Industry Clustered Prediction Errors on the Valuation Accuracy of US IPOs

Bachelor Thesis

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Abstract

The use of multiples in IPO valuation has been widely recommended over the years. This research is in search to find better accuracy in IPO valuation by using an industry-comparison analysis compared to an individual IPO analysis. The results show weak predictive values which are in the contrary to the expectations prior to the study. This is due to the recent changes in the IPO environment where the average IPOs per year has decreased. Therefore, it is recommended not to use the comparable multiples valuation using historical accounting numbers in further research. Lastly, there is doubt whether the industry criteria should be used again in IPO valuation due to the recent changes in the IPO environment.

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1. Introduction

In the world of finance, the valuation of Initial Public Offerings (IPOs) still is a complicated matter. Despite many studies into the valuation methods, there still is no consensus about the optimal technique which yields the highest accuracy. This thesis will participate in the debate by looking into the valuation accuracy of industry clustered prediction errors in the multiples valuation method on IPOs. The multiple valuation method is widely used academically and in practice but often contains large estimation errors. This is due to the generalization of the prediction errors of the different multiples for the entire dataset. But each industry contains its own characteristics which leads to different errors per multiple of each industry. By clustering the prediction errors on industry level, the results of a valuation could be more precise which gives more power to the explanatory value of different multiples in IPO valuation.

Using multiples in valuation was examined by Alford (1992) who tested the accuracy of the Price/Earnings (P/E) method on comparable companies within the same industry. He found that selecting companies on the basis of a three digit SIC-code was relatively effective. The effectiveness grew if the firms were also selected on the same size. Though, he found that larger firms produced a better outcome in valuation then smaller firms.

Lie and Lie (2002) further examined the usefulness of various multiples in estimating company value. They conducted their research on financial firms and non-financial firms. These firms were also separated within their samples between high- and low levels of intangible assets and research and development activities. In their conclusion they stated that asset-based multiples perform best and the sales-based multiples the worst. Furthermore, the valuations of financial companies were more precise then the valuations of nonfinancial firms. At last, they conclude that firms with high intangible assets have less precise estimates.

The paper of Kim and Ritter (1999) was the first to start examining the usage of comparable firm multiples in the valuation of IPOs. They extended the range of different multiples to test which multiples were most effective on IPOs. Most of the multiples used were effective as long that forecasts are used instead of historical numbers of earnings. The accuracy of the valuation increased when they used the forecasts. In the contrary, the authors conclude that within the industry the multiple ratios contained a large variation which gave them a modest predictive value. But when adjustments are made on these ratios for differences in growth and profitability, the influence of idiosyncratic factors will be limited, for example.

The Kim and Ritter (1999) paper gives a restriction which lays the pathway for this thesis. As said, the multiples contained large variations across the industries which yielded modest predictive values. The restriction of the authors was the neglection of weights on multiples per industry. This means that in their opinion some multiples in IPO valuation have more predictive value per industry than others. This phenomenon can be tested by taking the average of the prediction errors of each multiple on industry level and comparing it to an individual analysis of the IPOs. With this we presumably find better predictive estimates for valuation. Hence the research question is formulated as follows:

'What is the effect of clustering prediction errors of multiples on industry level on the accuracy of IPO valuation?'

To answer this question, this thesis will conduct the Comparable Company Analysis (CCA) with the use of multiples. This method compares ratios between the companies such as Price/Earnings and Price/Sales in order to find the value of an IPO. The mean and median multiples of the comparable companies will be estimated and compared to the IPOs within the same industry. The difference between the IPO multiple and the multiple of the comparable companies is described as the prediction error. The smaller the prediction, the more precise the valuation of the IPO is. For every IPO in the dataset the prediction errors of the multiples will be obtained. Firstly, the prediction errors will be valued individually and examined in a total distribution table where the average prediction errors of the multiples will be displayed. Secondly, the prediction errors will be clustered on industry level to see if the accuracy of the valuation increases significantly as compared to the individual prediction errors.

Furthermore, this thesis will use data withdrawn from the ThomsonOne database. This database contains financial data taken from annual reports from corporations worldwide. It also contains specific data about Mergers and Acquisitions and IPOs. The data will be selected on the basis of various criteria. This thesis will compare American IPOs from 2000 till 2019 with other IPOs within the same industry. The comparable companies will be selected on the basis of three digit SIC-codes in order to obtain enough comparable companies per different industry for the research. Also, various other criteria will be determined to create a more homogeneous dataset.

Lastly, the expectations for this research are that the accuracy for multiple valuation on IPOs will increase significantly if the prediction errors are compared on industry level instead of the individual analysis. Due to the difference in explanatory powers of the multiples across the industries. This is in line with the expectations in the given restriction of the paper of Kim and Ritter (1999).

2. Theoretical Framework

In this section the theoretical background of IPO valuation will be elaborated. First a brief introduction of IPOs will be given. Further, the pricing process and valuation methods of an IPO will be explained, and the determinants of comparable companies will be given. Lastly, the current IPO environment in the US will be discussed.

2.1 Introduction IPO

Issuing new shares for the first time to the public and subsequently trading this on the stock market is seen as the definition of an IPO. The first question raised is: Why should a firm go public? The first theory on why firms go public stated that a company is spotted much easier on the market by a potential acquirer when it is a public firm. The initial owner of a company maximizes his proceeds through the offering of shares to the public shareholders and additionally selling control rights to a potential buyer (Zingales, 1995). Still, the main reason for a company to issue its shares to the public is to raise new capital in order to create new wealth for the companies' shareholders in the future through operating activities (Draho, 2004). But this author also states that the IPO decision is made through a detailed analysis because a public issue is not purely beneficial due to the high fixed direct costs. There are costs made for an IPO such as filing and registration fees and compensation costs for investment banks, auditors and lawyers who are involved in the offering. Due to these high costs, some smaller firms decide not to go public because it might be the more expensive option for the future. Further, for a part of the firms going public is more of a timing issue. Not why they should go public, but rather when they should issue their shares to the public. The decisive factor for an IPO is based on favourable market conditions in which to go public. Also, the stage in the lifecycle of a firm seems to be an important factor for the decision (Ritter & Welch, 2002).

2.2 IPO Valuation

After the decision is made in favour of the IPO, the underwriter will start the pricing process. This process is seen as one of the most puzzling events in the world of finance due to many biases (Lowry & Schwert, 2004). Lowry and Schwert (2004) found that underwriters not always incorporate all the public available information at several points within the process. This made them believe that such a process may not be fully efficient. Time points of information such as the offer price at the filing date and the offer range during the book-building period are not fully incorporated by the underwriter. Also, other anomalies affect the pricing of an IPO. The phenomenon of under-pricing affects the final offer price set significantly due to information asymmetry between informed and uninformed investors. There is a significant relation between the under-pricing of the offer price and the uncertainty of the investors for its value (Beatty & Ritter, 1986). Thus, conducting the right offer price is actually more difficult than anticipated.

In order to set the offer price as an underwriter, the private firm going public must be valued appropriately. Here, two approaches can be used for valuation. First you have direct valuations such as the Discounted Cash Flow (DCF) method. This method is used for project valuations, security valuation and firm valuation (Shrieves & Wachowicz Jr., 2001). Hereby the overall value of Free Cash Flows of the Firm (FCFF) are discounted at the weighted average cost of capital (WACC) after tax. This results in the sum of values of debt and equity. The FCFFs are calculated for the Post-IPO period with an implied growth rate for the explicit forecast period. This explicit forecast period is the short time horizon where the FCFF are forecasted individually. After this period, a continuous formula is used where a constant growth rate is used for the firm's indefinite value. Here is assumed that the firms grow at a constant rate forever. But the estimated growth rate in these valuations is often too high than the actual growth rate is in the Post-IPO period. This resulted in a median in overvaluation of 74% for IPO firms caused by over-optimism of the underwriter in the expected performance (Cogliati et al., 2010). This is why there is often argued that it is difficult to forecast the right cash flows. In the US, IPOs are typically young firms where accounting information prior to the issue is not always representative for the future. Further the growth options within these firms are difficult to capture with the DCF method. Thus, the second approach, the relative valuation of using comparable firm multiples, is academically and practically recommended for IPO valuation (Kim & Ritter, 1999).

2.3 Multiples valuation

The usage of multiples in valuation is one of the most common techniques in equity valuation. This is method is often used for IPOs, Leveraged Buy Outs (LBO), Seasoned Equity offerings (SEO) and Mergers and Acquisitions (M&A) (Bhojraj & Lee, 2002). A multiple is the expression of a market value relative to a key value driver of a company that is related to the market value. There are two basic types of multiples. First, you have enterprise multiples, which express the value of a company relative to a factor which relates to this such as sales or EBITDA. Second, you have equity multiples which express the claims of the shareholders on the assets of the company relative to the factor that applies to the shareholders only such as earnings (Suozzo et al., 2001). The multiples valuation method requires calculating these multiples for peers that are used as comparable companies and subsequently finding the implied value of the firm of interest based on the comparable multiples (Lie & Lie, 2002). Even though many researches are conducted in search for the minimal estimation error of the different multiples, there is still no uniform multiple which a valuation solely can be based on. That is why there are many different outcomes and insights from different studies on the multiples used in valuation.

2.3.1 P/E ratio

The price to earnings ratio is the most popular multiple used by analysts in order to value a firm (Fernández, 2001). Alford (1992) has done research for the valuation accuracy of the P/E ratio when comparable firms are selected on the same industry, size and earnings growth factor. This multiple estimates a firm's stock price relative to its earnings. Alford (1992) found that estimating the P/E multiple based on a three digit SIC-Code yields relatively effective results. His tests did also indicate that the accuracy of valuation increases with firm size. Further, Lie and Lie (2002) conducted a research for the valuation accuracy of several multiples. Among other things, the authors found that using forecasted earnings instead of historical earnings improves the value estimates of the P/E ratio.

2.3.2 P/S ratio

The price to sales (P/S) ratio is also a very popular ratio used by investors for selecting stocks. It measures the willingness to pay for each dollar of sales of the investor and is a good indicator for the popularity of the stock (Fisher, 1984). Fisher (1984) advises investors to buy stocks with low P/S because each invested dollar will buy more dollars of sales. Subsequently,

higher profitability of returns will arise if this stock belongs to an under-valued firm. This ratio is supposed to be useful in finding these firms. Vruwink, Quirin and O'Bryan (2007) further investigated the usefulness of the P/S ratio compared to other ratios. The authors found that the usage of sales in comparing returns is of equal importance as earnings or the book value of equity in explaining the stock returns. They even extent their research further by adjusting the P/S ratio for profit margins of sales. As a result, this adjusted P/S was superior to the other ratios.

2.3.3 EV/EBITDA ratio

This multiple is the enterprise value divided by the earnings before interest, taxes, depreciation and amortization. It explains market valuations and yields better estimates than operating profit does in stock returns. Further, EBITDA is often seen as a better measure than traditional metrics because it has a broad measure of cash flow and can be positive when companies have negative earnings. Besides, it is more useful for companies that want to minimize their taxes because interest expenses are tax deductible (Mauboussin, 2018).

According to Fernández (2001) it is the most used multiple by analysts after the P/E multiple. Baker and Ruback (1999) analysed industry multiples and estimated the error and the small sample minimum variance. The authors tested the performance of the simple mean, harmonic mean, the value-weighted mean and the median multiples. The results vary per industry but suggest that the EBITDA yields the smallest estimation errors.

2.3.4 EV/S ratio

The enterprise value to sales ratio is also a multiple that is often used in the valuation of multiples. Holthausen and Zmijewski (2012) investigated the performance of market multiples in valuation based on enterprise value. According to the authors, differences in operating characteristics of firms can result in differences in the market multiples and every multiple has his own kind of effect. The authors conclude that the EV/S ratio can be affected by changes in cost structure, higher income taxes and changes in depreciation and amortization cost structure. Further, adjustments for differences in the capital expenditure and working capital can have a significant effect on the accuracy of the multiple.

2.3.5 IPO valuation by using multiples

Until the paper of Kim and Ritter (1999) there has been no systematic study on the usefulness of using multiples valuation for valuing IPOs. The authors examined the estimation accuracy of different multiples on two different sets of IPOs. The first was self-chosen on

industry basis and the other by a research boutique specialized in IPO research. The authors used different ratios such as P/E, P/S, P/B, EV/S and EV-to-Operating Cash Flow. They conclude that the ratios give only modest predictive value due to the use of historical numbers rather than forecasts. Thus, using forecasts improves the valuation accuracy significantly. Further idiosyncratic factors are not captured unless adjustments are made for differences in growth and profitability of the firms. By making these adjustments the accuracy would also increase substantially. Also, the valuation of older firms is higher than for younger firms, but by using historical accounting information the EV/S ratio works well for both old and young firms. The authors eventually state that there is a large role for investment bankers in the valuation of IPOs. Because of their 'superior fundamental analysis', the investment bankers can obtain much smaller prediction errors in valuation. Additionally, they can achieve even more accuracy due to the adjustments in market demands before setting the final offer price (Kim & Ritter, 1999).

2.4 Comparable companies in IPO valuation

In order to conduct an appropriate multiples valuation, the right comparable companies must be chosen to match the IPO. Due to the different degree of value drivers between the companies is can often be difficult to find the right companies with good comparability (Holthausen & Zmijewski, 2012). Because this selection can sometimes be quite difficult, Meitner (2006) described two core determinants for the selection of comparable companies. The first determinant is similarity between the companies. Multiple similar characteristics could make a sufficient comparable. Nonetheless, Meitner (2006) states that due to the number of public companies in reality, a perfect match is often hard to find. But this problem can be resolved. For example, by selecting comparable companies on the basis of industry SIC codes, you can obtain sufficient comparable companies.

Alford (1992) investigated, among other things, the effect of different levels of SIC codes for choosing comparable companies. He used up to a four-digit SIC code but found that three-digit SIC code comparable companies yields the best estimates on the accuracy of P/E valuation. Even though, Kim and Ritter (1999) used IPOs within the same four-digit SIC code which went public within the past 12 months as a comparable for valuation. The authors stated that this classification of a comparable is an advantage because you can exactly choose comparable firms that are not influenced by behavioural aspects of justification for particular

high or low multiples. A disadvantage is that you restrict your comparable companies to the same SIC code and thus neglect potential comparable firms outside the industry.

Furthermore, Meitner (2006) stated about the similarity determinant that it should not be interpreted as identical. But, when there are suspicions that a company differs too much, it should be eliminated from the sample. Meitner (2006) also mentions that when a valuation is done using a multi-factor model instead of a single-factor model, the similarity determinant is less necessary and capturable.

The second determinant of Meitner (2006) refers to the degree of market efficiency and pricing quality. Here an efficient market is described as a market which fully incorporates all information in the stock prices. Pricing quality refers to the degree of mispricing of stocks, where it is mispriced if it is not equal to the fair value of the stock. However, Meitner (2006) mentions that academically market efficiency can be interpreted differently by whomever. Also, pricing quality is quite impossible to capture since very precise valuations must be conducted for every single stock.

2.5 Current IPO environment in the US

In recent years the number of IPOs in the US has significantly declined. Gao, Ritter and Zhu (2013) state that the average number of IPOS per year has dropped from 310 to 99 after the millennium change. There were two main explanations for this phenomenon. The first is that the Sarbanes-Oxley Act of 2002 enforced more compliance costs for publicly traded firms. This made the IPO activity decrease because going public became more distressing for smaller firms. The second explanation was that underwriters did not focus enough any more on the smaller firms because the decline in bid-ask spreads of the smaller firms decreased the incentives for the underwriter in these firms. In addition, Gao, Ritter and Zhu (2013) link the decline in IPO activity to their own *economies of scope* hypothesis. The authors conclude that small companies will have lower profits by going public and staying independent. Larger organizations are more eager to buy smaller firms to create value through economies of scope and expanding the production. The profit is probably higher for smaller firms when they are sold to the strategic buyer within the same industry.

Grulon, Larkin and Michaely (2019) concluded similar outcomes. These authors stated that the US industries have become more concentrated over the past 20 years. This additional concentration level in most industries has had impact on the firm performance. Higher profit margins were obtained by firms in more concentrated industries. Thus, the M&A waves

increased market power in these industries. Lastly, they observed that in these industries the abnormal stock returns were significantly high, which signals an increase in shareholders wealth. These changes are probably caused by the weak execution of anti-trust laws and large technological innovation.

3 Data

3.1 Sample

The sample of IPOs contains 117 companies that went public in the US from the year 2000 till 2019. Normally, due to the changes of market multiples in time, a comparable IPO is chosen that went public within the same fiscal year (Kim & Ritter, 1999). But here a larger time range than one fiscal year is chosen due to the restrictive number of IPOs per year for certain industries. This specific time range is chosen because of then decrease of average IPOs per year since the millennium change (Gao et al., 2013).

The data is withdrawn from the ThomsonOne database, where the advanced search option for equity data is used. In order to the selection as a fitting IPO for this research, a various number of variables should be available on this database. The IPOs must have a positive EPS in the 12 months before the offering. Furthermore, the issue date, offer price, proceedings, number of shares offered and the closing stock price of the first trading day. Also, financial variables such as positive EBITDA, sales and debt must be available at the database.

Lastly, there were criteria that excluded a great number of IPOs but were necessary to obtain a more homogeneous dataset. Therefore, the offer price of an IPO must be at least 5 dollars per share and the proceedings must be at least 5 million dollars in order to exclude too small IPOs. Furthermore, unit offerings, firms with no available prospectus, financial companies like banks and excessive outliers are also excluded from the set. Examples of excluded companies are those which have a P/E ratio over a 1000 or other multiples which far exceed the rest of the sample.

3.2 Descriptive statistics

The table below represents the descriptive statistics of the variables and the multiples of the sample. These statistics gives better insights in the distribution of the IPO variables. Also, all the variables in the sample were taken from the prospectus of the company. As mentioned, the EPS is taken from 12 months before the offering. This because the offer pricing process begins months before the offering (Lowry & Schwert, 2004). Thus, the incorporation of the EPS from

12 months before the offering but also Sales before the offering should be better estimates for a valuation of an IPO. Both these variables have very widespread statistics, which can be linked to some outliers in the sample. Further, the enterprise value is calculated by adding the proceedings of the offering with the value of debt before the offering. Normally cash and cash equivalents should be subtracted from this equation, but due to a large number of missing values this variable is excluded. According to Lie and Lie (2002), multiples based on earnings and sales will yield the same results regardless of the cash level. Hence, it is not seen as a large limitation.

Table 1: Descriptive statistics of the sample

Variable			**Percentiles**				
	Mean	**Minimum**	**25th**	**50th**	**75th**	**Maximum**	**Std. deviation**
Offer Price (OP)	18,44	5,00	14,00	18,00	21,00	85,00	8,37
First market price	21,59	5,20	15,10	19,50	25,75	100,33	10,99
Proceeds, millions	386,13	7,00	107,14	188,70	458,33	3.786,00	556,69
EPS	4,14	0,01	0,26	0,64	1,34	300,26	27,88
Sales, millions	1.555,21	13,40	161,80	361,50	1.477,70	41.190,00	4.791,14
EBITDA	241,05	1,70	29,20	96,20	181,40	5.600,00	588,19
Enterprise Value (EV)	1.471,50	8,30	141,30	475,20	1.182,09	29.152,00	3.463,49
P/E (OP/EPS)	78,68	0,10	12,82	27,78	66,69	1.875,00	207,57
P/S (OP/sales)	0,09	0,00	0,01	0,05	0,10	1,12	0,15
EV/EBITDA	7,46	0,04	4,25	5,88	8,06	46,16	6,05
EV/S	1,93	0,11	0,51	0,98	2,47	15,80	2,51

The median of the P/E multiple is 27,78 which is quite similar to the paper of Kim and Ritter (1999) which contained a median of 24. But the standard deviation is 207,57, which is very large. This is probably due to some outliers, as seen at the maximum. These outliers will be appropriately adjusted. If P/E multiples exceed the number of 100 it will be adjusted to 100. The median of the P/S ratio is 0,05 which can be explained by the large numbers of sales of the IPO firms. This is also why the median of the EV/S is only at 0,98.

4 Methodology

In this thesis the Comparable Company Analysis (CCA) is applied. This analysis is a widely approved method for valuation on different types of companies of the same size and industry. Thus, also for the valuation of IPOs. This method is based on relative where multiples derived from comparable companies are compared to the company of interest. The basic idea behind CCA is that all substitutes should sell for the same price (Meitner, 2006). But in reality, the prices of the comparable companies will differ because a perfect substitute does not exist. How much the comparable companies differ from the actual company is expressed by the estimation error.

The multiples that will be used in this research are selected on the basis of previous studies. Kim and Ritter (1999) used mostly the same multiples but the authors mentioned that Market-to-Book ratio, a ratio often used in valuation, is a poor metric in IPO valuation because of the large change in book values due to the offering. Hence, this ratio will not be used in this research. Lie and Lie (2002) also mentioned that the EBITDA yields better estimates than EBIT multiples. Thus, the EBIT will also not be used in this research. The multiples that will be used in the research are as follows:

(1) P/E = Offer Price / Earnings Per Share

This multiple is defined by the offer price set by the underwriter on the issue date divided by the earnings per share from the 12 months before the offering.

(2) P/S = Offer Price / Sales in millions

This multiple is defined by the offer price set and the sales expressed in millions from 12 months before the offering.

(3) EV/EBITDA = Enterprise value / Earnings Before Interest, Taxes, Depreciation and Amortization

Here the enterprise value is defined by the market value of equity plus the total debt outstanding after the offering. The market value of equity is calculated by multiplying the offer price with the total shares offered in all the markets. The EBITDA is also taken from the 12 months after the offering in order to maintain consistency with the timing of the enterprise value. Both of the variables are expressed in millions.

(4) EV/S = Enterprise value / Sales

This multiple is defined by the enterprise value divided by the sales in millions. Here the sales are again from 12 months before the offering. This is done in order to execute a consistent comparison with the P/S ratio.

Further, the comparable companies used in this research are selected on the basis of 3-digit and 4-digit SIC codes with a time range from 2000 till 2019. This time range is much larger than previous IPO studies have used, but it is necessary due to the restrictions of the current IPO environment. The industries that are chosen on the 3-digit SIC code are carefully checked for corresponding descriptions of industries. If the companies differed too much in core activities, they were eliminated from the sample. These industries are added to the sample in order to obtain enough observations to make a representative dataset. Within these industries, the IPOs are compared to each other. If there were more than 5 companies within an industry, the IPO is compared to the 5 companies with the closest sales.

In the search to find the different estimation errors of the multiples, the mean and the median of each multiple of the comparable companies is calculated for each individual IPO. The logarithmic factor of the comparable companies is defined as the predicted value. The predicted value contains the mean or median of the multiples of the selected comparable companies, where the maximum of comparable companies is set to 5. Thus, if we have an industry where more than 5 observations are present, the natural logarithm of the mean or median of the different multiples is calculated for the 5 selected comparable companies with the closest sales to the IPO of interest. This is subsequentially compared to the multiple of the IPO of interest by subtracting the natural logarithms of both factors from each other in the equation. The formula is defined as follows:

(5) Prediction error: $\varepsilon = \ln(predicted\ value) - \ln(actual\ value)$

The more the prediction error differs from zero, the worse the predictive value of the multiple is. This will be computed for every multiple in the analysis. Also, the absolute prediction errors are calculated for each multiple. With these, the distribution of the prediction errors will be calculated, and the degree of accuracy of the multiples will be found. Consistent with previous studies such as Kim and Ritter (1999), the percentage of predicted valuations within 15% will be used to find this degree of accuracy. Here applies that if this percentage is

higher, the accuracy of the multiple is better. The formula of the absolute prediction errors within 15% is defined as follows:

(6) Absolute prediction error: $|\varepsilon| = |\ln(predicted\ value) - \ln(actual\ value)| < 0{,}15$

To answer the research question, two different tests are conducted. First, the mean of the prediction errors of each individual IPO will be obtained. Secondly, the prediction errors will be clustered on industry level and here the average of the mean and median prediction errors of the industries will be conducted. The average of the prediction errors of the multiples in the industry comparison will be compared to the individual analysis to see if the accuracy will increase.

5 Results

In this section the results of the analysis will be presented and interpreted. Firstly, the analysis of the IPO prediction errors individually will be discussed. Here will also be shown how each individual IPO multiples will be evaluated using the comparable company multiples. Secondly, the analysis of the industry comparison will be presented. These results will be compared to the first analysis in order to form a discussion and conclusion in the next sections.

5.1 The individual analysis

In order to come to a final result per analysis, first the prediction error of the multiples for each IPO in the sample must be calculated individually. In table 7 and 8 in the appendix, the descriptive statistics are given of this single analysis. This example displays the analysis of the High Technology industries with the three-digit SIC code of 737. Here, the multiples of Match Group Inc are compared to the multiples of a maximum of five comparable companies, because this industry contains more than 5 companies. In table 8 of the appendix, the difference in sales is displayed where the revenues of Match Group Inc are subtracted by the revenues of the comparable companies. The 5 companies with the closest sales to the IPO of interest are chosen as comparable companies. In this example, these are Switch Inc, GreenSky Inc, Inovalon Holdings Inc, SRA International Inc and Mantech International Inc.

Table 2: Mean and median multiples of the comparable companies of Match Group Inc.

Issuer	P/E	P/S	EV/EBITDA	EV/S
Switch Inc	21,04	0,05	10,83	3,17
GreenSky Inc	45,83	0,07	8,45	3,97
Inovalon Holdings	50,51	0,07	6,81	2,48
SRA International	96,41	0,06	3,18	0,29
ManTech I.C.	25,00	0,04	3,90	0,33
Mean	*39,30*	*0,05*	*5,53*	*1,71*
Median	*35,42*	*0,05*	*5,36*	*1,40*

After the comparable companies are chosen, the mean and median of the multiples are calculated. Table 2 shows the selected comparable companies based on closest sales to the IPO of interest. Here, 5 companies are chosen because more than 5 companies are present in this industry. As seen in the table, the mean and median of the comparable companies are calculated. In order to find the prediction errors of each multiple, the natural logarithm of these mean and median multiples must be subtracted by the natural logarithm of the multiples of the IPO of interest. The multiples of Match Group Inc, the IPO of interest, can be seen in table 8 in the appendix.

As seen in table 3, the results for Match Group Inc differ significantly per multiple. The first that stands out is that the prediction error of the P/S ratio is over a 100% for both the mean and median, which indicates a very weak multiple. If a multiple is above a 100%, by definition this multiple is set to an accuracy of zero. But, as seen in table 7 in the appendix, this is due to a relative low offer price and high sales compared to the whole industry. The P/E multiple yields only modest predictive value but this is also the result of the relative low offer price. In the contrary, the enterprise value multiples yield better results, where the EV/S contains the best accuracy. The mean absolute prediction error of this multiple is within the 15% control area for the degree of accuracy.

Table 3: Prediction errors – Match Group Inc.
In this table the calculations of the normal and absolute prediction errors of Match Group Inc are shown. These are calculated by subtracting the natural logarithm of the mean or median multiple of the comparable companies by the actual multiple of the IPO of interest. For example, the Mean Absolute Prediction Error of the EV/EBITDA is calculated as follows: |ln(5,53) – ln(6,50)| = 0,1608. This means that this absolute prediction error for this multiple is interpreted as 16,08%.

Multiple	**Prediction error**		**Absolute Prediction error**	
	Mean	**Median**	**Mean**	**Median**
P/E	0,5956	0,4790	0,5956	0,4790
P/S	1,3613	1,4651	1,3613	1,4651
EV/EBITDA	-0,1608	-0,1924	0,1608	0,1924
EV/S	0,0357	-0,1610	0,0357	0,1610

The analysis conducted in table 3 is performed for every single IPO in the sample. After all the prediction errors of the individual multiples are known, the average of the mean and median prediction errors is calculated. The results are presented in table 4 below. By looking at the standard prediction errors, one could conclude that the multiples have sufficient prediction accuracy and the negative errors could indicate that the under-pricing phenomenon is present. But in order to analyse the accuracy of the multiples, the focus point is the absolute prediction error. As seen in table 3, the absolute prediction errors yield very modest values. The mean absolute prediction errors of the P/E ratio and the P/S ratio yield an overall error of over a 100%, which are very poor values. Again, this means by definition that these multiples yield an accuracy of zero. These multiples also have the lowest results within the 15% of the actual multiple. Here, the average median multiples of P/E and P/S contain only 3,8% and 7,6% within the range of accuracy, respectively. The mean multiples of these ratios only yield slightly better results. In comparison, Kim and Ritter (1999) found that in their calculations 12,1% and 16,2% are in the accuracy range of the P/E and P/S ratio, respectively.

In the contrary, the enterprise value ratios give better estimates than the price ratios. The absolute prediction errors yield modest estimates, where the EV/EBITDA errors are just above 50% and the EV/S errors are above 80%. But, the enterprise value multiples within the 15% of the actual multiples have quite better values. Here, the average median multiples of EV/EBITDA and EV/S contain 15,2% and 11,4% within the range of accuracy, respectively. The best results of valuation are obtained by the mean EV/S multiple, which yielded an accuracy of 18,1%.

Table 4: Prediction errors of the individual analysis of the entire sample

In this table the calculations of the total individual analysis of the sample is presented. The average mean and median multiples of all the IPOs is displayed. These results can be interpreted as follows: The Mean Absolute Prediction Error of the EV/S is equal to 81,47% for the individual IPO analysis of the total sample. Further, the percentage of the absolute prediction errors that are within 15% of the actual multiple of the IPO of interest are shown. The median P/S multiple has a percentage of 7,62% that is within this accuracy range.

Multiple	**Prediction error**		**Absolute prediction error**		**Within 15% of actual**	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
P/E	0,1872	-0,0988	1,0544	1,1959	0,0857	0,0381
P/S	0,3382	0,0341	1,1809	1,2686	0,1333	0,0762
EV/EBITDA	-0,0838	-0,1793	0,5549	0,5368	0,1333	0,1524
EV/S	0,0895	-0,0366	0,8147	0,8710	0,1810	0,1143

5.2 The industry comparison analysis

After all the individual analyses are completed, the next step is clustering the prediction errors on industry level. This is done by taking the average prediction errors of the IPOs within the same industry. In order to give a clear view of the proceedings of the analysis, the industry prediction errors of SIC code 737 is given in table 5. In this table, the mean and median of the normal and absolute prediction errors are shown. In this case, the normal prediction errors yield some promising results. But the absolute prediction errors are needed for the valuation of the accuracy of the multiples and these show modest predictive values. This procedure is performed for the all the industries in the sample.

Table 5: Prediction errors of industry SIC 737

In this table the calculations of the normal and absolute prediction errors of the industry with SIC-code 737 are shown. These are calculated by taking the average of the prediction errors from the individual analyses of the industry. Thus, every individual analysis of the companies displayed in table 7 is incorporated in this table. Here, the Mean Absolute Prediction Error of the P/S ratio can be interpreted as 58,32%.

Multiple	**Prediction error**		**Absolute Prediction error**	
	Mean	**Median**	**Mean**	**Median**
P/E	0,4768	0,1598	1,0602	1,1071
P/S	0,2026	0,0518	0,5832	0,7212
EV/EBITDA	-0,0535	-0,3908	0,7816	0,8226
EV/S	0,3055	0,0939	0,8238	1,0842

On the whole, the analysis of interest is shown in table 6. Here, the industry-comparison prediction errors of the total sample are displayed. Again, for measuring the accuracy, the absolute prediction errors are of interest. If the average absolute prediction errors are compared to the individual analysis of table 4 in the previous subsection, we can conclude that almost all the errors have decreased. Only the P/S ratio has reported an increase on average. This means that overall the precision is closer to zero than before but for the actual accuracy of the multiple we have to analyse the prediction errors within 15% of the actual multiple. Clearly, the accuracy range of the ratios have decreased substantially, which goes against the expectations stated in the introduction. The P/S ratio has zero observations that are within this range and thus performs the worst in the industry-comparison analysis. Again, the enterprise value ratios perform best with the EV/S ratio containing 9,7% within the 15% range of the actual multiple.

Table 6: Prediction errors of the industry-comparison analysis
In this table the calculations of the industry analysis of the sample is presented. The average mean and median multiples of all the industries is displayed. These results can be interpreted as follows: The Mean Absolute Prediction Error of the EV/EBITDA is equal to 47,29% for the industry analysis of the total sample. Further, the percentage of the absolute prediction errors that are within 15% of the industry of interest are shown. The median EV/S multiple has a percentage of 9,68% that is within this accuracy range.

Multiple	**Prediction error**		**Absolute prediction error**		**Within 15% of actual**	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
P/E	0,0160	-0,1091	0,9572	1,1305	0,0323	0,0323
P/S	0,4720	0,3783	1,2188	1,4601	0	0
EV/EBITDA	-0,1622	-0,2010	0,4729	0,5059	0,0645	0,0645
EV/S	0,0232	0,0078	0,6809	0,8280	0,0968	0,0968

6 Discussion

In the previous section, we have observed some controversial results. Where the expectations were in favour of an increase in accuracy when the prediction errors are clustered on industry level, the results yielded a decrease in accuracy for the multiples. In general, the absolute prediction errors of the multiples have modest predictive values, where the price ratios have errors above a 100%. Kim and Ritter (1999) also concluded that multiples based on historical numbers have modest predictive values, but they yielded better results than in this analysis. Because the IPO volume per year has dropped, the precision of valuation with comparable multiples of other IPOs has subsequently decreased over time. The sample of this research is therefore limited, which may be the reason for these modest predictive values. The number of observations within the same industry could be too low and the IPOs may have been too far apart in time. The industries could have changed within the 19-year time range and making a comparison within the same industry might be inadequate.

Furthermore, the range of the multiples within the 15% of the actual multiples also yield modest to weak results. The P/E ratio is, in both analyses, a very weak predictor, which by definition has an accuracy of zero because the errors are above a 100%. This is quite unusual because according to Fernandez (2007), the P/E ratio is the most used ratio in valuation. This weak predictive values in IPO valuation may be caused the impact of market demand on the IPO stock, which can differ substantially between companies, even in the same industry. Investment bankers often incorporate growth expectations and market demand in the offer price and setting an offer price can be very volatile due to these factors. With the historical accounting numbers used in this research, it is difficult to capture these factors and control for it.

On the other hand, the EV/S ratio seems to yield the best results. Despite the limited opportunities that historical numbers offer in IPO valuation, the enterprise value is the best comparable variable. This is in line with Kim and Ritter (1999), because they also observed that the EV/S ratio performed the best with historical numbers for the IPOs overall. This might be due to the enterprise value incorporating multiple aspects that can be decisive in IPO valuation. Therefore, in comparing multiples of IPOs, enterprise value multiples are better than the price multiples. Also, the enterprise value is probably less affected by market demand than the offer price, thus it is a better comparable with solely using historical accounting numbers.

Finally, by comparing the range withing the 15% of the actual multiple of both analyses, a significant decrease in accuracy of the multiples is observed. According to previous literature, the prediction errors in the industry-comparison analysis should yield better results. According to Alford (1992) and Meinter (2006), using comparable companies within the same industry is found as best criterium. Kim and Ritter (1999) also used industry SIC codes for selecting comparable companies but found that it was somewhat restrictive because of the neglection of sufficient comparable companies outside of the industry. Investment bankers use a very wide spectrum of comparable companies that are not necessarily active in the same industry. Due to the weak predictive values of the multiples, the decrease in accuracy of the prediction errors in the industry-comparison analysis and the current IPO environment in the US, this may lead to questioning the value of using CCA in IPO valuation under the conditions used in this research. Academically and in practice, professionals often praise the use of multiples in valuation, but recent developments suggest that the use of comparable multiples based on industries is outdated for IPO valuation. Investment bankers can perform superior fundamental analyses which is not solely based on multiples valuation using historical accounting information. Probably, many valuation techniques are used to value an IPO. Additionally, these professionals incorporate factors like market demand in setting the offer price, which is difficult to capture empirically.

7 Conclusion

In order to give a conclusion, the research question will be answered. The question is stated as follows: *'What is the effect of clustering prediction errors of multiples on industry level on the accuracy of IPO valuation?'.* The effect of clustering the prediction errors is that, against expectations, the accuracy of valuation decreases. The results showed that the percentage of the multiples within 15% of the actual multiple decreases with the industry-comparison analysis if compared to the individual IPO analysis. This decrease is probably

caused by several factors which make the CCA within the same industry in IPO valuation obsolete. Because, the very weak predictive values of the prediction errors suggest that using comparable IPOs and historical accounting numbers in the valuation of a new IPO is not sufficient enough. These prediction errors show even higher values than Kim and Ritter did in 1999. The IPO market has changed over time and the volume of IPOs has decreased substantially over the years. Large companies are eager to buy smaller companies before they go public and the smaller companies can maximize their profits by being strategically bought by the larger companies. This resulted in fewer IPOs each year and thus using comparable IPOs from the same industry for new IPOs is a very restrictive method.

This research has shown that the use of comparable multiples on comparable IPOs within the same industry is a method that should not solely be used in order to set an offer price for a new IPO. The number of observations within the same industry is too low but most of all they are too far apart in time. This may have caused the high prediction errors within the same industry and thus decreased the accuracy in the industry-comparison analysis. IPO valuation is a very complicated matter where many factors influence the eventual offer price. Investment bankers use many different valuation techniques and do not restrict their comparable companies on industry SIC-code. Furthermore, they can incorporate factors such as market demand in order to set the price.

Altogether, by clustering the prediction errors on industry level in the industry-comparison analysis, the accuracy of multiples valuation decreases when you compare IPOs within the same industry. Using the industry criteria in IPO valuation is outdated due to the recent changes in the US IPO environment. Therefore, IPO valuation leaves a difficult task for the investment bankers. Even so, they can incorporate many factors in valuation and do a fundamental analysis for the IPO based on comparable companies outside of the same industry.

The main restriction of this research is the sample used for the valuation. Due to the low quantity of IPOs per year in the US after the millennium change, the sample had to be stretched from 2000 till 2019. This could have led to the overall poor comparable companies within the industries. The industries could have changed significantly in this time range.

Further research could investigate whether these changes in the IPO environment are a global phenomenon and that in most countries the industry criterium in IPO multiples valuation is insufficient. And if so, conduct research in the new and better criteria of comparable companies in IPO valuation that professionals like investment bankers use.

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9 Appendix

Table 7: Descriptive statistics of industry SIC 737 – Comparable companies Match Group Inc

Issuer	SIC Description	SIC Code	Issue Date	Offer Price	Proceeds	EPS	Revenues, mil	EBITDA, mil	Total Debt ($ mil)	Enterprise value
Parsons Corp	High Technology	7371	05-07-2019	27,00	500,00	2,15	3.655,10	158,00	250,70	750,70
Switch Inc	High Technology	7371	10-05-2017	17,00	531,25	0,81	360,80	105,70	613,50	1.144,75
Match Group Inc	**High Technology**	**7371**	**11-18-2015**	**12,00**	**400,00**	**0,55**	**991,90**	**251,50**	**1.233,50**	**1.633,50**
GreenSky Inc	High Technology	7372	05-23-2018	23,00	874,00	0,50	344,90	162,00	495,00	1.369,00
Taleo Corp	High Technology	7372	09-28-2005	14,00	93,80	13,94	67,90	2,50	21,60	115,40
Inovalon Holdings Inc	High Technology	7374	02-11-2015	27,00	600,00	0,53	361,50	131,40	295,20	895,20
IMS Health Holdings Inc	High Technology	7374	04-03-2014	20,00	1.300,00	0,12	2.576,00	265,00	3.970,00	5.270,00
Bandwidth Inc	High Technology	7375	11-09-2017	20,00	80,00	0,99	159,30	20,30	0,10	80,10
RetailMeNot Inc	High Technology	7375	07-18-2013	21,00	190,91	0,61	168,90	58,00	43,00	233,91
PlanetOut Inc	High Technology	7375	10-13-2004	9,00	41,85	4,66	23,20	2,60	1,80	43,65
Google Inc	High Technology	7375	08-18-2004	85,00	1.666,43	0,37	2.258,00	541,10	3,10	1.669,53
SRA International Inc	High Technology	7376	05-23-2002	18,00	90,00	0,19	312,50	28,90	2,00	92,00
ManTech International Corp	High Technology	7376	02-07-2002	16,00	115,20	0,64	431,40	36,20	26,10	141,30

Table 8: Multiples of industry SIC 737 – comparable companies of Match group Inc

The comparable companies are chosen on the basis of the difference in sales. The five companies with the closest sales to that of Match Group Inc are sufficient as comparable companies. In the table, the italic numbers in the last column represent these companies. Further, if a company has a P/E ratio higher than 100, the ratio is set to the limit of a 100. This is the case for IMS Health Holdings Inc and Google Inc in this example.

Issuer	**P/E**	**P/S**	**EV/EBITDA**	**EV/S**	**Diff. sales**
Parsons Corp	12,58	0,01	4,75	0,21	2.663,20
Switch Inc	21,04	0,05	10,83	3,17	*-631,10*
Match Group Inc	**21,94**	**0,01**	**6,50**	**1,65**	0,00
GreenSky Inc	45,83	0,07	8,45	3,97	*-647,00*
Taleo Corp	1,00	0,21	46,16	1,70	-924,00
Inovalon Holdings Inc	50,51	0,07	6,81	2,48	*-630,40*
IMS Health Holdings Inc	*100,00*	0,01	19,89	2,05	1.584,10
Bandwidth Inc	20,12	0,13	3,95	0,50	-832,60
RetailMeNot Inc	34,43	0,12	4,03	1,38	-823,00
PlanetOut Inc	1,93	0,39	16,79	1,88	-968,70
Google Inc	*100,00*	0,04	3,09	0,74	1.266,10
SRA International Inc	96,41	0,06	3,18	0,29	*-679,40*
ManTech International Corp	25,00	0,04	3,90	0,33	*-560,50*