LUT School of Business and Management

Bachelor's thesis

Finance Management

Global video game stock portfolio as an investment

Date of return: 6.1.2019

Albert Mäkinen

Azzurra Morreale

TIIVISTELMÄ

Tekijä: Albert Mäkinen

Tutkielman nimi: Global video game stock portfolio as an investment

Akateeminen yksikkö: School of Business and Management

Koulutusohjelma: Talousjohtaminen

Ohjaaja: Azzurra Morreale

Hakusanat: Videopelit, osakemarkkinat, sijoittaminen

Tämän tutkimus käsittelee videopeliyrityksistä muodostettua osakeportfoliota ja pyrkii vertailemaan sen suoriutumista osakemarkkinoilla viimeisen viiden vuoden ajalta eri indekseihin ja rahastoihin. Tavoitteena oli löytää vastauksia siihen, kuinka hyvin videopeliyritykset ovat tuottaneet voittoa, sekä onko tämä portfolio tuottanut tarpeeksi voittoa suhteessa videopelialan tuomaan riskitasoon. Osittain pyrittiin tutkimaan sitä, että onko muodostettu portfolio yli vai aliarvostettu markkinaan verrattuna. Tutkimus suoritettiin kvantitatiivisena tutkimuksena. Teoriaosuudessa esitellään videopelialaa ja sen luonnetta, sekä esitellään tutkimuksen keskeiset teoriat ja tutkimusmenetelmät. Videopeliyrityksistä luotua portfoliota verrattiin muihin arvopapereihin eri tunnuslukujen avulla ja portfolion tuottoja pyrittiin mallintamaan myös regressioanalyysin avulla.

Tutkimustulokset osoittivat, että videopeliyrityksistä muodostettu portfolio oli suoriutunut erinomaisesti annetulla aikajaksolla. Sharpen luvulla mitattuna portfolio ei kuitenkaan ollut paras suoriutuja vertailuryhmästä, joka johtui portfolion yritysten korkeasta positiivisten tuottojen hajonnasta. Vain negatiivisia tuottoja riskinä pitävä Sortinon luku taas osoitti portfolion olevan selkeästi paras suoriutuja. Markkinapohjaisten tunnuslukujen tulokset ja käyttö on kyseenalaista, sillä niiden tilastollinen merkitsevyys on alhainen. Volatiliteetin käyttö markkinan sijasta saattaa olla parempi mittari videopeliyritysten riskiä mitattaessa. Kokonaisuudessaan riskitaso huomioon ottaen, videopeliyrityksistä koostunut portfolio on suoriutunut erinomaisesti vuosien 2013-2018 aikana.

ABSTRACT

Author: Albert Mäkinen

Title: Global video game stock portfolio as an investment

School: School of Business and Management

Degree programme: Financial management

Supervisor: Azzurra Morreale

Keywords: Video games, stock market, investing

This research investigates stock portfolio of video game companies and attempts to compare its performance in the stock market over the past five years in various indexes and funds. The goal was to find answers to how well video game companies have made a profit, and whether this portfolio has generated enough profit in relation to the risk level brought by the video game industry. In addition, goal was to investigate whether the portfolio was over or underestimated compared to the market. The study was conducted as a quantitative study. The theory section introduces the video game and its nature and presents the main theories and research methods of the research. The portfolio created by video game companies was compared to other securities by different key statistics and the portfolio returns were also estimated by using regression analysis.

The research results showed that the portfolio of video game companies has performed well over the given period of time. However, measured by Sharp's ratio, the portfolio was not the best performer of the benchmark group due to the high variance of positive returns on portfolio companies. On the other hand, Sortino's figure, which only takes negative returns into consideration, showed that the portfolio was clearly the best performer. The utilization of market-based indicators as a measure of risk are questionable as their statistical significance is low. Using volatility instead of the market-based statistics may be a better way of measuring the risk of video game companies. Taking into account the overall level of risk, a portfolio of video game companies has performed extremely well during 2013-2018.

Table of Contents

1. Introduction

Video and mobile games are newcomers to the entertainment sector, and they have been stealing market shares from the traditional entertainment channels like TV and radio for many years now. According to a market data provider Newzoo, the video game industry has been, and will continue to grow, by 11% from the year 2012 to 2021. In total in 2017, the video game industry made 121 billion dollars in revenue and according to different sources the value of video game industry is getting close to 140 billion dollars in the year 2018 (Newzoo, 2018). Traditionally thought as an industry where a company's yearly revenue is made in the couple weeks after a new product's release, modern video game publishers have updated their games and business models so that revenue is gathered throughout the year. These new ways to make business in the video game world fits perfectly to the role of a publicly listed company. This switch in how these firms work has resulted in more video game companies entering the stock market. More companies in the stock market means that there is much more data available from video game publishers' but remarkably, the stock market data that is available from these modern-day entertainment companies is yet to be touched by the academic world. Video games themselves have been a popular topic in many studies in the area of psychology and behavioral research. This phenomenon has not transitioned to the academic world of business and finance. This study investigates how well video game stocks have performed in recent years and how they should be measured through quantitative research.

1.1 Research questions and goals for the study

The main reason for conducting this study is to investigate how well publicly listed video game publishers have performed against other industries and the market. Hence, the first and the primary research question for this study is the following:

How well has video game publisher stock portfolio performed in the stock market?

Related to the primary research question, two sub research questions were created in order to find how this industry's profits should be measured and if this industry has had the correct profit to risk ratio during the past 5 years.

Are video game stocks under- or overvalued?

Have video game company stocks offered enough compensation with respect to the risk of this industry?

1.2 Restrictions and structure

Empirical data for this study was gathered from the Thomson Reuters Datastream -program that provides economical time series for different securities like stocks, bonds and indices. The data is restricted to a 5-year period from the September of 2013 to the September of 2018. Data used in this study is daily data of the company's stock prices that were selected for the created portfolio. Further discussion about the data will be done in section 3.1.

Like discussed in the previous sections the primary focus is to find the performance of video game publishers. Obviously, this main research problem shaped the result of which companies were and could be selected for portfolio. In order for company to enter this portfolio, its primary source of revenue had to be created from video games. This restricted many companies from entering the portfolio. For example, one of the biggest current publishers in video game industry, Sony, had to be left out as it also creates massive revenue from consumer electronics, music services and movies to name a few. For the same reasons, other publishers like Microsoft Corporation and Konami Holdings Corporation were left out from the analysis of this research. The second restriction for a company was that it has to be publicly listed in a stock exchange but there were no restrictions made for the location, country or continent of the exchange. The reason for not making any restrictions for the location is because of the nature of the industry and how video game publishers gain revenue globally. This matter will be discussed in more detail in section 2.1. When it comes to the price of a company's stock, it is almost impossible to find this information of private companies. This is the reason for restricting this research to public companies. Public companies share very specific data in their financial statements and their stock price can be examined in real time, which helps enormously when calculating different ratios and statistics for the portfolio. As there are thousands of video game publishers in the world, but only a small percentile of them are public, there are not many companies to choose from when creating a stock portfolio.

This study consists of 5 sections and 21 sub-sections. The second sections consist of presenting the theoretical framework of this study. In addition, the pivotal theories of the research will be discussed with the literature that is used in this research. The third sections will present the time series data more precisely and it also presents the research and calculation methods used to find the results. The fourth section presents the results of the study and the fifth and final section will summarize this research as a whole.

2. Theoretical Framework

This section presents the theoretical framework and the pivotal theories of this research. The used theories lay basis for the research methods presented in section 3.2 and that are used to find results in section number 4. This section will also shed light into the researched industry and what the trends of the industry have been over last years.

2.1 Video game industry

The video game industry consists mostly of publishers and developers. The companies that are listed on the stock exchange are large global publishers that have their own development units or alternatively acquired smaller game developers to the corporation. This means that the publisher and developer can be the same company. The video game industry is highly competitive and solely in the United States the number of game development companies was over 2300 in 2016, while the same number for publishers was 526. According to Statista, 49% of the worlds video game developers were located in North America in 2017. 19% and 22% were located in Europe and Asia respectively. (Statista 2018)

The value chain of a video game starts from the game developer who creates and designs the game. Next is the publisher who is responsible of the marketing and sales. Most of the big game publisher's sales are made to the small number of large customers who are the game's retailers. Games are sold in either on store shelves or alternatively digitally in different online stores. The availability of digital games has also been a huge accelerator to the revenue of video game publishers.

Changes in business and revenue models have been a vital factor to the growth of this industry. As mentioned in Harvard Business School's Digital innovation platform and an article by Kotaku (JLuo 2018, Kotaku 2018), video games generate more money for a longer time now thanks to the "games as a service" -model or GaaS-model. The traditional way to release a game involved the development of the game and releasing it to the public, which after the development team switched to another project and leaving the finished game aside. This way the money generated from a game was made in the moment a customer buys the game and pays the lump sum for it. After this transaction games did not generate any additional revenue to the publisher. An alternative revenue model was popularized in the latter half of 2000's when publishers started to create additional content for their games which would cost anything from a dollar to 20$(some content can also be offered for free) depending on the size and form of the content. This enabled publishers to make more money of their games and at the same time keep their customers happy by adding more content that the players enjoyed playing. (Agarwal 2017)

Come the 2010's, the GaaS-model has evolved and for a video game to be successful it needs to offer new content for a longer time in order to keep customers interested and consequently make money for the publisher. Modern game's revenue is driven by DLC, stands for downloadable content, and micro transactions within the game. Micro transactions are transactions that are completed within a game and are usually worth under 10 dollars. Players use micro transactions to unlock additional content in the game (Superrewards 2018). In addition, with extra content, long term subscriptions create reliable revenue streams for video game companies (Nowak 2018).

For example, one of the biggest publisher Electronic Arts made 60% of its entire digital revenue from additional services and in-game add-ons (Electronis Arts 2018). On the other hand, only 20% of Electronic Arts' digital revenue was made from full game downloads. When taking the amount of physical sales of games and other goods into account, only 47% of Electronic Art's revenue was made from selling the actual game in 2018. The rest of the revenue was created with additional services that are offered to the customer and sales made in mobile apps. In this case additional services mean downloadable content in either form: DLC or micro transactions.

The impact of digitalization can be seen clearly in the video game industry. This can be interpreted from Electronic Arts' (shortened EA) financial statements. The percentage of EA's digital revenue has risen 29% from the fiscal year of 2012 to 67% in the fiscal year of 2018. The switch to selling more games digitally has been a trend in the whole industry as across the field all major publishers make new digital sales records every fiscal year in the 2010's.

Game publishers have also become more aware of their customers and their needs. In practice this can be seen firstly communication wise. Companies have more presence in online forums and they listen to the video game communities very closely. Secondly, games are developed for the customers. Customer experience is one of the most important factors for publishers when creating a game. Even though real fans tend to be loyal to their favorite game franchises, competition is so fierce in this industry that switching to another game is easy if one experience does not impress the customer. To conclude this paragraph, modern publishers have transitioned from their old model that had low user engagement to a platform-based model, were players can socialize with each other and that can create value for the publisher and the players alike for longer period of time. (Kotaku 2018)

Researching and analyzing this industry is especially important right now when taking into consideration the nature and size of the growth it has and still is offering. The potential for this industry is yet to be achieved and it is necessary to find out which statistics should be used to measure the performance of video game companies.

2.2 Pivotal theories

This section will present the theory basis for this study. All of the research methods are related to some or all of the introduced theories in this section.

2.2.1 Relationship of risk & return

One of the oldest fundamental ideas in finance is the relationship of risk and reward. If an asset has risk, it means the investor cannot associate a single number as the payoff of the investment. Instead, the payoff is formed from a set of outcomes. The probability of a single outcome can be calculated from an asset's return distribution. These distributions are often described either as expected return or standard deviation (Elton, Brown, Gruber & Goetzmann 2011, 44-48).

Expected return is be calculated as the average of all the events, which in this case are returns of assets. This is done by dividing the sum of all events with the number of events. Standard deviation (formula 1) on the other hand, measures how much an outcome differs from the mean of outcomes. If asset x has a bigger standard deviation, then asset y, it would commonly mean that the asset x carries more risk than y. Thus, investors would prefer x over y if the assets return would be the same. On the other hand, if the assets have the same constant standard deviation investors would prefer the asset with a larger average return (Elton 2011, 44-48). Standard deviation is also used as a measure of volatility (Pätäri 2018).

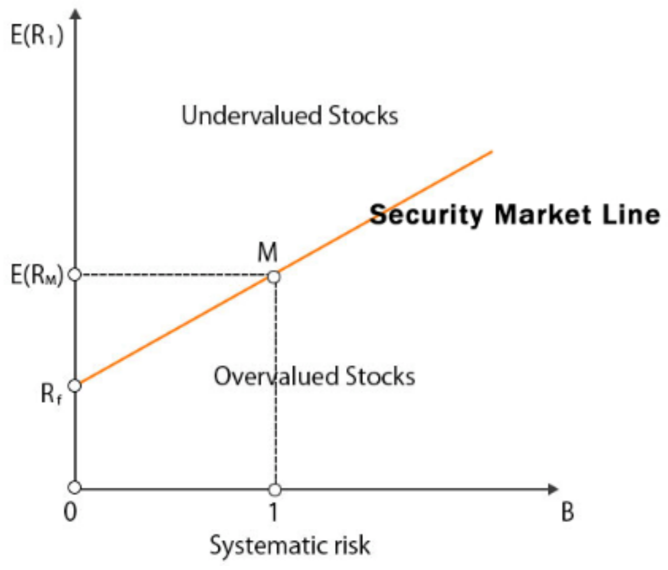
$$SD = \sqrt{\frac{\sum \left(r_i - r_{avg}\right)^2}{n-1}}$$

Formula 1. Standard deviation formula

These values can be used separately or together to valuate a single asset or portfolio. Many statistical figures that evaluate the performance of securities use these two values, of which are discussed in section 3.2.

Risk can be described in different ways and it is often divided into different categories. *Dispersion risk* illustrates the risk in change of the events and can be described with standard deviation for example. Dispersion risk can also be described with *downside risk* that only takes into account the distribution of events below the mean of events. (Prigent 2007, 3) Other dispersion measures are for example the alfa & beta factors.

Beta factor can be defined as the sensitivity of a stocks return to the return of market portfolio. It is an essential part of the traditional Capital Asset Pricing -model or the CAPM. Beta presents the systematic risk of a security as compared to the market portfolio. Beta coefficient and the idea of CAPM is easy to represent with the *Security Market Line* in picture 1. William Sharpe presented CAPM in 1964(Sharpe 1964) and it is one of the most used and simplest models to determine the price of assets.



Picture 1. Security market line (Wall Street Mojo 2018)

As previously mentioned, risk and return go hand in hand. The security market line depicts this fact with the relationship of the beta coefficient and the return of a security. With the methods presented in the section 3.2, this study investigates where the Video Game portfolio places itself the security market line.

Risk can be described in different ways, but assets are exposed to different risks either directly or indirectly. Although, a risk sources impact on an assets total risk, the amount changes between securities. Risk sources can be divided to two groups. Group one has risks that have impact on macroeconomic level. These are interest rate, market, inflation and business risk, of which business risk is partly limited to industry. Interest rate risk is related to the risk-free returns. Generally speaking, when interest rates rise the value of securities decreases due to higher discount rate. Even though, it clearly affects the value of bonds it also has an effect on stocks because of the rise of return on an alternative investment and also theoretically because of the higher discount rate mindset. Market risk is the amount of risk that comes from changes in market valuations. These switches in valuation occur due to changes in economic trends, consumer behavior or other big events such as war. Inflation risk affects all the securities and it can lower the purchasing power of an asset that can result in investors asking for inflation premium for their investment when inflation rises. Business risk relates to an organizations industry and operational environment. Business risk can be considered as how much an organizations results are tied to the industry's performance.

The second group of risk sources are organization-specific, and these risk sources are also called as unsystematic risk. The first of the three is financial risk, which is simply the risk that surges from how much debt a company has. After a certain point a large amount of debt with respect to the amount equity that can turn the debt to risk. Second is exchange rate risk, which can have an effect on international companies. Big changes in foreign currencies can affect an organization’s returns in that country. Country risk is related to a certain countries economic and political risk. Developed countries usually have less country risk than undeveloped countries. For example, countries in Africa have more instability compared to European countries, which leads to securities and organizations having more risk there. (Pätäri 2018)

This research does not investigate how much and which of these risk sources affect video game stocks. One reason for this is that the effect of a single risk source is hard to estimate, and the second reason is that the stock market has already estimated the overall risk into the stock prices. On top of all, this research is about studying the overall risk, which is the sum of all of the mentioned risk sources.

2.2.2 Regression Analysis

Brooks defines regression as “an attempt to explain movements in a variable by reference to movements in one or more other variables” (Brooks 2008, 27) He also describes it as the most important tool in econometrics. It is used to measure how much, and which *explanatory* variables x affect the *dependent* variable y. There are many different variations of regression analysis and the models can be linear or nonlinear and can include one or more explaining variables. Only linear regression will be used in this study, but single and multivariate regressions are both used. Regression equation is presented in its simplest form in formula 2. Variable a is the constant that presents the value of Y when x is 0. Value b is the coefficient for explaining variable x and it determines the slope of the estimated regression line. Value a is the constant that measures the value of y when x is 0.

$$Y = a + bX$$

Formula 2. regression function

In order to make this model more realistic, a random disturbance term *e* is also added into the formula. Term *e* can also be called as the residual (Brooks 2008, 30). It includes all the changes of variable Y that cannot be explained with variable X. It measures the distance of observation from the regression line. With the addition of term *e,* the formula can be called as the *classical linear regression model.*

Most common method for linear regression is the ordinary least squares -method or OLS. In OLS each observations distance to the estimated regression line is squared and then summed together and finding the smallest total. The estimated regression line goes through the average x and y. OLS is also the regression technique used in this study. (Brooks 2008, 31) (Carter Hill, Griffiths & Lim 2018, 61-63)

Usually one explanatory variable cannot fully explain the changes of value in the dependent variable and especially in the stock market there are many variables that affect the price changes of a single stock that most of the time it is more realistic to add more explanatory variables to the regression formula. There is no limit on the number of variables added, but depending on the model, at certain point when adding more variables, the explanatory coefficient stops rising and adding more variables might just lower the efficiency of the model. Formula 3 presents the composition of multivariate regression.

$$y_i = \beta_1 + \beta_2 x_{i2} + ...\beta_k x_{ik} + e_i$$

Formula 3. Multivariate regression function

In multivariate regression a coefficient is calculated for each explanatory variable and the coefficient determines the amount of the effect each variable has on the dependent variable. The coefficients are calculated independently, as in the coefficient for x_{i2} is created by examining its effect on y after eliminating the explanatory variables' effect on the dependent variable. (Brooks 2008, 89)

2.3 Literature & prior research

Basis of the literature used to conduct this research lies in traditional theories of finance. Literature consists of books, articles, magazines and lectures.

There is not much prior academical research done on the video game industry and the lack of knowledge and literature can be problem when conducting this study. In order to minimize this problem, extra caution must be taken when researching and looking into different sources for information. Information of the industry and companies is mostly collected from articles, forums and companies' financial statements. Financial statements can be considered as quite reliable information because of the rules and regulations the financial statements of public companies have. The lack of info and prior research is good to keep in mind when looking at the analysis, but this study and its results do not rely completely on this missing prior research as the empirical part consists mainly of stock analysis.

3. Research material and research methods

The aim of this section is to show what material was used in this study and how it was gathered. On top of that the research methods that are used are also presented and explained.

3.1 Research material and data

Research was conducted using the daily price data of the stocks of publicly listed video game companies. Like discussed in previous sections the data was collected from Thomson Reuters Datastream. Prices for different stocks and indices are measured in total return index. This means that the stock prices do not only take price changes into consideration, but they also include dividends that the companies pay out in a way that more of the same stock is bought with the dividends. Prices also take possible stock splits into consideration. All prices are measured in United States dollars.

After suitable stocks had been found from the Thomson Reuters database the data was then transferred into Microsoft Excel. Microsoft Excel came out as the best program to use in this study as it is performs well with the data size as big as it is in this research. Would the data been larger other softwares would have also been considered. Excel does have some restrictions when it comes to statistical testing. This is why statistical figures were generated by using data analysis tool STATA. It also enabled easier statistical testing, which is important when doing a regression analysis.

Stock portfolio that is studied in this research consists of stocks of 10 video game publishers. These companies are: Activision Blizzard Inc., Capcom CO. Ltd., Electronic Arts Inc., Nexon CO. Ltd., Nintendo CO. Ltd., Square Enix Holdings CO. Ltd., Take Two Interactive Software Inc., Tencent Holdings Limited, Ubisoft Entertainment SA. and Zynga Inc. This stock portfolio that is called Video Game portfolio, or VG portfolio, was created by giving each stock the same weight in the portfolio, which means that we imagine the same sum was invested to each of the ten stocks. Assuming that we invest all of 100% available, each stock got a 10% weight in the portfolio.

Some indices and funds are used in this study to present the profits of VG portfolio. On top of the fact that they are used to compare the statistical numbers of VG portfolio, some are also used to in the actual statistics for example in the beta-ratio. Five of the ten stocks in VG Portfolio are listed in western countries and four of them being in the

United States, which means that in order to take other markets into consideration, also global indices had to be picked with the Asian market ETF. Benchmark indices and ETFs consist of MSCI World, MSCI World IT, World IT Services, Nasdaq Composite, Vanguard IT ETF and Asia Pacific Dev Tech ETF, of which first 4 are indices and the last two are exchange traded funds or better known as ETFs. ETFs are mostly used in this study to compare the profits of VG portfolio to securities in the same industry or market. Like discussed earlier, there are no video game company funds or indices (that have been active for the time period of this study). Even though, ETF Managers Group created Video Game ETF called GAMR in 2016, due to its young age it is not used in this study. Instead, information technology ETF was chosen as IT-industry can be imagined as close relative of video game industry in terms of industry's nature and profits. As technology industry has had excellent performance in this study's time period, this Global IT ETFs is a great benchmark for VG portfolio. Vanguard's Global IT ETF is in the top 5 IT ETFs in the world when measured in total assets controlled and have also performed well in the given time period. Asia Pacific Dev Tech ETF is used to compare the profits of VG portfolio to the Asian technology market. As 50% of the stocks in VG portfolio are listed in Asian stock markets, it was only logical to use some Asian benchmark in addition to the western indices. Nasdaq Composite was picked as one of the benchmark indices as it has all of the stocks listed in Nasdaq, of which most are technology stocks. This makes Nasdaq Composite a great index to compare high technology companies into, as it has larger price changes and valuations, which reflects perfectly on the situation of video game industry. (Rutanen 2017) MSCI World IT reflects on the value changes in the global technology sector and MSCI World IT Services addresses service aspect of IT industry.

3.2 Research methods

This section presents the research methods that are used to find answers to the research questions. The methods are based heavily on the different theories shown in section 2.2.

3.2.1 Beta based statistics

Beta coefficients most popular use is probably in the CAP-model or just by itself. Both of these methods are used in this study to examine the risk of the video game company portfolio. In addition to these two, beta can also be used in Treynor's ratio. Presented by Jack Treynor (1966), it measures the amount of profit a security has offered in relation to the risk systematic risk of the market. It is calculated by dividing the excess return of a security with its beta coefficient (Formula 4).

$$T = \frac{Rp - Rf}{\beta p}$$

Formula 4. Treynor ratio

R_p stands for returns of asset p, R_f for the risk-free return of the market and β_p for the beta of asset p.Treynor suggested that securities are dependent on the fluctuations of the market. Treynor also mentions that some securities or funds are able to beat the returns of the market but that the relationship of returns and beta are linear, in the same way as in security market line showed in 2.2.1. Treynor's ratio does not give any specific value for the performance of the security that could be measured in money and thus should only be used as a tool to compare two different securities. It cannot be used solely for examining a single security. If a fund or portfolio is well diversified all differences between its returns and market returns are a result of short-term effects. Treynor ratio is a better indicator when market index is clear, and the portfolio is well diversified. (Treynor 1966)

Unlike Treynor ratio, Jensen's measure gives a measure for the actual performance of the portfolio. Jensen's measure (Michael C. Jensen 1967) is, like Treynor's measure, based on the CAP-model and presents the excess return of the security over the return CAP-model estimates. If alpha is larger than 0, the security can be considered to have beaten the market return and likewise. If alpha is 0 it means the security's profits are in equilibrium with the market returns. Jensen's alpha is calculated in the following method in formula 5, in which Rm is the returns of the market.

$$Ap = Rp - Rf - \beta_p \times (R_m - R_f)$$

Formula 5. Jensen's alfa

Unlike Treynor and Sharpe ratio for example, Jensen's alpha, which can also be referred to as Jensen differential performance index, can be used by itself as it contains the actual performance benchmark. Although, problems arise when one tries to compare portfolios together that have a different beta ratio, due to the particular form of the alpha. Jensen's alpha and Treynor's measure have some similarities: both only take systematic risk into consideration. (Prigent 2007, 133)

For each security, the beta is always calculated from the market portfolio, which can create a problem for certain securities. This fact laid basis for Richard Roll's (1977) criticism for the beta-based ratios. Roll argued that in theory, the market portfolio should obtain all risky assets. This alone shows that creating a perfect portfolio is impossible. Although, getting close to it is possible with correct selection of market portfolio. But in some cases, it might be hard to find the correct comparison portfolio for a security to calculate the beta from. (Roll 1977) Video game company portfolio used in this study is well diversified through different stock markets of the world. This creates a problem when calculating the beta for the entire portfolio, as it is questionable to compare this portfolio to a certain country's market index like S&P500 from The United States. The companies involved in the portfolio are also global agents and even comparing one stock from the portfolio to its stock markets index might give misleading results of its risk level.

3.2.2 Fama-French Model

The traditional capital asset pricing model has received much criticism for its simplicity. In 1993 Eugene Fama and Kenneth French created their own model for predicting price of assets. This model was called the three-factor model (Formula 6) and it centers around time series regression. Fama and French created this model because in their opinion the traditional beta-ratio did not capture the systematic risk of the market. In order to calculate the systematic risk, Fama & French created two variables: the size of a company and value of the company's stock as they had found out that both Book-to-market-ratio (B/M-ratio) and size of the firm are related to the returns of stocks. These variables were combined together with excess returns from the stock market in general. (Fama & French 1993)

$$r = R_f + \beta\left(R_m - R_f\right) + b_s \times SMB + b_v \times HML + \alpha$$

Formula 6. Three-factor model

In this formula, Rf stands for the risk-free return, Rm on the other hand is the return on the value-weighted market portfolio. The next value Fama & French named the SMB. SMB is a value that tells the returns of a stock portfolio consisting of small stocks minus the returns of a big stock portfolio, both of which had to be well diversified. Simply put, if SMB's value is below 0, it means that large companies have performed better in the given timeframe then smaller companies. HML describes the performance of high B/M-ratio companies to low B/M-ratio in the same way as SMB does: if HML's value is negative it means that low B/M-ratio companies have performed better than companies with low valuation and vice versa. The values B, bs and bv are slopes in a time series regression and it is the calculated coefficient to each variable in relation to the dependent variable.

Relying on empirical studies on historical values of the stocks, small firms with high B/M-ratio should have higher returns than predicted by the CAPM (Fama & French 1993 & 1995). These two factors capture another form of systematic risk that the beta of CAPM cannot do.

After receiving various criticism for their 3-factor model Fama & French improved their model and in 2013 they came back with a more advanced 5-factor model, which is presented in picture 8. The older 3-factor model had been described as incomplete as it did not take important factors like profitability and amount of money invested in a company into consideration, which are closely related to the variance of a stock's price. Thus, Fama & French added these variables into the original regression function that then changed to the 5-factor model (Formula 7). Representing the variables in the 5-factor model that were missing from the original 3-factor model are RMW and CMA. (Fama & French 2013)

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i \times SMB_t + h_i \times HML_t + r_i \times RMW_t + c_i \times CMA_t + e_{it}$$

Formula 7. Five-factor model

RMW is calculated by subtracting the returns of diversified portfolio of that involves companies with robust profitability from the returns of diversified portfolios involving companies with weaker profitability numbers. Fama & French used operating profit minus interest expenses to describe the profitability. CMA calculated in the same principle but by subtracting return of high investment firms from returns of low investment firms. Fama & French called these firms as aggressive and conservative. (Fama & French 2014) Even after adding two more variables to the model, Fama & French got criticism for the model leaving out the momentum effect and maintaining the assumption of the relationship of market beta and returns. (Blitz, Hanauer, Vidojevic & van Vliet, 2018)

CAP-model is a simple formula to calculate returns. Like explained in section 2.2.2. the more there are explanatory variables in the regression model the better the model should be in explaining the dependent variable. This study will also look into, which model is better at estimating historical profits: CAP-model or the 5-factor model. Before the study, an assumption could be made that 5-factor model would be the better of the two models just by looking at the amount explanatory variables. On the other hand, if the explanatory variables are not related to the growth of the video game portfolio it might lower the coefficient of determination. Explanatory variables will be tested before making the regression analysis in order to find any problems in the variables. For example, all of the variables should be normally distributed.

3.2.2 Sharpe -ratio

One of the more conventional methods to calculate portfolio's performance is to use Sharpe's measure (picture 9). It calculates the amount of reward a certain portfolio or asset has given for the amount of risk the portfolio has, also defined as reward-to-variability ratio. (Sharpe 1966)

Sharpe ratio is especially handy when it is hard to define the market portfolio for a certain security. As Sharpe ratio uses volatility as the only risk measure there is no need for a market portfolio when calculating the ratio for a single portfolio. Although, if one would like to compare Sharpe ratios between a portfolio and the market it would create the problem of finding the correct benchmark index (Prigent 2007, 139). For this reason, Sharpe Ratio works best in comparing two separate assets.

Another benefit that Sharpe ratio has over alfa and beta-based ratios, is that it is always meaningful. If an assets R-squared value is low when estimating beta coefficient for example, it means that the alfa might not be meaningful, unlike in Sharpe ratio.

In formula 8 R_p stands for the return of portfolio and R_f for the risk-free return. This difference is then divided by the portfolio's standard deviation. Interpretation of Sharpe ratio is simple: the higher the ratio, the more a security has provided excess return over the risk it offers and vice versa.

$$S = \left(\frac{R_p - R_f}{\sigma_p}\right)$$

Formula 8. Sharpe-Ratio formula

Like discussed earlier, Sharpe ratio is used in comparing assets and it cannot be used to evaluate a single asset. As it is expressed as a raw number, one cannot tell if a Sharpe ratio of 1 is good or bad. Risk-adjusted return can be interpreted only by comparing Sharpe ratios of at least two assets. (Morningstar 2018) For these reasons it is not reasonable for a portfolio manager for example to set a defined Sharpe ratio goal for the portfolio he is managing (John Mount, 2015). Although, a goal of having a better Sharpe ratio than a rival portfolio could be acceptable.

At least three choices should be made when comparing Sharpe ratios of two assets. Firstly, the time frame where the data of returns is collected for these assets should be the same, as returns and variance might change drastically in shorter or longer time frames and result could affect either assets ratio. This prompts towards the second choice, which is the correct length of the data. If the chosen time frame where the data is collected is too long, it can result the Sharpe ratio to take changes in returns into consideration that are no more present in the market. On the other hand, if the data is collected only from a few months, it can result the Sharpe ratio to be extremely high because the calculations might end up avoiding some big changes. Thirdly, because Sharpe ratio can only be interpreted by comparing it to another asset, benchmark has to be correctly picked even though the actual ratio itself is not dependent on benchmarks or rivals. Choosing a comparable asset with low returns will automatically make another asset look better. (Sharpe 1994) These three things are important to keep in mind when collecting data and analyzing the results.

3.2.3 Sortino ratio

Standard deviation is a good number that gives a quick glimpse of an assets price changes. It takes all changes into account. If a stock would rise 40% in value in a single day, the change in value would affect standard deviation negatively, as in making the standard deviations value bigger. Standard deviation does not indicate whether the change in value is positive or negative. This problem can be changed with semivariance measures like Sortino ratio (Sortino & van der Meer 1991). Sortino ratio can be especially good when the return distribution is asymmetrical. (Prigent 142) The ratio has a lot of similarities with the more traditional Sharpe ratio. Formula of Sortino ratio is presented below in formula 9.

$$Sortino\ ratio = \frac{R_{Mean} - MAR}{Downside\ deviation_R}$$

Formula 9. Sortino ratio formula

In the Sortino ratio formula the numerator is basically the same as in Sharpe, but risk-free rate is changed to minimum acceptable return. Minimum acceptable return is often defined as the risk-free return of the market, as in treasury bills (Morningstar 2018). This is due to the fact that MAR is defined by the investor doing the calculation. In this study we assume that MAR is the risk-free return, because it makes sense for an investor to pick a security that makes at least greater returns than the risk-free asset. In addition, return of the market is also used as MAR to compare the results. Denominator on the other hand is the downside deviation instead of standard deviation. Downside deviation is calculated by calculating the deviation of the returns below the mean return from the timespan.

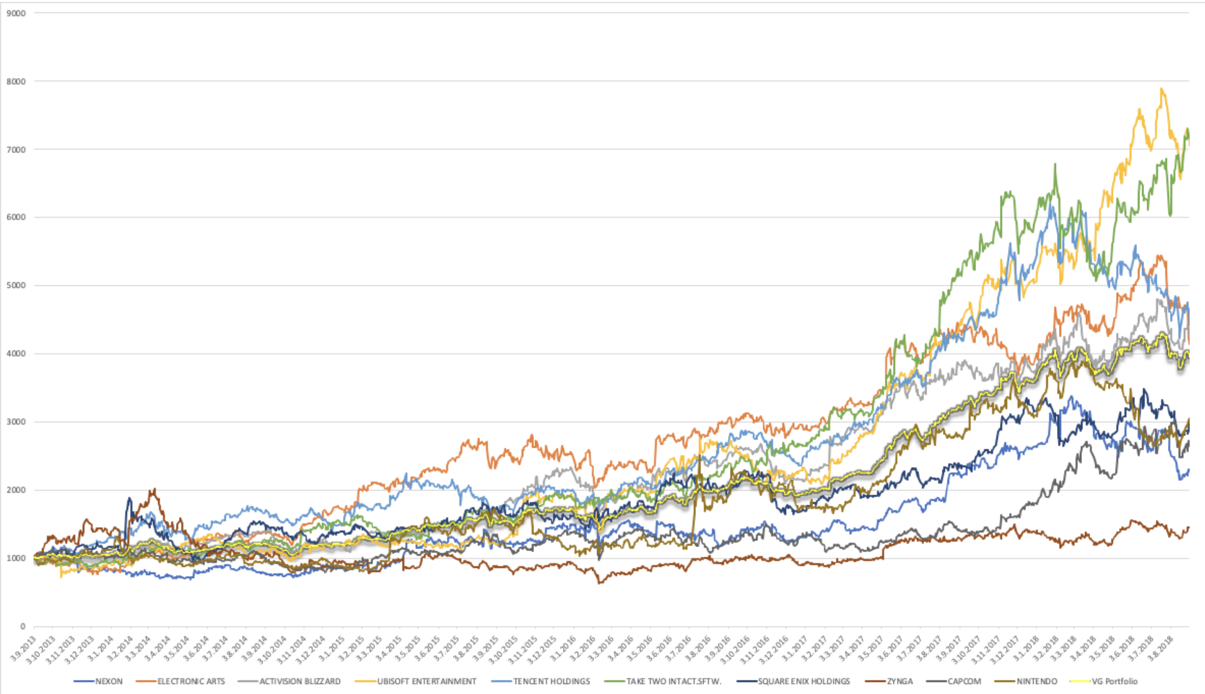
Sortino ratio gives an investor a more realistic view of the negative risk of the security. As positive variance in prices have a bad effect on an assets Sharpe ratio, the effect on Sortino ratio is much smaller.

4. Results

This section presents the empirical results of this study. Firstly, the raw returns will be presented and analyzed. After these we will move into more detailed statistics and models and try to find answers to the research questions.

4.1 Raw portfolio returns

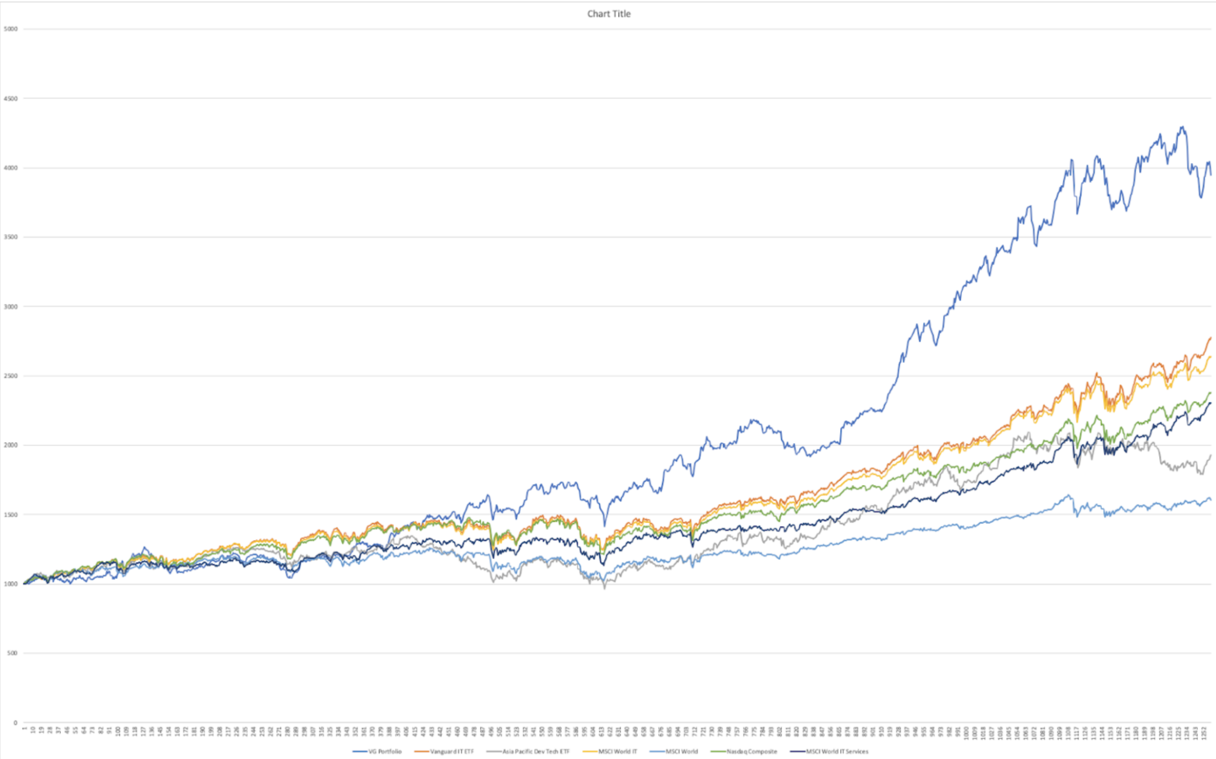
Stocks that are involved in the Video Game Portfolio have a big variance between the total profits in the examination period. Profits of individual stocks are presented in the picture 2. The chart was created by making an index of each stocks price. The first day's adjusted closing price was indexed at 1000 index points.



Picture 2. Returns of individual stocks in VG Portfolio

The lowest profits were generated by Zynga, which as the worst stock in this portfolio has risen approximately 45% in 5 years. Although, it did not beat the S&P 500-index for example that recorded profits of 72% in the same time period, the profits of Zynga can still be considered as decent. What is more, this percentage shows that even the lower profiting public video game companies have a profitable business. On the other end of the spectrum are the most profitable publishers in the last 5 years. Ubisoft and Take Two Interactive both have risen over 600%, which can be considered exceptional in any market in the world, let alone for companies that had a market capitalization of over 1 billion dollars already 5 years ago. Market capital is calculated by multiplying price of the stock with the total amount of stock. Although this study does not look too much into individual stocks, this graph is presented to show how much variance there has been inside the Video Game Portfolio in the last 5 years. The Graph also shows the portfolio itself as the yellow line with black edges, which places itself around in the middle of the stock returns like it should be as the average of all the stocks.

Comparing the Video Game Portfolio to different indices and information technology funds in picture 3 and table 1, we can see the massive amount of profits it has provided. VG Portfolio is in its own league with total profits of 295%.



Picture 3. VG portfolio returns vs. benchmarks

The benchmark and competition presented in this graph are the securities presented in section 3.1: Vanguard Global IT ETF, MSCI World IT, Nasdaq Composite, MSCI World IT Services, Asia Pacific Dev Tech ETF and MSCI World. These were listed in order of their total performance of the research period from highest to lowest. By raw performance, it is clear that the technology sector as a whole has beaten the total market. It is interesting to note that only one of the two ETFs beat the WORLD IT-index, though their graphs are almost identical to each other. By geometrical average, the average returns and total returns for each security has been the following:

Table 1. Raw returns

	VG Portfolio	Vanguard Global IT ETF	AS/PAC Dev Tech	MSCI World IT	MSCI World IT Services	Nasdaq Composite
Yearly return$_{Average}$	30,42 %	22,65 %	14,05 %	21,39 %	18,19 %	18,92 %
Total return	295%	178%	93%	164%	138%	131%

4.2. Portfolio performance

This section presents results of performance statistics for VG Portfolio and benchmark securities. Firstly, beta-based statistics are presented and analyzed, which after statistics are shown for ratio based on volatility of the securities.

4.2.1 Beta based statistics

Beta has questionable attributes when it comes to using it in performance statistics, especially when comparing global assets and securities in different markets. Biggest problem was to find the correct market portfolio or index to compare VG Portfolio to. In the end, MSCI World-index was chosen as the market portfolio, as it presents the overall performance of the global stock market quite well. Beta-based statistics are presented in table 2. Betas vary between 0,225 and 0,8711. VG Portfolio is located in the lower spectrum with a beta of 0,5198 that indicates that its price changes are 52% smaller than of MSCI World index. But when looking at the R-squared value the prior statement cannot be valid as MSCI World only explains 18% of the movements of VG Portfolio. Betas vary between 0,225 and 0,8711. VG Portfolio is located in the lower spectrum with a beta of 0,5198 that indicates that its price changes are 52% smaller than of MSCI World index.

Table 2. Beta based statistics

	VG Portfolio	Vanguard Global IT ETF	Asia Pacific Dev Tech ETF	MSCI World IT	MSCI World IT Services	Nasdaq Composite
Beta	0,5198	0,8711	0,2250	0,8106	0,7914	0,8544
Jensen	24,98%	13,91%	11,38%	13,22%	10,20%	10,34%
CAPM	16,07%	19,81%	3,59%	17,45%	14,51%	16,25%
Treynor	0,57	0,25	0,60	0,26	0,22	0,22
R-squared (Beta)	0,1818	0,5789	0,0287	0,5986	0,5818	0,6216

But when looking at the R-squared value the prior statement cannot be valid as MSCI World only explains 18% of the movements of VG Portfolio. Additionally, by security market line VG Portfolio would be extremely undervalued by beta when comparing it to the returns. In reality, stocks in VG Portfolio hold large valuations compared to the average stock market. Therefore, returns of VG Portfolio are hard to explain by the changes in the stock market even though it somewhat follows the stock indices. Only using beta as a measure of risk for video game stocks is questionable, which can be Results from Jensen's alfa are looking better at a glance, since they are closer to the actual performance of these securities. But for example, Asia Pacific Dev Tech ETF's alfa is highly inflated due to its low beta coefficient. It is clear that Asian technology stocks do not tend to follow the trends of the global market.

Treynor ratio gives VG Portfolio the second place by performance. As in Jensen's alfa, the largest Treynor ratios are affected by the unrealistically low betas, which again questions the use of beta as a performance measure.

By historical values CAP-model predicts yearly returns of 16,07% for VG portfolio, which is roughly 14% lower than the actualized average return for VG Portfolio. Through the field it is easy to see how beta affects the different results. P-values for betas and its constants were statistically significant that would the support the use beta from statistical point of view. In reality, especially the beta for VG Portfolio is unrealistic for measuring risk, which is likely a result of a difficult market portfolio pick. Due to the nature of the stocks in VG Portfolio results must be analyzed with caution as global technology securities are hard examine through the beta.

4.2.2 Sharpe -ratio

Sharpe ratio did not give out the results that were expected (Table 3). Like discussed 3.2.2 Sharpe ratio and returns should in theory have a positive correlation. By Sharpe-ratio VG Portfolio is one of the worst performers of the group, which means it has provided less amount of profit for each amount of risk it bears and by theory, low Sharpe ratio should also indicate relatively low profits, which in this case in not correct.

Table 3. Sharpe ratio results

	VG Portfolio	**Vanguard Global IT ETF**	**Asia Pacific Dev Tech ETF**	**MSCI World IT**	**MSCI World IT Services**	**Nasdaq Composite**
Sharpe-ratio	0,81	1,44	0,77	1,48	1,26	1,26

In order for VG Portfolio to achieve the same Sharpe-ratio as Vanguard Global IT ETF it should have recorded yearly return of 53,48% on average, which is over 45% than the returns of 30,42% it provided in this timeframe. If investors had to pick between these securities by only looking at Sharpe-ratio, VG Portfolio would not be the first choice as there are no indicators for the volatility to decrease in the future. However, it is important to remember that Sharpe ratio takes overall standard deviation into account, of which not all is bad for the investment, therefore the next section is dedicated to Sortino-ratio that removes the negative effect of positive returns.

4.2.3 Sortino ratio

Results of the Sortino ratio are very interesting and this statistic has the best linear trend when it comes to comparing the VG Portfolio and the benchmark securities. Sortino ratio uses MAR or maximum acceptable return in the numerator instead of the risk-free profit used in Sharpe ratio for example. MAR is not universal and is set by the individual calculating the ratio. In this study, Sortino ratio was calculated with two different MARs, which were the risk-free return and MSCI World-index. MSCI World was used as MAR to find out how well VG Portfolio returned profits over the average stock market with its downside deviation. Sortino ratios are presented in table 4.

Table 4. Sortino ratio results

	VG Portfolio	**Vanguard Global IT ETF**	**AS/PAC Tech ETF**	**MSCI World IT**	**MSCI World IT Services**	**Nasdaq Composite**
Upside deviation p.a. (MSCI World)	0,12648	0,11031	0,11030	0,10320	0,100006	0,12483
Downside deviation p.a. (MSCI World)	0,10902	0,10832	0,12486	0,09942	0,09796	0,10360
Sortino Ratio(MSCI World)	1,88	1,17	0,17	1,09	1,17	0,87
Sortino ratio (Risk-free return)	2,74	2,04	0,92	2,03	2,12	0,92

When MAR was set as risk-free return, VG Portfolio came out as the best performer and MSCI World IT that had the best Sharpe ratio was only the third best. This means that either the portfolio has less downside risk or profits were larger to the relative downside risk. In this case, MSCI World IT could not match the profits VG portfolio had accumulated. Slightly larger downside deviation indicates that VG Portfolio had more spread when it came to returns below risk-free rate of 0,55% p.a. Although, the global IT ETF almost matched the downside deviation of VG portfolio and Asian tech market ETF clearly had the biggest volatility when it came to negative returns. So, VG Portfolio had slightly bigger deviation than some of the IT benchmarks, but certainly it also delivered when it came to making profits. Especially the Sortino ratio suggests that it has been great at making up for the higher deviation of negative returns. This fact is solidified when we examine the Sortino ratio with MAR set as MSCI World. With this set up, Sortino ratio examines the profit efficiency of profits over the returns that MSCI World has provided. In this category VG Portfolio clearly has the highest number, which indicates that it has been the most efficient security of the pack to earn profits over the MSCI World.

If an investor was looking to earn the profits with a MAR of risk-free treasury bill, the VG portfolio would not the most efficient asset to do that. In addition, VG Portfolio is superior choice when trying to achieve returns higher than the market. Because investors are looking to get positive returns from securities, Sortino is better at examining results over the negative risk of the asset. As technology sector and the Video game industry tend to have higher highs (in profits) then most of the other stocks, Sortino ratio can be better indicator when measuring performance as it does not punish a security for positive returns, which are good for investors. In order to contrast on the effect of positive returns, upside deviation is also added to the table 4. VG Portfolio clearly has the highest variance when it comes to positive returns and it also higher than its downside deviation. This could suggest that positive returns affect VG Portfolio’s Sharpe-ratio more than the negative returns.

4.3. Estimating returns with the 5-Factor model

Five-factor model was used in this study to find if traditional regression analysis could excel at forecasting profits of a modern industry. Before the actual regression analysis, statistical tests were completed in order to ensure that the results are appropriate and that the data is eligible for OLS regression.

4.3.1 Diagnostic tests

In OLS the dependent variable and the residuals of the regression are assumed to be normally distributed. The returns for the VG Portfolio are quite normally distributed as can be seen from attachment 1 and 2, which present the distribution of the returns with Kernel density plot and with histogram plot. Kernel density plot can be imagined as histogram plot with many small bins and a moving average. Kernel density plot was also used to examine the distribution of the residuals in attachment 3, which shows that also the residuals are close to being perfectly normally distributed. After normal distribution tests, it is important to move into heteroskedasticity tests. In this study, White's test with visual plots were used to find out heteroskedastic tendencies in the data. The H0 Hypothesis for White's test is that the data is homoskedastic. Results from White's test are presented in attachment 4. As the P-value is under 0,05 the null hypothesis is rejected, which means the H1 hypothesis comes into effect that suggests the variance of residuals is not constant, therefore the residuals are heteroskedastic. Heteroskedasticity is also recognizable from attachment 5, which plots the residuals against the predicted values. Clearly, more values are centered around the middle area of the x-axis, which suggest heteroskedasticity is present. Although, the values are distributed quite well across the range so the effect of heteroskedasticity is not significant, but it is good to keep in mind as heteroskedasticity might skew the standard errors and consequently show the results of OLS as misleading (Brooks,135-136).

Multicollinearity is examined by looking at the correlation matrix of all of the variables. This is presented in attachment 6, which does not suggest that there would be multicollinearity, as largest correlation is measured only at 0,6202 between values HML and CMA. VIF was conducted in order to be sure that the data is not multicollinear. Results of VIF, or variance inflation factor, are found in attachment 7. VIF table shows that there is no significant multicollinearity as all value are modest and the mean VIF is 1.38. Usually VIF of 1 mean that there is no correlation at all and VIF of 5 or greater is considered as highly correlated. Therefore, modest but insignificant multicollinearity is present, and it should not affect the results of the OLS-regression. (Statistics How to 2015)

Final diagnostic test for the regression model is the test for possible autocorrelation. This was done by doing to Durbin-Watson test of which results are presented in attachment 8. Result of the test is 1.50261, which can be considered as good, but it indicates of a modest amount of autocorrelation. Andy P. Field (2009) suggests that values under 1 and over 3 should be a cause for concern. Autocorrelation has the same effect in regression as heteroskedasticity. It might affect the coefficients in a way that they are not efficient. This could be interpreted as that the OLS is not anymore, the best linear unbiased estimator (BLUE), which means that wrong conclusion could be made of whether the explanatory variable x has or has not got an effect on dependent variable y (Brooks 2018, 149-150). Brooks also adds that positive autocorrelation, which is present somewhat in this data, could have an effect of lower standard errors in OLS, relative to their true standard errors. Furthermore, lower standard errors could end up rising the R-squared value, which again would skew the explaining power of the five-factor-model in this case.

After diagnostic tests some problems can be recognized with the data like small positive autocorrelation and slight heteroskedasticity for example. However, the statistical tests indicated that these questions are powerful enough that changes would need to be made into the data. The nature of the data will be taken into account when analyzing the results and for example the standard errors and the coefficient of determination will be looked into more critically.

4.3.2 Regression results

Results of the regression analysis are presented below in picture 13, which is the regression analysis output from STATA. Confidence level of 95% was chosen as significance level for all tests in this study as it is often the default level (Carter Hill et al. 2018, 128).

All but one of P-values, which are found in the P>| t | -column, are statistically significant on a 95% confidence limit, which is recognized from a P-value of smaller than 0,05. In regression analysis we examine the value of R-squared. When a regression analysis has multiple explanatory variables, it is desirable to look at the adjusted R-squared because it adjusts the explaining power of the model to the number of explanatory variables. (Brooks 2008, 110) The value of adjusted R^2 is 0,2036, which means that in overall the five-factor-model explains 20,36% of the returns of VG Portfolio. This can be considered as a bad result as almost 80% of the changes in returns are out of the reach of five-factor model.

Source	SS	df	MS			
				Number of obs	=	1,260
				F(5, 1254)	=	64.12
Model	.029078394	5	.005815679	Prob > F	=	0.0000
Residual	.113734374	1,254	.000090697	R-squared	=	0.2036
				Adj R-squared	=	0.2004
Total	.142812767	1,259	.000113433	Root MSE	=	.00952

VGP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
MktRF	.005157	.0003638	14.18	0.000	.0044434	.0058707
SMB	-.001156	.0005663	-2.04	0.041	-.0022669	-.000045
HML	-.0023105	.0007172	-3.22	0.001	-.0037175	-.0009034
RMW	-.0016951	.0008913	-1.90	0.057	-.0034436	.0000534
CMA	-.0029485	.0011429	-2.58	0.010	-.0051907	-.0007063
_cons	-.0008645	.0002694	-3.21	0.001	-.0013929	-.000336

Picture 13. Regression analysis results

Coefficients for the explanatory variables are all negative except for the market returns. Positive coefficient tells us that when market returns rise also returns of VG Portfolio rise but in relation to the coefficient, which is 0,005157 in this case. MktRF also has the largest coefficient, which means that it has the highest impact of explanatory variables on the returns of VG Portfolio. All other variables, more or less, affect the returns of VG Portfolio negatively. SMB described the return of small and big companies and in this regression, it shows that VG Portfolio follows the profits of big companies as the coefficient for SMB is negative. This coefficient can be interpreted as following: when small companies have higher returns than big companies the returns of VG Portfolio are negative. As all of the stocks in VG Portfolio are in the upper end of the market capitalization spectrum this result was not surprising. Although, the small coefficient indicates that video game stocks do not follow the profit trends of any specific market capitalization level. HML might be the most interesting variable of all as it has a coefficient of -0,0023105. It indicates that when companies with high B/M-ratio have higher returns than companies with low B/M-ratio the profits of VG Portfolio rise. Therefore, video game stocks tend to follow the returns of companies with low valuation, which is interesting as video game stocks tend to be really highly valued in the stock market. Average trailing P/E, which is widely used as a measure for stock valuation, for stocks in VG Portfolio is 40,7 and average P/B is 4,2. P/B is a reciprocal for B/P-ratio that for example Fama & French have used in their studies. Although, Fama & French (Fama & French 1995) have shown that stocks with high B/M-ratio have been more profitable, especially when it comes to long term profits, in the past it is only logical that VG Portfolio that has had fantastic last 5 years in terms of returns follows the returns companies that are also profitable continuously. All the same, it is interesting to note that video game stock returns do not tend to follow returns of other highly valued stocks. RMW has the lowest coefficient and is also the only variable that is not statistically significant. Therefore, the results are questionable on this variable. Removing RMW from the regression lowered the R-squared of the model and it ended up rising the p-values on other variables. Assuming that RMW was statistically significant, the coefficient of -0,0016951 would indicate that when companies with low profitability have higher returns than stocks with high profitability, the returns of VG Portfolio rise. Latest statistics (October 2018) from companies of VG portfolio indicate that large video game companies are quite profitable: average return-on-equity was 15,2% and average operating margin was 20,1% on average. CMA has the second highest coefficient after MktRF at -0,0029485. This tells us that VG Portfolio would rise in value when high investment stocks rise.

All factors included, 5-factor model forecasts average daily return of 0,2013% for VG portfolio, which is almost twice the amount of profits VG portfolio has offered historically. When measured on a yearly level 5-factor model estimates profits 66% p.a. on average. Is this indication that there are much more profits to come from video game stocks. Probably, but as R-squared is as low as it is these numbers should be examined with extreme caution. Although, single variables could help to indicate the direction of these stocks. Just like in simpler beta-based statistics the nature of video game industry is making it hard to explain profits with changes to the overall stock market.

5. Summary and conclusions

This research studied the performance of a stock portfolio built of video game companies that either publish or create video games and accumulate most of their revenue from selling video games and additional services related to these products. Video game companies gather their revenue globally and also the companies in this particular portfolio are listed in markets around the world. Therefore, this portfolio was matched against benchmarks ranging from Global information technology indices to Asian IT sector ETFs. Beta and volatility adjusted performance measures were used to find out how good of an investment this portfolio has been in the last five years.

How well has video game publisher stock portfolio performed in the stock market?

Video game portfolio has clearly recorded excellent profits in the last five years and it safe to answer the first research questions that the performance in raw numbers has been immaculate. Average return of 30% over a 5-year period can be considered as exceptional. In addition, performance measures like Sortino- and Sharpe-ratio show that the industry has performed well when risk is taken into consideration.

Are video game stocks under- or overvalued?

When placed into the Security Market Line (presented in section 2.2.1) VG Portfolio seems to be greatly undervalued as it is located in the upper left corner with a beta of 0,51 and yearly return of 30%. Although, individual video game stocks have high valuation, when combined into a portfolio the stocks seem to be massively undervalued in statistics like the beta-coefficient.

Have video game company stocks offered enough compensation with respect to the risk of this industry?

Even though the results from beta-based statistics for VG portfolio are questionable, Jensen’s alfa gives 25% excess returns over the overall stock market per year, which is not that far away from the real returns that VG portfolio has provided historically. The beta and hence the overall market were quite poor at explaining the returns of video game companies and this study suggests to rather use volatility as a measure of risk when evaluating video game companies’ performance.

Whether VG portfolio has or has not provided enough compensation for risk it has carried throughout the years depends on which statistics one wants to use as the performance measure. Sharpe ratio gives out a relatively poor performance for VG portfolio, but on the other hand Sortino-ratio, which negates the effect of positive returns clearly places VG portfolio as a great performer. The use of negative risk-adjusted statistics could be a better indicator when dealing with securities that record large positive returns. All the same, VG portfolio has returned great returns for the risk level it withholds.

CAP- and five-factor-model were used to predict the profits of VG portfolio, of which both more or less not great at doing so. The models themselves are not bad but the results relate to the problem of beta-coefficient and the inability of market to forecast the returns of video game companies. This would suggest that the recent profits of video games companies are mostly explained by the growth of video game industry itself and not by the overall market.

Video game industry is an interesting investment opportunity as it grows and evolves with a pace that can match the biggest high-tech firms. Even though the weights of video game companies have been low in the technology funds and ETFs, the industry is getting recognized more and more every day by investors and ordinary people. This is seen from the amount of investment products related to the video game industry. It is unclear how long the growth of the industry will continue and by how much but there are no indicators for stopping of the video game industry in the following years. For investors looking to get into an industry that appeals especially for the generations Y and Z, video game industry is an excellent choice. Individual companies can be seen as stocks that hold massive risks as the companies still rely on few products to succeed, volatility of the stocks is large, and valuation of video game stocks is high, which can result to large decreases in price if expectations are not met.

For future studies of this industry, it would be interesting to find variables that could explain the returns of video game stock better than the traditional models. Furthermore, video game companies could be studied on an individual level in a way, of which business models are turning out to be the most profitable in this industry.

6. References

AGARWAL, P., Nov 19, 2017-last update, *The Economics of Micro transactions in Video Games*. Available: https://www.intelligenteconomist.com/economics-of-micro transactions/ [Nov 4, 2018].

Electronic Arts, 2018. *Annual reports.* Web Page, Available: https://ir.ea.com/financial-information/annual-reports-and-proxy-information/default.aspx [Oct 2018]

ELTON, E., J., GRUBER, M., J., BROWN, S., J. and GOETZMANN, W., N., 2011. *Modern portfolio theory and investment analysis.* 8th ed., international student version. Hoboken, NJ.

Fama, E.F. and French, K.R., 1993. *Common risk factors in the returns on stocks and bonds.* Journal of Financial Economics, Volume 33, issue 1, pp. 3-56

Fama, E.F. and French, K.R., 1995. *Size and Book-to-Market Factors in Earnings and Returns. The Journal of Finance,* 50(1), pp. 131-155.

Fama, E.F. and French, K.R., 2013. *A Five-Factor Asset Pricing Model.* Rochester, NY

Field, Andy P. 2009, *Discovering Statistics Using SPSS*. 3rd ed. Sage Publications

GOURIEROUX, C., 2001. *Financial econometrics: problems, models, and methods.* Princeton University Press.

HILL, R.C., 2001. *Undergraduate econometrics.* 2nd ed edn. Wiley.

JENSEN, M.C., 1967. *The Performance of Mutual Funds in the Period 1945-1964.* Rochester, NY:

JLuo, 2018, *Rethinking the video game business-model*, Web Page Available: https://digit.hbs.org/submission/rethinking-the-video-game-business-model/ [Nov 2018]

Morningstar, 2018, *How to Use the Sharpe Ratio,* web page [Available]: http://news.morningstar.com/classroom2/course.asp?docId=2932&page=5&CN=com

6.11.2018

Nowak Brian, 2018. *Video Game Publishers Flip the Switch on Business Models. Web Page, Available: https://www.morganstanley.com/ideas/video-gaming-publishers-2018 [Dec, 2018]*

Mount, John, *What is a good Sharpe ratio?* blog [available]: http://www.win-vector.com/blog/2015/06/what-is-a-good-sharpe-ratio/ 6.11.2018

PRIGENT, J., 2007. *Portfolio optimization and performance analysis.* Chapman & Hall/CRC.

Pätäri, E. 2018. Finanssi-investoinnit- lecture material.

Roll, R. 1977*. A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory*. Journal of Financial Economics Volume 4, Issue 2. pp. 129-176

Rutanen, Jenna 2017. *Nasdaq indeksi selitettynä: sadasta 5650: een pisteeseen*. Web page. Available: https://www.lynxbroker.fi/tietopalvelu/artikkelit/nasdaq/ [Nov, 2018]

SCHREIER, J., Feb 12, 2018-last update, *Why Ubisoft Is Obsessed With 'Games As A Service'*. Available: https://kotaku.com/why-ubisoft-is-obsessed-with-games-as-a-service-1822938255 [Nov 4, 2018].

SHARPE, W.F., 1964. Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk*. *The Journal of Finance,* 19(3), pp. 425-442.

SHARPE, W.F., 1966. *Mutual Fund Performance*. *The Journal of Business,* 39(1), pp. 119-138.

SHARPE, W.F., 1994. The Sharpe Ratio. *The Journal of Portfolio Management.*

Sortino, F. A. and van der Meer R. 1991. *Downside risk*. Journal of Portfolio Management, 17 (4): pp. 27-31

Statista, 2018. *Video Game developer distribution world wid*. Web page Available: https://www.statista.com/statistics/453785/game-developer-region-distribution-worldwide/ [Nov 2018]

Statistics How to, 2015, *Variance Inflation Factor*, Web Page Available:

https://www.statisticshowto.datasciencecentral.com/variance-inflation-factor/ [Nov,2018]

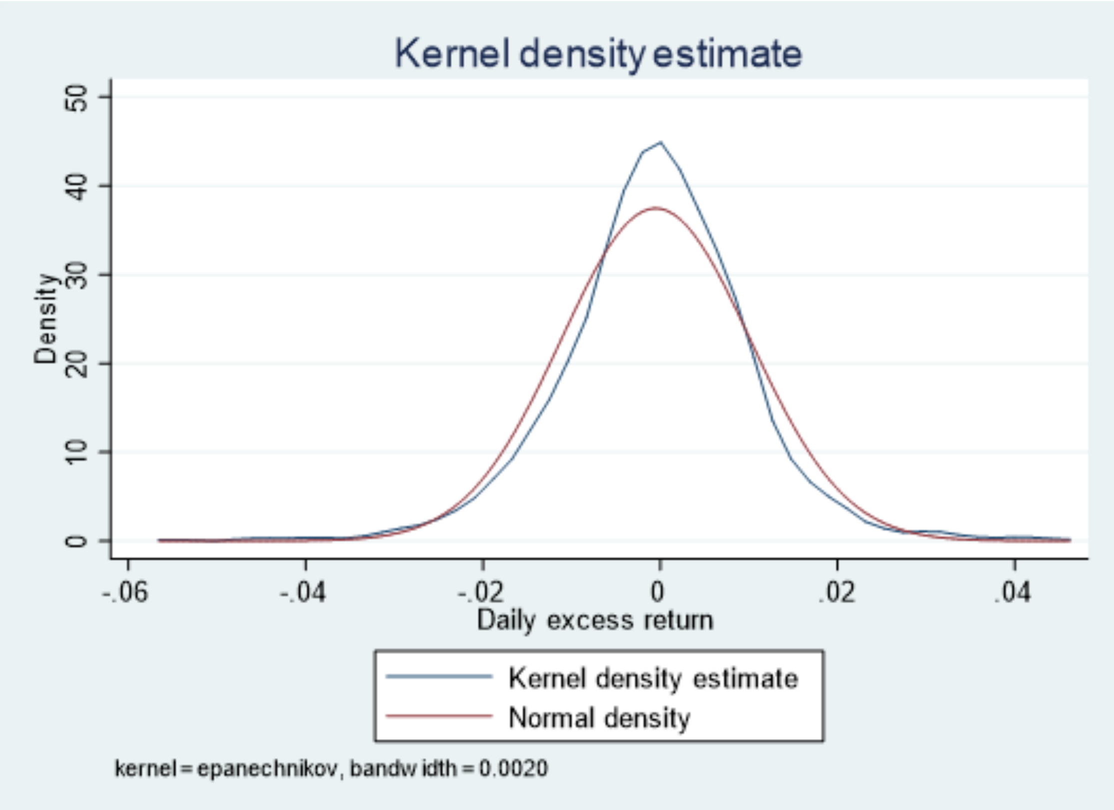
Superrewards, 2018, What's a microtransaction and how do developers use them? Web Page Avvailable: http://www.superrewards.com/micro-transaction [Nov,2018]

VASSALOU, M. and XING, Y., 2002. *Default Risk in Equity Returns.* Rochester, NY:

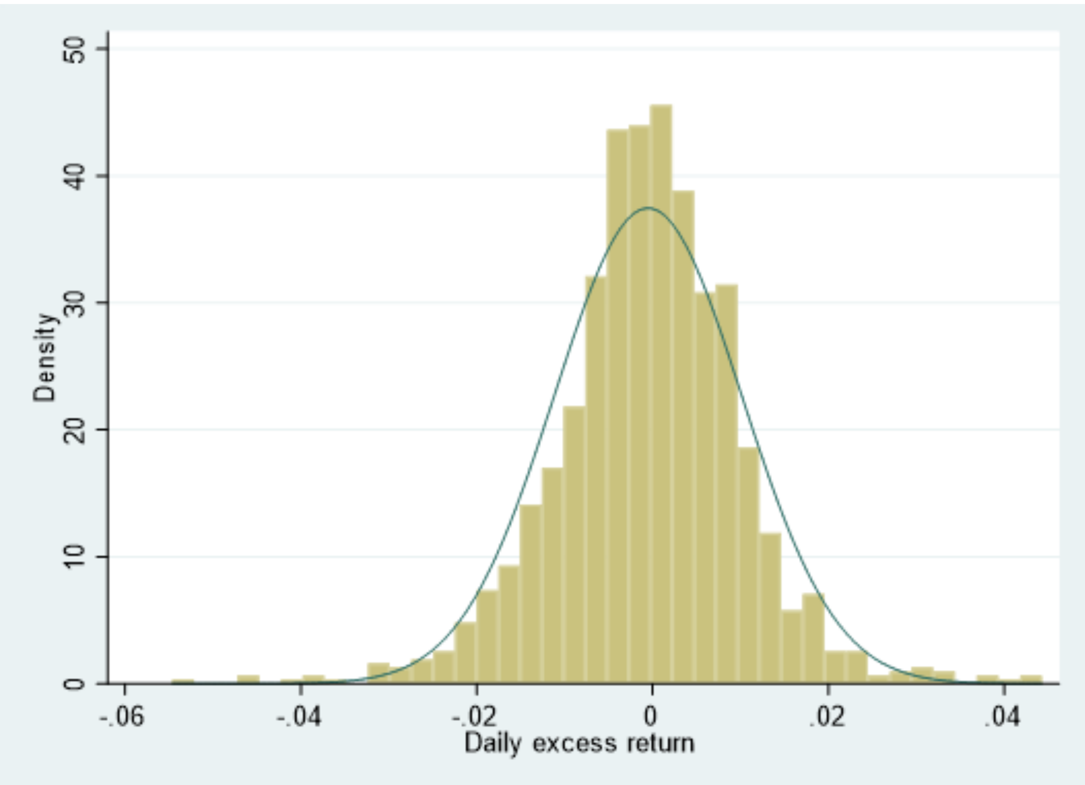
Wall Street Mojo, 2018. *Security Market Line.* Web Page, Available: https://www.wallstreetmojo.com/security-market-line/

WIJMAN, T., April 30, 2018-last update, Global Games Market Revenues 2018 | Per Region & Segment. Available: https://newzoo.com/insights/articles/global-games-market-reaches-137-9-billion-in-2018-mobile-games-take-half/ [Nov 4, 2018].

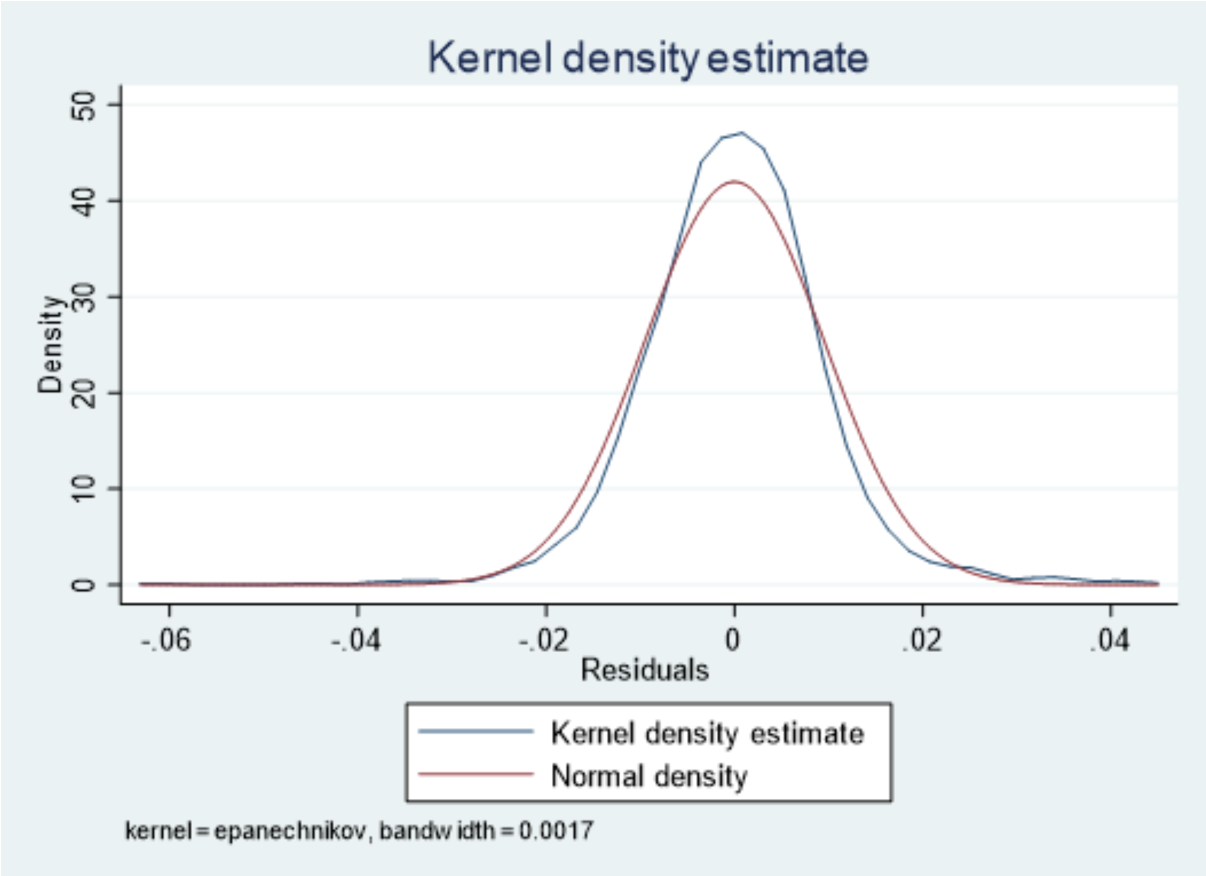
Attachments



Attachment 1.



Attachment 2.

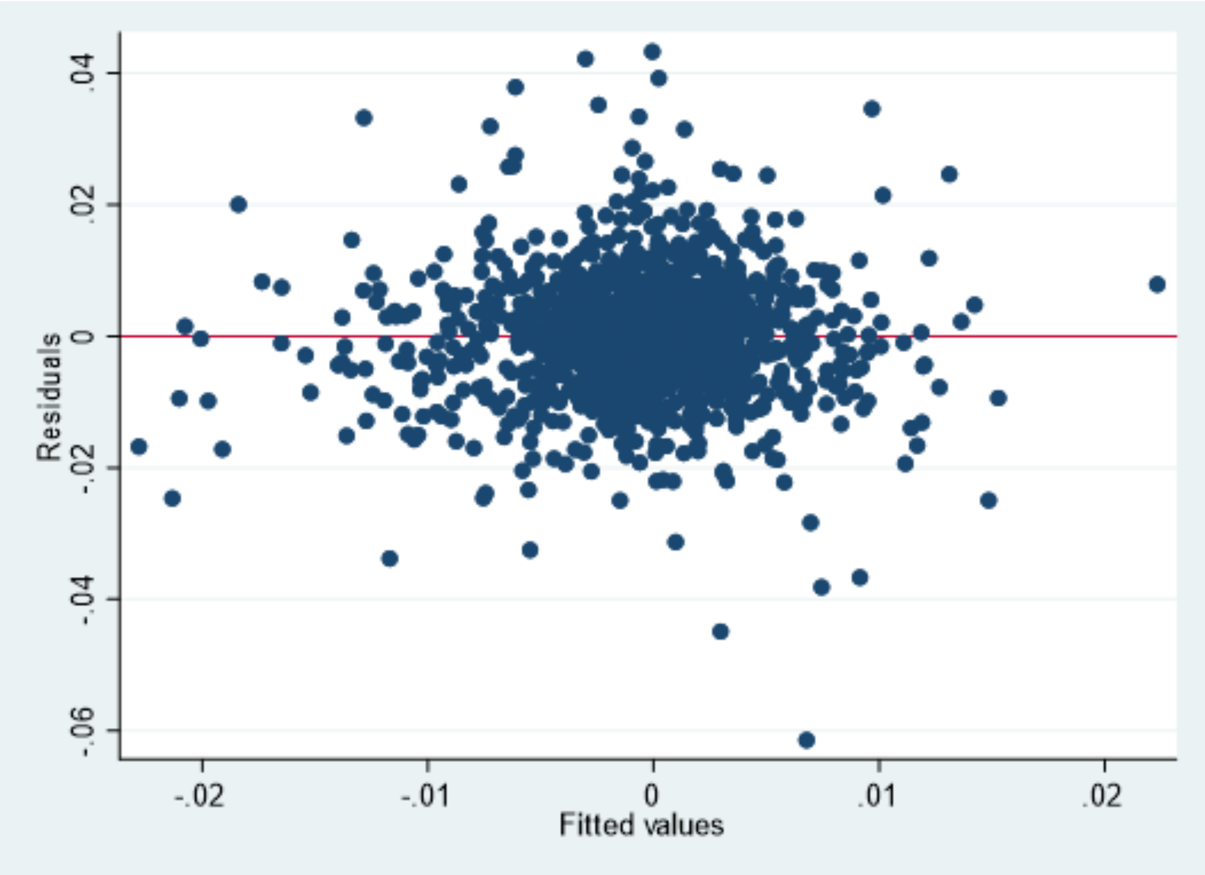


Attachment 3.

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(20)      =     52.13
         Prob > chi2   =    0.0001
```

Attachment 4.



Attachment 5.

	VGP	MktRF	SMB	HML	RMW	CMA
VGP	1.0000					
MktRF	0.4134	1.0000				
SMB	0.0350	0.1653	1.0000			
HML	-0.1702	-0.0387	-0.0614	1.0000		
RMW	-0.1622	-0.2988	-0.3088	0.0137	1.0000	
CMA	-0.2359	-0.2108	-0.0380	0.6202	0.1188	1.0000

Attachment 6.

Variable	VIF	1/VIF
CMA	1.74	0.574778
HML	1.66	0.600897
RMW	1.20	0.834627
MktRF	1.16	0.863190
SMB	1.12	0.892170
Mean VIF	1.38	

Attachment 7.

```
Number of gaps in sample:  271

Durbin-Watson d-statistic(  6,  1260) =   1.50261
```

Attachment 8.