (see Figure 1). The timeframe also includes the banking crisis of 2008. Although this event is not related to IPOs in a way that the dot-com bubble was, it is notable that the amount of IPOs in the year 2008 is the lowest amount in the timeframe of 20 years (see Figure 1). The research looks at the largest dataset possible after the height of the

dot-com bubble. The size of the time period is chosen to look at general stock returns around the expiration of the lock-up period.

5 Methodology

Data was collected for US firms that had an IPO between the years 2000 and 2020. The focus of the research lies on the stock returns around the expiration date of the lock-up period of each individual stock. Therefore, the daily stock prices for each stock were gathered as well as factors that may influence the stock price such as volume, return, value-weighted index returns, bid price, ask price, industry and index type. To every trading day a number was assigned; 0 for the first trading day the locked up shares could be traded, -1 for the day prior and +1 for the day after. This was done for each firm for all available trading days in the sample. As not every lock-up period ended on a trading day, the value zero was assigned to the first trading day that followed so that the value zero is always linked to the first trading day of lock-up expiration.

The daily returns for the stocks were downloaded from CRSP and had been calculated using the following formula:

(1) $$Daily\_return = Price\ (t) / Price\ (t\text{-}1)$$

where Daily_return (t) is the return of day (t). This gives the returns of the IPO stocks relative to the day prior. The focus lies particularly on the timeframe around the end of the lock-up period. In order to analyse if the stock prices behave abnormally around the expiration of this lock-up period, abnormal stock returns need to be determined. Abnormal stock returns are defined as:

(2) $$Abnormal\_return\ (t) = Return\ (t) - Normal\_Return\ (t)$$

The normal return of stock (t) is predicted based on past returns. For each stock a prediction for normal stock prices around the lock-up period is made using an estimation window. The period around the lock-up expiration that is analyzed is called the event window and differs

across the paper. The period that is used to estimate normal stock behavior is called the estimation window. The estimation window consists of the trading days -100 until -21 relative to the lock-up expiration day. For each stock a regression is run between the daily returns of the stock and the returns of the value-weighted index in the estimation window. Based on this regression a prediction of normal stock behavior is made for the event window. The estimation window of trading days -100 to -21 is chosen as large as possible without overlapping with the multiple event windows. Once normal stock behavior is predicted, abnormal returns can be calculated using the formula mentioned above.

For the analysis multiple event windows are regarded. For each individual event window the cumulative abnormal returns are calculated using the following formula:

(3) $$Cumulative\_abnormal\_return\ (t) = \sum Abnormal\_returns\ (event\_window)$$

Different event windows were analyzed using the cumulative abnormal return of the stocks. For the analysis of the cumulative abnormal returns, four subsamples each consisting of five years were created in the data. The different subsamples were created to control for the price effect in different time periods. The four subsamples are i). 2000-2005 ii) 2006-2010 iii) 2011-2015 iv) 2016-2020.

One of the factors that plays an important role concerning the expiration of the IPO lock-up period is trading volume. In order to control for excessive trading around lock-up expiration, excess volume is determined. Excess volume is calculated by using the following formula

(4) $$EV\ (t) = V(t) / AVEW$$

Where EV is the excess volume of the stock at time (t), V is volume at time (t) and AVEW is the average volume of the estimation window. AVEW is determined by calculating the average volume of the trading days -100 to -21, just like for the returns, and represents normal trading volume.

To check for increased liquidity, the bid-ask spread is calculated using the following formula

(5) $Bid\_Ask\_Spread\%\ (t) = |\ Ask\ Price\ (t) - Bid\ Price\ (t)\ |\ /\ Ask\ Price\ (t)$

The bid-ask spread is regarded in multiple ways. Firstly the average bid-ask spread is regarded for the trading days - 20 until +20 to visualize the general development of the bid-ask spread around the lock-up period. Secondly the average bid-ask spread is regarded around the expiration of the lock-up period, and its relationship to excess volume and cumulative abnormal returns. Finally for each stock an average value of the bid-ask spread is calculated for the estimation period (days -100 until -21) to investigate the relationship between the bid-ask spread in the estimation window and the cumulative abnormal returns in the event window.

Lastly for all the stocks in the sample, idiosyncratic volatility of the stocks is calculated in the estimation window using the following formula

(6) Idiosyncratic Volatility (I) = Total Variance (I) - Market Variance (I)

where idiosyncratic volatility (I) is the idiosyncratic volatility for stock I. Total variance (I) is the total variance for stock I, calculated by squaring the standard deviation of the stock's daily returns. Market variance (I) is the total market variance for stock I, calculated by squaring the standard deviation of the value-weighted index returns of the stocks.

For each individual company an event window and an estimation window is created. The event window is the set of days that will be analyzed, the estimation window is the period of time that will be used to make predictions about the event window. Across the sample different event windows will be analyzed. The estimation window consists of trading days -100 until day -21 relative to lock-up expiration. For each company the days -100 until -21 are assigned the value 1 as a dummy, the rest a value 0 as a dummy. For the stock returns in the estimation window a regression is run on each individual stock between the daily returns and the returns of the value-weighted index. Based on the regression results, the "predict" command is used in STATA to estimate normal performance for those firms in the event window. This means that the event window is estimated using the regression results of 80

trading days, namely day -100 until -21 relative to lock-up expiration. This large estimation window will be able to produce normal performance as precise as possible.

4 Results

4.1 Summary Statistics

Table 1 to Table 4 provide summary statistics on the firms investigated in the sample. Table 1 contains the macro-industries of the firms included in the sample. It shows that the firms in the sample are divided among twelve industries and can therefore be regarded as a relatively diverse group of firms. Table 2 contains the exchanges on which the stocks are listed. The NASDAQ and NYSE stock exchange are the primary exchanges and make up about 97% of the firms. Table 3 shows that during the lock-up period there was considerable trading going on with a mean trading volume of 359,443 shares. Table 3 also displays the bid-ask spread of the stocks. This is of importance when looking at the exploitability of possible price fluctuations and is also a strong indicator of market liquidity. As the bid-ask spread has a mean of 0.633%, it can be concluded that the supply and demand is high for these stocks and that the market for the stocks is highly liquid.

Table 4 and Figure 2 illustrate the average trading volume around the lock-up period. The figure shows that once the shares are unlocked at day zero, the trading volume peaks and then stays higher than prior to the expiration.

Figure 3 shows the development of the bid-ask spread around the expiration of the lock-up period. The graph shows that the bid-ask spread decreases when approaching the expiration of the lock-up period. The bid-ask spread bounces back and forth after the unlocking of the shares, but consequently stays relatively lower with respect to the period prior to the lock-up expiration.

4.2 Empirical findings

Figure 4 together with Table 5 show the average excess volume of the stocks traded. The excess volume is highest, as hypothesized, on the day that the lock-up period expires. The average excess trading volume for days 0 and +1 amounts to 64.8% above the average trading volume. While the trading volume decreases after this first day of unlocked shares, the average trading volume remains higher. The higher trading volume of the expiration day itself is expected with regard to the risk diversification theory for insiders. Along with the increase in trading volume following the lock-up expiration, a decrease in the bid-ask spread is observed (Figure 3). This provides strong evidence that market liquidity is high and transaction costs are low. If the theory for downward sloping demand curves holds for stocks, it is expected that a simultaneous drop in returns is seen alongside the increase in trading volume.

In Figure 5 the abnormal returns for the event window of -20 until +20 days relative to lock-up expiration are visualized. No clear pattern emerges, but it can be observed that especially in the five days prior to expiration the stock returns perform relatively bad compared to the estimation period. A steep decrease in stock returns on the day of expiration, however, is not seen. Furthermore the fluctuation in abnormal returns is relatively low, with the lowest daily abnormal return of approximately -0.3%. To illustrate the total effect of the lock-up expiration date on the stock returns, the cumulative abnormal returns are regarded. The cumulative abnormal returns are calculated for different event windows and are shown in Table 6. The results show significant cumulative abnormal returns around the expiration of the lock-up period. While the cumulative abnormal returns of the stocks are significant, the magnitude of the drop is relatively small. When regarding the three days prior to the lock-up expiration and the three days following the lock-up expiration, the cumulative abnormal returns equal respectively -0.58% and -0.24%. It is however notable that all the observations have a negative coefficient, meaning that for all the event windows the cumulative abnormal return of the stocks is negative. In Table 6 the percentage of positive abnormal returns is displayed, showing that a significant average of 53-55% of the observations regarding abnormal returns are negative, depending on the event window under investigation.

The dataset was divided into four subgroups of five years each, investigating a period of five days prior to the lock-up expiration date. The results for the cumulative abnormal returns too were relatively similar to all of the subgroups showing negative cumulative

returns. The first three subgroups had a drop in stock returns of less than 1%, while the subgroup consisting of the years 2016 until 2020 had an average cumulative return of -1.946% in this event period. This shows that the results from the subgroups are consistent with the overall effect measured in the whole dataset.

Table 8 and Table 9 show the correlation between the bid-ask spread and the excess volume as well as the correlation between the cumulative abnormal returns and the excess volume for two event windows. The correlation between the excess volume and the average bid-ask spread is negative, as expected. This means that if the excess volume increases, the bid-ask spread decreases. This is because the increased trading volume leads to increased liquidity of the stock, which lowers the bid-ask spread. The correlation between excess volume and cumulative abnormal return is also negative for both event windows. This means that if excess volume increases, cumulative abnormal returns drop. However, this correlation is relatively weak. The negative correlation between return and volume however, is in line with the theory of downward sloping demand curves. Table 10 shows the ordinary least squares regression between cumulative abnormal returns, excess volume and the bid-ask spread for several event windows. It shows that the excess volume as well as the bid-ask spread are of significant influence on the cumulative abnormal returns of the stocks. Table 11 shows the ordinary least squares regression between cumulative abnormal returns in the event window and idiosyncratic volatility in the estimation period. The regression coefficient is highly significant for all event windows, showing that the idiosyncratic volatility of the stocks is of substantial importance for the cumulative abnormal returns around the expiration period of the IPO. The coefficient of the regression is negative, showing that if the idiosyncratic volatility of the stocks is higher in the estimation window, the cumulative abnormal returns are extra low in the event period. This means that the negative effect of the lock-up expiration on the cumulative abnormal returns is stronger if the idiosyncratic volatility of the stock is higher. This agrees with the research of Aabo et al (2017), stating that a higher absolute idiosyncratic volatility leads to higher mispricing. Table 12 shows the ordinary least squares regression between cumulative abnormal returns in the event window and the average bid-ask spread in the estimation window. The results show a significant relationship between the average bid-ask spread and the cumulative abnormal returns. The regression has a negative constant, meaning that the cumulative abnormal returns are at their lowest when the bid-ask spread is zero. The coefficient is positive, meaning that the higher the average bid-ask spread

is during the estimation period for the stocks, the closer the cumulative abnormal returns approach zero.

Finally, Figure 6 shows the cumulative abnormal returns graphed over a large event window around the lock-up expiration date. The figure shows that cumulative abnormal returns start to decrease as soon as 18 days prior to lock-up expiration.

5 Conclusion

The research finds strong evidence that there is not a significant drop in the stock price on the first trading day after the lock-up expiration period. Different event windows around the lock-up expiration period are characterized by negative abnormal returns, but the drop is nowhere near as significant as the 1.15-3.29% drop as found by Ofek and Richardson (2000). However, significant cumulative abnormal returns in the days prior to the lock-up expiration are observed. While the drop is still not as substantial as the one found by Ofek and Richardson (2000), it is still significant. In the three days prior to lock-up expiration, the results show an average cumulative abnormal return of -0.58%. If the event window is extended to five days prior to lock-up expiration, the cumulative abnormal returns amount to -0.94%. The effect of the lock-expiration is therefore present, albeit not on the exact day of lock-up expiration. This difference in results could have multiple reasons. Firstly Ofek and Richardson (2000) looked at a time period of high volatility in the stock market, especially for IPOs. This period, better known as the period of the dot-com bubble, was characterized by high speculation and significant underpricing. So, the volatile time period selected could very well have played a role in the results of Ofek and Richardson (2000). Another possibility is that after the paper of Ofek and Richardson (2000), people started trading on this anomaly eventually causing the effect to shift slightly forwards.

While the price drop is not significant on the first trading day after lock-up expiration, the excess trading volume is. As the lock-up period expires, insiders are allowed to sell their newly freed shares. The high excess trading volume indicates that a lot of the insiders choose to immediately sell their shares when possible. The selling of the shares by the insiders is most likely because of diversification considerations. By selling their shares, the insiders are

able to diversify their portfolio and secure the profit on their stocks which averages 18.4% (Table 3).

Although the cumulative abnormal returns of the IPOs are significantly negative around the lock-up period, arbitrage is still not possible. The reason for this lies in the bid-ask spread. The bid-ask spread is regarded as the principal cost of trading. As the cumulative abnormal returns are relatively small, the bid-ask spread does not allow for arbitrage. The research shows that when the average bid-ask spread decreases, meaning the cost of trading lowers, cumulative abnormal returns decrease as well. This indicates that the effect of the lock-up expiration on the cumulative abnormal returns diminishes when costs of trading decrease. The exploitability of the negative cumulative abnormal returns therefore decreases together with the bid-ask spread, showing arbitrage is not possible.

The results of the paper concur with the hypothesis that arbitrage is not possible at the time of the expiration of an IPO lock-up period. Increased information transparency together with market efficiency makes the event anticipated with the effect of the increased trading volume absorbed into the share price in the days prior to lock-up expiration.

6 Limitations and recommendations

As with all types of research, this study has its limitations. One of the parts of the research that could increase the significance is the amount of firms researched. The significance of the data improves when data of more firms is analyzed. Many potential observations were thrown out because multiple firms did not have their lock-up expiration date and 9-digit CUSIP code listed in the ThomsonOne database.

Investigating the same phenomenon in stocks listed in countries outside of the United States would also increase the significance of the research. These results can be cross-referenced with the results of the present study on firms in the United States. This will make it possible to analyze whether or not the effect of the lock-up expiration is tied to the legal tendencies of the United States or if the effect is universal.

Furthermore it will be interesting to look at different lengths of the lock-up period. That way it can be analyzed whether or not the length of the lock-up period has an influence on the returns around the lock-up expiration period. Signaling theory regarding the lock-up period states that lock-up periods are used in order to send a signal stating that a firm is of good quality as holding onto the shares is costly for insiders. A longer lock-up period could therefore be an incentive for insiders to sell a larger portion of their shares at lock-up expiration. This research was not able to look into IPOs with multiple lengths in lock-up periods as the data on firms with a lock-up period different from 180 days is too scarce.

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8 Appendix

Table 1

TF Macro Description	Freq.	Percent	Cum.
Consumer Products and Services	72	5.03	5.03
Consumer Staples	25	1.75	6.78
Energy and Power	111	7.76	14.54
Financials	251	17.54	32.08
Healthcare	346	24.18	56.25
High Technology	284	19.85	76.10
Industrials	71	4.96	81.06
Materials	49	3.42	84.49
Media and Entertainment	32	2.24	86.72
Real Estate	71	4.96	91.68
Retail	88	6.15	97.83
Telecommunications	31	2.17	100.00
Total	1,431	100.00	

Table 2

The primary stock exchange on which the stocks are listed. Full sample 1431 firms.
A = NYSE MKT **N** = NYSE **Q** = NASDAQ **R** = NYSE Arca.

Primary Exchange	Freq.	Percent	Cum.
A	41	2.87	2.87
N	548	38.29	41.16
Q	839	58.63	99.79
R	3	0.21	100.00
Total	1,431	100.00	

Table 3

Summary statistics of the sample consisting of 1,413 firms based in the US between the years 2000-2020.

	Mean	Median	Std. Dev.	Q1	Q3
Sample Description					
Bid-Ask Spread	0.006333	0.002445	0.126079	0.001000	0.006089
Shares Outstanding	47048.52	25934	88991.37	16842	46895
Offer Price	15.70279	15	6.125125	12	19
Return Offer Price until Day -1	0.184267	0.076012	0.6109776	-0.1473684	0.397333
Average Volume Day -100 to -20	359,443	347,929.3	59,344.67	332,619.5	367,524.5

Table 4

Summary statistic of average trading volume of the IPO stocks.

	Mean
Full Sample (1431 observations)	
Average volume days -10 to -2	403,139.2
Average volume days -5 to -2	403,318.8
Average volume days -1 to 0	486,424.3
Average volume days 0 to +1	727,204.6
Average volume days +2 to +5	526,561.8
Average volume days +2 to +10	473,565.0

Table 5

Excess volume for full sample determined for different event windows. Excess volume is calculated relative to the average volume in the estimation period of day -100 until day -21

	Mean
Full Sample (1431 observations)	
Average excess volume days -10 to -2	1.126***
	(0.000561)
Average excess volume days -5 to -2	1.175***
	(0.000682)
Average excess volume days -1 to 0	1.216***
	(0.0010491)
Average excess volume days 0 to +1	1.648***
	(0.0053215)
Average excess volume days +2 to +5	1.421***
	(0.0014037)
Average excess volume days +2 to +10	1.347***
	(0.0008703)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6

Cumulative abnormal returns for full sample of 1431 firms

VARIABLES	Mean	% Positive
Full Sample 1431 Firms		
CAR (days -5 to +5)	-0.0120*** (0.00114)	0.46***
CAR (days-5 to 0)	-0.0094*** (0.00112)	0.45***
CAR (days -3 to -1)	-0.0058*** (0.0019)	0.46***
CAR (day 0)	-0.0008 (0.0013)	0.46
CAR (days 0 to +2)	-0.0024*** (0.0015)	0.47***

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7

Cumulative abnormal returns for subgroups 2000-2005, 2006-2010, 2011-2015 and 2016-2020.

CAR from -5 to 0 Subgroups	Mean
2000-2005 (341 firms)	-0.00644*** (0.00250)
2006-2010 (308 firms)	-0.00333** (0.00173)
2011-2015 (430 firms)	-0.00587*** (0.00170)
2016-2020 (352 firms)	-0.01946*** (0.00270)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8

CORRELATION	Excess Volume Day 0 to Day +2
Average Bid-Ask Spread (Day 0 to Day +2)	-0.0610
Cumulative Abnormal Return (Day 0 to Day +2)	-0.0143

Table 9

CORRELATION	Excess Volume Day -2 to Day 0
Average Bid-Ask Spread (Day -2 to Day 0)	-0.0119
Cumulative Abnormal Return (Day -2 to Day 0)	-0.0057

Table 10

Ordinary least squares (OLS) regression of bid-ask spread and excess volume on cumulative abnormal returns for different event windows. Whole sample, 1431 firms.

VARIABLES	(1) Day -2 to Day 0	(2) Day -4 to Day 0	(3) Day 0 to Day + 2	(4) Day 0 to Day +4
Intercept	-0.00867***	-0.12613***	-0.01312***	-0.00996***
	(0.00140)	(0.00126)	(0.00186)	(0.00178)
BAS	0.481***	0.477***	0.231*	-0.00837
	(0.0951)	(0.0929)	(0.1333)	(0.1263)
EVOL	0.000668	0.00096***	0.005487***	0.004566***
	(0.000505)	(0.002922)	(0.0004458)	(0.0004714)
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Table 11

Ordinary least squares (OLS) regression of idiosyncratic volatility in estimation window on cumulative abnormal returns for different event windows. Whole sample, 1431 firms.

VARIABLES	(1) Day -2 to Day 0	(2) Day -4 to Day 0	(3) Day 0 to Day 2	(4) Day 0 to Day 4
IDIO_VOL	-0.615*** (0.153)	-0.926*** (0.148)	-0.792*** (0.211)	-1.384*** (0.195)
Constant	-0.00394*** (0.00114)	-0.00702*** (0.00110)	-0.00104 (0.00156)	-0.00028 (0.00145)
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Table 12

Ordinary least squares (OLS) regression of average bid-ask spread in estimation window on cumulative abnormal returns for different event windows. Whole sample, 1431 firms.

VARIABLES	(1) Day -2 to Day 0	(2) Day -4 to Day 0	(3) Day 0 to Day 2	(4) Day 0 to Day 4
Bid_Ask_Spread%	0.126*** (0.0247)	0.132*** (0.0309)	0.168*** (0.0341)	0.023 (0.0409)
Constant	-0.00587*** (0.000274)	-0.00952*** (0.000342)	-0.00355*** (0.000378)	-0.00282*** (0.0004526)
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Figure 1

Amount of IPOs in the United States between 2000-2020. Source: *Ritter (2021)*

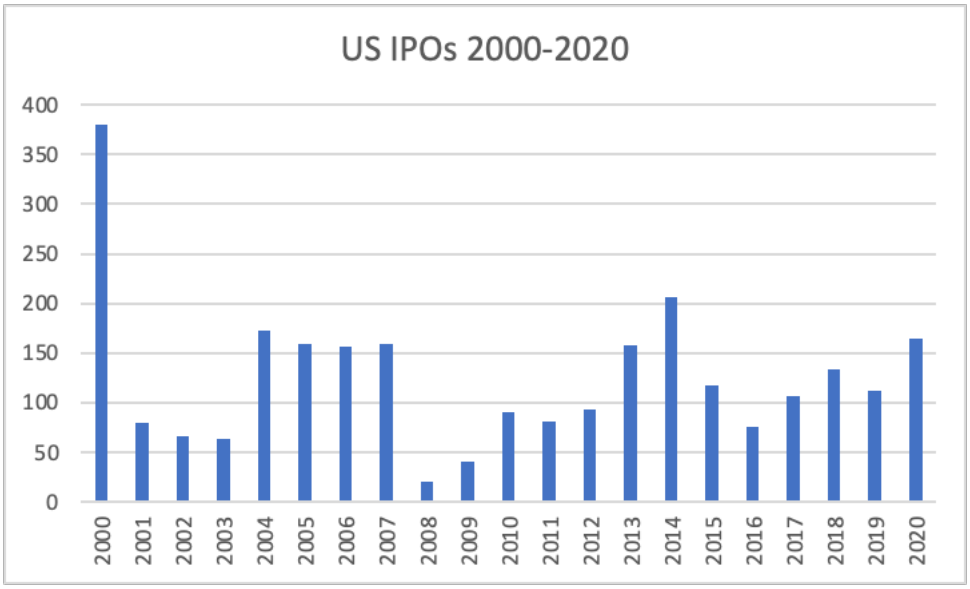

Figure 2

Average volume of stocks for full sample of 1431 firms.

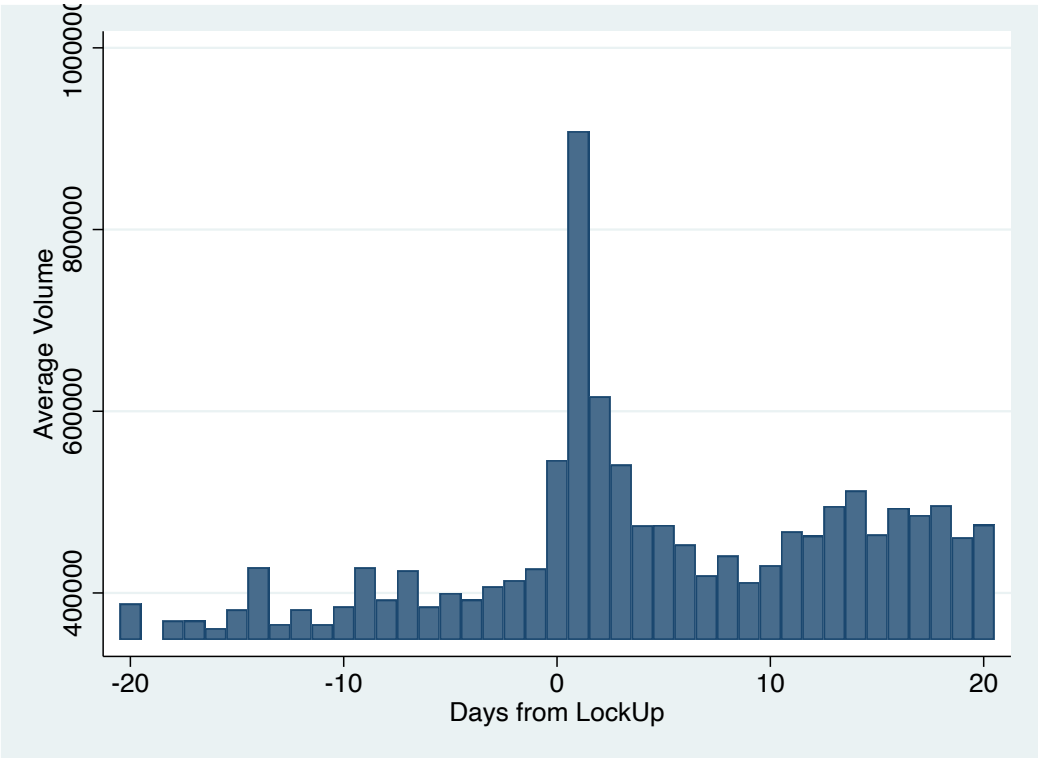

Figure 3

Average bid-ask spread for full sample of 1431 firms.

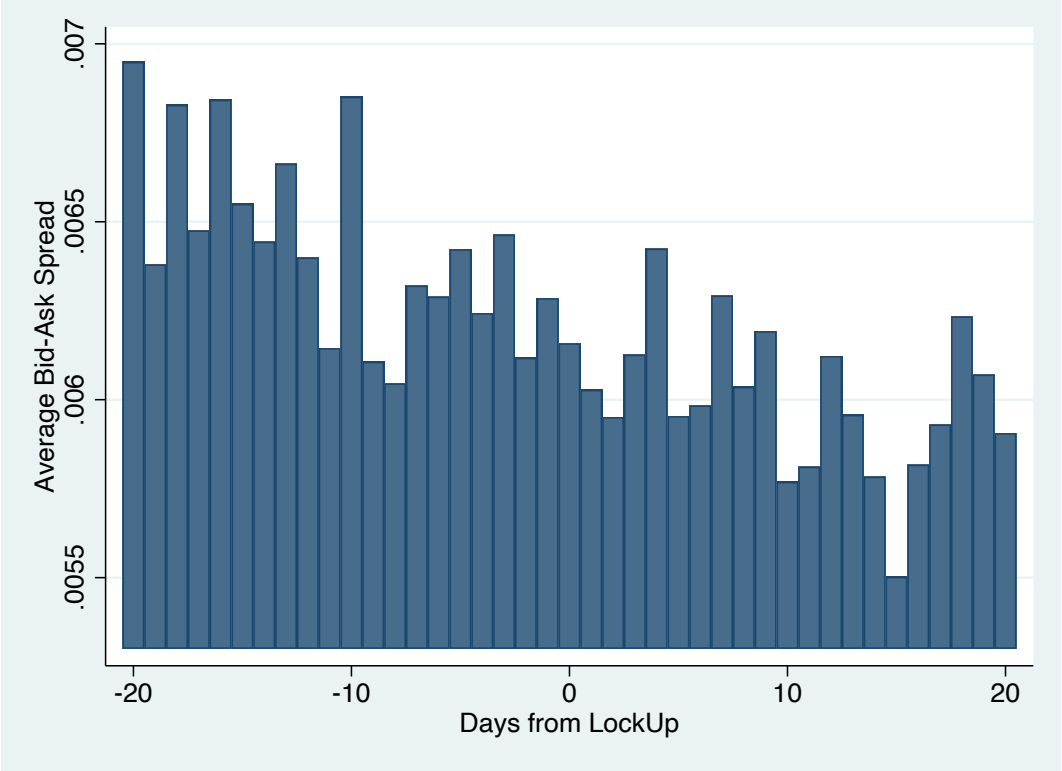

Figure 4

Average excess trading volume for full sample of 1431 firms.

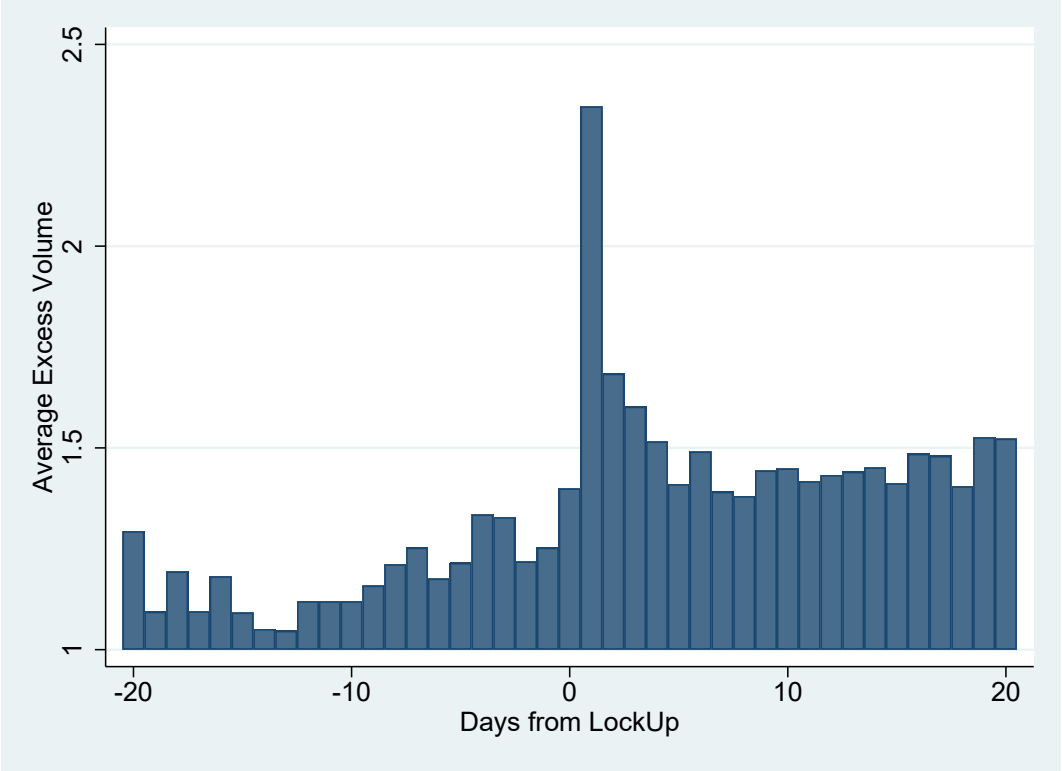

Figure 5

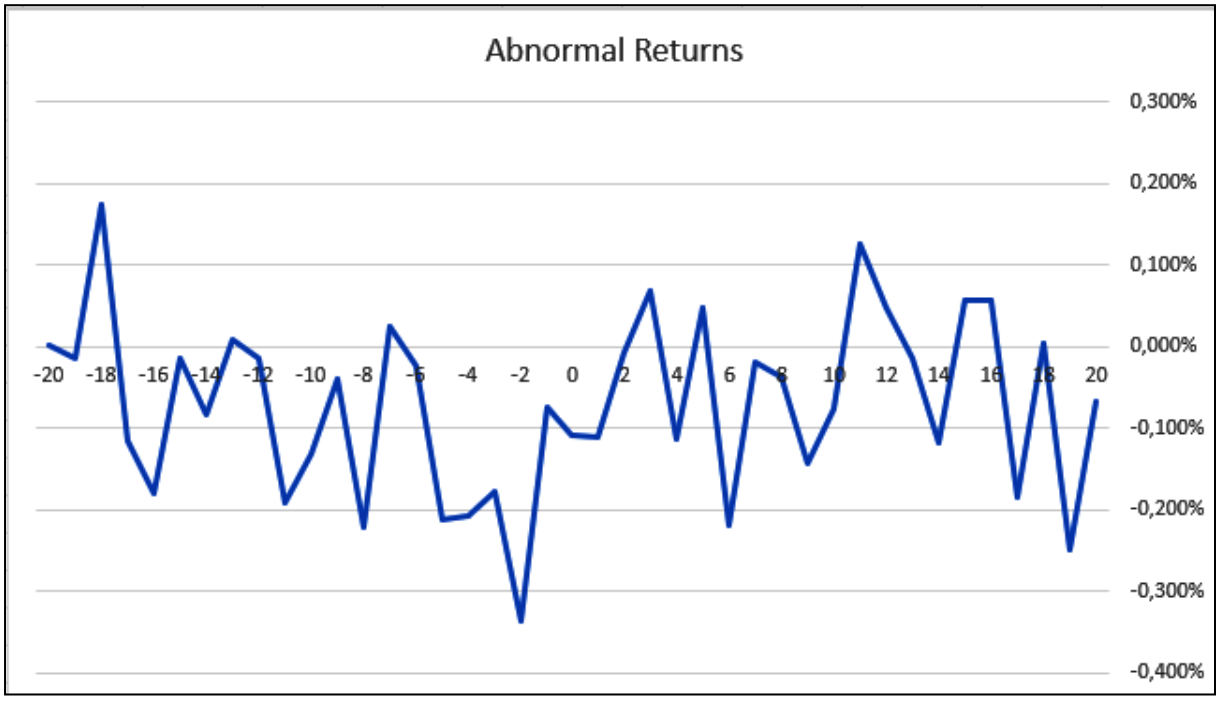

Figure 6