POST-MERGER PERFORMANCE OF HIGH TECHNOLOGY SPACS IN THE U.S. STOCK MARKET IN 2015-2022

Lappeenranta–Lahti University of Technology LUT

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ABSTRACT

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Special purpose acquisition companies, SPACs, have existed decades, but recently the number of SPACs has increased significantly. High-technology companies have been preferred targets of SPACs, the high-technology industry itself also being highly emerging. The aim of this thesis is to examine the post-merger performance of SPACs that have completed merger or acquisition with a high-technology company. The study is focused on the U.S. stock market, and the performance of SPACs is examined in relation to two selected benchmark indices in 2015-2022. The performance is examined for three post-merger holding periods: three, six and twelve months.

The results of this study indicated that the high-technology SPACs have performed poorly compared to the market. The post-merger returns are highly negative for all three holding periods. Moreover, the results indicated that the more time had passed from the completion of the merger or acquisition, the lower were the returns. Based on these findings, it can be concluded that the SPACs haven't offered a good investment alternative for the investors within the year after completing the merger. These findings are also in line with the previous studies on the SPACs post-merger performance.

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Teknologia-alan yrityksen ostaneiden SPAC-yhtiöiden yrityskaupan jälkeinen suoriutuminen Yhdysvaltain osakemarkkinoilla vuosina 2015-2022

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Yritysostoihin tarkoitettuja erillisyhtiöitä eli SPAC-yhtiöitä on ollut olemassa jo vuosikymmenien ajan, mutta viime aikoina SPAC-yhtiöiden määrä on lisääntynyt merkittävästi. Teknologia-alan yritykset ovat olleet SPAC-yhtiöiden suosimia yritysoston kohteita. Tämän opinnäytetyön tavoitteena on tutkia teknologia-alan yrityksen ostaneiden SPAC-yhtiöiden suoriutumista osakemarkkinoilla yrityskaupan jälkeen. Tutkimus keskittyy Yhdysvaltain osakemarkkinoihin, ja SPAC-yhtiöiden suoriutumista tarkastellaan suhteessa kahteen valittuun vertailuindeksiin vuosina 2015-2022. SPAC-yhtiöistä muodostetuiden portfolioiden tuottoja tutkitaan kolmen, kuuden ja kahdentoista kuukauden ajanjaksoilta yritysoston toteutumisen jälkeen.

Tämän tutkimuksen tulokset osoittivat SPAC-yhtiöiden suoriutuneen heikosti markkinoihin verrattuna. Yrityskaupan toteutumisen jälkeiset osaketuotot ovat selvästi negatiiviset kaikilla kolmella aikaikkunalla. Lisäksi tulokset osoittivat, että mitä pidempi aika oli kulunut yrityskaupan toteutumisesta, sitä alhaisempia olivat tuotot. Näiden havaintojen perusteella voidaan todeta, että SPAC-yhtiöt eivät ole olleet kannattavia sijoituskohteita vuoden aikaikkunalla toteutuneesta yrityskaupasta. Nämä havainnot ovat myös linjassa aiempien tutkimusten tulosten kanssa.

ABBREVIATIONS

SPAC	Special Purpose Acquisition Company
IPO	Initial Public Offering
CAPM	Capital Asset Pricing Model

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1. Introduction

In the recent years, private companies have entered to the U.S. stock market more actively than ever before. The total number of initial public offerings, IPOs, hit the new record in the U.S in 2021 by increasing 88% from 2020. One reason behind this significant increase is the explosively grown SPAC market, as 63% of all IPOs in the U.S. market in 2021 were SPAC IPOs. The number of SPAC IPOs hit the all-time highs as well by increasing as much as 150% from 2020. These numbers show how the SPACs have recently become popular investment vehicles as well as an increasingly popular alternative way for the private companies to access public markets. (Nasdaq 2022) There has been seen increase in the number of new SPAC IPOs in the other stock markets around the world as well, but the market sizes still remain relatively small compared to the U.S. For example, the total number of European listed SPACs was only 35 at the end of the year 2021. (White & Case 2022)

SPAC is an abbreviation from special purpose acquisition company. SPAC is referred as a blank check company, which is formed specifically to raise funds with the purpose of financing merger or acquisition with a private company within the predetermined time-period. Before the merger or acquisition SPACs do not have any commercial operations, and usually not even the industry of the searched acquisition candidate is not revealed to the public. Due to this are SPACs perceived as speculative investments at the IPO phase, since the investment decision can only be done based on the investor's trust on the SPAC's management and sponsors. (SEC 2022) SPACs have occurred in the market already from the beginning of the 20th century as the first SPAC went public in the U.S. already in 2003, but the market has remained quite small until this recent explosive growth in the market. Figure 1 shows the development in the total number of IPOs in the U.S. in 2003-2021, as well how the number is divided between SPAC IPOs and traditional IPOs during that time-period.

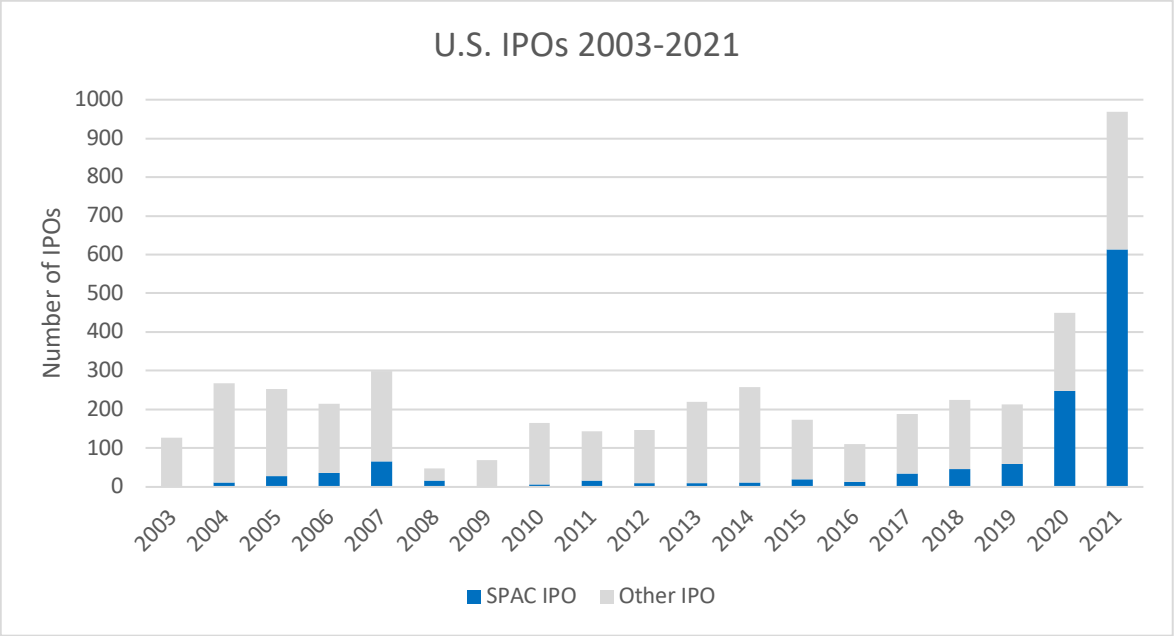


Figure 1. U.S. IPOs 2003-2021 (Reuters 2022)

When looking at the distribution between the traditional IPOs and SPAC IPOs, the number of new traditional IPOs per year has remained quite stable throughout the years, whereas in the SPAC IPOs there is a huge spike when coming to years 2020-2021. The number of SPAC IPOs was 388 in the time-period of 2003-2019, when in 2020 alone it was 248, and in 2021 the number was as high as 613. It is also notable that before the year 2020, the percentage of new SPAC listings from all IPOs has been relatively small, but in 2020 and 2021 more than a half of all IPOs were SPAC IPOs. (SPAC Analytics, 2022)

High-technology companies have been preferred targets of SPACs, and recently an increasing number of private technology companies have gone public through SPAC. About 25% of all completed SPAC acquisitions in the U.S. have been with a private company from the high-technology industry. Going through the traditional IPO process may be difficult and too expensive for small high technology start-ups that need big amount of capital for scaling their technologies in business. Indeed, it has been identified that for these kinds of companies SPACs can offer more convenient way to access the public markets. For example, going public via SPAC is much faster and offers more certainty than traditional IPO, and thus it is a good alternative for private companies to go public.

Since the SPAC market has been relatively small before the recent spike in the SPAC IPOs, the market is not yet that well-understood and more timely research is needed on the market performance of SPACs, especially for the private investors. The performance of SPACs has been examined in previous studies, but not that many have concentrated on specific industry. In addition, previous studies on SPACs' performance have mostly concentrated on the stock's performance on the day before and on the day of the merger, omitting the longer post-merger performance. In the light of these facts and because of the high popularity of high-technology companies as SPAC targets, the purpose of this study is to examine the post-merger performance of SPACs that completed merger or acquisition with a company operating in high technology industry in the U.S. This study will give important insights for investors how technology focused SPACs perform compared to other technology companies in the market and to the stock market in general.

1.1. Research questions and hypotheses

The main purpose of this study is to examine how the SPACs that have acquired or merged with a company from high technology industry have performed after the completion of the merger or acquisition, and whether they have been profitable investments for private investors. In other words, this study investigates the post-merger performance of high technology SPACs, and this is examined in the U.S. stock market. The main research question for this study is as follows:

How U.S. SPACs that have acquired or merged with technology companies have performed in 2015 – 2022?

This paper also aims to answer the following sub questions:

Do the returns of technology SPAC portfolios differ from the returns of the benchmark index in 2015-2022?

Have the technology SPAC portfolios been profitable for investors?

From these research questions the following hypotheses are formed:

H1 The portfolio, consisting of U.S. SPACs that have acquired or merged with a high technology company, has outperformed the benchmark indices

H2 Technology SPAC portfolio has been a profitable investment

1.2. Research method and data

This study is implemented as quantitative analysis and the data for this study is collected from the Refinitiv Eikon -database. The data used for examining the performance of SPAC's will be mainly time series data of daily stock prices. This study is geographically limited to the U.S. market as it was indicated to be the leading market on SPACs, and thus the data available is the most comprehensive. Another limitation on this study is the industry of the SPAC's target companies as this study will concentrate only on SPACs that have acquired or merged with a high-technology company.

Based on these limitations the data includes all the SPACs that have completed merger or acquisition with the high-technology company during the chosen time-period of 2015-2021, resulting in total number of 118 companies. Furthermore, all the SPACs that have chosen target company geographically from some other than the U.S. market, are sorted out, after which 78 companies are left. The daily price data is collected for these companies for the years 2015-2022. Because of the high number of listed SPACs in 2021, year 2022 is included in collecting the daily price data for being able to investigate post-merger performance of the SPACs listed in 2021. In addition, two benchmark indices were chosen for this study. Dow Jones Technology index is used to compare the performance of high technology SPAC with the other technology companies on the market. Furthermore, S&P 500 -index is used as the benchmark to represent the whole stock market. Daily price data of these indexes is also collected from the Refinitiv Eikon database, over the time-period of 2015-2022.

Modern portfolio theory is used as a background theory to analyze the performance of SPACs. Portfolio of high technology SPACs is formed and benchmarked with the chosen technology focused and market indices. Based on the Modern portfolio theory, the following commonly used measures and ratios were considered as relevant and selected for evaluating

the performance of the SPAC portfolios: Capital asset pricing model, Sharpe ratio, Jensen's alpha and Treynor's ratio.

1.3. Structure of the study

This paper is organized so that this introduction part is followed by the literature review and theoretical framework. The third section gives detailed description on the data and the methodologies applied in the empirical part. The fourth section introduces the results. The last section concludes the main findings with the suggestions for the future research.

2. Literature review

This section gives an overlook to previous research on SPACs. Along with the previous findings, the important terms and concepts are also explained. First SPACs in general are introduced: what is SPAC, what is the SPAC process and what has led to the peak in SPAC IPOs recently. After that, previous literature on the SPACs is reviewed.

2.1. SPAC

Special purpose acquisition company, SPAC, is a shell company that is formed specifically to raise capital through initial public offering (IPO) with the purpose of completing merger or acquisition with a private company. SPACs, that are also referred as blank check companies, don't have any commercial operations before acquiring or merging with the searched target company. Usually, even the industry of the searched target company candidate is kept unrevealed at the IPO phase, and no information on the target company won't be revealed before the final target has been found and published. By these means, from the investors' point of view SPACs are speculative investments at the IPO phase, and the investment decisions can only be made based on the trust on the SPAC's management and sponsors. (SEC 2022)

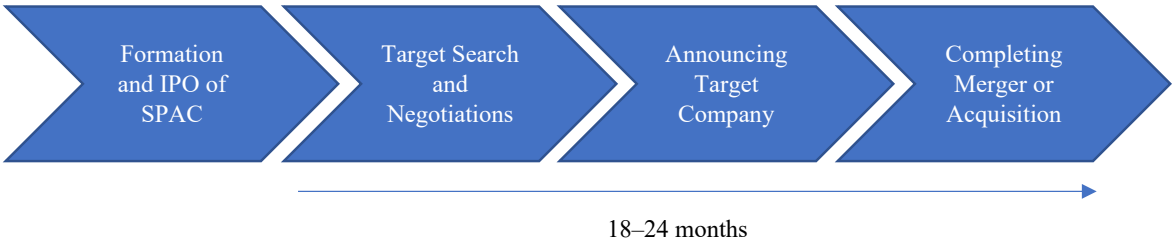
The first wave of SPACs occurred already in 1990s, but SPACs didn't become popular before mid 2000s, when small companies started to face more difficulties in accessing public markets through traditional IPO. (Hale 2007; Heyman 2007). Since SPACs are relatively new financing tools, the academic literature on them is also quite scarce. The first academic papers examining SPACs emerged in both, financial and legal literature, in 2007 when the SPAC market as well as the sizes of SPACs had started to grow significantly. Among the first studies were papers by Hale (2007), Heyman (2007) and Davidoff (2008), who described the structure and characteristics of SPACs as well as looked at the advantages and disadvantages for private companies and investors. According to Hale (2007) SPACs offer something for everyone: upside potential and downside guarantee for investors, possibility

to capitalize expertise and experience for management, and group of publicly available potential buyers for the target companies.

For private companies SPACs offer an alternative way to become a publicly traded company, and it is even stated that compared to traditional IPO, SPAC can offer more certainty for company to go public (SEC 2022). For example, the following characteristics are typical for SPAC mergers: circumstances that are complicated and not suitable for a traditional IPO, expertise that is difficult to replicate from the specialized management, having available cash for facilitating capital structure, and collaborative transaction structure aligning the interests of the target company and shareholders. In addition, SPACs offer solutions for private companies operating in the less examined sectors and which values are thus harder to be benchmarked. Furthermore, SPAC can be an exit opportunity for private company that has difficulties with finding strategic buyer. (Berger 2008)

2.1.1. SPAC process

SPACs' process can be roughly divided into four phases: formation of SPAC and IPO, search of the target company and negotiations regarding it, announcing the target company for the public and finally completing the merger or acquisition. This SPAC process's timeline is illustrated in Picture 1 below.



Picture 1. SPAC process

As seen in the Picture 1 above, at the first phase the SPAC is formed, and listed to the stock exchange through an IPO. Through IPO a private company becomes a publicly traded and owned entity by listing its shares on a stock exchange. IPO is one way for companies to raise

capital, but there are also many other reasons why companies decide to go public. For example, listing to stock exchange can provide a lot of visibility for the company or the early investors are let to cash out their investments. (Forbes 2022) Generally, companies are listed to their domestic stock exchange, but there is also possibility to list stocks to a foreign market.

After a company has decided to go public through IPO, the first step is to hire advisor and underwriter, usually an investment bank, to assist in the IPO process. The advisors will execute a due diligence process for the company and do comprehensive evaluation, and the needed regulatory documents are filed. (CFI 2022a) To register an offering in the U.S., a company needs to file a registration statement with the SEC. As a part of the registration statement is an important document, the prospectus, in which the company, its financial situation, IPO terms and other relevant information are provided to solicit investors. SEC will review the documents, and when they have given approval, the underwriter will value the company to set a price for the offering. Indications of interests from the potential investors that the underwriter have obtained will be used as an important part of the price determination. (SEC 2022) Then the next step is to allocate the shares to prospective investors, and after the allocation is approved and the shares have been registered, the IPO process is completed, and the company has become public traded.

Although going public might offer many new possibilities for a company through raising capital, it also brings many new obligations and requirements for the company as well as it increases company's transparency and public scrutiny significantly. For instance, a listed company needs to file financial reports quarterly and annually, and report to authorities and shareholders for things like planning M&A or selling its assets. (Forbes 2022) Additionally, IPO is a complex and time-consuming process and a lot of interaction with regulators, external advisors as well as with potential investors is required. Also, going public is not a cheap transition. (CFI 2022a)

At the IPO phase, SPAC is only a shell company and has not any commercial operations. In addition, usually any information on SPAC's plans regarding the searched target company is not released at the IPO phase. Compared to traditional businesses, for SPAC the IPO process is less complex because there is no ongoing operating business or acquisition identified (Hale 2007). The funds raised through IPO are strictly only for the purpose of completing a merger or an acquisition, and the funds will be placed in a trust account until

the new business combination will be completed. This is also where the SPAC IPO differs from the traditional one.

After the IPO, on the second phase of the process the SPAC will try to find a suitable target company. SPAC will have predetermined timeframe, usually 18-24 months, to find a potential target company and complete the business combination transaction. (SEC 2021) M&A is a common way for companies to grow their businesses. The abbreviation M&A is composed from the terms mergers and acquisitions, and it refers to financial transactions to combine two (or more) companies. Mergers and acquisitions have different legal meanings even though the terms are often used interchangeably, and the aims are the same. A merger refers to a transaction where two, usually about same sized, companies combine their assets and form one new entity, whereas in an acquisition one company purchases another company's assets or shares and becomes owner of it. Merger is usually implemented through the exchange of the shares of the companies, whereas in case of acquisition the deal can be executed with cash, stock purchase or other asset purchase. (Sherman 2018, 1-3) Furthermore, M&A transactions can be divided by form or by type. The different transaction forms are statutory, subsidiary and consolidation. In turn, the different transaction types are horizontal, vertical, and conglomerate. (CFI 2022b)

Companies' motivations to execute a merger might be, for instance, in restructuring the industry value chain, in responding to cost pressures or in improving process engineering and technology. In turn, motivation drivers behind an acquisition differs between the seller and buyer party: the seller might be unable to compete as an independent operator or seeks access to better resources of the acquiring company, whereas the buyer might aim revenue enhancement or look for operational synergies or economies of scale. (Sherman 2018, 11) It is notable that there are no synergy gains in SPAC mergers as the acquirer doesn't have any operating business (Kiesel et al. 2022).

After the potential target is found, it is followed by the negotiations on proposed merger or acquisition with them. If the negotiations between the companies have ended into agreement of executing the M&A, the business plans will be announced to investors, which is the third phase of the process. The focal point of the SPACs lifecycle is indeed the announcement day of the target company and proposed merger. However, the announced target isn't necessarily positively met by the market. (Kiesel et al. 2022) When the potential target has been found and announced, investors will be given comprehensive information about its business as well

as the terms of the intended business combination. Investors will then have a right to vote for approving or rejecting the business combination. If the investors approve the proposed business combination, the merger or acquisition, as well as the whole SPAC process, is completed.

Nevertheless, it also might be that suitable target company is not found or that the acquisition is not completed within the predetermined time-period. In these cases, the net proceeds of the SPAC's offering will be returned to the investors. In both situations the downside for the investors is minimized. (Hale 2007)

2.2. Short- and long-term performance

The efficient market hypothesis is usually considered as a base framework for evaluating the returns of the stocks. Fama (1965) was the first one to introduce this hypothesis. The efficient market hypothesis introduces the three different forms of the efficiency, based on the nature of the information that is available: weak form efficiency, semi-strong efficiency, and strong efficiency. When the stock market is weakly efficient, it is not possible to predict future performance of stocks based on the historical information on stock prices, and thus no excessive returns are possible to earn based on that. If the market is semi-strong, all available public information is reflected on the stock prices, and all the new information adjusts instantly to the stock prices. Thus, there are no possibilities to earn any additional returns by analysing that information. Strong form efficiency occurs in the market when the stock prices reflect all the private and public information available, and any excessive returns cannot be achieved. (Fama 1965)

The first empirical studies on SPACs performance started to emerge from 2007 (Jog and Sun 2007; Berger 2008; Boyer & Baignet 2008). Earlier studies have concentrated more on the short-term performance around the announcement day of the target company. These earlier studies on SPACs' short-term performance have indicated relatively low abnormal announcement returns, being under 2% on average (e.g., Lakicevic & Vulanovic 2013; Dimitrova 2017). Later Kiesel et al. (2022) found the abnormal returns to be even +7,4% on average in the 5 days around the day of announcing the target. Their results showed that the longer the time from IPO until the target is announced is, the lower the announcement effects

are. However, despite the short-term effects being positive, performance in a longer period, for 12 months to 2 years from the announcement date, was found negative. They observed negative average abnormal returns of -14,1% after 12 months, and after 24 months it was even -18%.

Later more comprehensive studies on also longer post-merger performance of SPACs have been published (Floros & Sapp 2011; Lakicevic & Vulanovic 2013; Kolb and Tykvova 2016; Dimitrova 2017; Vulanovic 2017; Gahng et al. 2021). The results have been very similar, indicating that SPACs severely have underperformed the market and the companies going public through traditional IPO respectively. Vulanovic (2017) reported a failure rate of 58,09% for SPACs which was higher than any results have indicated in previous literature on post-IPO survival. Negative long-term performance was also observed by Dimitrova (2017), who also found evidence that the post-merger performance was worse for the SPACs that announced the intended business combination closer to the end of the deadline. Later also Ghang, Ritter, and Zhang (2021) found the average 12-months returns to be at the level of -11,3%. In addition, many studies have indicated fall in the post-merger share price for most of the SPACs (Jenkinson & Sousa 2011; Klausner, Ohlrogge & Ruan 2022).

Despite the poor post-merger returns on SPACs, some studies have investigated and found SPACs to offer relatively good returns before the completed business combination. For example, Ghang et al. (2021) indicated positive returns on all the SPACs included in their study, all in all offering the annualized return of 23,9% on average for the SPAC period investors. They concluded this finding as follows: “Investing in SPAC IPOs can be viewed as investing in underpriced default-free convertible bonds with extra warrants.”

2.3. Management characteristics and benefits

The impacts of management factors on SPACs have also been one topic that has been studied in several previous studies (Kim 2009; Collins 2012; Hung et al. 2021). The results of the study of Hung et al. (2021) indicated that team size correlated positively to the merger succession, whereas the heterogeneity of management’s experience correlated negatively. Other factors, such as education level and financial experience, were found insignificant. On

the other hand, it has been found that having managers with long experience on the industry positively affects investors attraction on SPAC.

Cummin, Haß and Schweizer (2014) state that in addition to evaluating the abilities of management and board in finding a good target, investors should pay attention to factors that are most crucial for the deal approval. They found that more experienced management didn't have positive effect on probability of deal approval, instead SPACs with younger management tend to have higher probability. Surprisingly, their study also indicated that well-known large underwriter syndicates weren't usually involved in successful SPACs. On the other hand, engagement of high-quality sponsors might add value (Dimitrova, 2017; Klausner & Ohlrogge 2020; Gahng, Ritter and Zhang, 2021). However, behind the under-performance of SPACs there might be contracts with embedded incentives that can affect sponsors and underwriters' intensions to make bad acquisition (Dimitrova 2017).

2.4. Target companies

Berger (2008) examined three SPACs that had completed mergers and recognized many characteristics which SPACs can provide for private companies in accessing public markets that traditional IPOs can't. Indeed, the following characteristics are typical for SPAC mergers: circumstances that are complicated and not suitable for a traditional IPO, added and difficulty replicated expertise from the specialized management, cash that is readily available for facilitating capital structure and collaborative transaction structure aligning the interests of the target company and shareholders. In addition, SPACs can offer solutions for the private companies operating in the less examined sectors which values are harder to be benchmarked, as well as exit opportunities for private companies that are struggling with finding strategic buyers. (Berger 2008) Subsequently also Kolb and Tykvova (2016) indicated that companies can access public markets through SPAC acquisition even in difficult circumstances, in which it would be hard to execute through traditional IPO.

However, Klausner et al. (2022) as well as Gahng et al. (2021) argued SPACs to be more expensive and leading to lower returns on average compared to companies that went public through traditional IPO. Underpricing of IPOs have been a popular research topic, and many studies have indicated underpricing trend among IPOs, but any significant signs of

underpricing with SPAC IPOs there had not been recognized (Jog & Sun 2007; Boyer & Baignet 2008).

3. Data and methodology

In this section, first the Modern portfolio theory, which is behind the chosen methodology and ratios, is shortly introduced. This is followed by explaining the logics behind the chosen performance measures: Capital asset pricing model, Sharpe ratio, Jensen's alpha and Treynor's ratio. After this the process of the data collection and data processing is gone through, and the characteristics of the data set are investigated more closely.

3.1. Modern portfolio theory

Modern portfolio theory is commonly used theory in evaluating portfolio performance and thus it is important framework to understand also in this paper. It was introduced by Harry Markowitz (1952) in his article "Portfolio Selection", and he was later awarded a Nobel Prize for his work on the theory. The key point in the modern portfolio theory is to use diversification for maximizing the expected returns of the portfolio and for keeping the level of risk acceptable at the same time. According to Markowitz (1952) investor should evaluate how the characteristics of the risk and return of an individual investment affects the portfolio's overall risk and return and this way choose the optimal mix of multiple assets to achieve the best results in the light of the investor's tolerance for risk. The theory indeed assumes that the investors are risk averse.

It is notable that in this paper the intension is not to construct diversified portfolio and seek the optimal combination of assets to maximize the returns or to minimize the risk of the portfolio. Rather, the aim is to examine the riskiness and returns of the formed portfolio that consists of high technology SPACs. The measures used for the evaluation, CAPM, Sharpe's ratio, Jensen's alpha and Treynor's ratio, are indeed based on the Markowitz (1965) modern portfolio theory.

3.1.1. Capital Asset Pricing Model

One of the most widely used models for calculating the expected returns on the investment is the Capital Asset Pricing Model (CAPM), which was introduced by Sharpe (1964), Lintner (1965) and Mossin (1966) based on the Markowitz portfolio theory as well as on the main assumptions of the efficient market hypothesis. CAPM describes the relationship between the expected return on the asset and the systematic risk. Systematic risk, which is indicated as beta of the investment in the model, refers to a market risk, which includes different variables, like interest rates and inflation, that are affecting the markets. (Knüpfer and Puttonen, 2018) The mathematical formula of CAPM is as follows:

$$CAPM = R_a = R_f + \beta_a(R_m - R_f) \quad (1)$$

In which:

R_a	Return on the asset
R_f	Risk free return
β_a	Beta
R_m	Return for the market index

It is assumed that there is a linear relationship between the expected risk and the expected return on the investment. This relationship between the risk and the return can be demonstrated graphically as below in Figure 2.

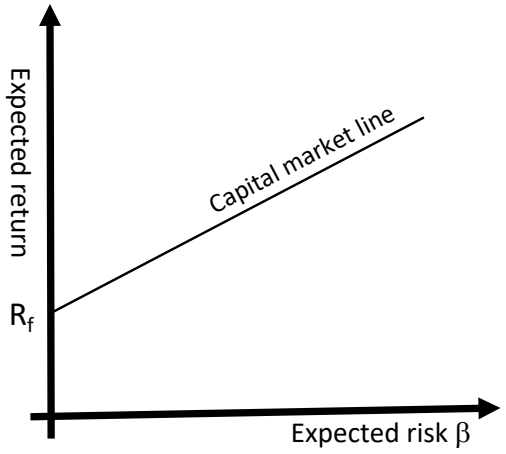


Figure 2. CAPM

Figure 2. clearly shows the basic idea of the CAPM model: when the systematic risk of an investment increases, also the expected returns of the investment increases. In addition, it is notable that according to the CAPM, the minimum expected return of an investment is the risk-free return, which can be seen clearly from the Figure 2.

3.1.2. Sharpe Ratio

Introduced by William Sharpe (1966), Sharpe ratio is one of the commonly known measures for evaluating risk-adjusted performance of the investment portfolio. It is a ratio between the return of the portfolio and the standard deviation of the portfolio's excess returns. In Sharpe ratio the excess returns are defined to be the portfolio return's subtracted by the risk-free return. Mathematically the formula of Sharpe ratio is defined as below:

$$Sharpe\ Ratio = \frac{(R_p - R_f)}{\sigma_p} \quad (2)$$

In which:

R_p Return for portfolio

R_f Risk free return

σ_p Standard deviation of the excess return

High Sharpe ratio indicates that the portfolio's returns are higher relative to its riskiness, meaning the higher the ratio, the better. If the Sharpe ratio is above 1, it is considered usually to be a good measure. However, what should be considered with the Sharpe ratio is that the ratio uses historical returns and volatility for evaluation. The historical performance might not predict well the future performance of the asset. (Mistry & Shah 2013)

It might be also so that the excess returns are negative, in case of which the reliability of the ratio decreases. In this case the equation needs to be modified. (Israelsen 2005) The modified version of the equation is illustrated below:

$$\textit{Modified Sharpe Ratio} = \frac{ER}{SD^{\left(\frac{ER}{absER}\right)}} \tag{3}$$

In which:

ER Excess return for portfolio

SD Standard deviation of ER

abs Absolute value

If the portfolio's excess return is positive, there is no difference whether the standard or modified equation is used for calculating the Sharpe Ratio (Israelsen 2005).

3.1.3. Jensen's Alpha

Another common measure for evaluating the performance of the portfolio is the Jensen's alpha, also referred to as alpha, which is based on the CAPM. It is a risk-adjusted measure, and it indicates the difference between the portfolio's returns to the predicted overall market returns derived from the CAPM. (Jensen 1968) The mathematical equation of Jensen's alpha is as follows:

$$\alpha = R_i - [R_f + \beta_i(R_m - R_f)] \quad (4)$$

In which:

R_i Return for portfolio i

R_f Risk free return

β_i Beta

R_m Return for the market index

Positive Jensen's alpha indicates that the portfolio has performed better compared to the market as well as that the portfolio has generated higher returns relative to the riskiness. If the alpha is zero, the investment has performed according to the expectations, and on the other hand, the values below zero indicates worse performance to the expectations.

3.1.4. Treynor Ratio

Third risk-adjusted ratio for measuring portfolio's performance is Treynor ratio, which was developed by the Jack Treynor (1965). The Treynor ratio measures the relationship between the portfolio's excess returns and the risk like Sharpe ratio, but the difference of these measures is that instead of standard deviation of the portfolio's excess returns, Treynor ratio

uses the market risk, beta, of the portfolio to adjust the portfolio's systematic risk. Below is defined the mathematical formula of how the Treynor ratio is calculated:

$$T_i = \frac{R_i - R_f}{\beta_i} \quad (5)$$

In which:

T_i Treynor ratio for portfolio i

R_i Return for portfolio i

R_f Risk free return

β_i Beta

There is not any indicative values or scale on how to compare the resulting values of the Treynor ratio. Since the ratio is ordinal, it doesn't indicate how much better another asset has performed compared to another. However, when comparing the similar asset's, the higher Treynor ratio is better and indicates the investment to be more suitable.

3.1.5. Volatility

Commonly known measure for the risk of the investment is volatility. Usually, it is considered that the higher volatility of the investment indicates higher risk. Volatility is the standard deviation of the historical returns of the investment and can be calculated as follows:

$$\sigma_i = \sqrt{\frac{\sum_{i=1}^{n}(r_1 - m)^2}{n-1}} \quad (6)$$

In which

σi	Volatility of the investment
ri	Return of the investment
m	Average return of the investment
n	Number of observations

3.1.6. Beta

Beta is another important measure of the investment's systematic risk. Beta compares the risk of an investment to the market risk, and thus it is also important to have comparable beta values when analysing the betas. The market beta is one (1.0) to what investment's beta is compared to: beta that is higher than one is considered to indicate that the investment has more risk than the comparable market portfolio, and on the contrary, beta that is lower than one is considered to indicate that the investment has less systematic risk than the market. The formula for calculating the beta of an investment is:

$$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_{m^2}} \quad (7)$$

In which

βi	Beta of the investment
Ri	Return on an investment
Rm	Return on the market
$Cov()$	Covariance of the returns
σ_{m^2}	Variance of the portfolio

3.2. Data collection and exploratory analysis

The data for this research was collected from Refinitv EIKON database. The data collection started by looking into the overall list of SPACs listed in the US stock market. The list of companies was then delimited to SPACs that had completed the merger or acquisition within the time-period of 2015-2021. Furthermore, the data set was limited only to one macro target industry of the SPACs, high technology, which is one of the most frequent industry SPACs enter through completing the M&A. Also, if the target company was somewhere else than in the U.S., was it excluded from the dataset. After these limitations the list of companies included 67 different SPACs. After the final scope of companies was specified, the daily historical prices for these stocks were collected from the time-period of January 2015 until the end of December 2022. Although the list of companies was limited to SPACs that completed M&A between 2015-2021, the price data was collected until the end of 2022 so that the post-merger performance is possible to be investigated better. In the price data collection phase still a few of the companies was left out since the price data was not available for them. The final list of companies then included 63 companies.

Two different benchmark indices were chosen for measuring the performance of high technology SPACs. The first one is S&P 500 index to compare the performance to the whole market, and the other chosen index is more industry specific, Dow Jones U.S. Technology Index, to examine how the high technology SPACs have performed compared to other technology companies in the U.S. market. The daily price data for both indices was also collected for years 2015-2022. The price developments of the indices are presented in the following Figure 3.

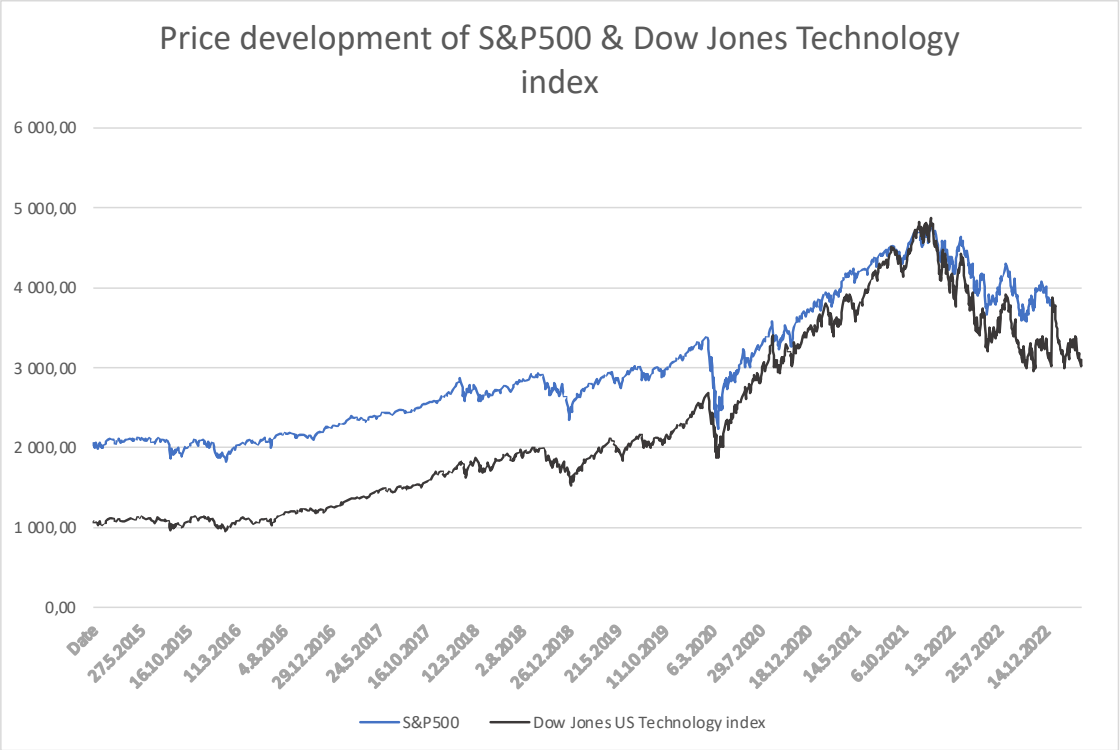


Figure 3. Price development of benchmark indices

As seen from the Figure 3. above, both indices have been relatively stable during the years until 2020. In 2020 there can be seen huge drop on the both indices, which is due to the COVID-19 pandemic that caused a huge decline in the markets globally in the beginning of 2020. However, despite the huge impact on the economy and markets overall, it is notable that the technology industry didn't suffer from the pandemic as much as many other industries. Furthermore, during the 2020-2021 the huge peak in SPAC IPOs appeared.

After the downwards peak caused by the pandemic, the stock markets started relatively quickly to recover as a result of the actions taken by the governments and central banks, and S&P 500 index even hit its all-time high at the time at the end of 2020. (Forbes 2023) The intense rise in the stock markets continued until the beginning of 2022, after which the global indices started to decline as a result of holdover from the pandemic and economic recession and inflation surge. In addition, the Russian invasion of Ukraine escalated the decline in the market globally in the beginning of 2022.

What is also notable is that the two benchmark indices have performed quite hand in hand, which is due to that the S&P500 includes many large technology companies that also have

huge role in the performance of the Dow Jones Technology index. Still, it is good to have both as a benchmark index for the portfolios to see whether there are any differences in the portfolios' performance compared to the peer companies operating in the technology industry only, or to the whole market.

US 10-years Treasury Yield is used as a risk-free rate in this research. The rate is used for calculating the excess returns for the portfolios, which in this paper are calculated as a difference between the portfolio's returns and the US 10-years Treasury Yield. The development of the yield over time is presented in the Figure 4 below.

Figure 4. US Treasury Bond Yield

The development of the US Treasury Bond rate is in a line with the development of the market indexes when looking at the bigger movements of the graph in general. There was a huge decline impacted by the Covíd-19 pandemic in 2020, and in turn the rate has peaked up very quickly in 2022 because of the increased inflation and other post-pandemic effects on the global economy. The rate values have been quite stable and on a decent level before the pandemic and during its aftermath. At the end of the 2022 the direction of the US Treasury Bond rate was still upwards.

3.3. Portfolios

After collecting all the data, the daily raw returns and daily excess returns were calculated for the stocks as well as for the benchmark indices. Furthermore, betas and standard deviations were calculated for each stock individually as well as some descriptive statistics of the data were investigated.

Next the SPAC portfolios were formed. To evaluate the post-merger performance of the SPACs, that have entered the high technology industry, three portfolios were formed based on the time frame after the completed M&A. The portfolios are “SPAC 3-month”, “SPAC 6-month” and “SPAC 12-month”. The post-merger returns for the given time periods were calculated for each stock individually from the moment of completion of the merger. After this the returns of the portfolios were calculated, as well as the returns of the market indices were also calculated and finally compared to the returns on the three portfolios. Furthermore, the chosen measures, Sharpe ratio, Treynor ratio and Jensen’s alpha, were evaluated and compared. The results are presented in the next section.

4. Results

In this section the results and the empirical findings of the research are gone through, and the key findings are summarized. First, the performances of the SPAC portfolios are reviewed and compared to the performance of the benchmark indices, S&P500 and Dow Jones US Technology index. Performance evaluation starts with reviewing the returns on the three portfolios with different timespans calculated from the moment of the completion of the SPAC merger. After this a deeper look into the calculated risk ratios of the portfolios is taken. At the end of this section the results are summarized and analyzed as well as mirrored to the results of previous studies on the area.

4.1. Performance of portfolios

As described in the previous section, three portfolios were formed to investigate the post-merger performance of SPACs in three different timespans: 3 months, 6 months, and 12 months after the completed M&A. The post-merger returns were first calculated for each stock individually for the three predetermined time periods, after which the portfolios were formed, and the average returns for portfolios were calculated. The weights of the stocks in each portfolio were equal as the intention was to investigate the performance of the portfolios and not to maximize the returns or minimize the risk. The annualized raw returns were also calculated for both benchmark indices for the corresponding time-periods of the portfolios. Below in the Table 1. are presented the average raw returns of each portfolio and the annualized returns of the benchmark indices during the time period of 2015-2022.

Table 1. Performance of the portfolios and market indices

SPAC Portfolio	SPAC 3-month	SPAC 6-month	SPAC 12-month
Average raw returns	-8,51 %	-14,27 %	-24,93 %
S&P500	3-month	6-month	12-month
Average return	0,11 %	0,43 %	1,83 %
Dow Jones US Technology Index	3-month	6-month	12-month
Average return	0,25 %	0,79 %	3,34 %

In the Figure 5. below are visually illustrated the average returns of the portfolios and the average yearly returns of the market indices.

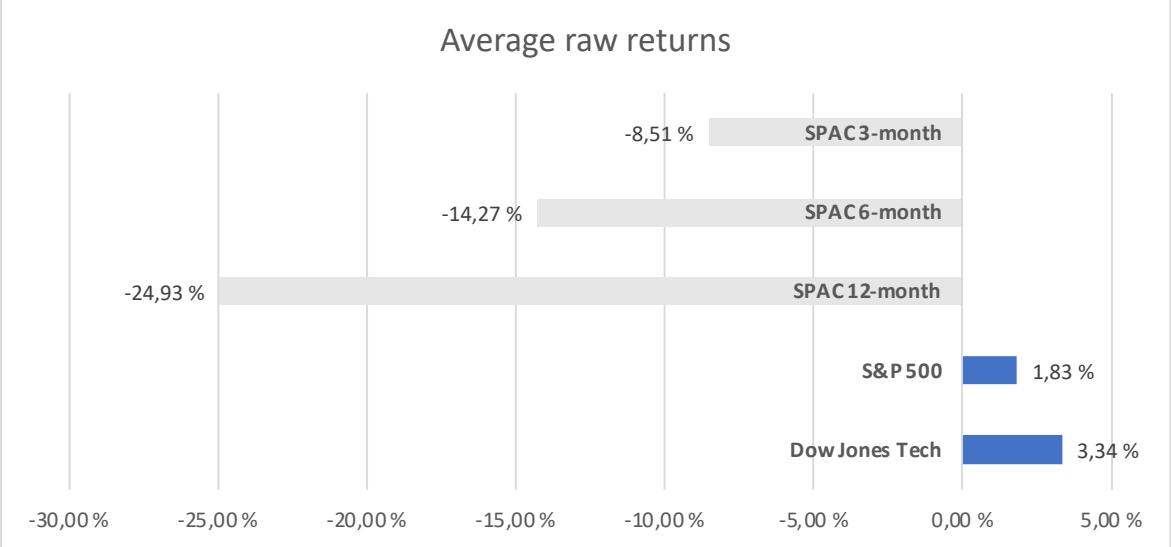


Figure 5. Average returns of the portfolios and market indices

From the results presented in Table 1 and in Figure 5. it can be clearly seen that the SPAC portfolios have performed poorly compared to the market. The returns of all three SPAC portfolios have been significantly negative and the results indicate that the negative returns increase the longer the time has passed from the completion of SPAC merger. The market indices have in turn offered positive annualized returns during all corresponding time

periods. What is also notable from the returns of the market indices, the annualized 12-month raw return of Dow Jones U.S. Technology index (3,3390%) was higher than the equivalent return of S&P500 (1,825%), indicating that the technology industry in general have performed relatively better compared to the whole market.

One explanation for the highly negative returns of the portfolios can be found from the skewness and kurtosis of the data, that indicated clear positive values. This means that the data is clearly right skewed, indicating that it has more extreme values than in normal distribution. This big number of extreme values indeed explains the returns of the portfolios getting such low values.

Next the performance was examined more in the light of the selected risk measures: Sharpe ratio, Treynor ratio and Jensen's alpha. To calculate these ratios, the standard deviation as well as the betas were calculated for the portfolios and market indices according to the formulas presented in the previous section. For calculating the Sharpe and Treynor ratio, the modified formulas were used due to the negative excess returns. The risk measures are presented in the Table 2. below

Table 2. Risk measures

	SPAC 3-month	SPAC 6-month	SPAC 12-month	S&P500	Dow Jones US Tecnology index
Average return	-8,51 %	-14,27 %	-24,93 %	1,83 %	3,34 %
Standard deviation	33,42 %	25,96 %	23,72 %	1,19 %	1,57 %
Sharpe ratio	-0,11	-0,16	-0,27	-0,002	0,81
Treynor ratio	-0,035	-0,042	-0,063	-0,002	0,01
Jensen's alpha	-0,09	-0,15	-0,27	0,00	0,00

As seen from the Table 2. above, the standard deviations of all three portfolios have been quite high, indicating that stock prices among the portfolio have been highly spread out. The volatility of the SPAC 3-month portfolio was the highest with the value of 33,42%. It is logical that the stock prices are more volatile right after the completion of the merger or

acquisition. The volatility of the SPAC 6-month portfolio was clearly lower, 25,96%, whereas the difference between the volatilities of the SPAC 6-month and SPAC 12-month portfolio was only about two percent, the value of SPAC 12-month portfolio being at the level of 23,72%. The standard deviation values of the benchmark indices also indicate how volatile the portfolio returns have been compared to the market. The standard deviation of S&P500 was only 1,19%, and the respective value for the Dow Jones US Technology index was 1,57%.

The average beta of SPACs was 1,016. The market beta being at the level 1,0 this indicates that the SPACs are more volatile and riskier investments on average compared to the market, but still, this would indicate the portfolio being at a low risk. The beta could have assumed to be much higher since the standard deviation of the portfolios indicated much higher volatility and riskiness compared to the market. However, when looking at the individual stock betas, like within the returns of the stocks there are also very differing values among the betas. For some of the stocks the beta even took negative values, indicating an inverse relation to the market trend for these individual stocks.

The values of the utilized measures were found out to be negative for all portfolios. The average rate of the US Treasury Bond that was used as a risk-free return in the calculations, was 2,074%. Sharpe ratios of the portfolios (-0,11, -0,16, -0,27) are poor and indicate that the excess returns of the portfolios are negative and that the risk of the portfolios are not being offset well enough by their returns. However, the ratio was slightly negative also for the S&P500 index (-0,002), but the value still being very close to zero and thus indicating low risk. Dow Jones US Technology index was the only one having a positive Sharpe ratio, the value being 0,81 which is not that good either but considered as a sub-optimal value for Sharpe ratio.

Treynor ratios of the portfolios were also negative but slightly better than the values of Sharpe ratios. These two measures share similarities as both measure the ratio between the risk and the return of the portfolio, but the difference is that Treynor ratio utilizes portfolio beta to measure the volatility of the portfolio whilst Sharpe ratio utilizes the standard deviation of the portfolio. Indeed, the standard deviation indicted higher riskiness compared to the beta value. Treynor ratio was -0,035 for the SPAC 3-month portfolio, -0,042 for the SPAC 6-month portfolio and -0,063 for the SPAC 12-month portfolio. These values indicates that the portfolios have performed worse than a risk-free instrument in the market.

Treynor ratios for the benchmark indices were very close to the zero, -0,002 for the S&P500 index and 0,01 for the Dow Jones US Technology index. These values indicate that the indices have been nearly risk-free investments during the time-period.

Correspondingly, the values of Jensen's alphas indicated also poor performance for the portfolios compared to the benchmark indices. The alphas of all three portfolios were negative (-0,09, -0,15, -0,27). Respectively, The Jensen's alphas of the S&P500 and Dow Jones US Technology index were 0. These values shows that the portfolios didn't outperform the market indices during the time period, and that the portfolios have performed below the expectations set by the CAPM.

4.2. Result analysis

The overall performance of the SPAC portfolios was very bad, but what is important to consider when looking at the results, is that there were huge differences among the returns of the individual stocks in the portfolios. This can be derived from the standard deviation values of the portfolios, that indicated high volatility. However, standard deviation assumes a normal distribution, but as the values of skewness and kurtosis of the data indicated, the returns are clearly right skewed. Thus, it is important to note the effects of the extreme values when judging the returns of the portfolios. The significant movements, and very high or low returns of an individual stock might have a huge effect on the return of the whole portfolio. These huge differences in the performances of individual SPACs indeed makes SPACs complex investment targets. Some of the factors that might affect the price movements of SPACs, especially when looking at the post-merger performance, are for example how favourable the proposed target company is for the investors, how successful the completion of the M&A is and what is the technique that the M&A is executed with. However, high price movements are not necessarily always negatively affecting issue as on the contrary these might also offer possibilities for high returns. Nevertheless, according to this and most other previous studies, in case of SPACs it has led mostly to highly negative returns. In addition to the fact that the high volatility is typical characteristic for SPACs, it is notable that the technology companies in general also tend to be more volatile for the market movements.

Another notable fact when looking at the results is that as the peak of SPAC IPOs appeared during the years 2020 and 2021, most of the SPACs in the portfolios also have entered to the market as well as completed the M&A during these years. Thus, most of the return observations are from 2020-2022 and there are much less observations from earlier years of the chosen time period. Because of this the market conditions of these years are very important factor to consider, especially because during the years 2020-2022 there were exceptionally huge movements in the market. During this time the Covid-19 pandemic had huge effect on the global economy, which might have had a huge impact on the performance of SPACs.

Overall, the results observed in this paper are in line with the previous studies as these have also indicated poor post-merger performance and negative returns for SPACs (e.g., Floros & Sapp 2011; Lakicevic & Vulanovic 2013; Kolb and Tykvova 2016; Dimitrova 2017; Vulanovic 2017; Gahng et al. 2021; Klausner, Ohlrogge and Ruan 2021; Gahng et al. 2023). For instance, Klausner et al. (2021) discovered in their paper that the SPACs offered the negative return of -2,9% on average after three months of the merger, -12,3% after six months, and after a year the return was as low as -34,9%, when in this paper the corresponding returns were -8,51%, -14,27% and -24,93%. In addition, the calculated values of the risk measures, Sharpe's ratio, Treynor's ratio and Jensen's alpha, reflected the poor returns, indicating that the SPACs have performed poorly compared to the market and haven't offered good return on investment in relative to the risk. Furthermore, in the paper of Vulanovic (2017) documented post-merger returns of even -40,0%.

5. Conclusions

This is the final section of this paper and concludes the aim as well as the results of this study. The section ends with suggestions for further studies.

5.1. Concluding remarks

The goal of this study was to investigate how the high technology SPACs have performed in the US stock market, since the SPAC market has experienced a huge spike recently and there is not that much research on this area yet. High technology industry was selected as industry of interest because it is one of the most common target industries of SPACs as well as the industry itself is highly emerging and becoming more and more important nowadays.

The following research questions were investigated in this paper:

How U.S. SPACs that have acquired or merged with technology companies have performed in 2015 – 2022?

Do the returns of technology SPAC portfolios differ from the returns of the benchmark index in 2015-2022?

Have the technology SPAC portfolios been profitable for investors?

The results indicated clearly negative returns for all three formed SPAC portfolios, which is in line with the previous findings on the SPAC performance. High technology SPACs didn't outperform the market indices and weren't favorable investment targets in 2015-2022. Although the results were in line with other studies on the performance of SPACs, they were surprising in the sense that in this thesis the focus was narrowed only to the high technology industry and the stocks of the companies operating in this industry have generally performed relatively well despite the unfavorable market conditions. However, it needs to be considered that in this paper the post-merger performance of the high technology SPACs was

investigated only for the time period of 12-months after the merger, so the companies might offer better returns in a longer run.

It is also notable that during the examined time-period the global economy has experienced huge impacts from the Covid-19 pandemic, first causing a huge crash in the market, which was followed by quite quick recovery and the stock markets were hiking up to the all-time highs, but then at the end of the period another significant decline in the market started because of economy recession and increasing inflation. Most of the SPACs included in this study have entered to the market as well as completed the merger during these two last years and thus these uncertain market conditions surely have had an impact on the overall performance of the portfolios.

In the light of the findings on this study as well as referring to previous studies conducted on the performance of SPACs, it can be concluded that the SPACs haven't offered a good investment alternative for the investors within the year after completing the merger in 2015-2022. SPACs are to some extend speculative investments which make them relatively risky, but on the other hand they might also offer high returns for the investors due to high volatility. According to these results, it might not be favourable to construct a whole portfolio including only SPACs, but rather mixing SPAC stocks together with other less risky and more stable stocks.

The number of new SPAC IPOs have dropped in 2022. Because of the huge spike in SPAC listings in 2021 there is now a lot of competition in searching the suitable target companies. Due to this as well as due the current market conditions, it is more convenient for new SPACs to wait until the current SPACs in the market have completed the mergers or liquidated.

5.2. Further studies

SPACs are still relatively new topic in academic research as the amount of data has been quite narrow before the recent hype in the SPAC market. Therefore, there is a need to investigate the topic further to be able to understand better how the SPACs perform in the market, especially in the long term. Currently there are not yet many findings about SPACs performance in a longer run, but as the amount of the data increases the more comprehensive studies can be implemented and more reliable results on the long-term performance can be

found. Furthermore, the research could be conducted also on the other geographical markets. There has been a spike in SPAC IPOs also in the other markets, like in Europe, and it would be interesting to investigate, whether the results are similar to findings from the U.S. market. Currently most of the studies have concentrated on the U.S. market. Also, it would be interesting to focus on some other industry of the target companies. For example, healthcare industry is another popular target industry of SPACs, which could be investigated.

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