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# The effect of financial ratios on the firm value of video game companies

Evidence from the global gaming sector

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**TIIVISTELMÄ:**
Tämä pro gradu -tutkielma käsittelee kansainvälisiä videopelimarkkinoita ja yhteyttä tunnuslukujen ja yritysten arvostuksen välillä. Tutkimus koostuu lineaarisesta regressioanalyysistä ja 24:stä julkisesti noteeratusta osakeyhtiöstä joiden pääosainen liiketoiminta koostuu videopelien tai niiden oheistarvikkeiden myynnistä ja kehittämisestä. Lisäksi tutkimus suorittaa F-testin samanaikaisten vaikutusten selvittämiseksi. Julkisen osakeyhtiön arvostusta kuvataan Tobin's Q tunnusluvulla. Tämä tutkielma pyrkii lisäämään akateemista tutkimusta videopelimarkkinoiden ominaisuuksista.

Tutkielma löysi tilastollisesti merkitsevää positiivista yhteyttä koko pääoman tuottoasteen (ROA) ja Tobin's Q;n arvon välillä. Yhden yksikön kasvu tässä tunnusluvussa vaikuttaa positiivisesti yhtiön arvostukseen näillä markkinoilla. Muiden tunnuslukujen osalta tulokset eivät ole tilastollisesti merkitseviä, ja tarkempien havaintojen analysoiminen vaatii useamman datapisteen tietokantaa. Lisäksi, samanaikaisen hypoteesitestauksen (F-testi) tulos osoittaa, että käytetyillä tunnusluvuilla ja yhtiön arvostuksella ei ole tilastollisesti merkitsevää yhteyttä tässä kontekstissa. Yhtiön koon kontrolloiminen regressiomallissa johti hyvin samankaltaisiin tuloksiin.

Videopelialan kehittyessä ja kasvaessa datan saatavuus todennäköisesti helpottuu, jolloin tämän tutkimuksen luoman viitekehyksen pohjalta voidaan mahdollisesti luoda jatkotutkimuksia ja uusia päätelmiä. Videopelit luovat pohjan ainutlaatuisille liiketoimintamalleille ja erinomaiselle tuottavuudelle tulevaisuudessakin.

**AVAINSANAT:** Tunnusluku, Tobin's Q, Yrityksen arvo, Videopelit, Toimiala-analyysi, Lineaarinen regressio, F-testi

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# 1 Introduction

## 1.1 Purpose of the study

The purpose of this study is not only to examine the video game industry in the European Union in great depth, but also to provide insight into financial ratios and their effect on the firm value of the retrospective companies. The video game industry is surprisingly large, but very few research papers exist on the topic. This paper aims to provide insight to investors and companies in the field about the nature of valuation within the sector. The paper provides answers to how well the different financial ratios explain the actual value of the companies in this field.

Testing which of these hypotheses is true, this study constructs a multiple regression model and tests for the two-tailed statistical significance and draws conclusions from the results from the coefficients. The F-statistic is also analyzed in simultaneous hypothesis testing to acquire results on the simultaneous effect of these financial ratios on the firm value of video game companies.

Potential outcomes of this study can help stakeholders in valuating and assessing publicly available information and make better decisions on the actual magnitude of these financial ratios. Investors in the sector can also benefit from the results of this study as financial ratios are an essential part of the public information used to assess the performance of any firm. A main part of this study is to provide an extensive introduction to the video game industry as a whole and provide study material for the field since existing literature is lacking despite the industry being huge as measured in revenue and profitability.

This study aims to provide the necessary evidence with data analysis in the form of multiple regression and simultaneous hypothesis testing. These methods are discussed in detail and the results interpreted into real world relationships. The goal is to provide grounds for future industry analysis as the video game market continues to grow.

## 1.2 Hypothesis development

In testing whether financial ratios have an impact on firm value in the videogame industry this study provides statistical evidence through regression analysis. To analyze the coefficients of this model, hypotheses must be defined. This study constructs a null hypothesis and an alternative hypothesis based on the relative change in firm value that is influenced by financial ratios.

This study is conducted by statistically testing against two hypotheses. These are defined as follows.

$$H_0 = Financial\ ratios\ have\ no\ impact\ on\ firm\ value$$
$$H_1 = Financial\ ratios\ have\ an\ impact\ on\ firm\ value$$

These hypotheses are used to together with test statistics and coefficients to find the statistical significance based on which the null hypothesis is either accepted or rejected. The hypothesis expects to find both positive and negative relationships depending on the examined ratios. In other words, the nature of the examined financial ratio determines whether the positive increase is a desirable effect for the firm's business model.

## 1.3 Structure of the study

The initial value this study offers is an extensive review of the video game industry with latest data points and visualizations to help the reader get familiar with the properties and magnitude of this field. Geographical differences are examined and estimations on the future growth of the industry are presented. The purpose of this segment is to give a clear introduction to video games and how they produce value. Financial ratios and their purpose in the space of publicly listed companies are also presented and explained to the reader with examples.

The second part of this study is highly related to the actual research question of the thesis. How do financial ratios effect the firm value of publicly listed video game companies? The data set to

study the relationship consist of publicly listed companies manufacturing or selling video game related content/hardware. In addition, multiple financial ratios and other performance indicators are fetched from the Orbis (2020) database. This data is then presented and described in detail before constructing the model used to explain this phenomenon.

Certain criteria must be fulfilled for multiple regression analysis to be conducted so this study tests for the classical assumptions of regression analysis such are tests for normality, heteroskedasticity test, and tests for multicollinearity. After the data and the model are deemed acceptable for statistical analysis, multiple regression is performed with and without controlling for size variables and the results interpreted.

# 2 Background and literature review

## 2.1 Introduction to the global video game sector

The video game industry consists of companies that engage in the selling and distributing of intellectual property in the form of virtual games. These games can be played on a multitude of devices and can be tailored for just about anyone. Because of easy accessibility and massive popularity, the industry has seen substantial growth over the past decade. This is largely due to technological innovation and the growing scale of internet across the planet. Based on a report made by Grand View Research (2019), the global video game sector is expected to grow 12.9% annually until the year 2027. WePC (2020) states that the market size for this industry is valued at around 159.3 billion USD. Figure 1 illustrates the predictions of future growth in the U.S markets. (Grand View research 2020; WePC 2020)

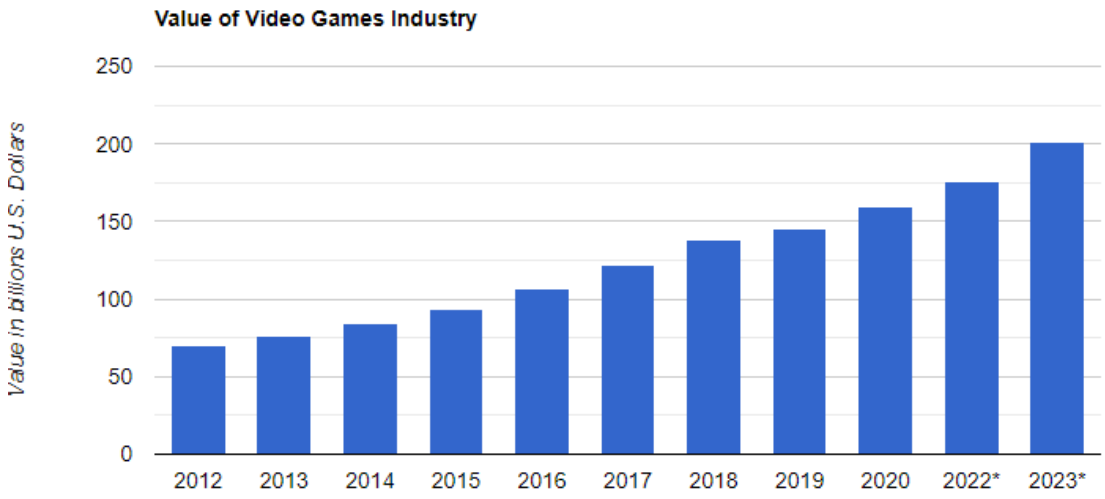


*Figure 1. The value of the global video games industry (WePC 2020)*

In the recent decades gaming has evolved from physical board games to online variants. These games can be played on different devices and are also used to divide the industry into sections. These sections are most referred to consoles, mobile/tablet, PC, and handheld devices. The games within these segments are similar but tailor to different segments of consumers. Figure 2

shows the split between revenue among these segments in European markets. Most of the revenue in the sector is coming from console and mobile gaming markets and these are the ones expected to experience the most growth. According to WePC (2020) that gets their data from Statista (2020), the biggest areas of growth for the sector are the developing markets in Latin America and APAC countries. (ISFE 2020; WePC 2020)

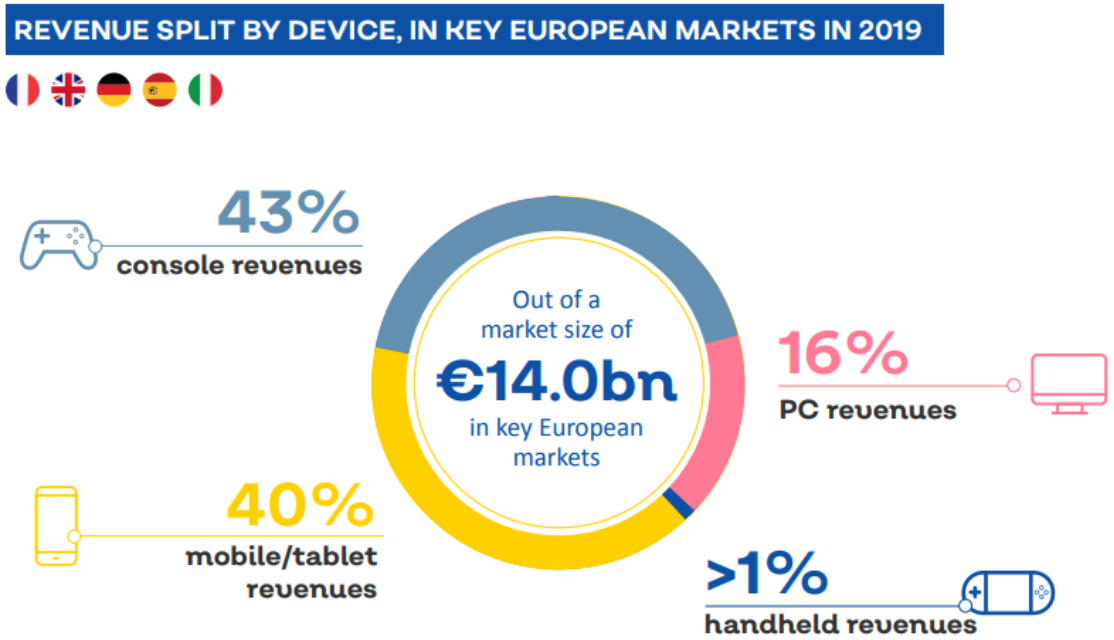


*Figure 2. Revenue split in European markets (ISFE 2020)*

The largest region for the video gaming industry based on revenue is China followed by The United States and Japan (Figure 3). These developed countries are frontrunners in the technological development of video games and have a wide array of customers. Most of the customers who consume video games are based in Asia. Almost half of all consumers are based in the Asia-Pacific area. With the purchasing power of these consumers constantly evolving, these markets are extremely potential candidates for growth. (WePC 2020)

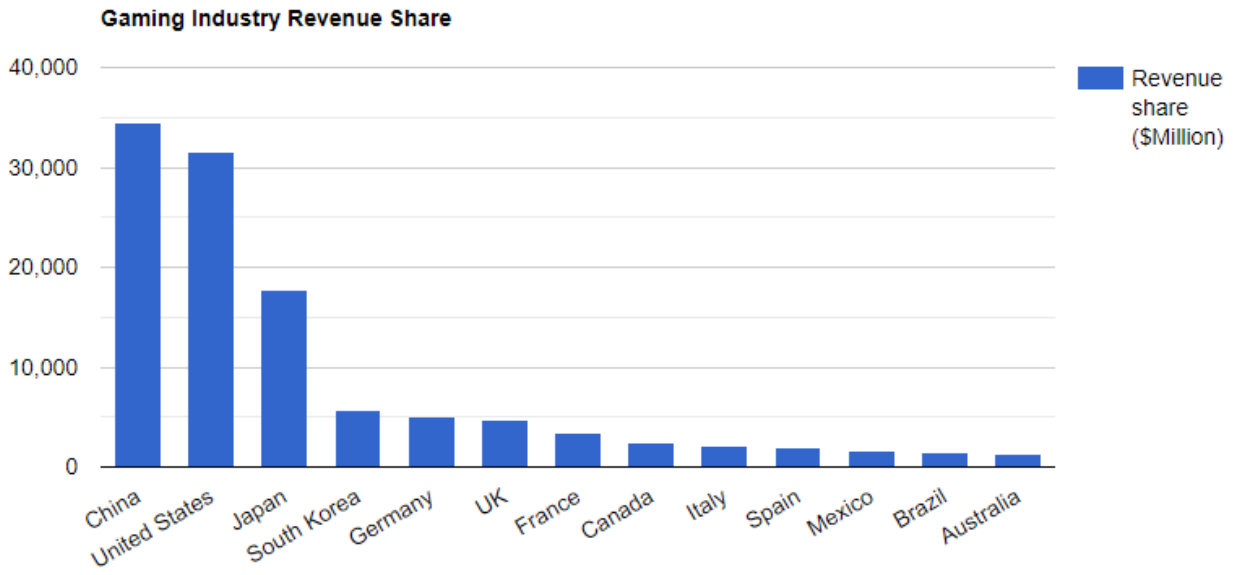


*Figure 3. Revenue share in the industry (WePC 2020)*

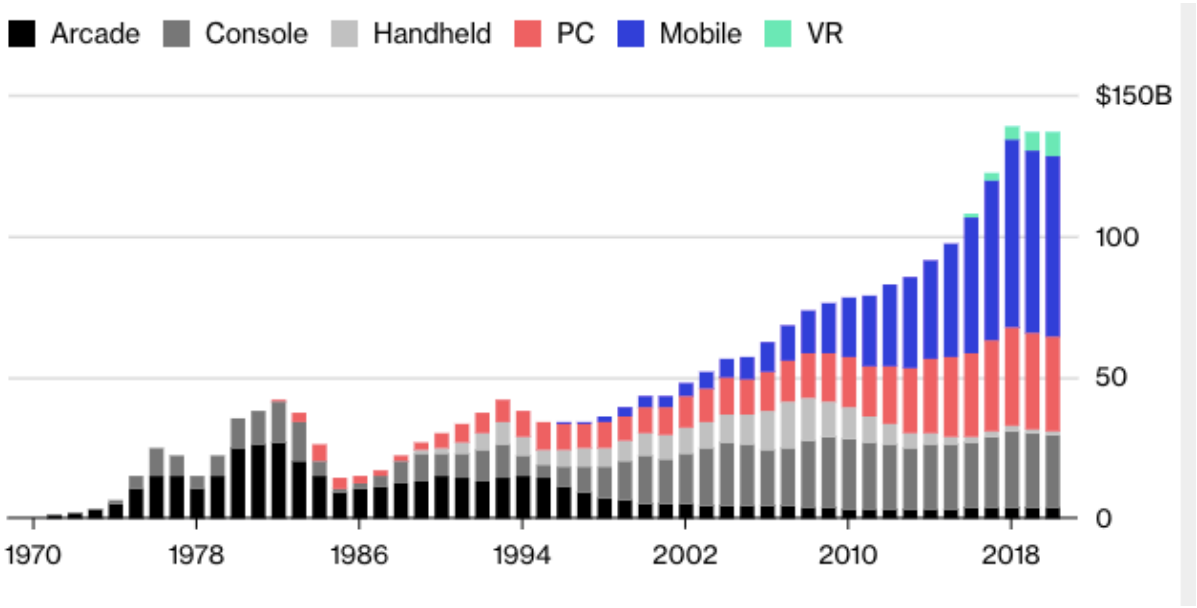


*Figure 4. Revenue trend for video games per platform (McAloon 2020)*

Recently new formats of playing games have emerged and taken the industry by storm. This is called freemium or free-to-play gaming and is especially typical for the mobile gaming industry. In essence, this means giving the consumer access to the product free of charge and selling

additional premium services for a cost. This leads to a drastic increase in active users and has accounted for much of the growth in mobile gaming. In 2019, this free-to-play market accounted for nearly 50% of the revenue in the whole global sector and most of the top companies in the world utilize this strategy. Figure 4 shows the rise in revenue shares over the past 50 years and illustrates how mobile gaming has taken a foothold of the markets both due to accessibility and the implementation of these freemium strategies. (Tenbusch 2020; McAloon 2019)

Eredy & Mollick (2008) emphasize the importance of the video game industry by comparing to other forms of entertainment. They conclude that in the year 2008 the release of major video game titles outperformed movie counterparts in revenue terms. The scale and profitability of the video game sector is often overlooked while it should not be. In fact, the video game industry today is larger than the movie and music industry combined.

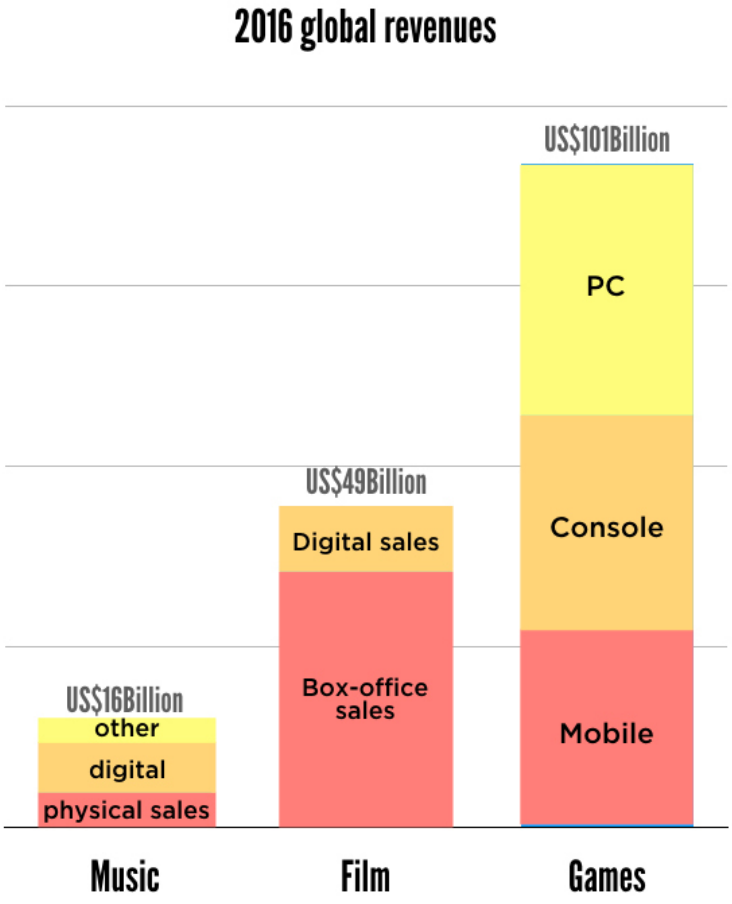


*Figure 5. Global revenues of main entertainment (Malim 2018)*

Figure 5 shows the revenue generated by the main forms of entertainment across the global setting divided by categories. From the graph we can see that in the year 2016 video games had a global revenue of more than double that of the film industry which is thought of as massive by the major population. Malim (2018) notes that the growth of the sector has been even more notable in recent years due to digitalization. Whereas the digitalization of content has been somewhat disruptive for music and films, video games have enjoyed an opportunity to grow consequently.

A big part in the success of the industry is due to internet becoming more readily available in nearly every region in the world. Figure 6 shows the share of the population that are actively using the internet in the year 2017. From the graph it is visible that the developed world is engulfed in the use of the internet which is essential for the video game industry to strive. In the developing world, the share of people using the internet is lower but steadily increasing according to Roser, Ritchie & Ortiz-Ospina (2015). With more people connected to the internet and consuming digital media, the video game industry is most likely going to benefit from these added users.

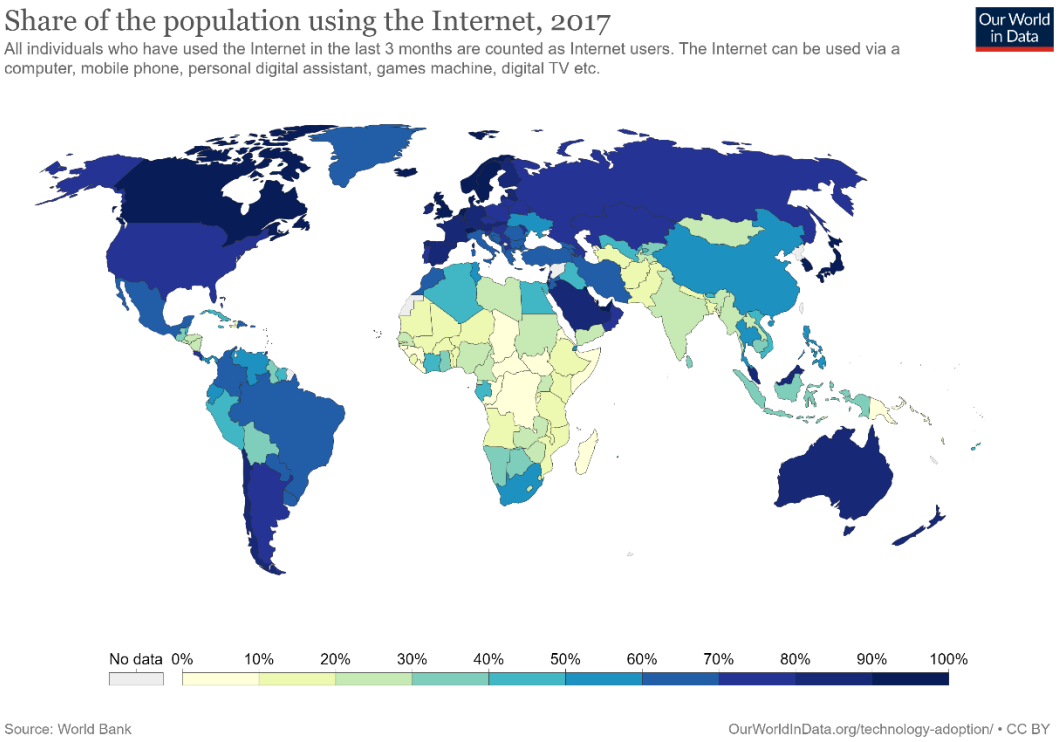


*Figure 6. Share of population using the internet. (World Bank 2017)*

## 2.2 Financial ratios

Financial ratios are measures of companies and their performance. These numbers are presented for all kinds of purposes and include assessments of debt, managerial performance, or overall firm performance among other things. The use of financial ratios has been a norm of performance evaluation for decades and have been recorded of affecting performance across certain industries. Financial ratios are primarily used to predict the performance of an enterprise by accountants, analysts, and researchers. The reason financial markets use ratios as opposed to absolute values is a mathematical one. These ratios allow for the comparison between different sizes of companies. A value allows an investor or other stakeholder to evaluate the company against other agents in the field. (Barnes 1987)

Eagan (2018) notes that financial ratios are also essential for the leadership of the company to monitor and predict the state of business. Financial ratios can also provide warnings when it is time to make a change. With the ratios being universal, a company can easily compare its values with other enterprises in the landscape to determine areas of strengths, weaknesses, and opportunities. (Eagan 2018)

The numbers of which financial ratios are based, are collected from the company's financial statements and should in theory reflect the actual state of business that the company is in. These ratios are then used by managers and current of future shareholders to evaluate and decide about future endeavors. Some of the most used financial ratios include liquidity ratios, leverage ratios, efficiency ratios, profitability ratios, and market value ratios. Each of them tailors to a specific viewpoint of the firm's performance. Table 1 gives examples of financial ratios and their primary uses in the landscape of business evaluation. (CFI 2020)

| Financial ratio | Category | Formula | Measure |
|---|---|---|---|
| Current ratio | Liquidity ratio | Current assets / Current liabilities | Measures the company's ability to pay off short term debt with current assets |
| Debt ratio | Leverage ratio | Total liabilities / Total assets | Measures the amount of assets provided from debt |
| Asset turnover ratio | Efficiency ratio | Net Sales / average total assets | Measures the ability to generate sales from assets |
| Return on assets ratio | Profitability ratio | Net income / Total assets | Measures how a company is using its assets to generate profit |
| Earinings per share ratio | Market value ratio | Net earnings / Total shares outstanding | Measures the amount of net income earned from shares outstanding |

*Table 1. Examples of financial ratios (CFI 2020)*

Table 1 shows various handpicked financial ratios, their category, the formula, and what the ratios is used for in the real world. This table can be used to familiarize oneself with some of the metrics used in this study.

## 2.3 Previous literature

The existing academic literature for the video game industry is at the time of this paper far and few in between. Most of the available resources are centered around blog posts and freelancer articles. However, studies regarding financial ratios and their effect on a company's performance has been studied previously on multiple occasions.

Barnes (1987) stated in his paper dedicated to financial ratios that there is evidence of the predictive ability of financial ratios. Multivariate testing has been used to successfully predict business failure based on financial ratios as early as the 1960's. Famous models have been constructed based on this idea, such as Altman's (1968) z-score that predicts bankruptcy using strictly financial ratios. Furthermore, Lewellen (2004) showed that financial ratios like dividend yield can somewhat accurately predict aggregated stock market returns.

Marsha & Murtaqi (2017) analyzed the effect of financial ratios on the food and beverage sector in Indonesia with a linear regression model and found significant relationships between three financial ratios and retrospective firm values. This study aims to use similar methods in assessing the effect of financial ratios to the video game industry. Marsha & Murtaqi (2017) found that the relationship between these two variables is in fact linear and highly significant. Actionable insights form this study conclude that companies in the food and beverage sector should place considerable attention to these financial ratios proves that there is an increasing need for proper disclosure of financial ratios in the annual reports of firms. (Marsha & Murtaqi 2017)

Tobin's Q has been used in many papers as a measurement of firm value. This measurement expresses the relationship between market valuation and intrinsic value. Karaca & Savsar (2012) examined the effect of financial ratios the firm value in Turkish markets for food-drink-tobacco and basic metals industries. In this study Karaca & Savsar (2012) also found significant relationships between Tobin's Q and selected financial ratios.

In previous research the selected financial ratios are heavily based on the field of business the company exists in. Marsha & Murtaqi (2017) used return on assets (ROA), current ratio and acid test ratio to examine the food and beverage sector while Karaca & Savsar (2012) only found causality between return on equity (ROE), receivables turnover, and inventory turnover. For the video game industry, a set of financial ratios must be selected that best explain the nature of the industry.

Santosa (2020) expresses the importance of firms using correct and reliable financial numbers in their reporting. Transparency is key in any analysis regarding the prediction of performance in the business sector. This study also found significant relationships between the degree of leverage and the firm value of a company.

Blose & Shieh (1997) examined the relationship between Tobin's Q and the magnitude of stock market reaction to capital investment theory and found that there is a substantial link between

the Tobin's Q variable and real investments value for firms in the industrial sector. This link was not however observed for companies in public utilities. The study shows that Tobin's Q is a good proxy for firm value and can be used in the real world to direct investments towards firms with higher Tobin's Q ratios and that the procedure is common practice across industries.

# 3 Empirical evidence

## 3.1 Sample description

The data for this assignment consists of 25 companies located in the global sector and their respective selected financial ratios. All the companies in this dataset are publicly listed and operate in the manufacturing and/or selling of video game content or peripherals. The data in its entirety is fetched from the Orbis database and contains the latest annual report information available. Most are from the year 2019 while a few have already released information from the year 2020. In addition to the companies, financial ratios are recorded from the same database. In total this study examines the effect of 11 financial ratios on the firm value. Tobin's Q is used as a proxy for firm value while the independent variables are Return on Assets (ROA), current ratio, profit margin %, EBITDA margin %, cash flow / operating revenue, liquidity ratio, solvency ratio, profit per employee, and total assets per employee.

| No. | Company name | Country code |
|---|---|---|
| 1 | SONY CORPORATION | JP |
| 2 | TENCENT HOLDINGS LIMITED | CH |
| 3 | NINTENDO CO LTD | JP |
| 4 | NVIDIA CORP | US |
| 5 | ADVANCED MICRO DEVICES INC | US |
| 6 | ACTIVISION BLIZZARD. INC. | US |
| 7 | GAMESTOP CORP. | US |
| 8 | ELECTRONIC ARTS INC | US |
| 9 | TAKE-TWO INTERACTIVE SOFTWARE INC. | US |
| 10 | KONAMI HOLDINGS CORPORATION | JP |
| 11 | SEA LIMITED | KY |
| 12 | ZYNGA INC. | US |
| 13 | UBISOFT ENTERTAINMENT | FR |
| 14 | RAZER INC. | US |
| 15 | GLU MOBILE INC. | US |
| 16 | ROVIO ENTERTAINMENT OYJ | FI |
| 17 | GRAVITY COMPANY LIMITED | KR |
| 18 | PARADOX INTERACTIVE AB | SE |
| 19 | CD PROJEKT S.A. | PL |
| 20 | REALNETWORKS INC | US |

| | | |
|---|---|---|
| 21 | NEXT GAMES OYJ | FI |
| 22 | REMEDY ENTERTAINMENT OYJ | FI |
| 23 | MAG INTERACTIVE AB | SE |
| 24 | GIGAMEDIA LIMITED | SG |

*Table 2. Summary of the companies used (Orbis 2020)*

In table 2, the companies used in the analysis are presented. These companies are either fully, or partly engaged in the selling and manufacturing of video game related content or technology. Out of the total of 24 companies, 10 are in the united states, 7 are in Asia, and 7 in Europe. Most of the companies in this sample are in the U.S which makes sense taking into consideration the large size of the market. The Asian video game industry is also considerably large and quickly developing but due to limitations in data availability this study only examines 7 of these companies. This division in companies based on their countries makes sense when the information in figure 3 is analyzed. United states has the second highest revenue share on the planet when it comes to video games.

| Measure | Mean | Median | SD | Min | Max |
|---|---|---|---|---|---|
| Operating revenue (Th) $ | 8199075.08 | 1861048.50 | 18391156.83 | 6645.00 | 75987905.00 |
| Number of employees | 12721.75 | 3470.00 | 25186.67 | 92.00 | 111700.00 |
| Tobin's Q | 3.39 | 1.92 | 4.45 | 0.09 | 19.13 |
| ROA | 3.65 | 5.42 | 14.94 | -28.00 | 27.78 |
| Current ratio | 3.14 | 2.03 | 3.28 | 0.57 | 16.43 |
| Profit margin % | 4.76 | 10.60 | 23.86 | -62.46 | 35.73 |
| EBITDA margin % | 12.81 | 18.17 | 24.87 | -40.60 | 54.77 |
| Cashflow / operating revenue % | 12.42 | 17.57 | 26.37 | -61.21 | 57.59 |
| Liquidity ratio | 3.03 | 1.89 | 3.28 | 0.57 | 16.43 |
| Solvency ratio | 57.61 | 64.35 | 20.29 | 20.79 | 93.79 |
| Profit per employee | 79.33 | 49.00 | 134.15 | -82.00 | 536.00 |
| Assets per employee | 934.29 | 648.00 | 757.32 | 175.00 | 2870.00 |

*Table 3. Descriptive statistics*

Table 3 shows the descriptive statistics for the financial ratios and other measures for the companies in the sample. Here we examine the mean, median, standard deviation, minimum, and maximum values for measures queried from the database. Operating revenue represents the

revenue that is responsible from the company's actual business ventures. From the operating revenue and number of employees, we can see that the size of the companies in this sample differs quite a lot. This sample contains massive companies as well as smaller ones. The smallest company in the data set has only 92 employees whereas the largest employs 111 700. The same can be said for all the metrics in this study, the sample gives a detailed picture of the industry with variability in the profitability and size of the companies. All these metrics above are not used for the final multiple regression model due to problems in multicollinearity. For now, these descriptive statistics should only be used to get a clear understanding of the properties of the companies within the sample.

## 3.2 Methodology

### 3.2.1 Dependent variable

The dependent variable for this study is the Tobin's Q as this is the measurement most used in previous studies to examine firm value. The value has been used in a plethora of studies in various fields and methods. It is calculated as follows.

$$Tobin's\ Q = \frac{Market\ capitalization}{Total\ assets} \quad (1)$$

Tobin's Q is a common way to measure the value of a company and has been used in multiple financial studies ever since a paper by Brainard & Tobin in 1968. According to Chung et.al (1994), the Tobin's Q represents the ratio of market value to the replacement costs of its assets and plays an important role in many financial interactions. At its core, the Tobin's Q reflects the difference between market valuation and intrinsic value. A low Tobin's Q ratio means that the cost of replacing a firm's assets is greater than the market value of said company. In this case the ratio would have values between 0 and 1. This measure has been used by Allayannis & Weston (2001) to examine the effect of foreign currency derivatives to the firm value of companies. Roll et al. (2008) Conclude that the Tobin's Q ratio is a useful metric when examining future growth opportunities.

Fu, Singhal & Parkash (2016) state that the Tobin's Q ratio is a valid proxy for assessing investment opportunities and therefore there should be a relationship between the Tobin's Q and the operating performance of the firm in question. This was proven with statistical testing in their study and concluded that the ratio is an efficient way to examine firm value.

Apart from financial literature, Tobin's Q has been used in other fields too. Bharadwaj, Bharadwaj & Konsynski (1999) used Tobin's Q ratio to examine the relation between IT investments and values of the Tobin's Q after controlling for firm specific elements. There are also numerous papers where Tobin's Q has been used as a control variable.

Based on the extensive usage in financial literature, Fu, Singhal & Parkash (2016) deem it as an important variable within the space. They also note that due to the number of studies, different variations of the ratio have also been used. More complex method usually require data from a variety of sources, and these might not be available to all users and missing for some firms. Therefore, the authors conclude that the methods used to calculate Tobin's Q ratios produce similar estimates of the ratio and it is more important to determine the overall usability.

### 3.2.2 Independent variables

This study uses a selection of financial ratios as independent variables. These financial ratios are the return on assets (ROA), current ratio, solvency ratio, and total assets per employee. These variables are chosen based on their wide scale use in previous literature and the availability of data in the Orbis (2020) database. Variables with high multicollinearity have been removed to acquire more reliable results. The calculations for these financial ratios are explained in the equations below.

$$Return\ on\ assets\ (ROA) = \frac{Net\ income}{Total\ assets} \quad (1)$$

The return on assets is a profitability ratio and explains how efficiently the company is using its assets in the generation of profit. The higher this ratio, the more profitable the company is relative to its total assets. (CFI 2020; Marsha & Murtaqi 2017)

$$Current\ ratio = \frac{Current\ assets}{Current\ liabilities} \quad (2)$$

The current ratio is a liquidity ratio that describes the firm's ability to pay off short term debt with quick assets. It reveals if the company can survive with the payment of liabilities within the next year. This ratio indicates the financial health of the company and can they efficiently use their current assets to settle liabilities in the short term. (CFI 2020)

$$Solvency\ ratio = \frac{Net\ income+Depreciation}{All\ liabilities} \quad (3)$$

The solvency ratio measures whether the company can meet its obligations in the long term. It is essentially a ratio that compares the profitability of the company to its outstanding obligations to determine the healthiness of the enterprise. This ratio is especially used by lenders, investors, and suppliers. (CFI 2020)

$$Assets\ per\ employee = \frac{Total\ assets}{Number\ of\ employees} \quad (4)$$

Assets per employee ratio expresses the amount of total assets the company has per its number of employees. This ratio is not as widely used as some of the other independent variables but offers an interesting view into financial ratios divided by employees. (Orbis 2020)

### 3.2.3 The model

With the dependent variable being firm value, and the independent variables financial ratios, the model for this study simplifies to the following equation.

$$Y_{Tobin's\ Q} = \alpha + \beta_1 ROA + \beta_2 Current\ ratio + \beta_3 Solvency\ ratio + \beta_4 Assets\ per\ employee + \varepsilon \quad (5)$$

Where:

$Y = Dependent\ variable\ Tobin's\ Q$

$\alpha = The\ intercept\ term$

$\beta_{1,2,3,4} = Regression\ coefficients\ for\ the\ independent\ variables$

$\varepsilon = The\ error\ term$

This model measures the linear dependency of firm value to financial ratios and works in testing the hypothesis in hand. This study is interested in analyzing the coefficients for each independent variable and determine whether financial ratios have an impact on the firm value of companies in the video game sector.

## 3.3 Tests for classical assumptions

Before the regression model can be constructed and the results presented, it is important to test the data for classical assumptions and whether the model gives BLUE (Best Linear Unbiased Estimator) estimation. Based on previous studies by Marsha & Murtaqi (2017), the assumptions this study tests are the assumptions for normality, heteroskedasticity, and multicollinearity. These tests are in place to make sure that the estimations given to us by the model are trustworthy and not skewed by the properties of the data.

### 3.3.1 Tests for normality

According to Jim Frost (2020), the residuals of the regression model should follow the normal distribution to perform hypothesis testing. In this study normality of the residuals is tested in various ways to determine the effectiveness of the model. This can be done by examining visualizations of the model residuals as well as running statistical testing. (Jim Frost 2020)

Pek et.al (2018) state that the problem with non-normality in a data can result in inferential results regarding the p-values of the test. This means that the significance of our results might be skewed and lead to false conclusions. Secondly, non-normality in the data might mean that the relationship between variables might not be linear. In this case the estimates for coefficients can turn out to be biased.

Non-normality might not always be fatal to the model when it is observed. Studies find that in samples with a sample size N large enough are not affected by non-normality as much as smaller datasets. This is due to Central Limit Theorem that states that distribution of the estimates converges into a normal distribution when the sample size increases. (Pek, Wong & Wong 2018)

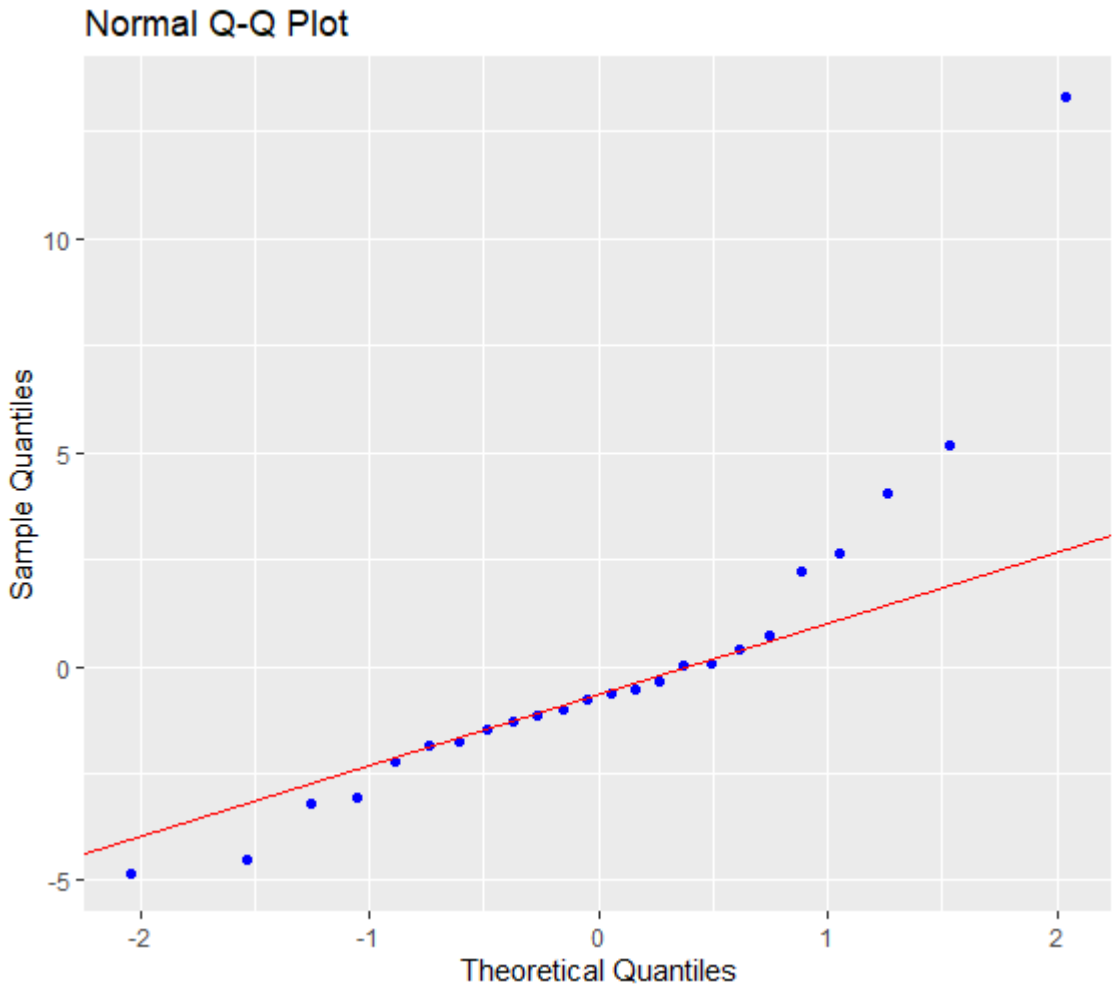


*Figure 7. Quantile plot of the residuals*

In figure 5, the residuals of the fitted model are plotted against their theoretical quantiles to assess normality. We can see that for the most part the data points follow the red line and hence the residuals are considered normally distributed for the most part. There are however a few outliers so additional testing should be done to determine the effectiveness of this model.

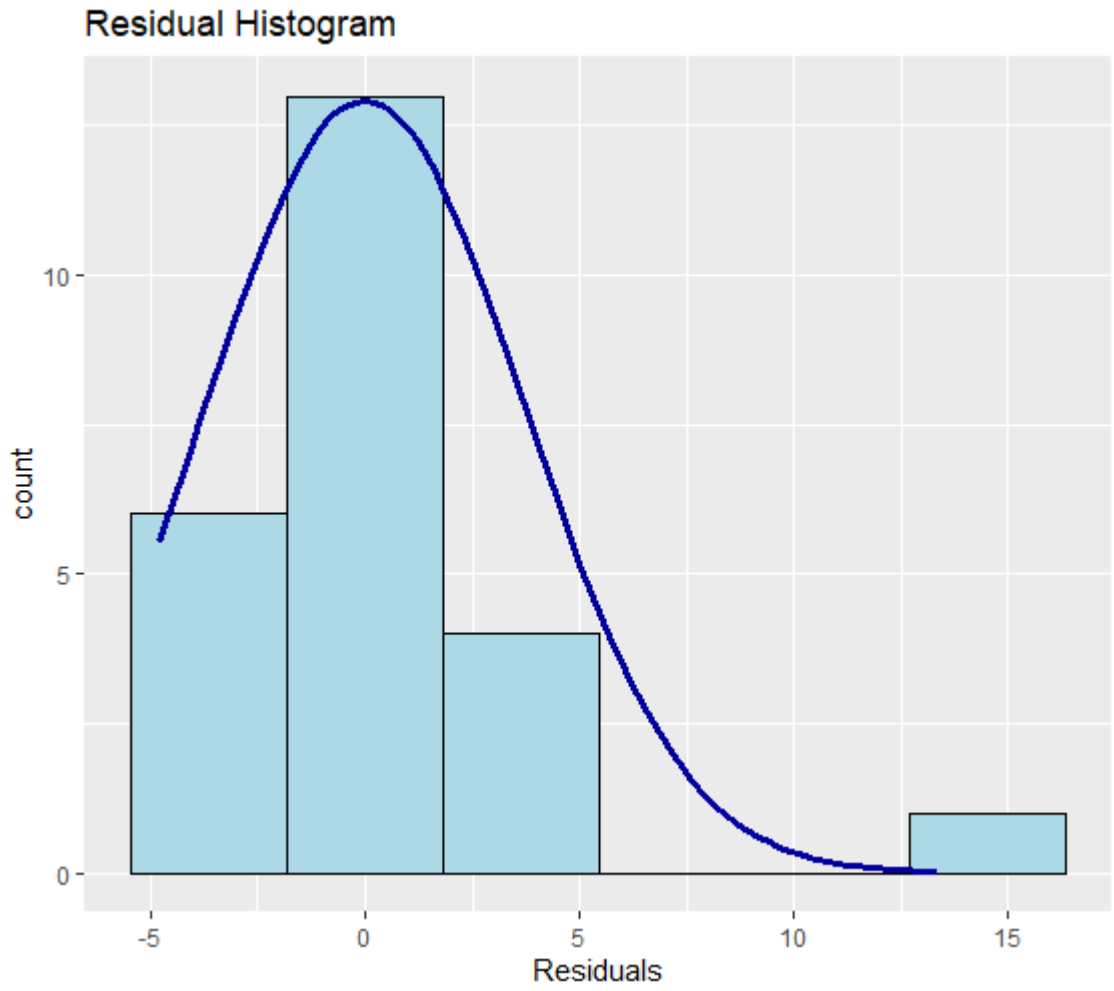


*Figure 8. Histogram of the residuals*

Table 6 graphs the residuals as a histogram and serves as another visual aid in determining the normality of the residuals. We see that apart from a few outliers, the residual data is normally distributed for the most part. These results are however not conclusive and should be quantified by statistical testing. This study uses a variety of normality tests to determine the normality of the residuals.

| Test | Statistic | P-value |
|---|---|---|
| Shapiro-Wilk | 0.8112 | 0.0005 |
| Kolmogorov-Smirnov | 0.2165 | 0.1816 |
| Cramer-Von Mises | 2.8894 | 0.0000 |
| Anderson Darling | 1.3217 | 0.0015 |

*Table 4. Normality test results*

Table 4 shows the results from a collection of statistical tests to determine the likelihood of the residuals being normally distributed. The most used test to determine the degree of normality in a regression models residual is the Kolmogorov-Smirnov test that is also used by Marsha & Murtaqi (2017) in their study. Here the test statistic for the Kolmogorov-Smirnov test is 0.2165 with a significance of 0.1816. This means that on a 5% significance level we accept the null hypothesis that the residuals in our model are in fact normally distributed.

There is enough evidence to support the argument that the residuals of the model do in fact arise from a normal distribution and we can use this model to acquire trustworthy results. However, the relationship is not perfect, and this is most likely due to a relatively small sample size. These inconsistencies are not enough to skew the results but is something that could be improved for further research.

### 3.3.2 Heteroskedasticity test

According to Yobero (2016) heteroskedasticity refers to the situation when the variances in the observations of a dataset are not the same. This affects the reliability of the models results and should be accounted for if any exist in the model. Heteroskedasticity can be checked by examining a scatter plot of the residuals against the dependent variable. Models with problems in heteroskedasticity appear to have a cone shape associated with them in these scatterplots. A healthy model shows no distinguishable pattern. (CFI 2020)

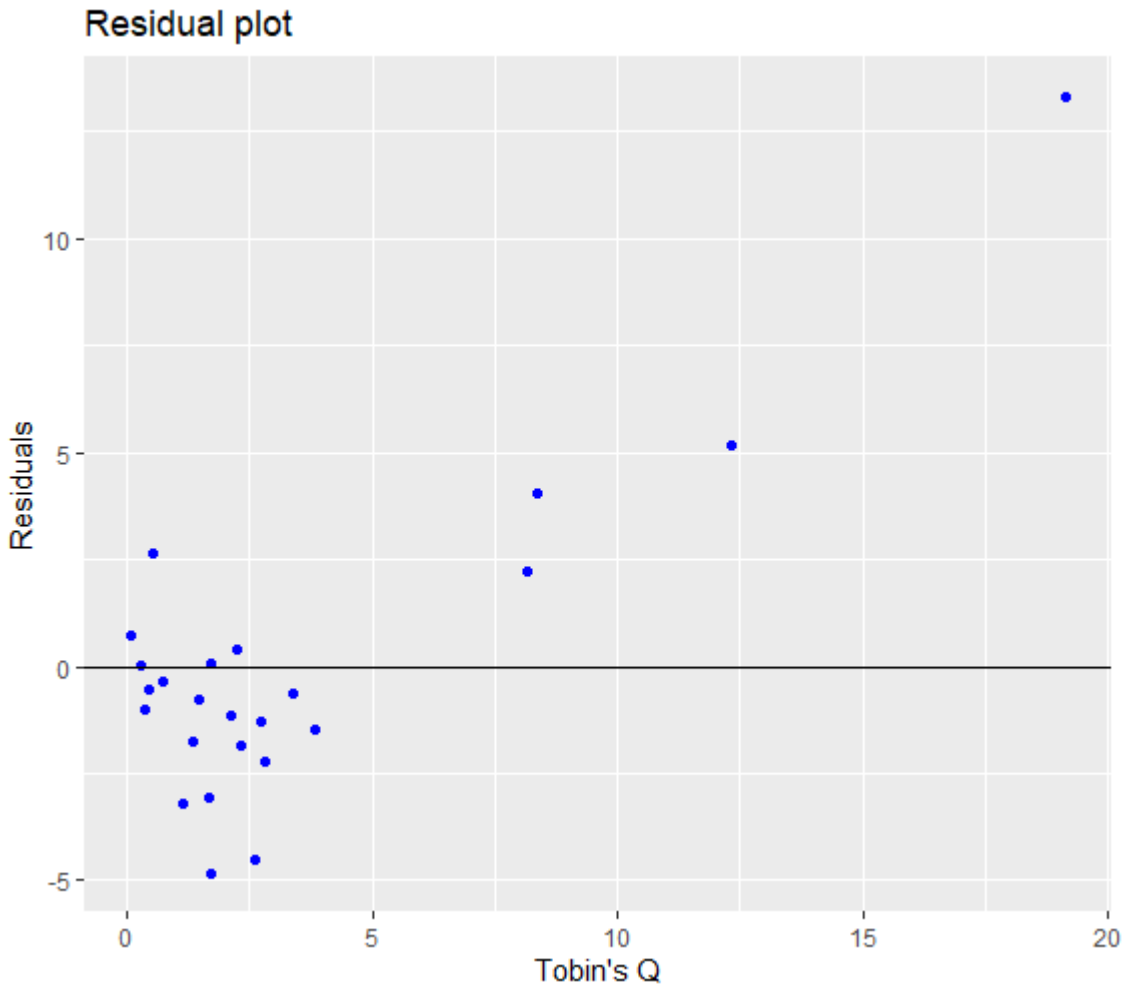


*Figure 9. Residual plot*

The residual plot in figure 7 plots the residuals of the least square's regression against the explanatory variable Tobin's Q or firm value. No distinguishable pattern is visible in the scatterplot, indicating that heteroskedasticity is probably not an issue in this model. The dots on the scatterplot seem to fluctuate on both sides of the line and display no cone shaped formation.

### 3.3.3 Multicollinearity test

According to Alin (2010), multicollinearity refers to the linear correlation between two or more independent variables in a multiple regression model. This is a fundamental issue in data and if it exists, the reliability of the results model can be badly affected. The more dependent the independent variables are of one another the more severe the problem when interpreting the results. To detect multicollinearity, this study uses Variance Inflation Factor analysis (VIF). VIF measures the multicollinearity in each independent variable and the commonly used threshold is 10. A higher figure means that multicollinearity exists and should be accounted for before analyzing the results. (Alin 2010)

| Independent variable | VIF |
|---|---|
| ROA | 1.523628 |
| Solvency ratio | 2.408694 |
| Current ratio | 1.890492 |
| Assets per employee | 1.139782 |

*Table 5. Variance Inflation Factor (VIF)*

As seen from table 5, the values for VIF are very low and satisfy the threshold of 10. Therefore, we can determine that there is no measured multicollinearity within the suggested model. These variables were chosen for the model such to avoid any multicollinearity.

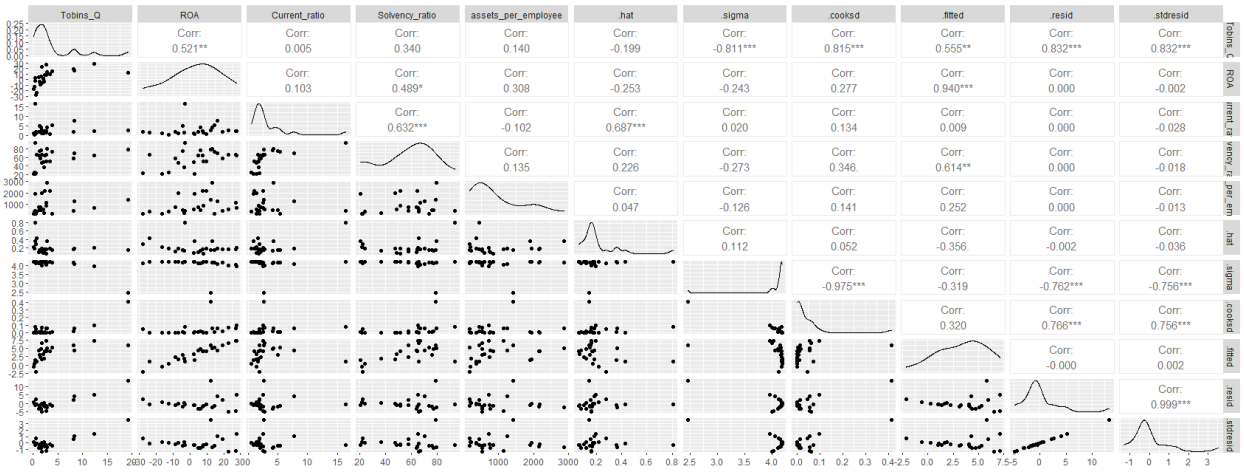


*Figure 10. Correlation matrix*

Figure 8 illustrates the pair-correlations of all the variables in the model. From the figure we can see that the largest correlation of any independent variable to the dependent variable is the ROA. Generally, we want variables that correlate strongly with the dependent variable but want to avoid any independent variables that are correlated with each other. From this figure we can also see that correlation is very weak among independent variables further establishing the lack of multicollinearity in this model.

## 3.4 Regression results

With the model constructed and tested this study calculates the regression coefficients and interprets the results. Running this multiple regression model yields the results shown in table 6.

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.55458749 |
| R Square | 0.307567285 |
| Adjusted R Square | 0.161791976 |
| Standard Error | 4.07584557 |
| Observations | 24 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 4 | 140.2011583 | 35.05028958 | 2.109872294 | 0.119421444 |
| Residual | 19 | 315.637825 | 16.61251711 | | |
| Total | 23 | 455.8389833 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 0.618557327 | 3.201593477 | 0.193202957 | 0.848850361 | -6.082454834 | 7.319569487 |
| ROA | 0.126092817 | 0.070203117 | 1.796114224 | 0.088396068 | -0.020843996 | 0.273029629 |
| Solvency ratio | 0.061344371 | 0.065006004 | 0.9436724 | 0.357183167 | -0.074714758 | 0.197403501 |
| Current ratio | -0.299205293 | 0.356670884 | -0.838883424 | 0.411965195 | -1.045726033 | 0.447315448 |
| Assets per employee | -0.00030083 | 0.001198074 | -0.25109502 | 0.804436183 | -0.002808429 | 0.002206768 |

*Table 6. Multiple regression results*

Table 6 provides quantifiable results from the multiple regression model ran through the data set used by this study. The table shows different regression statistics such as the coefficient of determination R. This value tells us how much of the observed change in the dependent variable is

explained by changes in the independent variables. The number of observations and the standard errors of the model are also visible from this table. F-statistic used in simultaneous hypothesis testing is presented here along with all the coefficient for the independent variables, their standard errors, statistical significance, and selected quantiles.

We can see from the output that the coefficient of determination adjusted R square is only 16%. This means that the variation in the independent variables explain only 16% of the variation in the dependent variable when adjusted for added variables. This implies that the change in Tobin's Q is not perfectly explained by the financial ratios.

Only one of the independent variables show statistically significant results at 10% significance. This ratio is the return on assets (ROA). The coefficient for this variable is positive indicating that an increase in ROA leads to an increase in the firm's value measured with Tobin's Q. An increase of one unit increases Tobin's Q by 0.13 units. Therefore, we can conclude that ROA has a positive impact on firm value. The higher return on assets a videogame company has, the higher the firm value.

The coefficient for the solvency ratio is also positive indicating that higher current ratios lead to higher valued firms in the video game sector. The better solvency structure a company has the better is the firm value, respectively. This relationship is however not statistically significant, and more data should be analyzed for reliable results.

Current ratio shows a negative relationship in the regression equation. This means that an increase in current ratio results in the decrease in firm value. Firms with higher current ratios post lower Tobin's Q ratios. This relationship is again not statistically significant, and more data is needed for more reliable results.

Assets per employee shows the least amount of dependance to the Tobin's Q ratio. With a value of -0.003, an increase in assets per employee ratio does not sway firm value in either direction.

This combined with very low statistical significance we can conclude that the assets per employee ratio does not influence firm value in video game companies.

The regression equation simplifies to equation 6 when coefficients are considered.

$$Y_{Tobin's\ Q} = 0.61855 + 0.12609\ ROA + (-0.29920\ Current\ ratio) + 0.06134\ Solvency\ ratio + (-0.00030\ Assets\ per\ employee) + \varepsilon \quad (6)$$

## 3.5 Controlling for firm size

Operating revenue is considered as part of the model when controlling for firm size in the model. The equation used for the controlled model is the following.

$$Y_{Tobin's\ Q} = \alpha + \beta_1 ROA + \beta_2 Current\ ratio + \beta_3 Solvency\ ratio + \beta_4 Assets\ per\ employee + Control(Operating\ revenue) + \varepsilon \quad (7)$$

The reason this study controls for firm size is to confirm or deny the whether the size of the company influences the relationship between financial ratios and firm value. Larger companies could enjoy higher Tobin's Q ratios than smaller companies. Below are the results for the controlled model.

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.55842484 |
| R Square | 0.311838302 |
| Adjusted R Square | 0.120682275 |
| Standard Error | 4.174598641 |
| Observations | 24 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 5 | 142.1480547 | 28.42961094 | 1.631328643 | 0.202455469 |
| Residual | 18 | 313.6909286 | 17.42727381 | | |
| Total | 23 | 455.8389833 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|
| Intercept | 1.247998089 | 3.781453389 | 0.330031329 | 0.745186282 | -6.696540681 | 9.192536858 |
| ROA | 0.133506236 | 0.075247237 | 1.77423439 | 0.092940505 | -0.024582343 | 0.291594815 |
| Solvency ratio | 0.045774293 | 0.081259308 | 0.563311387 | 0.58017314 | -0.124945177 | 0.216493764 |
| Current ratio | -0.258822744 | 0.384773512 | -0.672662583 | 0.509705946 | -1.067201896 | 0.549556407 |
| Assets per employee | 2.33687E-05 | 0.001564164 | 0.014940032 | 0.988244374 | -0.003262817 | 0.003309555 |
| Operating revenue | -2.30536E-08 | 6.89736E-08 | -0.334238668 | 0.742062286 | -1.67962E-07 | 1.21854E-07 |

*Table 7. Controlled model regression results*

We see form table 7, that the controlled model performs similarly to the uncontrolled model. ROA still produces statistically significant results at 10% while others remain statistically insignificant. Controlling for firm size in the sample seems to affect the results in a minimal way and therefore this study concludes that the size of the company does not influence its exposure against financial ratios in a meaningful way.

| **Financial ratio** | **Effect on tobin's Q** | **Result** |
|---|---|---|
| ROA | Positive, significant at $\alpha = 10\%$ | Reject the null-hypothesis |
| Solvency ratio | Positive, non-significant at $\alpha = 10\%$ | Accept the null hypothesis |
| Current ratio | Negative, non-significant at $\alpha = 10\%$ | Accept the null hypothesis |
| Assets per employee | Neutral, non-significant at $\alpha = 10\%$ | Accept the null hypothesis |

*Table 8. Conclusions from the regression model*

Table 8 shows the compiled conclusions drawn from the regression results against the two hypotheses of this test.

## 3.6 Simultaneous hypothesis test (F-test)

As in the study by Marsha & Murtaqi (2017) the F-statistic is also analyzed. The F-test can be used to test anything with the test statistic following the F-distribution. It is most used to compare variances between samples but can be used in spotting simultaneous relationships between regression variables. In this case the hypotheses are the following.

$$H_0 = Selected\ financial\ ratios\ have\ no\ impact\ on\ firm\ value$$
$$H_1 = Selected\ financial\ ratios\ have\ an\ impact\ on\ firm\ value$$

From table 6 we can see that the F-test statistic is 2.1098 with a significance of 0.11942. Meaning that no matter if this study chooses a significance level of 5% or 10% the results are not significant enough to reject the null hypothesis and conclude that these financial ratios together have an impact on firm value in the video game sector.

Looking at the F-distribution table for α = 10% we can find a value of 2.23334 with degrees of freedom $V_1 = \big(n - (k+1)\big) = 21$ and $V_2 = 4$. Then one can compare $F_{table}$ and $F_{test}$. Comparing the two we can see that $F_{test} < F_{table}$ or 2.10987 < 2.23334. Thus, concluding that there is not enough statistical evidence to conclude that these financial ratios together have a significant impact on the firm value of these companies. The null hypothesis is accepted based on this analysis of the F-test. There is no measurable effect of these selected financial ratios on the firm value of video game companies. (Marsha & Murtaqi 2017)

The results from this test are not significant but significance is not far away for the 10% significance threshold. With more data than what the author has available, statistical significance could be reached on both the regression results and the simultaneous hypothesis test.

# 4 Conclusions

The video game industry is a large profitable industry that offers digital entertainment to billions of people around the globe. The growth in these markets has been exponential in the recent decades and shows no signs of stopping anytime soon. The nature and the size of this industry calls for more academic work as currently very few papers exist. Other more traditional industries have been the focus of major academic literature and the video game industry has a lot of interesting properties worth exploring.

When assessing whether financial ratios have an impact on the firm value of a company in the video game sector, this study found statistical evidence to support the fact that on a 10 per cent significance level the return on assets ratio has a positive impact on the Tobin's Q of said firm. Meaning that the firms that post higher values of ROA, enjoy higher Tobin's Q ratios, and therefore have a higher firm value. Companies in the video game sector should pay close attention to the return on assets and aim to maximize this ratio. Investors can monitor this ratio and make decisions based on this research.

For the other ratios in this study, no statistical significance was found in the multiple regression analysis. However, the solvency ratio also showed a positive relationship to Tobin's Q indicating that firms with higher solvency ratios have higher firm values. This relation ship is not statistically significant and requires more data points to acquire more trustworthy results.

The current ratio showed a non-significant negative coefficient in respect to Tobin's Q. This indicates that firms with higher current ratios have lower firm values in the video game industry. This relationship is not statistically significant, and more data is needed for proper analysis of the results.

Assets per employee ratio was chosen to examine ratios that include the division of by number of employees as a proxy. This study found no relationship between assets per employee and the

Tobin's Q. Indicating that the use of this ratio as a measure of performance in the eyes of Tobin's Q does not make sense. An increase in assets per employee does not result in a significant lift or decrease in firm value of video game companies.

Simultaneous hypothesis testing with the F-statistic revealed that these ratios combined did not show statistical evidence in having an impact on the firm value of companies on a 10 per cent significance level. Meaning that there is no statistical evidence of these financial ratios having an impact on the firm value.

Therefore, this study rejects the null hypothesis regarding return on assets and concludes that the return on assets has a positive and significant ($\alpha$ = 10%) impact on the firm value of video game companies.

For the other financial ratios tested in this paper this study accepts the null hypothesis that these financial ratios do not have a significant effect on the firm value of video game companies. With more data available, these results could be further investigated, and more precise conclusions could be drawn.

Simultaneous hypothesis conducted with the F-statistics shows near statistical significance at 10 per cent significance level but does not reach this threshold with the data set used in this study. This leads to a conclusion that all the financial ratios combined do not influence the firm value of video game companies and we accept the null hypothesis. Financial ratios have no impact on the firm value of video game companies.

Based on this research, it is advised for video game companies listed in publicly traded market-places to carefully follow and maintain their return on assets since it directly effects the valuation of said company.

The limitations of this study include lack of previous research material to compare to and to expand upon. The industry continues to lack academic literature and hopefully in the future more studies such as this emerge in the academic landscape. Other limitations include lack of data points and firm year observations. Publicly listed video game companies are still rare and relatively new occurrence in the field. This means data availability is present in every step of the investigation. With more data comes more accurate estimations of coefficients and the results better mimic real-world applications. For future research I suggest adding yearly information from the revenue statements once those are available to receive more data points.

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