Diversifying a technology portfolio with videogame industry shares

- An investment analysis

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Master's thesis in Information Systems

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Abstract:

The videogame industry as changed drastically the last 70 years, and this change has partly been due to technological advancements, but also due to changes within the industry itself. As the videogame industry has grown, it has gained interest among companies operating within other industries, such as the technology industry. Some technology companies have created or acquired their own videogame studios, and some have started to offer products that cater to those who play videogame. These changes have brought the two industries closer to one another, and it could become hard to differentiate between the two. This study examines the videogame industry and the technology industry and aims to answer the following questions: Do investors see the videogame industry as part of the technology industry, can shares of companies in the videogame industry be used to diversify technology portfolios, and is the videogame industry a lucrative investment of diversification in upward and downward trends.

The study was conducted using qualitative and quantitative methods, with the former consisting of a literature review, and the latter being a portfolio analysis. The first research question is answered using both methods, whereas the other two are answered by the portfolio analysis. Data consists of weekly closing prices for 16 companies, of which eight represent the videogame industry, and eight the technology industry. Additionally, data of US Treasury rates, currency exchange rates, and closing prices for stock market indices are included.

The results suggest that the videogame industry is perceived by investors separately from the technology industry, as videogames are more likely considered cultural goods, rather than technology goods. The results from the portfolio analysis suggests that shares of companies from the videogame industry can both be used to diversify a technology portfolio and are lucrative investments of diversification in upward and downward trends. Videogame companies appear to have a lower risk than technology companies, which in this case means that the prices for videogame companies fluctuate less during stronger upward or downward movement.

Based on the results, the videogame industry is considered its own industry, but a continuing increase in interest for the industry can lead to the consolidation of the videogame and technology industry, where larger technology companies are the largest stakeholders. This would mean that investors who invest in the technology industry could also be required to have some understanding of the videogame industry, as it would affect the companies' results.

Keywords: Videogame industry, technology industry, portfolio analysis

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Abbreviations

CAPM – Capital Asset Pricing Model

CPU – Central Processing Unit

ETF – Exchange Traded Fund

GICS – Global Industry Classification Standard

GPU – Graphical Processing Unit

HKD – Honk Kong dollar

ICAPM – International Capital Asset Pricing Model

JPY – Japanese yen

KRW – Korean Republic won

MPT – Modern Portfolio Theory

MSCI – Morgan Stanley Capital International

PC – Personal Computer

RAM – Random Access Memory

S&P 500 index – Standard & Poor's 500 index

TV – Television

U.S. – United States

USD – United States dollar

1. Introduction

The videogame industry has evolved together with technology and changed drastically the last 70 years. Videogames began as projects for academic research, and later became a mainstream source of entertainment, starting in the 1970s with visiting arcade galleries and playing on arcade machines to playing games on mobile phones in the 2000s. The videogame industry has grown and changed more rapidly during the period between 1990 and 2020, from buying videogame cartridges in stores and playing them at home on a console to simply downloading or streaming videogames through a library online. With the change in how videogames are played, so too did the way revenues generated from games change. Instead of only receiving revenues from selling copies of games and the hardware to play them, purchasable in-game digital content and add-ons were introduced, such as expansions.

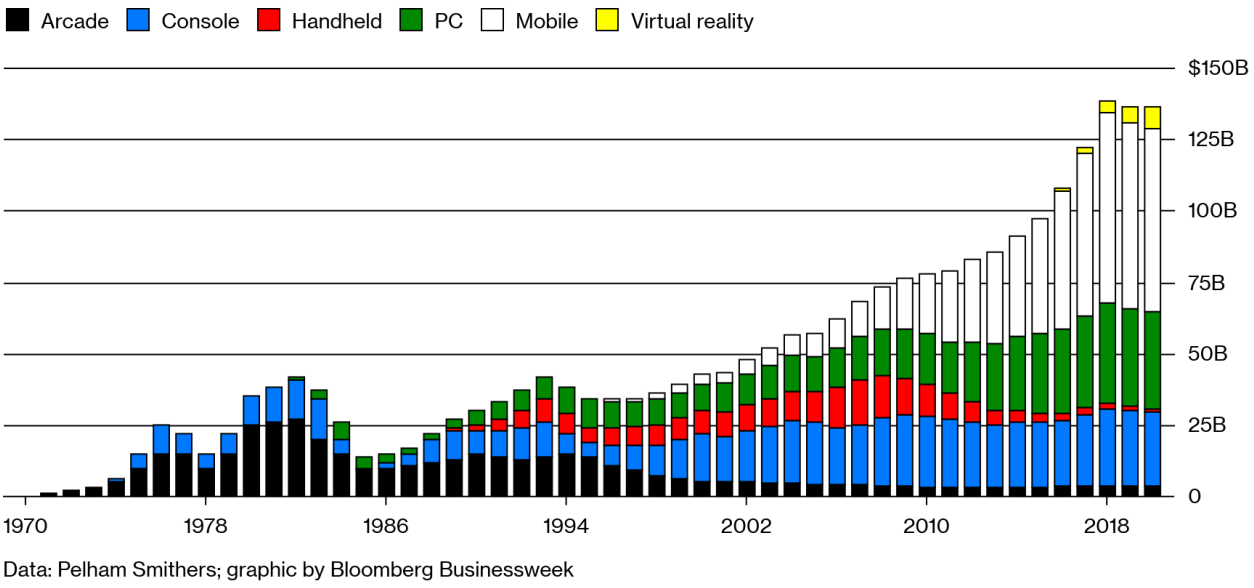

Figure 1. The graph shows the change in videogame industry revenue for different gaming platforms, source: Bloomberg

Videogame events and live broadcasting videogames online have also become a major part of the industry. Events such as world championships, with notable prize pools, the record being 40 million USD (esportsearnings.com, 2022), have spectators watching both locally and virtually.

Live broadcasting videogames has become a way to socialize while playing and large communities have formed around those who stream, with live viewer counts reaching substantial numbers, the record being 3.3 million peak concurrent viewers (Twitchstats.net, 2022).

The number of companies that manufacture hardware and accessories that are marketed for those who play videogames have also increased. These products span from computers and monitors to headsets and gaming chairs.

As the industry is estimated to grow, deciding to invest in the videogame industry could potentially yield good returns, and this study will focus on both passive and active investors with technology portfolios, and whether these investors might want to consider including videogame companies in their portfolios to either increase their returns or to lower the risk of their portfolios.

1.1. Background

As technology and the technology industry have advanced, so too have videogames and the videogame industry. With the introduction of the first smartphones, videogame apps were created and quickly became popular. As smartphones became widespread, videogames became more accessible and suddenly, everyone could play videogames, as all that was needed was a smartphone, whereas before one was required to own a videogame console or PC to play videogames. This change can be seen in Figure 1. where the largest revenues have been generated from videogames on mobile phones since 2015, and from the revenues generated from videogame apps, as 50% of mobile app revenues worldwide have been generated from videogame apps (Statista, 2021).

Videogames also became more popular with the introduction of playing online with friends, which built upon the social aspect of a videogame console. Earlier only those who played on PC were able to play online with others. As videogame consoles were less expensive and more accessible than PCs, the introduction of online gaming on consoles had a notable impact on the growing popularity of gaming. The popularity of gaming and the social aspect that came with it, in turn helped e-sports to grow.

The effects of the popularity of videogaming can be seen in other consumer electronics as well, as companies also want to cater to gamers with their products. An example of this are the higher refresh rates on TVs, which does not benefit someone who watches cable TV, films, or series as much as someone who plays videogames. The reason for this is that most films, series, and cable TV programmes are displayed with around 24 and 60 frames per second. Semiconductor manufactures also take into consideration gaming with their CPUs and GPUs for PCs, laptops, and smartphones. This can be seen in the marketing done by these companies when releasing new products.

The popularity and accessibility of videogames is growing, and the videogame industry is also estimated to keep growing and is estimated to reach a total revenue of 321.1 billion dollars in 2026 (PwC, 2022). The number of videogame company acquisitions have also increased, which suggests an increased interest in the industry. Larger technology companies such as Microsoft and Sony have been very active in acquiring videogame companies. An example being Microsoft's ongoing acquisition of Activision Blizzard, which if it succeeds, is the largest videogame industry acquisition to date as the transaction is valued at 68.7 billion USD. The largest successful acquisition is 12.7 billion USD, when Take-Two Interactive acquired Zynga in 2022.

The acquisitions mentioned have all been made by companies that have already had a stake in the videogame industry, but companies such as Netflix have also showed interest in the industry by acquiring four videogame companies in 2021 and 2022. Companies operating in the hardware sector, such as Samsung, also have a stake in the videogame industry by producing gaming monitors in addition to their other monitors.

These acquisitions would indicate that larger companies see value in the videogame industry, which might be partly fueled by the metaverse-trend. For example, the company Meta (former Facebook) has started to invest heavily in the metaverse, and even changed its name to reflect this. Meta acquired the company Oculus VR in 2014 and are using the technology by Oculus VR to build their metaverse.

The metaverse is a considered to be a virtual social space, where people can meet and socialize in different ways. Most commonly the hardware used for this are the Virtual Reality (VR) headsets, through which the user sees only the virtual world in front of them. Popular games that are considered part of the metaverse are World of Warcraft, Minecraft and VRChat. In addition to

socializing in a virtual social space, metaverse could also be used for educational or training purposes.

The growing interest in the metaverse and an increase in acquisitions have also led to share prices for many companies in the videogame industry to rise in the hopes of new acquisitions being announced. The continuous increase of interest in the videogame industry has made the differentiation between technology and videogame companies unclear, as technology companies increase their stake in the videogame industry.

Major changes in the videogame industry have made it possible for videogame companies to increase revenue generated from videogames, in addition to the revenue from initial sales, companies also receive a continuous stream of revenue in the form of digital monetization.

As the differentiation between videogame companies and technology companies become unclear, the views of investors regarding these industries might have changed. Understanding what the views possibly have been, what they are now, and what they could be, can be valuable for both passive and active investors alike. Passive investors might want to consider adding videogame companies to their technology portfolios for better long-term returns, whereas active investors might want to consider adding videogame companies to their technology portfolios for hedging purposes or to increase returns.

1.2. Key concepts

The key concepts used for the portfolio analysis in this study are the portfolio theories and the market indices used in the analysis. The videogame and technology industry, and the metaverse are concepts used to give a better understanding of how the industries have reached the current situation, and how the future might look for them. These concepts are used to answer the three research questions of this study. The portfolio analyses are in their nature technical analyses, which are more commonly used by professional investors compared to passive investors. Fundamental analyses are also used when making investment decisions and trying to understand the investor views of the videogame and technology industries can be considered fundamental analyses to some extent.

According to Dongcheol and Francis (2013) portfolios are objects of choice, where individual assets that are included in a portfolio are inputs. These inputs are however not the objects of choice that an investor should focus on, instead investors should focus on the best possible portfolio that can be created. The process of creating and choosing between portfolios to find the optimal portfolio is considered portfolio analysis.

The Modern Portfolio Theory (MPT) is used to create a portfolio consisting of assets, where the expected return is maximised based on a given level of risk. Diversification is a key component in the theory. The original portfolio theory model was introduced in 1952 by Markowitz and has since then been used as a basis for other models, such as the Capital Asset Pricing Model (CAPM). CAPM is used to analyze different portfolios and how they compare to a market portfolio, which are often stock market indices. The data for portfolio analyses are based on historical data. With CAPM, an investor can calculate an estimate for expected return on an asset or a portfolio. The model is based on the original Portfolio Theory by Markowitz, which assumes that an investor is risk averse and will not invest if the risk-free return is higher than the possible return from risky investments.

A stock market index consists of varying numbers of companies. Different indices can contain companies from different industries depending on what part of the stock market is measured. Indices are used by investors to see market performance, which is calculated by comparing current and past stock prices. The indices that are used in the study are the Nasdaq-100 index and Standard and Poor's 500 (S&P 500) index. The Nasdaq-100 index is considered a technology index, and the S&P 500 is considered technology heavy, because of the high weight in technology companies.

The technology industry will be used in the study to describe the industry consisting of technology companies, such as Apple and Microsoft. The technology industry is defined in this study as the Information Technology sector, by the Global Industry Classification Standard (GICS). The videogame industry consists of companies that sell goods and services in the form of videogames, accessories, and hardware. The accessories and hardware are often marketed for playing videogames. In this study companies that are part of the videogame industry are those, that generate the most of their revenue from videogames, or gaming related accessories and hardware.

The Metaverse is currently a buzzword in the technology industry and could be considered one of the reasons why there is an increased interest in the videogame industry. The Metaverse is defined

by Dionisio et al. (2013) as 3D virtual worlds in an integrated network. Currently most virtual worlds are described as independent, and these independent worlds are required to become integrated for the Metaverse to become a viable option for social interaction in society (Dionisio et al.,2013). The Metaverse could become in the future a common platform for socializing and interacting with both other people and institutions. In addition to socializing, education, training, and work could also be conducted through the Metaverse in the future.

1.3. Methodology

In this research, qualitative and quantitative research methods will be used. The qualitative methods will be in the form of a literature review, which will be used to answer the first of three research questions in this study. Quantitative methods are used for the portfolio analysis and is used to answer the other two research questions and will help in answering the first research question as well. Qualitative research methods are used to understand social and individual interpretations at points in time, and in particular contexts (Merriam, 2022). The literature used to answer the first research question will consist of academic research, articles on the videogame and technology industry, and company financial reports. The literature will be retrieved online from Google Scholar, company investor relation webpages, and news websites. The literature will be used to form a better understanding of past, present, and future views of investors on the differences between the videogame and technology industries. Quantitative research methods are defined by Creswell (2014) as a means for objective theories to be tested by the examination of relationship among variables. Creswell (2014) also states that the variables can be measured, by analysing numbered data using statistical procedures. The data for the research will be collected through webpages and will be analyzed using a portfolio analysis method. The data will consist of adjusted closing prices for company stocks, market indices and the rates for relevant bonds.

1.4. Aim and research questions

In this study, CAPM will be used to analyze how videogame industry companies compare to technology industry companies. These companies will also be compared to the S&P 500 and Nasdaq-100 indices. Lastly, optimal portfolios will be created based on the expected returns for individual stocks.

The aim of the study is to determine how the videogame industry is viewed by investors, whether it offers a way to diversify a technology portfolio, and whether it performs better or worse than the technology industry. Because of the estimated growth and an increased interest by companies in the videogame industry, understanding it as an investment opportunity and how it is viewed by investors can be valuable.

The research questions are the following:

- Do investors see the videogame industry as part of the technology industry?
- Can shares of companies in the videogame industry be used to diversify technology portfolios?
- Is the videogame industry a lucrative investment of diversification in upward and downward trends?

1.5. Limitations

The limitation of the study is that the analysis is mostly based on historical data. This means that in the analysis one can only see how the videogame industry has performed in the past compared to the technology industry, but it is uncertain how the two will compare in the future. Expected returns are also based on historical data.

Another limitation is that the data is based on share prices of companies. This means that only companies that are publicly listed can be considered.

The videogame industry could be divided into three groups: software, hardware, and events and e-sport. Including companies from these different groups in the analysis could give a better understanding of the industry performance. However, due to lack of publicly listed companies that could be considered representing the hardware and the events and e-sport groups, the hardware group is narrowly represented in this analysis, and the events and e-sports group will not be included.

For the study, eight companies from the videogame industry and eight companies from the technology industry will be included. The stock market indices that are included are the Nasdaq-100 index and the S&P 500 index. These two indices are considered technology indices, due to the high percentage of technology companies included in them.

Three time periods will be looked at, of which two are six-year periods and one is an elven-year period. The eleven-year period will be from 2009 to 2019, and the six-year periods will be from 2005 to 2010, and 2017 to 2022. The six-year periods represent more volatile market periods, and the eleven-year period represents a more long-term and stable upwards trending market period.

1.6. Structure of the thesis

The study is structured into six chapters, and begins with an introduction, where the background, limitation and aim of the study are included.

In the second chapter the relevant theories for the study will be presented.

The third chapter will contain the methodology of the study, which includes the method and data gathering for the analysis that will be conducted, after which the technology and videogame industry will be defined, and the companies chosen will be briefly presented.

The fourth chapter includes the results from the analysis.

The fifth chapter comprises of a discussion of the results.

The sixth and last chapter include concluding remarks and suggestions for future research.

2. Theory and Literature Review

In this chapter, the relevant theories for the research are presented. This includes stock market and portfolio analysis theories. Theory for indices, and information regarding the selected indices will also be presented. This section will also include a literature review of the technology and videogame industry.

2.1. Stock Market and Portfolio Analysis Theories

In this section, the theories used for the method and result analysis is presented. The Modern Portfolio Theory and Capital Asset Pricing model will be presented, the mathematical theories for CAPM laid out, and the strengths and weaknesses of the models will also be discussed. The Modern Portfolio Theory will only be presented and discussed briefly, as the Modern Portfolio Theory is not used for the method and result analysis, but since CAPM is based off it, it is included.

2.1.1. Modern Portfolio Theory (MPT)

The basis for MPT is the portfolio theory created by Harry Markowitz in 1952. The theory presents a way to select optimal portfolios based on statistical inputs, and key assumptions. One of the key components in the theory is diversification. Improvements and extensions were made to the model by James Tobin and William Sharpe, where Tobin for example included a risk-free rate to the analysis model.

Markowitz (1952) presented the process of selecting portfolios as a two-step process, where the first step starts with the observation and experience of securities, and ends with future performance estimates of the securities, while the second step starts with relevant estimates of future performance and ends with the choosing of a portfolio.

The key assumptions of Markowitz's portfolio theory are that investors seek to maximise return, with the lowest possible risk, an increase in risk is acceptable only when higher returns can be expected, and information on the market is obtainable by all investors.

The statistical inputs of Markowitz's portfolio theory are the expected rate of return and standard deviation of returns for each included security, and the correlation coefficient between the pairs of all the securities included.

Although Modern Portfolio Theory was initially praised when introduced and was used as a basis for other models, it still has limitations and disadvantages. One limitation of the model is that it is considered to not properly represent the financial market of the real world, since the inputs of the model are expected values based on historical data, which do not consider possible future scenarios. One notable disadvantage is that the portfolios are evaluated in the model based on variance. Two portfolios can have the same variance and returns, which means that the model sees them as equally good options, even though the underlying reason behind the variance might differ.

2.1.2. Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM) is a model used for determining an expected price for a portfolio or a security. The model builds upon the Modern Portfolio Theory and the works of Harry Markowitz.

The development of the model is usually accredited to William F. Sharpe, John Lintner and Jan Mossin, however, Jack Treynor might possibly have been the first to develop the first CAPM (French, 2003).

As shown by Fama and French (2004), the CAPM model is derived from the following equation:

$$\frac{E(R_i) - R_f}{\beta_i} = E(R_m) - R_f$$

When solving for $E(R_i)$ we have the Sharpe-Lintner CAPM (Fama and French, 2004):

$$E(R_i) = R_f + \beta_i\,(E(R_m) - R_f)$$

Where:

$E(R_i)$ is the expected rate of return of a security

R_f is the risk-free rate

β_i is the beta, which indicates the sensitivity of the expected returns of a security compared to the expected return of the market. The beta, β_i, is derived from the following equation:

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)}$$

where $Cov(R_i, R_m)$ is the covariance between the security and market return, and $Var(R_m)$ is the variance of the market return.

$E(R_m)$ is the expected rate of return for the market.

$E(R_m) - R_f$ is called the market premium, and $E(R_i) - R_f$ is called the risk premium, and it is the difference between the return and the risk-free rate.

The risk-free rate is the rate of return on an investment which is considered to have no risk or a very low risk. Government obligations issued by stable and safe countries are usually considered to be risk-free, such as the bills and bonds issued by the United States. One should note, that although these bills and bonds are considered risk-free, they still carry a certain level of risk.

The result of CAPM can be visually graphed with the Security Market Line (SML), where the risk is the x-axis, and the expected return is the y-axis. The slope of this line is the market risk premium.

Although CAPM is widely used within financial institutions, CAPM is also criticized for having many simplified assumptions (Fama & French, 2004), which means results can be considered invalid. Because of this, a qualitative research method is also used in this study, so that the results from the portfolio analysis can be compared with the results from the literature review.

2.1.2.1. International Capital Asset Pricing Model (ICAPM)

The International Capital Asset Pricing Model (ICAPM) is very similar to the standard CAPM, where investors are awarded for risk in form of the risk premium, and the risk-free rate. However, it differs from the standard CAPM by considering currency risk, and foreign risk-free rate, in the form of foreign currency exchange rate fluctuations and foreign interest rates on bonds.

The ICAPM will be used in the portfolio analysis as foreign companies are included in the portfolios. ICAPM will help to consider changes in currency exchange rates between the U.S. dollar and other currencies, such as the Japanese yen, but foreign interest rates will not be considered in this study.

The mathematical derivations, based on the original research of the Intertemporal Capital Asset Pricing Model by Merton (1973), and as shown by LGT Economic Research (2020) for calculating the return for foreign stocks in U.S. dollars are the following:

$$R_{t+1}^{in\ USD} = \frac{Stock_{t+1}^{in\ JPY}}{Stock_{t}^{in\ JPY}} \times \frac{JPY/USD_{t+1}}{JPY/USD_{t}} - 1$$

When re-arranged, we have the following equation:

$$R_{t+1}^{in\ USD} = \Delta\%Stock_{t+1}^{JPY} + \Delta\%\frac{JPY}{USD}_{t+1} \times \left(\Delta\%Stock_{t+1}^{JPY}\right)$$

They further simplify the equation as:

Return in USD = Local return + currency return

2.1.3. Efficient Frontier

The efficient frontier can be used to further optimise a portfolio, based on adjustments to the risk-return profile of the portfolio.

The Efficient Frontier consists of different portfolios, with a different mix of return and risk, where the frontier indicates the highest possible return for a given level of risk. This frontier curves

towards the y-axis in a graph, and the portfolio, which is in the centre of the curve, is the portfolio with the lowest risk.

Every portfolio on the efficient frontier that is underneath this lowest risk portfolio, are considered undesirable, as they yield a lower return, for the same or higher level of risk. Portfolios in the efficient frontier that are above this lowest risk portfolio yield higher returns, but also increase in risk.

A portfolio can be considered optimal when it achieves the highest return compared to other portfolios at the same level of risk. This optimal portfolio would be tangent to the Capital Allocation Line (CAL).

2.1.4. Sharpe Ratio

The Sharpe ratio was created in 1966 by William F. Sharpe and is used to measure the reward-to-risk ratio of an asset, or a portfolio compared to a risk-free asset. The Sharpe ratio shows how much risk is added when the return increases.

The first version of the Sharpe ratio was called Reward-to-Variability ratio and was introduced to measure mutual fund performance (Sharpe, 1966).

The Sharpe ratio has had revisions over the years, but the original in 1966 was defined as the following:

$$S = \frac{E[R - Rf]}{\sqrt{var[R]}}$$

In theory, a portfolio that has the highest Sharpe ratio, is also the one to yield the best return when considering the risk that comes with it. Because of this, the optimal portfolios in this study will be defined as those with the highest Sharpe ratio.

2.2. Stock Market Indices

The most common definition for a financial index is a market-capitalization-weighted average of a list of securities (Lo, 2016). An example of such an index is the Standard and Poor's 500 (S&P 500) index. These stock market indices serve as tools to see how the stock markets are currently moving or have moved in the past and are used in portfolio management. The indices can also be used to try and predict future movement.

2.2.1. Standard and Poor's 500 (S&P 500) Index

One of the most popular stock market indices is the Standard and Poor's 500 (S&P 500) index, which contains 503 companies and comprises of approximately 80% of the available market capitalization (S&P Dow Jones Indices, 2022). The S&P 500 index has requirements that need to be met for a company to be included in it, two of these requirements are that a company needs to have an unadjusted market capitalization of 14.6 billion USD or greater, and the eligible company needs to be a common U.S. equity listed on an eligible U.S. exchange (S&P Dow Jones Indices, 2022).

The weighting method for the index is a float-adjusted market capitalization weighted. Float-adjusted means that the count of shares outstanding is adjusted to only reflect those that are available (S&P Dow Jones Indices, 2022).

The index is used in the study because it is a technology heavy index, consisting of approximately 26.4 % Information technology companies according to S&P Dow Jones Indices (2022). The top companies by index weight include notable technology companies such as Apple Inc., Microsoft Corp., and Alphabet Inc A and C.

2.2.2. Nasdaq-100 Index

The Nasdaq-100 index contains 102 of the largest based on market capitalization, Nasdaq listed non-financial companies (Nasdaq, 2022). Unlike the S&P 500 index, the Nasdaq-100 index includes both U.S. and international companies.

The weighting method for the index is modified market capitalization weighting, where weighting adjustments are made quarterly and annually (Nasdaq, 2022).

As with the S&P 500 index, the Nasdaq-100 index is also used in this study because of the heavy weight of technology companies. The weight of the technology industry in the index is approximately 54.8%, and top companies also include the same as in the S&P 500, e.g., Apple Inc., Microsoft Corp., Alphabet A and C.

2.3. Technology and videogame industry

In this part of the thesis, the technology industry and the videogame industry will be presented. Here the two industries will also be defined using the Global Industry Classification Standard (GICS) by Morgan Stanley Capital International (MSCI) and S&P.

2.3.1. Global Industry Classification Standard (GICS)

The Global Industry Classification Standard (GICS) is a classification standard developed by MSCI and S&P in 1999. The purpose of this classification standard is to offer a method of classifying global industries that is accurate and widely accepted among global financial actors.

The GICS classifies global industries into 11 sectors, 24 industry groups. 69 industries, and 158 sub-industries (MSCI, 2022).

Companies that are eligible for a classification in GICS are required to have issued equity securities. The eligible companies can only be classified to one group at each level, and the classification is done based on a company's revenue and earnings. According to MSCI (2022), the

general rule is that a company is classified into a sub-industry that best describes the business activities that generate over 60% of the revenue.

2.3.2. Technology industry

The technology industry is hard to define because many companies are using technology as part of their business. Ernst & Young (2022) talks about industries reimagined, where industry lines are blurring because of how technology is connecting businesses, governments, and societies. PwC (2022) states that the technology industry is seen as segments containing software, hardware, internet services, and semiconductors. In this study the technology industry will be defined as the Information Technology sector by MSCI (2022) in their Global Industry Classification Standard (GICS). According to GICS, the Information Technology sector consists of the three industry groups: software and services, technology hardware and equipment, and semiconductors and semiconductor equipment.

2.3.3. Videogame industry

The videogame industry saw its beginning in the early 1970s, after Stephen Russell at Massachusetts Institute of Technology (MIT) lab developed the first computer game called Space War in 1961. Nolan Bushnell played Space War in a computer laboratory and decided to develop a simplified version of the game, which did not require a fully-fledged computer to play. Bushnell founded Atari in 1972 and is considered the first to successfully commercialise videogames. The videogame industry grew to a 200 million USD business in 1978, and in 1981 it was worth 1 billion USD, and half of it consisted of Atari's revenue (Izushi & Aoyama, 2006).

According to O'Donnell (2012), the videogame industry is often associated with the software industry, partly because of early videogames being developed by software engineers, who both designed the games, and programmed the game cartridges. As the industry evolved, and games started to become more graphically complex with the introduction of the Nintendo Entertainment system (NES) in the United States in 1985, more people with different skills were required to

create videogames, particularly those with skills in art and graphical design. This change would later lead to the industry being categorized as part of the cultural entertainment industry, rather than the software industry. However, games are still often viewed as software even today, and many videogame companies are owned by large technology companies, such as Microsoft Corp, which strengthens the association.

Today the videogame industry consists of companies that develop videogames, publish videogames, manufacture hardware and other accessories to play videogames, and those that host videogame events. The industry also comprises of companies that do all the above, for example Nintendo, Sony and Microsoft all develop and publish games, manufacture hardware and accessories, and even host events.

Based on GICS, the videogame industry is placed under the Communication Services sector, and the industry group Media & Entertainment (MSCI, 2018). Although the videogame industry is categorized as media and entertainment, it is often associated with technology, as it is the form of entertainment that has had the most notable advancements together with technology.

3. Methodology

In this chapter, the methodology of the research will be presented, that is how data was gathered, and from which sources, from where the literature was found, what data for the different models were used, and finally how the models were created and analyzed.

3.1. Research method

The research methods for the study are qualitative and quantitative, where the qualitative method used is a literature review and the quantitative method has a correlational design. According to Creswell (2012), the correlational design is used to explain relationship among variables and predict scores. The correlational design has two types, which are the explanation and prediction designs (Creswell, 2012). Out of these two, the prediction design is that which is used in this study, as the aim is to possibly predict future performance based of off past performance. In the explanatory design the investigator is not interested in past or future performance (Creswell, 2012).

The prediction design is used, as we are interested in seeing whether stock prices between technology and videogame companies correlate, and how much. In addition to creating a correlation matrix of these variables, we also create optimal portfolios to test this correlation and see whether videogame company stocks offer diversification in a technology portfolio. These optimal portfolios will also show whether investing in videogame companies is lucrative during upward and downward market trends. This method and its results are more likely valuable to active investors, especially institutions, as they more commonly hedge compared to passive investors, who usually look for a passive long-term return.

The literature review will be conducted to better understand how investors view the videogame industry, and whether it is part of the technology industry. Understanding how the videogame industry is perceived by investors can explain to some degree the results from the portfolio analysis, but the portfolio analysis will also help to answer the question on how the industry is perceived by investors, as correlation between the stock prices and the stock betas give an indication to how the stock price movements possibly differ during different market conditions.

3.2. Data

The data used in the study will be historical weekly closing prices for publicly listed technology and videogame companies, stock market indices, foreign exchange rates, and historical yield rates for U.S. treasury bonds. The data are for the time periods 2005-2010, 2009-2019, and 2017-2022.

Weekly closing prices were chosen, as the different markets differ in the number of trading days. Using weekly closing prices means that there are returns for every week of every market.

Publicly listed companies that are included are required to have been listed during these three time periods. The yield rates used are also required to have been available for these time periods.

Historical price data have been retrieved from finance.yahoo.com, where price data can be downloaded for specific time periods for listed companies, indices, and foreign exchange rates. The price data will consist of weekly adjusted closing prices which means, according to Yahoo Finance web site, that the closing prices have been adjusted for splits, dividends, and capital gain distributions. The data contains a total of 313 observations per company, index, currency exchange rate, and treasury rate for the period 2005-2010, 574 observations for the period 2009-2019, and 304 observations for the period 2017-2022.

Historical data on yield rates are retrieved from the U.S. Department of the Treasury website. The data consists of U.S. Treasury 13-week T-bill rates given daily. These rates are used as the risk-free rate in CAPM.

3.3. Literature

The literature used in the study will consist of theory for the models, literature on the stock market indices, and yield rates. Literature that describes the industries discussed are also included to further understand the two industries and how these are interpreted by investors.

The literature will be found online, mostly from Google Scholar.

3.4. Correlation

In this study correlation is used to measure how technology and videogame company stock returns correlate as it gives and indication on how the stock prices compare to one another. The correlation can then be used to measure variance of portfolios, and in turn see whether videogame company stocks can diversify a technology portfolio. Although correlation shows the strength of relationship between two variables, it does not explain causality. The most used method to measure correlation is the Pearson correlation, where the coefficient for correlation varies between -1 and 1. The value 0 means that there is no correlation, -1 indicates a perfect negative correlation, and 1 indicates a perfect positive correlation.

3.5. Modelling

The models will be created in Microsoft Excel using the imported data. Both tables and graphs will be created to help visualize the portfolios and results.

The data will be used to create models in an excel spreadsheet, where the different portfolios will be created. Using the imported data, weekly returns in percent are calculated. The returns and the yield rates are then used to calculate the beta of the stocks, which are used in CAPM to calculate the expected returns for the individual stocks. Using expected returns from CAPM, variance-covariance matrixes and correlation matrixes are created. With the variance-covariance matrix and correlation matrix, portfolios are created using the Microsoft Excel solver -function. Excel solver is used calculate a portfolio with the highest possible Sharpe ratio, and a portfolio with the lowest portfolio standard deviation. The portfolios are required to have a sum of weights that equals 100%, and short positions or using loan is not allowed. This means that the weight of the portfolio or a stock cannot be lower than 0% or higher than 100%. The number of companies included in a portfolio are not restricted in any way, thus the number of companies in the optimal and minimized risk portfolios might vary. In this study, optimal portfolios are considered as those that give the highest Sharpe ratio, that is the best return-to-risk ratio.

Foreign currency exchange rates are factored in by adding the return of the foreign currency to the return of a foreign stock of the same currency.

Representing both industries is a total of 16 companies, with eight companies representing the technology industry, and eight companies representing the videogame industry. Based on the imported data, optimal portfolios will be created including different companies with different weightings. The optimal portfolios based on the models, will most likely be a mix of different companies from the different industries.

The technology industry and the videogame industry will include companies that represent both the software and hardware groups.

Regarding videogame companies, the software group consists of companies that create videogames, publish videogames, and companies that create software for videogames, such as game engines. This group will mainly consist of publishers, as most independent videogame developing companies are not publicly listed. Six of the videogame companies in the study are considered to represent the software group.

The hardware group consists of companies that manufacture and sell hardware that is marketed for gaming. These companies consist of those that manufacture components for videogame consoles and PCs, but also those that manufacture monitors and other gaming accessories, such as keyboards, gaming mice and headsets. Two companies represent this group, out of which only one is purely manufacturing hardware, as the second also develops games.

3.6. Companies selected for the portfolio analysis

The companies that have been selected from the respective industries will be presented below. Every company will have a short summary, and why it was chosen. Companies from the two industries have been divided into two groups: Software and hardware.

3.6.1. Technology industry companies

As mentioned earlier, the technology industry is defined in this study as the GICS Information Technology sector. However, three companies outside this sector have been included in the technology portfolio. This is done to represent a more realistic portfolio, which already has diversification. The companies included from outside this sector are Amazon.com, Inc., Alphabet Inc., and Tencent Holdings Ltd. Note that these companies could be considered technology companies as well.

The companies from the GICS Information Technology sector have been chosen based on current market capitalization within their respective industry groups.

The companies are presented according to market capitalization as of November 2022, from largest to smallest.

Apple Inc., ticker symbol (AAPL)

Market cap. ~2.219 trillion USD
GICS Sector: Information Technology
Industry group: Technology Hardware & Equipment
Apple Inc. is one of largest technology companies in the world. It manufactures and sells smartphones, laptops, tablets, wearables, and accessories. Apple is known for their iPhone smartphones and MacBook laptops. The company is included as it has the largest market capitalization within the industry group Technology Hardware & Equipment.

Microsoft Corporation, ticker symbol (MSFT)

Market cap. ~1.706 trillion USD
GICS Sector: Information Technology
Industry group: Software & Services
Microsoft Corporation is best known for their Windows operating system. The company has created several software that are widely used in the world. Microsoft also manufacture and sell hardware. Microsoft is included as it has the largest market capitalization in its industry group.

Alphabet Inc., ticker symbol (GOOGL)

Market cap. ~1.127 trillion USD

GICS Sector: Communication Services

Industry group: Media & Entertainment

Alphabet Inc. is best known for Google, and the different services associated with it, such as the Google search engine. The company also owns the mobile phone operating system Android. Alphabet Inc. used to be part of the GICS Information Technology sector, but in 2018 structural changes were made, and Alphabet Inc. became part of the new Communication Services sector, formerly known as the Telecommunications Services sector (MSCI, 2018).

Amazon.com, Inc., ticker symbol (AMZN)

Market cap. ~0.917 trillion USD

GICS Sector: Consumer Discretionary

Industry group: Retailing

Amazon.com, Inc. owns of the largest online retail stores Amazon.com. The company also offer other online services such as subscription services and Amazon Web Services. The company is included as it is one of the largest online retailers.

NVIDIA Corporation, ticker symbol (NVDA)

Market cap. ~0.363 trillion USD

GICS Sector: Information Technology

Industry group: Semiconductors & Semiconductor Equipment

NVIDIA is one of the largest semiconductor companies and are known for their Graphic Processing Units (GPU). The company offers products for gaming, data centres and professional visualisation among others. The company has the largest market capitalization within its industry group.

Taiwan Semiconductor Manufacturing Company Ltd. (TSMC), ticker symbol (TSM)

Market cap. ~0.337 trillion USD

GICS Sector: Information Technology

Industry group: Semiconductors & Semiconductor Equipment

TSMC is a Taiwanese company and is one of the largest semiconductor manufacturers. It manufactures chips for many well-known companies, such as Advanced Micro Devices (AMD), Apple and NVIDIA. TSMC is included as it manufactures semiconductors, whereas NVIDIA only designs them.

Samsung Electronics Co., Ltd., ticker symbol (005930.KS)

Market cap. ~0.30 trillion USD (~416.110 trillion KRW)

GICS Sector: Information Technology

Industry group: Technology Hardware & Equipment

Samsung Electronic is a South Korean company that is known for their broad line of different consumer electronic products, such as mobile phones and TVs. The company is included as it is one of the largest foreign Information Technology companies.

Tencent Holdings Ltd, ticker symbol (0700.HK)

Market cap. ~0.29 trillion USD (~2.268 trillion HKD)

GICS Sector: Communication Services

Industry group: Media & Entertainment

Tencent Holdings is a Chinese company that has a wide variety of products and services in their portfolio, such as e-commerce, cloud computing, and media entertainment. The company has a stake in many videogame companies as well.

3.6.2. Videogame industry companies

The companies for the videogame industry have been chosen based on market capitalization. Because most publicly listed videogame companies are publishers or videogame developing companies, only two companies are considered representing the hardware side of the industry.

Activision Blizzard, Inc. ticker symbol (ATVI)

Market cap. ~57 billion USD

Activision Blizzard Inc. was founded in 2008 through a merger between Activision Inc. and Vivendi Games, the parent company of Blizzard Entertainment. The company owns well-known intellectual properties, such as the Call of Duty franchise and the MMORPG World of Warcraft. In the beginning of 2021, Microsoft Corp. announced that it will acquire Activision Blizzard for 68.7 billion dollars. The deal is accepted by both parties but is currently still being reviewed by government agencies.

Nintendo Co., Ltd., ticker symbol (7974.T)

Market cap. ~46 billion USD (~6.733 trillion JPY)

Nintendo is one of the largest and well-known videogame companies. The company owns intellectual property such as Super Mario and are known for creating videogame consoles that differ from their competitors' such as the Nintendo Wii and Nintendo Switch consoles. The company is one of two companies that in this study represent the hardware group in the videogame industry.

Electronic Arts Inc. (EA), ticker symbol (EA)

Market cap. ~35.896 billion USD

EA is a large videogame publisher that owns intellectual properties such as the Battlefield franchise, and until recently sold football games under the FIFA name. EA also has a 10-year Star Wars exclusivity deal with Disney, which started in 2013.

Take-Two Interactive Software, Inc., ticker symbol (TTWO)

Market cap. ~15.703 billion USD

Take-Two Interactive is a videogame publisher that owns intellectual property such as the GTA franchise. The company also completed its acquisition of the videogame company Zynga Inc. during the first half of 2022.

Bandai Namco Holdings Inc., ticker symbol (7832.T)

Market cap. ~14 billion USD (~2.085 trillion JPY)

Bandai Namco Holdings was founded in 2005, when the toy manufacturing company Bandai acquired the videogame developer Namco. The company's products are videogames, toys, visual and music media entertainment, and amusement parks. The largest sales are usually generated from the videogame business segment (Bandai Namco, 2022).

Logitech International S.A., ticker symbol (LOGI)

Market cap. ~8.818 billion USD

Logitech is a Swiss-American company that manufactures computer software and peripherals, such as keyboards, mice, and headsets. The company is not considered a videogame company, but it is included as a videogame hardware manufacturer in the study as it has a strong gaming brand. The revenue from their gaming business segment is the largest of all their business segments since 2019, and the third largest since 2016 (Logitech, 2022). Logitech (2022) mentions in their 10-K Annual Report that competitors for their gaming products are Corsair Gaming, Inc., Razer, SteelSeries, Turtle Beach Corporation among others, however, out of these companies Logitech is the only one that has been publicly listed since at least 2005, which is why it is included in the study.

Capcom Co., Ltd., ticker symbol (9697.T)

Market cap. ~6.2 billion USD (~0.908 trillion JPY)

Capcom is a videogame publisher and developer. The company owns famous franchises such as the Resident Evil and Street Fighter franchises.

Square Enix Holdings Co., Ltd., ticker symbol (9684.T)

Market cap. ~5.5 billion USD (~0.807 trillion JPY)

Square Enix Holding was founded in 2003, through the merger of Square and Enix. The company owns famous franchises such as Final Fantasy. The company's business also includes merchandise, film, and manga. These are often based off their videogame franchises.

4. Results

In this chapter the results from the literature review and the portfolio analysis will be presented. First the results from the literature review will be presented, where academic research, articles, and financial reports have been read and compared to better understand investor views of the videogame industry in relation to the technology industry. The results from the portfolio analysis will be divided into the three time periods that have been looked at, and the results of the expected returns based on the two indices used. The results will consist of company specific results, correlation matrixes and results of different portfolios, such as the optimal portfolios for minimizing risk and maximizing the Sharpe Ratio. The results of the different time periods will also be compared with one another. Tables and graphs will be used as part of the results presentation.

4.1. Literature review results

As mentioned earlier in the study, videogames are often considered software, which is partly due to the first games being created by software engineers. When videogames became more complex, a broader spectrum of skills were required to create them. These additional skills include graphical and audio designers. As videogames became more popular, videogames were established as one among other sources of entertainment, and this change has most likely also changed the overall views on what videogames are.

According to Kretchsmer et al. (1999), the videogame industry can be considered a cultural industry, as it has the following four structural characteristics:

1. An oversupply of potential goods that could become sold products.

For the videogame industry this could be interpreted as an oversupply of potential unfinished projects that could become videogames that are sold to consumers.

2. The quality of the goods in the industry have a higher uncertainty.

This uncertainty comes from videogames being experience goods, and that the experience can be affected by many different factors, such as reviews by others, and the personal experience when the game is played. The experiences can also change over time, and a game that might be considered bad today, could be considered good in the future when it is experienced again. Note that films, books and music are also experience goods.

3. Certain kinds of networks are formed by the consumers of the goods.

These networks consist of both technological and social networks, with their own network effects. In the case of videogames, the technological networks and their effects consist of platforms in the form of consoles, mobile phones and PCs, with their possible technological advantage compared to the others. These platforms often have games that can exclusively only be played on them, which can strengthen the network effect. The social networks and their effects can be seen in the form of specific games becoming very popular, which can lead to many wanting to play them. Some games can in theory also cause a social network effect in the form of having achievements or digital items. Completing these achievements or obtaining specific items in a game could be seen as "fashionable" among others in the game.

4. The demand for the goods in the industry can have cyclical reversals.

Several factors could cause a reversal in demand for a videogame. These factors include the videogame becoming stale after having played it for too long, or the game becoming unpopular. In the case of change in popularity, especially videogames that are played online can be affected considerably when the number of players playing the game diminishes. The diminishing player numbers could ruin the experiences when playing the game, and in the worst case even cause the servers for the game to be shut down, which means for a game that is solely played online, that the game can no longer be played.

Based on the characteristics for cultural industries by Kretchsmer et al. (1999), it is easier to understand why videogames are seen as entertainment goods instead of technological goods. However, technological advancements have always had a noticeable effect on how videogames

have evolved, and as technology has advanced and become more accessible, so too have videogames become more complex and more accessible. This parallel change could make videogames seem like technological goods. The claim by Kretchsmer et al. (1999) that videogames are cultural goods is backed up by Campbell-Kelly (2003), where he mentions that the appropriate business model and way of promoting videogames is closer to that of books and music, than that of other software. Videogame and movie marketing share similarities, as both are often marketed for example through trailers, and putting an emphasis on the cover art, whether digital or physical. Cover art is also used by books and music albums. However, Campbell-Kelly (2003) do categorize videogames as software, whereas O'Donnell (2012), who was mentioned earlier in this study, considers videogames as not being software. This shows that it can be problematic to define the videogame industry to some extent.

Institutional investors most likely view the videogame industry as a cultural industry. This can be seen by how the videogame industry is categorized by GICS, which is made by MSCI and S&P, both American finance companies that offers portfolio analytics and financial indices that institutional investors use. Another example that gives an indication on the institutional investors views on the videogame industry, are the videogame ETFs (Exchange Traded Funds). These ETFs aim to offer investors exposure to companies that are considered to benefit from increased growth in the videogame industry. Videogame ETFs usually only include companies that receive over 50% of their revenue from the videogame industry. Examples on these ETFs are VanEck Video Gaming and eSports ETF and Global X Video Games & Esports ETF. However, there are also ETFs that focus on specific industry groups of the technology industry, so one might argue that videogame ETFs are focusing on specific industry group within the technology industry.

4.2. Portfolio analysis results

Included in the study was 16 companies, out of which 8 are considered technology companies, and 8 are considered videogame companies. In Table 1. the companies are showed, ordered according to current market cap from highest to lowest. The different time periods have their own columns. Under the time periods are expected rates of returns and betas, divided by the two markets. The average risk-free rates for the time periods are shown in the CAPM columns as *Rf*.

	2005-2010				2017-2022				2009-2019			
	Beta		*CAPM (Rf 2.37%)*		*Beta*		*CAPM (Rf 1.16%)*		*Beta*		*CAPM (Rf 0.54%)*	
Company	**S&P 500**	**Nasdaq-100**	**S&P 500 0.35%**	**Nasdaq-100 5.45%**	**S&P 500**	**Nasdaq-100**	**S&P 500 -8.45%**	**Nasdaq-100 17.22%**	**S&P 500**	**Nasdaq-100**	**S&P 500 12.64%**	**Nasdaq-100 20.35%**
Apple	1.08	1.25	2.75%	9.18%	-0.06	1.06	1.68%	19.41%	1.08	1.17	14.13%	24.34%
Microsoft	0.78	0.79	2.64%	6.70%	0.01	0.95	1.06%	17.57%	0.96	0.94	12.66%	19.72%
Google	1.02	1.07	2.73%	8.21%	-0.07	0.99	1.76%	18.16%	1.04	1.05	13.67%	22.00%
Amazon	1.01	1.15	2.72%	8.62%	0.02	1.08	1.01%	19.84%	1.16	1.22	15.17%	25.33%
Nvidia	1.56	1.67	2.92%	11.49%	-0.07	1.64	1.72%	29.33%	1.50	1.52	19.53%	31.46%
TSMC	0.98	1.04	2.72%	8.02%	-0.02	0.82	1.30%	15.22%	0.86	0.83	11.35%	17.49%
Samsung	1.04	1.05	2.74%	8.10%	-0.03	0.66	1.44%	12.47%	0.92	0.80	12.22%	16.76%
Tencent	0.92	0.94	2.69%	7.48%	-0.04	0.47	1.49%	9.20%	0.80	0.76	10.68%	16.04%
Activision Blizzard	0.83	0.84	2.66%	6.96%	0.03	0.56	0.89%	10.74%	0.74	0.75	9.89%	15.78%
Nintendo	0.41	0.47	2.52%	4.93%	0.08	0.40	0.45%	8.08%	0.57	0.48	7.69%	10.37%
EA	0.93	0.92	2.70%	7.41%	0.09	0.56	0.42%	10.80%	0.99	0.94	13.09%	19.73%
Take-Two Interactive	1.03	1.06	2.73%	8.13%	-0.10	0.70	2.01%	13.14%	1.00	0.99	13.23%	20.60%
Bandai Namco	0.34	0.26	2.49%	3.76%	-0.10	0.46	2.04%	9.06%	0.18	0.16	2.87%	3.80%
Logitech	1.13	1.08	2.77%	8.26%	-0.08	0.79	1.79%	14.74%	1.28	1.11	16.76%	23.20%
Capcom	0.56	0.50	2.57%	5.09%	-0.09	0.38	1.91%	7.76%	0.28	0.28	4.03%	6.33%
Square Enix	0.30	0.19	2.47%	3.42%	-0.22	0.35	3.00%	7.18%	0.34	0.33	4.89%	7.32%

Table 1. Expected rate of return and Beta for the markets and companies during the different time periods

Figure 2. visualizes the different time periods that are looked at in this study, and how the two market indices have moved during these periods.

In the results, the first period presented will be for the period 2009-2019, which is the longest of the three periods analyzed. This period consists of 11 years of weekly stock market closing prices, 13-week U.S. treasury T-bill rates and currency exchange rates. The period consists of a longer upward trend in the stock market after the financial crisis of 2007-2008. The U.S. treasury rates declined during the period of 2009-2019, and stayed at lower rates closer to 0%, but would even become negative.

The second period presented will be the period between 2005 and 2010, which consists of 6 years of weekly stock market closing prices, 13-week U.S. treasury T-bill rates, and currency exchange rates. The period started off with a stronger uptrend between 2005 and 2007, followed by a strong downward turn during the financial crisis 2007-2008, and ended with an upward trend between 2009-2010. During this period, the rates would rise until the stock market crash in 2007, after which the rates started to move lower.

The final period will be for the period 2017-2022, which consists of 5 years and 10 months, from 2017 to 2021, and the time between January and October of 2022. During this period the stock market experienced the upward trend of 2017-2019, which abruptly ended with a crash in the beginning of 2020 due to COVID-19. The crash caused by COVID-19 was very short, lasting only a few months, after which there was a strong uptrend lasting until the end of 2021. This uptrend ended during the beginning of 2022, due to a combination of many factors including rising inflation, the looming energy crisis, and the Russian attack on Ukraine. This period saw mostly low or negative rates, but during 2022 the rates started to rise as central banks focused on combating the rising inflation.

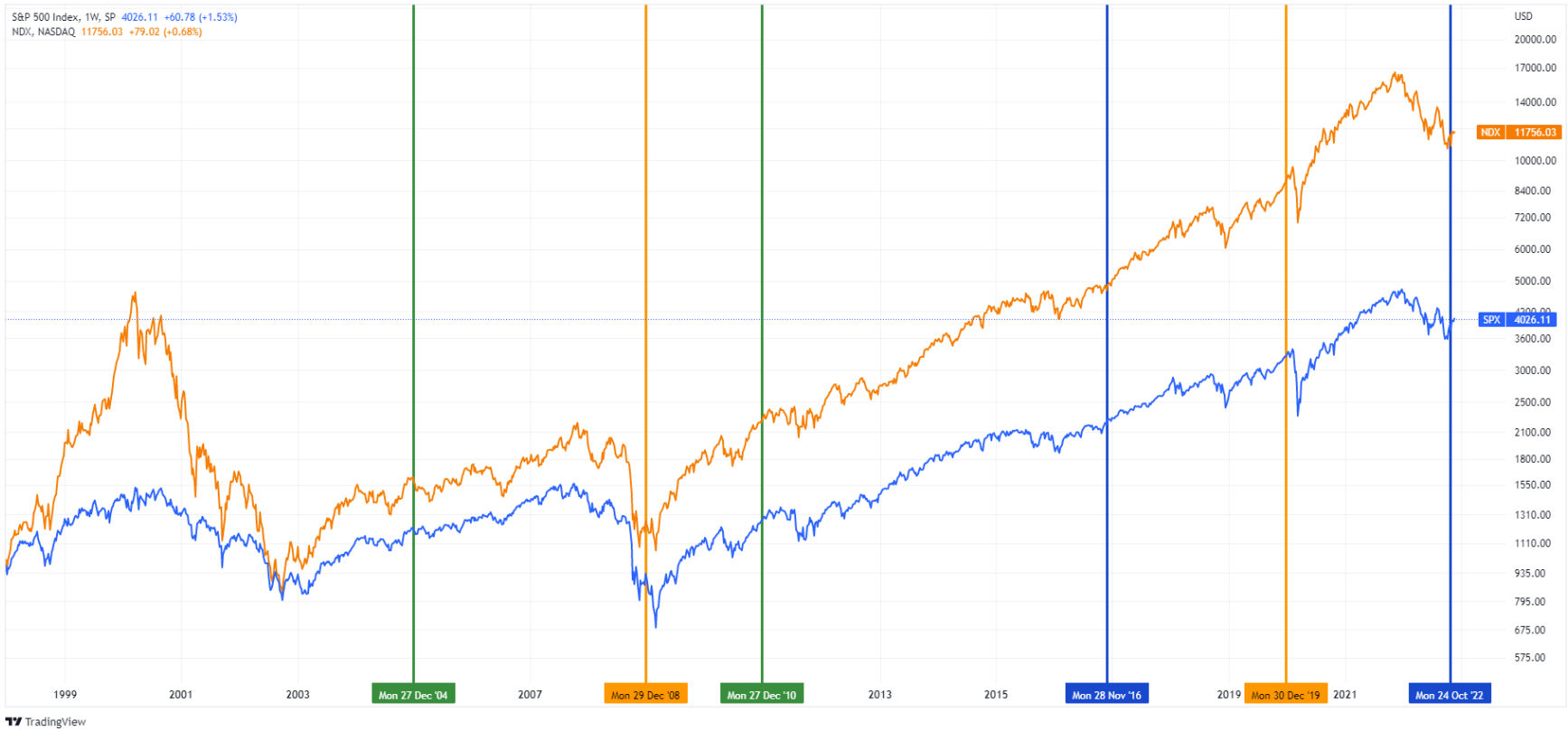

Figure 2. The graph shows the movements of the S&P 500 (blue line) and Nasdaq-100 (orange line) indices for the timespan between 1999 and 2022. Logarithmic scale. The vertical lines highlight the different periods observed in this study. Green 2005-2010, Orange 2009-2019, Blue 2017-2022. Created in TradingView.com.

4.2.1. Results for period 2009-2019

The results from the portfolio analysis for the period 2009-2019 indicate that higher returns were achieved by investing in technology companies compared to videogame companies, for both the S&P 500 and Nasdaq-100 indices as markets. However, the optimal portfolio aiming to maximize the Sharpe ratio with S&P 500 index as the market, suggests that allocating approximately 21% of the total portfolio into videogame stocks will help achieve a better return-to-risk ratio in the portfolio. The portfolio with the lowest risk can be achieved by further increasing the allocation of the portfolio into videogame stocks. The allocation into videogame stocks for this portfolio is approximately 48%. Out of the 16 companies included in the analysis, the optimal portfolio would include 14 and the lowest risk portfolios would include 13, of which both portfolios included 6 videogame companies. An equally weighted portfolio, that is a portfolio with a 6.25% allocation in each stock, would give a Sharpe ratio closer to that of the risk minimizing portfolio.

Optimal Weights	Max Sharpe
Apple	13.70%
Microsoft	23.10%
Alphabet	16.94%
TSMC	4.68%
Amazon	6.49%
Nvidia	3.92%
Tencent	2.51%
Samsung	7.87%
Activision Blizzard	0.19%
EA	6.35%
Logitech	9.08%
Take-Two Interactive	2.61%
Bandai Namco	0.11%
Nintendo	2.45%
Square Enix	0.00%
Capcom	0.00%
Portfolio Expected Return	13.60%
Sharpe Ratio	5.02
Portfolio Standard Deviation	2.60%
Number of assets in portfolio	14

Optimal Weights	Minimize Risk
Apple	7.81%
Microsoft	20.05%
Alphabet	5.24%
TSMC	12.14%
Amazon	0.03%
Nvidia	0.00%
Tencent	3.77%
Samsung	3.33%
Activision Blizzard	11.34%
EA	1.66%
Logitech	0.00%
Take-Two Interactive	0.00%
Bandai Namco	24.68%
Nintendo	3.38%
Square Enix	1.26%
Capcom	5.33%
Portfolio Expected Return	9.13%
Sharpe Ratio	4.12
Portfolio Standard Deviation	2.08%
Number of assets in portfolio	13

Table 2. Optimal portfolio and lowest risk portfolio for the period 2009-2019 with S&P 500

In the case of using the Nasdaq-100 index as the market, the results were similar. The optimal portfolio when maximizing the Sharpe ratio, shows an allocation of approximately 13% into videogame stocks, and when minimizing the risk of the portfolio the allocation was approximately 48%. In the case of the Sharpe ratio maximizing portfolio, the number of videogame companies in the portfolio was 6 out of 14, and for the risk minimizing portfolio, the number was also 6, but the total number of companies included was 12. The equally weighted portfolio had a Sharpe ratio closer to that of the minimized risk portfolio.

Optimal Weights	Max Sharpe
Apple	21.15%
Microsoft	22.55%
Alphabet	16.26%
TSMC	5.09%
Amazon	9.99%
Nvidia	5.50%
Tencent	2.82%
Samsung	3.37%
Activision Blizzard	1.32%
EA	3.83%
Logitech	3.75%
Take-Two Interactive	2.68%
Bandai Namco	0.64%
Nintendo	1.04%
Square Enix	0.00%
Capcom	0.00%
Portfolio Expected Return	21.86%
Sharpe Ratio	8.05
Portfolio Standard Deviation	2.65%
Number of assets in portfolio	14

Optimal Weights	Minimize Risk
Apple	7.82%
Microsoft	20.06%
Alphabet	5.23%
TSMC	12.14%
Amazon	0.00%
Nvidia	0.00%
Tencent	3.78%
Samsung	3.36%
Activision Blizzard	11.45%
EA	1.63%
Logitech	0.00%
Take-Two Interactive	0.00%
Bandai Namco	24.66%
Nintendo	3.21%
Square Enix	1.29%
Capcom	5.36%
Portfolio Expected Return	14.14%
Sharpe Ratio	6.52
Portfolio Standard Deviation	2.08%
Number of assets in portfolio	12

Table 3. Optimal portfolio and lowest risk portfolio for the period 2009-2019 with Nasdaq-100

During the period, the yearly average return for owning Hong Kong dollar over U.S. dollars was close to 0%. The return on Japanese yen over the U.S. dollar was -0.96% and for Korean Republic won the return was 1.67%. The expected returns based on CAPM were higher for technology companies in general, and the Japanese videogame companies had the lowest expected returns. When Nasdaq-100 was used as market, the expected returns were higher for all companies, compared to the expected returns with S&P 500.

4.2.2. Results for period 2005-2010

For the period 2005-2010 the analysis indicates that a larger allocation into videogame companies, compared to the period 2009-2019, would have yielded higher returns and lower risk.

With the S&P 500 as the market, the optimal portfolio would allocate approximately 37% of the portfolio into videogame companies. 15 assets were included in the optimal portfolio, where Nintendo was the only one excluded. The portfolio when minimizing risk would allocate approximately 60% into videogame companies. In this portfolio, 6 out of 10 companies are videogame companies. The equally weighted portfolio has the same expected Sharpe Ratio as the optimal portfolio, although the risk would increase slightly.

Optimal Weights	Max Sharpe
Apple	3.52%
Microsoft	20.03%
Alphabet	11.96%
TSMC	10.44%
Amazon	5.97%
Nvidia	3.36%
Tencent	1.95%
Samsung	6.12%
Activision Blizzard	4.37%
EA	7.89%
Logitech	8.19%
Take-Two Interactive	2.78%
Bandai Namco	5.26%
Nintendo	0.00%
Square Enix	7.10%
Capcom	1.07%
Portfolio Expected Return	2.68%
Sharpe Ratio	0.10
Portfolio Standard Deviation	2.99%
Number of assets in portfolio	15

Optimal Weights	Minimize Risk
Apple	0.00%
Microsoft	23.75%
Alphabet	5.02%
TSMC	8.63%
Amazon	2.86%
Nvidia	0.00%
Tencent	0.00%
Samsung	0.00%
Activision Blizzard	7.58%
EA	1.13%
Logitech	0.00%
Take-Two Interactive	0.00%
Bandai Namco	19.26%
Nintendo	7.55%
Square Enix	23.15%
Capcom	1.06%
Portfolio Expected Return	2.58%
Sharpe Ratio	0.09
Portfolio Standard Deviation	2.39%
Number of assets in portfolio	10

Table 4. Optimal portfolio and lowest risk portfolio for the period 2005-2010 with S&P 500

With the Nasdaq-100 index representing the market, the results are similar. The allocation into videogame companies is approximately 20% in the optimal portfolio. The number of assets in the portfolio is 15, with EA being excluded. In the risk minimizing portfolio, the allocation into videogame stocks is 57%, and the portfolio would include 10 assets, out of which 5 are videogame companies. The equally weighted portfolio has a Sharpe ratio just below that of the optimal portfolio.

Optimal Weights	Max Sharpe
Apple	12.21%
Microsoft	22.59%
Alphabet	12.94%
TSMC	13.07%
Amazon	8.83%
Nvidia	6.33%
Tencent	0.12%
Samsung	3.85%
Activision Blizzard	5.45%
EA	0.00%
Logitech	5.08%
Take-Two Interactive	3.37%
Bandai Namco	2.04%
Nintendo	0.04%
Square Enix	2.47%
Capcom	1.60%
Portfolio Expected Return	7.87%
Sharpe Ratio	1.67
Portfolio Standard Deviation	3.29%
Number of assets in portfolio	15

Optimal Weights	Minimize Risk
Apple	0.00%
Microsoft	24.61%
Alphabet	5.07%
TSMC	9.84%
Amazon	3.52%
Nvidia	0.00%
Tencent	0.13%
Samsung	0.00%
Activision Blizzard	8.22%
EA	0.00%
Logitech	0.00%
Take-Two Interactive	0.00%
Bandai Namco	21.03%
Nintendo	0.05%
Square Enix	24.84%
Capcom	2.69%
Portfolio Expected Return	5.52%
Sharpe Ratio	1.30
Portfolio Standard Deviation	2.42%
Number of assets in portfolio	10

Table 5. Optimal portfolio and lowest risk portfolio for the period 2005-2010 with Nasdaq-100

During this period, it would have been favourable to own Japanese yen over U.S. dollar, with foreign exchange returns being on a yearly average of 4.62%. The foreign exchange rates for Hong Kong dollar and Korean Republic won compared to U.S. dollar were close to 0%.

The expected returns were very close between the companies when using S&P 500 as the market. Calculating expected returns with Nasdaq-100 as the market gave higher expected returns for all companies, with technology companies having the highest, and the Japanese videogame companies having the lowest.

4.2.3. Results for period 2017-2022

For the period between 2017 and 2022, the results also suggest that allocating into videogame stocks lowers the risk of the portfolio.

With S&P 500 representing the market, the allocation into videogame companies was 80%, with almost 50% being allocated into Square Enix. The number of assets in the portfolio is 6, out of which 4 are videogame companies. In the risk minimizing portfolio, the allocation was approximately 57% into videogame companies. The portfolio consisted of 7 videogame companies, with a total number of assets being 11. The equally weighted portfolio has a Sharpe ratio between the other two portfolios.

Optimal Weights	Max Sharpe
Apple	5.36%
Microsoft	0.00%
Alphabet	14.79%
TSMC	0.00%
Amazon	0.00%
Nvidia	0.00%
Tencent	0.00%
Samsung	0.00%
Activision Blizzard	0.00%
EA	0.00%
Logitech	3.76%
Take-Two Interactive	11.92%
Bandai Namco	14.80%
Nintendo	0.00%
Square Enix	49.37%
Capcom	0.00%
Portfolio Expected Return	2.44%
Sharpe Ratio	0.38
Portfolio Standard Deviation	3.34%
Number of assets in portfolio	6

Optimal Weights	Minimize Risk
Apple	0.00%
Microsoft	24.48%
Alphabet	0.00%
TSMC	3.59%
Amazon	0.00%
Nvidia	0.00%
Tencent	8.93%
Samsung	5.79%
Activision Blizzard	7.41%
EA	13.83%
Logitech	4.17%
Take-Two Interactive	0.00%
Bandai Namco	16.60%
Nintendo	11.80%
Square Enix	1.68%
Capcom	1.71%
Portfolio Expected Return	1.20%
Sharpe Ratio	0.02
Portfolio Standard Deviation	2.32%
Number of assets in portfolio	11

Table 6. Optimal portfolio and lowest risk portfolio for the period 2017-2022 with S&P 500

The optimal portfolio with Nasdaq-100 as the market, allocated around 13% into videogame companies. The portfolio consists of 4 videogame companies out of the 11 assets in total. The risk minimizing portfolio allocated 57% into videogame companies, and the number of videogame companies in the portfolio is 7 out of 12 assets. The equally weighted portfolio Sharpe ratio is close to that of the risk minimizing portfolio.

Optimal Weights	Max Sharpe
Apple	19.87%
Microsoft	36.81%
Alphabet	0.00%
TSMC	5.83%
Amazon	12.76%
Nvidia	5.96%
Tencent	0.60%
Samsung	4.83%
Activision Blizzard	0.00%
EA	2.95%
Logitech	3.95%
Take-Two Interactive	1.74%
Bandai Namco	4.70%
Nintendo	0.00%
Square Enix	0.00%
Capcom	0.00%
Portfolio Expected Return	17.71%
Sharpe Ratio	5.61
Portfolio Standard Deviation	2.95%
Number of assets in portfolio	11

Optimal Weights	Minimize Risk
Apple	0.21%
Microsoft	24.41%
Alphabet	0.00%
TSMC	3.51%
Amazon	0.00%
Nvidia	0.00%
Tencent	8.93%
Samsung	5.88%
Activision Blizzard	7.37%
EA	13.85%
Logitech	4.18%
Take-Two Interactive	0.00%
Bandai Namco	16.33%
Nintendo	11.81%
Square Enix	1.75%
Capcom	1.77%
Portfolio Expected Return	12.02%
Sharpe Ratio	4.68
Portfolio Standard Deviation	2.32%
Number of assets in portfolio	12

Table 7. Optimal portfolio and lowest risk portfolio for the period 2017-2022 with Nasdaq-100

The average yearly return on foreign exchange rate was -3.70% when holding yen over dollar, and -2.61% when holding won. Owning Hong Kong dollar over U.S. dollar had a return of -0.20%.

During the period the expected returns with S&P 500 as the market were very similar between videogame and technology companies, whereas expected returns with Nasdaq-100 are higher for technology companies on average. The expect returns differ between the two markets, with returns being between 1% and 5% for S&P 500, and Nasdaq-100 showing returns between 6% and 25%.

4.2.4. Summary of portfolio analysis results

The table below summarises the key values from the portfolio analysis for the different time periods.

Summary	S&P 500		Nasdaq-100	
Expected return / St. Dev ***Sharpe ratio*** *Videogame portfolio weight*	*Max Sharpe*	*Min Risk*	*Max Sharpe*	*Min Risk*
2009-2019	13.60% / 2.60% ***5.02*** *20.79%*	9.13% / 2.08% ***4.12*** *47.64%*	21.86% / 2.65% ***8.05*** *13.28%*	14.14% / 2.08% ***6.52*** *47.60%*
2005-2010	2.68% / 2.99% ***0.10*** *36.66%*	2.58% / 2.39% ***0.09*** *59.74%*	7.87% / 3.29% ***1.67*** *20.06%*	5.52% / 2.42% ***1.30*** *56.83%*
20017-2022	2.44% / 3.34% ***0.38*** *79.85%*	1.20% / 2.32% ***0.02*** *57.20%*	17.71% / 2.95% ***5.61*** *13.34%*	12.02% / 2.32% ***4.68*** *57.06%*

Table 8. Summary of results showing the key values for the different time periods and markets

From the table we can see that when minimizing risk, the weight of videogames in the portfolio was between 47% and 60% for all time periods. The optimal portfolios have a higher allocation in videogames during the more turbulent periods 2005-2010 and 2017-2022, which indicates that investing in videogame companies during uncertain times could be a good investment strategy. When comparing the values between the two indices, the Nasdaq-100 gives a more positive outlook, even during turbulent periods.

The average correlation between videogame companies and technology companies for the three time periods were between 0.21 and 0.28. Low correlation between the companies in the videogame industry could also explain the lower risk portfolios have when adding videogame

companies to them. In comparison, the technology companies had a much higher correlation between one another. The average correlation between technology companies for the three time periods were between 0.38 and 0.47. The correlation was almost identical between the two markets. The correlation between videogame companies was between 0.21 and 0.28 during the three time periods. Once again, the correlation was as good as identical between the two markets.

The portfolios with the lowest risk usually had a higher weight in Japanese videogame companies. This could indicate that currency exchange rates and differences in the stock markets where these are traded affect the results. Both U.S. dollar and Japanese yen are considered safer currencies during more volatile market periods.

4.3. Acknowledgements (limitations)

Limiting factors in this study was the number of listed videogame companies being low, which meant that it was difficult to try and represent the whole videogame industry. Many videogame companies have also not been listed for long enough to be included in the study.

Most videogame companies included in the study are large videogame publishers, with a mix of both console, PC, and mobile games, that do not sell hardware. Nintendo and Logitech were the only companies selling hardware, out of which only Nintendo is a videogame company, as Logitech is considered a technology company.

Half of the companies representing the videogame industry are Japanese companies, which means the results can be affected by the differences between US and Japanese stock markets and the currency rate between the yen and dollar.

The analysis and its results are based on historical data and do not reflect the current or future performance of a portfolio. Most of the data have been gathered from Yahoo Finance, which means that there can be errors in the data which in turn affects the results.

Inflation rates have not been accounted for when calculating the risk-free rate. Foreign bond yields have also not been considered when calculating the return for foreign exchange rates.

5. Discussion

In this chapter the results will be interpreted and discussed.

5.1. Discussing results

The results from the literature review suggests that investors, particularly active investors, see the videogame industry as different from the technology industry. Videogames as goods are closer to other entertainment goods in their characteristics than to technology goods. How the videogame industry is categorized by GICS, and the existence of videogame ETFs only further strengthens this.

The results from the three time periods suggest that a technology portfolio can be diversified by including videogame companies, both US and foreign. The results would also indicate that the videogame industry is a lucrative investment of diversification in both upward and downward trends.

Based on the results, there is indication that investors see the videogame industry as different from the technology industry, however this distinction can be narrow, and recent changes in the videogame industry with large technology companies acquiring videogame companies and increasing their stake in the videogame industry suggests that this distinction can become even narrower. This can already bee seen as all eight technology companies included in the study have a stake in the videogame industry. Microsoft has its own game studio and sells their own Xbox videogame console, Google's and Apple's revenue from their mobile application stores consist of sales from videogame apps and purchases made in them. Google also had their Stadia platform, which was a videogame streaming service, but was shut down in 2022. Amazon owns videogame studios, and the popular streaming website Twitch.tv. Tencent owns videogame companies, such as Riot Games, the studio behind League of Legends, and Supercell, the studio behind Clash of Clans. TSMC manufactures chips for companies such as AMD, that generates part of their revenue from selling CPUs and GPUs that are marketed for videogame purposes. Samsung manufactures and sells monitors that are targeted towards gamers. When technology companies receive larger

revenue streams from the videogame industry, investors will have to become more knowledgeable on the videogame industry to be able to estimate future performance of technology companies.

Microsoft had a weight over 20% in every portfolio, except the optimal portfolio during the period 2017-2022, where it had a weight of 0%. This might possible be due to Microsoft being a large and stable company, but it could also be due to the company operating in both the technology and videogame industries.

The expected returns from CAPM were considerably higher when using the Nasdaq-100 index as the market. This might suggest that the Nasdaq-100 index is not the best index to use with CAPM, as it often gave very positive outcomes. The lower number of companies included in the index might be causing this.

The results indicate that videogame companies that represent the software group are more often included with a higher allocation, than those that represent the hardware group. The reason for this can be that companies that focus on developing videogames and publishing them perform better and have a lower risk, but it could also be due to 6 out of 8 videogame companies representing the software group. The allocation is more even between the software and hardware groups when looking at technology companies.

6. Conclusions

The aim of this study was to analyze and compare the differences between the videogame and technology industry from an investors point of view. This was done by a literature review and by comparing historical stock prices of companies from these two industries during three different time periods, representing both longer uptrends and more volatile periods of shorter up- and downtrends.

The expected performance of these companies was estimated by using CAPM, with two different indices representing the market. With the expected returns of each individual stock, optimal portfolios were created where the Sharpe ratio was maximized. The Sharpe ratio was used to create well diversified portfolios, with a good return-to-risk ratio. The optimal portfolios indicated that technology portfolios can be diversified by including videogame companies, which suggests that technology and videogame stocks react to some degree differently to different market conditions, and thus giving an indication that videogame companies can be seen as lucrative investments of diversification.

6.1. Key findings

The key findings of the study suggest that a technology portfolio can be diversified by including videogame companies. The optimal portfolios always included videogame companies for the different time periods, and the lowest risk portfolios would allocate around 50% or more into videogame companies. The results would indicate that investors differentiate between technology and videogame companies. However, the results can also be affected to some extent by the foreign exchange rates between Japanese yen and U.S. dollar, as half of the videogame companies are listed in Japan Stock Exchange and are traded with Japanese yen.

The results suggest that Nasdaq-100 index might not be the best to use as market when calculating the CAPM expected returns for the individual stocks. The reason for this is the noticeably higher returns given by Nasdaq-100 index compared to the S&P 500 index. This might be caused by the

lower number of companies included in the Nasdaq-100 index, and the index being very technology heavy.

RQ 1. The results suggest that investors do not consider videogame companies as technology companies. This is apparent from both a fundamental and technical view. From a fundamental perspective, the videogame industry can be categorized as a cultural industry, which also means that videogame industry goods have different characteristics than technology industry goods. The technical perspective suggests the same, as the correlation between videogame companies and technology companies are not notable. The results also suggest that videogame company stock prices move less than that of technology companies when comparing betas, which also indicates that the stock prices of videogame companies move differently from technology company stock prices. As stock price movements in theory are the result of supply and demand, the difference in stock price movements between the two industries also suggest that investor supply and demand are driven by different factors within the industries.

RQ 2. Based on the results, videogame companies could be used as a way of hedging or lowering the risk of a technology portfolio. This is visible by the higher weight of videogame companies in a risk minimizing portfolio. The correlation and betas of videogame companies compared to technology companies also further strengthen this.

RQ 3. We can see from the optimal portfolios that the inclusion of videogame companies in technology portfolios during both upward and downward market trends might be a good idea, as it gives a higher Sharpe ratio than only including technology companies in the portfolio. This seems to be true especially during market downtrends or more volatile periods, as a higher Sharpe ratio is achieved by increasing the weight of videogame companies in the portfolio.

6.2. Suggestions for future research

Suggestions for future research is to compare a greater number of videogame companies with technology companies, and to include additional indices in the analysis, such as the Nasdaq Composite. Videogame companies are part of the GICS Media & Entertainment industry group and could be compared to other companies that are included in this group and examine how different forms of entertainment differ from an investment perspective, when compared to the technology industry.

The analysis was done using weekly returns for stock prices, indices, foreign currency exchange rates and U.S. treasury rates. Using daily returns would give more data to analyze, which in turn should give more accurate results.

The expected rate of return could be calculated using more complex CAPM methods such as the Fama-French 3-, or 4-factor models, which consider the size of the companies included. In this study, the technology companies were notably larger than the videogame companies when comparing market cap.

In addition to conducting more extensive quantitative research methods, there is also a possibility to learn more about investor perception on the videogame industry using more extensive qualitative research methods.

7. Summary in Swedish – Svensk sammanfattning

Diversifiering av en teknologiportfölj med hjälp av spelindustriaktier - En investeringsanalys

7.1. Inledning

Spelindustrin har utvecklats och förändrats drastiskt under de senaste 70 åren. Under 1950-talet började spel som projekt för akademisk forskning, men blev på 1970-talet en form av underhållning. Spelindustrin har vuxit och förändrats snabbast mellan åren 1990 och 2020, från att man under 90-talet ännu köpte spelkassetter för att spela spel hemma på en spelkonsol, till att man enkelt kan ladda ner eller direkt strömma spel via internet. I och med förändringen av hur spel kan spelas, förändrades även möjligheterna att få intäkter från spel. Förutom de intäkter som fås från försäljningen av spel och hårdvaran för att spela dem, infördes digitalt innehåll som kan köpas i spelen.

Spelens popularitet och tillgänglighet har ökat, och det beräknas att spelindustrin kommer att fortsätta växa och nå en total omsättning på 321,1 miljarder dollar år 2026 (PwC, 2022). Antalet företagsförvärv inom spelindustrin har också ökat, vilket tyder på ett ökat intresse för spelföretag. Större teknologiföretag, som Microsoft och Sony, har varit mycket aktiva när det gäller att förvärva spelföretag. Ett exempel på detta är Microsofts pågående förvärv av Activision Blizzard, vilket kommer att vara det största förvärvet inom spelindustrin, förutsatt att förvärvet godkänns. Transaktionen har ett värde på 68,7 miljarder dollar.

Dessa förvärv har gjorts av företag som redan tidigare varit aktörer inom spelindustrin, men även företag som inte tidigare varit aktörer inom industrin har visat intresse för industrin. Till exempel Netflix har gjort fyra förvärv på spelföretag mellan åren 2021 och 2022.

Dessa förvärv skulle tyda på att större företag ser ett mervärde i spelindustrin, vilket delvis kan bero på metaverse-trenden. Företaget Meta (tidigare Facebook) har gjort stora investeringar i metaverse och har till och med bytt namn för att återspegla detta.

Det kan vara värdefullt för både passiva och aktiva investerare att förstå vad synen på dessa industrier eventuellt har varit, vad de är nu och vad de kan vara i framtiden. Passiva investerare kanske vill överväga att ta med spelföretag i sina teknologiportföljer som ett sätt att få bättre långsiktig avkastning, medan aktiva investerare kanske vill ta med spelföretag i sina teknologiportföljer för att minska risken i portföljen eller för att öka avkastningen.

Syftet med den här studien är att bättre förstå hur spelindustrin uppfattas av investerare, om den erbjuder ett sätt att diversifiera en teknologiportfölj och om den presterar bättre eller sämre än teknologiindustrin. På grund av den förväntade tillväxten och det ökade intresset för spelindustrin kan det vara värdefullt att bättre förstå spelindustrin som en investeringsmöjlighet, samt hur den betraktas bland investerare.

Forskningsfrågorna är följande:

- Ser investerare spelindustrin som en del av teknologiindustrin?
- Kan spelföretags aktier användas för att diversifiera teknologiindustri portföljer?
- Är spelindustrin en lukrativ investering för diversifiering när aktiemarknaden har en uppåt- eller nedåtriktad trend?

7.2. Teori

I studien kommer Capital Asset Pricing-modellen (CAPM) att användas för att analysera hur spelföretags aktiekurser korrelerar med teknologiföretags aktiekurser. Dessa aktiekurser jämförs även med aktiemarknadsindexen Standard & Poor's 500 (S&P 500) och Nasdaq-100. Slutligen kommer optimala portföljer att skapas utifrån de förväntade avkastningarna för dessa enskilda aktier. Teorin för CAPM, aktiemarknadsindexen och portföljerna kommer att presenteras i det här kapitlet.

Grunden till modern portföljteori (MPT) är portföljteorin som skapades av Harry Markowitz år 1952. Teorin presenterar en process för att välja optimala portföljer baserat på statistiska data och antaganden. En av de viktigaste komponenterna i teorin är diversifiering. Förbättringar och utvidgningar av modellen gjordes av James Tobin och William Sharpe, där Tobin till exempel

inkluderade en riskfri ränta i modellen. Markowitz (1952) presenterade val av portfölj som en process med två faser, där den första fasen börjar med observationer och erfarenheter av värdepapper och slutar med uppskattningar om värdepapperens framtida avkastning. Den andra fasen börjar med relevanta uppskattningar av den framtida avkastningen och slutar med valet av en portfölj. De viktigaste antagandena i Markowitz portföljteori är att investerare försöker maximera avkastningen med lägsta möjliga risk, och en ökning i risk är acceptabelt endast då en högre avkastning kan förväntas. Ett annat viktigt antagande är att informationen på marknaden är tillgänglig för alla.

CAPM är en modell som används för att beräkna ett förväntat pris för en portfölj eller ett värdepapper. Modellen bygger på den moderna portföljteorin och Harry Markowitz portföljteori. CAPM-modellen består av den förväntade avkastningen på ett värdepapper och marknaden, den riskfria räntan samt beta som anger hur känslig den förväntade avkastningen på ett värdepapper är jämfört med marknadens förväntade avkastning.

De optimala portföljerna kommer att definieras som de som har de högsta Sharpekvot-värdena. Sharpekvoten skapades av William F. Sharpe år 1966. Sharpekvoten används för att mäta förhållandet mellan akvastning och risk för ett värdepapper eller en portfölj, jämfört med en riskfri tillgång, såsom statsobligationer. Sharpekvoten visar hur mycket risken ökar då avkastningen ökar (Sharpe, 1966). En portfölj med det högsta Sharpekvotvärdet kan anses vara den portfölj som ger den högsta avkastningen med den lägsta möjliga risken i förhållande till avkastningen.

Börsindex fungerar som verktyg för att se hur aktiemarknaderna rör sig för tillfället eller har rört sig tidigare. Dessa används ofta då man förvaltar portföljer, eller användas för att försöka förutspå framtida marknadsrörelser. Standard and Poor's 500-indexet (S&P 500) är ett av de vanligaste aktiemarknadsindex och innehåller 503 företag och består av cirka 80 % av det tillgängliga marknadsvärdet (S&P Dow Jones Indices, 2022). Indexet används i den här studien eftersom det består till circa 26,4 % av informationsteknologiföretag enligt S&P Dow Jones Indices (2022). Förutom S&P 500-indexet används även Nasdaq-100-indexet i studien. Nasdaq-100-indexet består av 102 av de till marknadsvärdet största icke-finansiella företagen som är börsnoterade på en av Nasdaqs börser (Nasdaq, 2022). Till skillnad från S&P 500-indexet innehåller Nasdaq-100-indexet både amerikanska och internationella företag. Liksom S&P 500-indexet används Nasdaq-100-

indexet också i denna studie på grund av att det består till största del av teknologiföretag, där cirka 54,8 % av företagen är teknologiföretag.

Global Industry Classification Standard (GICS) är en klassificeringsstandard som Morgan Stanley Capital International (MSCI) och S&P utvecklade år 1999. Syftet med en klassificeringsstandard är att ha en allmänt accepterad metod för att klassificera globala industrier. Företag kan endast klassificeras i en industri, och enligt MSCI (2022) är den allmänna regeln att företag klassificeras i industrier enligt den affärsverksamhet som står för över 60 % av företagets intäkter.

Spelindustrin förknippas enligt O'Donnell (2012) ofta med mjukvaruindustrin, delvis på grund av att de första spelen utvecklades av programutvecklare, som både skapade splen och programmerade spelkassetterna. I takt med att industrin utvecklades och spelen blev mer visuellt krävande, i och med lanseringen av konsolen Nintendo Entertainment System (NES) i USA år 1985, krävdes det fler personer med olika färdigheter för att skapa spel, särskilt personer med färdigheter inom konst och grafisk design. Denna förändring skulle senare leda till att índustrin kategoriserades som en del av den kulturella underhållningsindustrin, snarare än teknologiindustrin. Spel betraktas dock fortfarande ofta som mjukvara ännu i dag, och många spelföretag ägs av stora teknologiföretag, såsom Microsoft Corp, vilket stärker associationen.

Nuförtiden består spelindustrin av företag som tillverkar spel, publicerar spel, tillverkar hårdvara och diverse tillbehör för att spela spel, och företag som även ordnar evenemang för spel, såsom e-sportturneringar. Baserat på GICS skulle spelindustrin klassas som en del av media och underhållningsindustrin (MSCI, 2018).

7.3. Metod

Kvalitativa och kvantitativa forskningsmetoder används i denna studie. De kvalitativa metoderna har formen av en litteraturöversikt som används för att besvara den första av de tre forskningsfrågorna. Kvantitativa metoder används för portföljanalysen, för att besvara de andra två forskningsfrågorna, och för att besvara även den första forskningsfrågan.

I portföljanalysen jämförs aktiekurserna mellan teknologi och spelföretag, om de korrelerar och om de presterar olika under uppåt- eller nedåtriktade trender. Teknologiföretagen är Apple, Microsoft, Google, Tencent, Amazon, TSMC, Nvidia och Samsung. Spelföretagen är Activision Blizzard, Electronic Arts, Nintendo, Logitech, Bandai Namco, Take-Two Interactive, Square Enix och Capcom.

Utifrån data skapas optimala portföljer. Resultatet som fås är troligen mer värdefullt för aktiva investerare, såsom institutioner, eftersom de mera aktivt förvaltar sitt investeringskapital och vill skydda sina portföljer från att sjunka i värde då aktiemarknaderna allmänt sjunker.

Syftet med litteraturöversikten är att bättre förstå hur investerare ser på spelindustrin och om den ses som en del av teknologiindustrin. Genom att bättre förstå hur investerare eventuellt ser på spelindustrin, kan man i viss mån förklara resultaten från portföljanalysen. Å andra sidan kommer portföljanalysen också att bidra till att besvara frågan om hur investerare ser på industrin, eftersom korrelationen mellan aktiekurserna ger en indikation på hur aktiekursernas rörelser eventuellt skiljer sig under olika marknadsförhållanden.

Data som används i studien består av de historiska slutkurserna för totalt 16 företag, där hälften representerar spelindustrin och hälften teknologiinudstrin. I data ingår också aktiemarknadsindexens slutkurser, samt valutakurser och årsräntor på Förenta staternas statsobligationer. Tidsperioderna som beaktas i studien är år 2005 till 2010, år 2009 till 2019 och år 2017 till 2022. Portföljanalysen har gjorts i Microsoft Excel.

Portföljerna skapas genom att först räkna ut den förväntade avkastningen för varje enskilda aktie med hjälp av CAPM. Med den förväntade avkastningen kan en matrtis med variansen och kovariansen samt en korrelationsmatris skapas. Dessa matriser används sedan för att skapa portföljer med hjälp av Microsoft Excel solver-funktionen. Solver-funktionen används för att skapa en portfölj med högsta möjliga Sharpekvotvärde, och en portfölj med den lägsta möjliga standardavvikelsen, delvis lägsta möjliga risk. Summan av vikterna för de enskilda aktierna i portföljerna måste vara 100 %, vilket betyder att man inte kan investera med lånade pengar och att blankning inte är möjligt. Antalet företag som ingår i en portfölj är inte begränsat, vilket innebär att antalet företag i portföljerna kan variera.

7.4. Resultat

Spelindustrin kan enligt Kretchsmer et al. (1999) anses vara en kulturell industri eftersom den har följande fyra strukturella egenskaper:

1. Ett överutbud av potentiella varor som eventuellt blir sålda produkter.
2. Kvaliteten på varorna är osäker.
3. Olika typer av nätverkseffekt kan bildas av dem som konsumerar varorna.
4. Efterfrågan på varorna kan ha cykliska vändpunkter.

Utifrån de egenskaper som kulturella industier ofta har enligt Kretchsmer et al. (1999) är det förståeligt varför spel ses som varor för underhållning. Utvecklingen inom spelindustrin har dock ofta följt den teknologiska utvecklingen, och i takt med att teknologi har utvecklats och blivit mer lättillgänglig har också spel blivit mer tillgängliga och mångformiga. Denna parallella utveckling får spel att framstå som teknologivaror. Kretchsmer et al. (1999) hävdar dock att spel är kulturella varor, och Campbell-Kelly (2003) stöder detta genom att nämna att den lämpliga affärsmodellen och sättet att marknadsföra spel liknar det som används för varor som böcker och musik. Det finns även likheter med hur spel och filmer marknadsförs, där båda ofta marknadsförs genom exempelvis trailers. Campbell-Kelly (2003) kategoriserar dock spel som mjukvara, medan O'Donnell (2012) anser att spel inte är mjukvara. Detta visar att det i viss mån kan vara problematiskt att definiera spel.

Institutionella investerare anser troligen att spelindustrin är en kulturell industri. Detta framgår av hur spelindustrin kategoriseras av GICS, som görs av MSCI och S&P, två amerikanska finansföretag som erbjuder portföljanalyser och index som institutionella investerare använder aktivt. Ett annat exempel som möjligen stöder denna syn är videospel ETF (Exchange Traded Funds). Dessa ETF eftersträvar att erbjuda investerare exponering imot företag som anses vara gynnade av ökad tillväxt inom spelindustrin. Spel ETF består vanligtvis av företag vars intäkter kommer till över 50 % från spelindustrin.

Resultaten från portföljanalysen visar att spelföretagens vikt i portföljer med lägsta standardavvikelse låg mellan 47 % och 60 % i alla tidsperioder. Spelföretagens vikt i de optimala portföljerna är högre under de mer turbulenta perioderna år 2005 till 2010 och år 2017 till 2022, vilket tyder på att det kan vara en bra investeringsstrategi att investera i spelföretag under osäkra tider. Avkastning mellan de två indexen visar att Nasdaq-100-indexet ger en mer positiv syn, även under turbulenta perioder, vilket kan bero på ett mindre antal företag i indexet.

Den genomsnittliga korrelationen mellan spelföretag och teknologiföretag för de tre tidsperioderna låg mellan 0,21 och 0,28. Den låga korrelationen mellan företagen i spelindustrin kan möjligen förklara varför risken i en portfölj minskar då man ökar vikten i spelföretag. Korrelationen mellan tekologiföretag var mycket högre jämfört med korrelation mellan spelföretag. Den genomsnittliga korrelationen mellan teknologiföretagen var mellan 0,38 och 0,47 för alla tre tidsperioder. Korrelationen mellan spelföretag låg mellan 0,21 och 0,28 under de tre tidsperioderna, delvis samma som korrelationen mellan spelföretag och teknologiföretag.

7.5. Diskussion

Utrifrån resultaten kan man anse att investerare ser spel och teknologiindustrierna som olika. Denna skillnad kan dock vara otydlig, och händelserna inom spelindustrin där stora teknologiföretag förvärvar spelföretag, för att på så vis bli större aktörer i spelindustrin, tyder på att skillnaden kan bli allt mer otydlig. Otydligheten framträder redan genom att alla 8 teknologiföretagen i den här studien redan är aktörer i spelindustrin. Microsoft äger flera företag som gör spel, och de har även en egen spelkonsol. Google och Apple får intäkter från spelapplikationer för mobiltelefoner. Amazon äger den populära strömingstjänsten Twitch.tv. Då intäkerna från spelindustrin börjar stå för en större del av de totala intäkerna för teknologiföretagen, kan det vara möjligt att investerare är tvunga att förstå spelindustrin bättre för att kunna uppskatta teknologiföretagens resultat i framtida.

7.6. Slutsats

Syftet med studien har varit att analysera och jämföra skillnaderna mellan spel- och teknologiindustrierna från investerares synvinkel. Detta gjordes genom en litteraturöversikt och portföljanalys.

Resultaten tyder på att investerare, särskilt aktiva investerare, ser spel- och teknologiindustrierna som olika. Spel som varor är mera likt filmer, böcker och musik till sina egenskaper jämfört med teknologivaror. Spelindustrins kategorisering enligt GICS och förekomsten av videospel ETF stärker denna syn ytterligare.

Resultaten från portföljanalysen för de tre tidsperioderna tyder på att en teknologiportfölj kan diversifieras med hjälp av spelföretag och att detta vore möjligt i både hög- och lågkonjunktur. De optimala portföljerna visade att teknologiportföljer kan diversifieras genom att investera i spelföretag, vilket tyder på att teknologi och spelaktier i viss mån reagerar olika under olika marknadsförhållanden, vilket därmed tyder på att spelföretag kan användas för att diversifiera en teknologiportfölj.

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