LUND UNIVERSITY
School of Economics and Management

Valuation Using Multiples - Accuracy and Error Determinants

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Abstract

Title: Valuation Using Multiples – Accuracy and Error Determinants

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Course: Master Thesis in Finance, Lund University

Seminar date: 2012-06-01

Keywords: Valuation, Multiples, Accuracy, Error Determinants, Discounted Cash Flow model, DCF, Market Efficiency Hypothesis, Mispricing, Panel Data, Market to Book ratio, Firm Size, Volatility, R&D.

Purpose: The purpose of this thesis is to investigate how accurate multiple valuations are in relation to the DCF. Furthermore, the accuracy of equity and entity multiples will be compared. Finally, we will try to determine the factors underlying the valuation errors.

Theoretical framework: The theoretical framework covers previous studies on the DCF and the multiples valuation approach and theories about efficient markets and mispricing.

Empirical framework: A sample containing 91 unique listed firms on the NASDAQ OMX Nordic Large Cap during 1995-2011.

Methodology: Quantitative approach using statistics and econometrics.

Conclusions: Our results suggest similar performance from the multiples approach in relation to the DCF model in estimating corporate value with eight of ten multiples producing valuation estimates with valuation errors of less than 15 % compared to market value. However, EV/EBITDA which is the closest related multiple to the DCF is outperformed. The equity multiple Price/Earnings yield the most accurate estimation of corporate value. Finally, firm size and market to book ratio are connected to the valuation errors obtained from the multiples valuation approach.

Contents

1 Introduction

This section begins with the background where the intensive usage and importance of the valuation area is highlighted. Then follows the problem discussion where our motives, intentions and expectations for the thesis are discussed. Purpose and research questions derived from the problem discussion are then reported and the section ends with delimitations and the thesis outline.

1.1 Background

Corporate valuation is a common topic within financial theory (Lie and Lie, 2002). When majoring in finance, a course on firm valuation is normally included in the course plan because of the large use of valuation models in practice. Investment bankers, stock analysts and investors value companies all the time for different reasons such as before mergers, giving buy or sell recommendations or to simply evaluate an investment opportunity. Because of the large use in practice, the valuation theme is certainly well deserved of even more academic attention.

Studying corporate finance, we have learned to use different models in order to value the firm's equity, for instance the widely accepted discounted cash flow (hereafter named DCF) model (Kaplan and Ruback 1995). In addition, we also had a guest lecture, held by Mr. Magnus Kenneby at Sequent, where he discussed different multiples in relation to firm value. According to Morgan Stanley Dean Witter Research in 2002, both Price/Earnings and EV/EBITDA (Enterprise Value/Earnings Before Interest Tax Depreciation and Amortization), two popular multiples, were both used more than the popular DCF model. Even though being used so frequently in practice, the method has been dedicated little time by academics. Combining those facts with the methods quite simple nature, the subject "valuation using multiples" really caught our attention. The method relies on an assumption of comparable companies in an industry having similar expected return and risk level, which an average or median multiple for instance Price/Earnings is supposed to reflect. To actually obtain an estimation of corporate value, this industry multiple, e.g. Price/Earnings (from t-1), is multiplied with the denominator for the individual firm at time t.

Certainly, coming up with a method that can estimate future firm value with 100% accuracy is impossible. However, comparing the existing models by investigating their accuracy is possible and something we intend to do. In reality, the discounted cash flow method is widely

accepted by economists (Kaplan and Ruback, 1995) and for this reason a good benchmark to compare the multiple results against. Because of the widespread usage of multiples in practice, we do expect a good performance by the model. Another interesting question is what causes the valuation models estimations to differ from the market price. A great deal of academic attention has been given to the theory of efficient markets and the theory of mispricing. In relation, different variables like the market to book ratio and firm size are pointed out to have a relation to mispricing of securities and have been addressed by academics. Since theoretical models like the DCF or the multiples approach that are supposed to yield the firm's value (equity or entity) actually differs from the quoted one, we intend to connect market efficiency and mispricing to our study.

By testing the valuation accuracy of the multiples approach, we intend to contribute to the understanding of this model, at least with regards to the Nordic market which make out or sample. Furthermore, if we can connect valuation errors to one or more independent variables, the precision of the model could be increased by in some way taking the error causing variables into account.

1.2 Problem discussion

Hypothesizes are derived mainly from earlier studies who also test the accuracy of firm valuation using multiples. However, we intend to extend their studies by also investigating what may cause the valuation errors. As mentioned, the DCF methodology is widely accepted by economists and practitioners (Kaplan and Ruback, 1995). Kaplan and Ruback (1995) were the first to really test the accuracy of the DCF method in a rigorous way by comparing their estimated firm values with highly levered transactions like management buyouts. They conclude by stating that the DCF is a good model for performing valuations with an average valuation error of 8,0 %. Furthermore, they perform valuations using the multiples technique and compare the accuracy of this technique with the DCF and conclude that the DCF is a better valuation tool, implying a similar result for our study. Their study is concentrated to the US stock market, while ours will be concentrated to the Nordic market. Examples of other studies within the area are performed by Lie and Lie (2002), Eberhart (2004) and Schreiner (2007), but compared to for instance the DCF model the amount of time dedicated to the multiples approach is very limited. Together with Kaplan and Ruback (1995), Lie and Lie (2002) will serve as our main benchmark study because of the high reliability and validity of those studies. However, the estimation periods used in earlier research is only one year while

we intend to use a five-year estimation period for every observation. Using a longer estimation periods has never been done before and we believe this will give us a broader view on the markets interpretation of the multiples. In addition, earlier studies have only used one year as evaluation period. We will have 12 years of observations, creating a more long-term view on the valuation accuracy.

Furthermore, the sources for the valuation errors have not yet been investigated, which according to us creates a large motive for doing so. Could there be a connection between the mispricing mechanisms and the valuation errors gained by our estimates? We believe that it could. If we are able to establish a conjunction between some independent variable(s) we can further contribute to the understanding and application of the multiples approach, by eventually proving that all valuation errors are not random. In the literature review we will discuss the market efficiency hypothesis, behavioural finance and mispricing mechanisms. Using the theoretical background we will derive variables from those theoretical areas which we believe could be connected to the valuation errors, where firm size, market to book, volatility and R&D are our suspects. The reasons for choosing precisely those variables are many and will be further discussed in the theoretical framework section. But in order for the reader to get a glimpse, for instance the R&D variable is chosen because of the trickiness in valuing intangible assets from which future value creation is hard to estimate. This fact suggests R&D intensive firms to have larger valuation errors. R&D, along with the other variables, will therefore be tested against the valuation errors using a panel data econometric approach, in order to see if a conjunction can be established.

1.3 Purpose and research questions

The purpose of this thesis is to evaluate the accuracy of the selected multiples regarding their ability to forecast the Enterprise Value/Stock Price of the companies on the NASDAQ OMX Nordic Large Cap list. This will be performed by computing the valuation error for each estimate generated by our multiples compared to the actual quoted stock price. A further comparison regarding the valuation errors using multiples and the valuation errors using the DCF method will also be presented. Finally, an investigation of which variable(s) may cause these valuations errors will be performed. This purpose has resulted in the following research questions:

1. How accurate are the estimations of corporate value yielded by the multiples approach, compared to our benchmark model (DCF)?
2. Does the valuation accuracy differ between equity and entity multiples, and which type of multiples yield the best performance?
3. Can one or more of the following variables explain the valuation errors: Firm size, market to book, stock price volatility and/or R&D intensity?

1.4 Delimitations

This study carries a couple of delimitations worth discussing. First, our choice to study the Nordic markets instead of choosing a sample that could be representative for the stock markets in general, like the S&P 500. This choice is made because of the non existing research regarding multiples in the Nordic market combined with our interest in it, from both living in the region and owning stocks in this particular market. Furthermore, our sample consists of companies listed on NASDAQ OMX Nordic Large Cap hence companies on Mid and Small Cap are excluded. This limitation is made due to lack of data for companies listed on Mid and Small Cap and because of Large Cap in general being more liquid. By being more liquid, we believe this data set generates a better sample with regards to a better reflection of investor behaviour. Moreover, when both A and B share class exist for a company, the A share is excluded. At last, our estimation period is set to begin in 1995 only due to data reasons, i.e. before 1995 there is insufficient data to create a satisfying industry classification.

1.5 Thesis outline

The first section provides an introduction to the valuation theme followed by a problem discussion and the research questions that we intend to answer in the thesis. Section two provides a literature review in the valuation area and theories regarding market efficiency and mispricing. Section three contains the methodology in which we describe how we obtain our valuation estimates, the valuation errors and test for valuation error determinants. In section four our empirical findings are presented followed by section five where those findings are analyzed, discussed and put in relation to earlier research. Section six concludes and gives recommendations for further research.

2 Literature review

This section begins with a description of the DCF model, our benchmark comparison model, multiples approach and empirical studies related to these models. Thereafter follows a summary of empirical studies related to the market efficiency hypothesis and mispricing theory. Those themes are put in relation to valuation theory and will be used in the analysis section for application on our empirical findings.

2.1 The Discounted cash flow model (DCF)

As already mentioned, the DCF methodology for valuing firms is widely accepted by economists and academics (Kaplan and Ruback, 1995), with future free cash flow discounted with the weighted average cost of capital (hereafter named WACC). The cash flow discounted is the cash flow available to all investors, i.e. equity holders, debt holders and other non-equity holders produced by the firms operations, yielding the firms enterprise value. To value the equity, claims from debt holders and non-equity holders are then subtracted. However, the model is constrained by several assumptions. In order for the DCF to work, one has to assume that the company enters a steady state (meaning constant growth) at some point and hence it is possible to estimate a continuing value for the company, and the question then immediately appears if assuming a steady state is reasonable. When testing the accuracy of the DCF, Kaplan and Ruback (1995) stress the fact that both academics and practitioners could make better assumptions in specific cases rather than relying on publicly available information as they did in when cash flows where forecasted. When using the DCF, the WACC also has to be estimated and Kaplan and Ruback (1995) use the CAPM approach. They highlight the importance of making proper assumptions regarding both growth rates and WACC by showing substantial differences in valuation errors if the steady state growth or the WACC assumptions are changed. Considering this varying performance, Kaplan and Ruback (1995) highlight the largest drawback of the DCF namely its large dependence on assumptions one has to make on your own, which could have large implications to the out coming value.

2.2 Multiples

According to Lie and Lie (2002) multiples are frequently used both as a pure valuation tool, but also as a complement to the DCF model as a helping tool when assumptions about growth rates in revenues are made. By comparing companies with similar characteristics, e.g. comparable companies within an industry, one can better understand strengths and weaknesses for individual companies and better project the companies' evolvement in the

future. Originally, the multiple valuation methodology relies on two assumptions. First, the comparable companies within an industry have similar expected future cash flows and risk and second, the multiple/performance measure being used is actually proportional to value (Kaplan and Ruback, 1995). Provided that these assumptions are valid, the multiples approach should yield better estimates than any DCF technique since it accounts for contemporaneous markets expectations regarding risk and future expected return (Kaplan and Ruback, 1995), instead of relying on assumptions as the DCF. The valuation method described by for instance Kaplan and Ruback (1995) and Lie and Lie (2002) is quite simple and intuitive and relies on the two stated assumptions. In order to value a company you need a multiple, for instance EV/EBITDA, and a set of comparable companies. To calculate the enterprise value for the company, an average or a median multiple is calculated for the comparables and multiplied with the denominator, e.g. EBITDA. Furthermore, theory recommends using forward looking multiples which means that a projected earnings estimate is preferred rather than the current (Lie and Lie, 2002). By using forward looking multiples, you further account for the markets (analysts) current expectations. When choosing between the multiples approach and the DCF the empirical issue one need to consider is: do the benefits of using firm specific information in the discounting cash flow methodology weigh heavier than the cost of ignoring the contemporaneous measures of market expectations built in the multiples approach (Kaplan and Ruback (1995)?

2.2.1 Equity value versus enterprise value multiples

Total equity value, or market capitalization, simply consists of the price per share multiplied by the number of outstanding shares. Enterprise value is defined as market capitalization plus book value of net debt (Schreiner, 2007). As the reader can observe, the two value measures differs. Equity value better reflect the value from an individual shareholders perspective while enterprise value mirrors the actual cost of buying the total firm, i.e. buying its shares and taking over the debt. Consider the two multiples Enterprise Value/EBITDA and Price/Earnings. The first multiple will give an estimation of enterprise value while the latter will yield an estimation of equity value. According to theory one should bear in mind the motive behind the valuation when choosing between equity and entity multiples (Schreiner, 2007). To exemplify, if you are interested in buying just a few shares, use equity multiples, if you are planning to purchase the entire company, use entity multiples. Furthermore, when looking at the company from en equity holders' perspective, be sure to match the nominator

with a variable considering the claims for equity holders. To clarify, Price/Earnings, where earnings is the same as net income, accounts for profits to equity holders after interest and taxes are paid to other stakeholders. In this thesis, the accuracy of both equity and entity multiples will be tested.

2.2.2 Empirical studies on multiples and the DCF

This section summarizes some of the main studies already performed within the valuation area with regards to the DCF and multiples approach. Because of these studies being closely, or perhaps directly, related to our thesis these studies will serve as benchmarks for our results. Thereafter, studies connected to different variables used in our valuation error investigation will be included in this section and further discussed in the analysis.

Despite being the most accepted model for equity valuation among economists, the DCF model had, until this point in time, not been empirically tested. Kaplan and Ruback (1995) were the first to really test the accuracy of the model. Using a slightly adjusted model compared to the one described in text books, they estimated entity value for firms with the discounted cash flow methodology. Note, entity value was estimated and not equity value making the model comparable to entity value multiples in first hand. The estimations were then compared with the transaction value for highly levered transactions (HLT), such as management buyouts. HLT are chosen as comparisons since this kind of transaction normally release the information, both projected cash flow and transaction value, needed to perform the analysis. Their sample consists of 53 transactions between 1983 and 1989. They use publicly available earnings forecasts to produce free cash flow estimates for the near future, and a steady state is assumed to occur once the projections end. In addition to evaluating the DCF method, they also create estimates using multiples in order to test the accuracy also for this method. They chose to only use the EV/EBITDA multiple since its relation to the DCF methodology is very close. The study is very rigorous and their results are many. Regarding the DCF, they conclude that the results differ when changing the beta used in the WACC. When using the firm WACC (which in theory is the right one to use) the average valuation error is 8,0 %, while when using the market beta the valuation error is 3,1 %. A surprising result, since the firm WACC should be the proper discount rate when discounting the particular firms' cash flows. Furthermore, when the authors vary the assumption regarding the steady state growth, the accuracy varies substantially. Combined, these two facts make out the largest criticism for the DCF. Even though they experience large variation in accuracy due to

these circumstances, the authors believe when used in practice, the DCF is a good valuation method. They base this conclusion on that practitioners should be able to provide more reasonable assumptions regarding WACC and growth rates when looking at specific firms instead of a large sample. With regards to the multiples approach, the accuracy is not as good as for the DCF. On average, and using median multiples for the industry, they obtain a valuation error of (-)16,6 %, comparing the multiple estimations to the same transactions as the DCF. Because of the smaller valuation error, the authors prefer the DCF over the multiples approach. Since Kaplan and Ruback (1995) are the only ones to test the DCF and compare it to the multiples approach, they will serve as our first benchmark study.

Kaplan and Ruback (1995) also address another important aspect of comparing valuation techniques. What is actually a "good" result? When is a method accurate enough? They compare their results with results gained from option pricing studies. Whaley (1982) conducts a study similar to theirs, using different variants of the Black-Scholes option-pricing model, in order to price American call options. He provides estimates which contain average prediction errors of 1,1 % to 2,2 %. Comparing their main findings with an average error of 8 % with the DCF, they conclude that their method provides a relatively good forecast. Furthermore, they use an evaluation tool where the fraction with valuation error less than 15 % are considered - implying that a 15 % valuation error is acceptable.

Moving on to our second benchmark study, we shall see that when compared to the actual quoted enterprise value/stock price, the multiples approach enhances its accuracy. Lie and Lie (2002) investigate the accuracy of multiple valuation techniques in the US market and receive an average valuation error (-)11,9 % using EV/EBITDA, compared to (-)16,6 % in Kaplan and Rubacks (1995) study. In addition to EV/EBITDA, they include the most frequently used multiples in practice, e.g. Price/Earnings, Market capitalization/Book value of assets (market to book) and EV/SALES. Regarding Price/Earnings, Lie and Lie (2002) use both historical earnings and future earnings estimates, and compare the accuracy. Descriptive statistics are used to measure the accuracy and the data consists of historical data collected from Standard & Poor´s *Research Insight*. Worth commenting is that their estimation period connected to every observation was only one year (1998), while we will use a five year estimation period in our study. To produce a value estimate for a company, an average or median multiple for the industry is calculated and then multiplied with the relevant financial figure for the company, e.g. EBITDA in the case of EV/EBITDA multiple, consistent with Kaplan and Rubacks

(1995) method. The authors, like there forerunners, prefer the median multiple since the estimates of using this measure yields less biased estimates as a result of less skewness. When choosing comparable firms for the multiple estimations Lie and Lie (2002) chose to classify companies according to industry classification. Choosing the wrong comparables could have a large impact on the valuation, but Lie and Lie (2002) argued industry classification should yield the smallest valuation error, a fact later supported by Eberhart (2004). The authors draw several conclusions from the study which is of importance for us. First of all, multiples, in general, generate negatively biased valuations. Secondly, asset value multiples generate less biased and more precise estimates than earnings and sales multiples in particular for large companies. Third, the use of forecasted earnings estimate yield better results than historical earnings. Fourth, the EV/EBITDA multiple yields more precise results than do the EV/EBIT multiple. Fifth, using multiples on financial firms yields more accurate results than on non financial firms, a result the authors believe origins from more liquid asset bases for financial firms.

Hernandez (2002) investigates whether multiples is suited for valuation on a broad basis, mainly by looking at the dispersion within industries. However, no accuracy check is performed. Hernandez, like all other researchers, motivates his study because of the multiple valuations being frequently used by practitioners. According to Morgan Stanley in 2002, over 50 % of their analysts used Price/Earnings as valuation method for European companies while approximately 30 % used EV/EBITDA. The popular DCF came at fifth place with a usage of just under 20 %. This fact strengthens both others and our claim of multiples being frequently used in practice. Conclusion wise, Hernandez argues that multiple valuations are highly debatable because of their large dispersion within industries. For instance, within cellular phone companies in Europe the EV/EBITDA multiple ranges from 8,8 to 37,1 in 2001, creating doubt on a valuation for a single company during a short period of time. But does the fact of dispersion really matter? Eberhart (2004) investigates the methods sensitivity of using different comparables within an industry and which comparables that yields the most accurate results. The data set consists of all firms available in Compustat and the time horizon is the same as the one used in the Lie and Lie (2002), namely one year data to forecast the next year. The author stresses the importance of choosing “right” comparables since the results vary greatly depending on which comparables you chose. On the other hand, the multiple chosen is also of great importance and the results vary depending on which multiple you chose, a fact stressed by both Lie and Lie (2002) and Eberhart (2004). The same method as in Kaplan and

Ruback (1995) and Lie and Lie (2002) used, is used by Eberhart (2004) in order to calculate forecasted stock price and enterprise value estimates. The different sets of industry comparables are chosen from well known from institution classifications like Dow Jones and Morningstar, but also classified according to classification systems, like Fama and French's. Eberhart provide the following conclusions: Overall, Dow Jones and Value Line yield the most accurate results, perhaps explained by the fact that those two indices cover large companies and hence fewer than available in Compustat. In order to cover the whole Compustat database a classification system must be used, for instance the Fama and French. No significant difference between the classification systems can be made, so the recommendation from the author is to use Dow Jones or Value Line when those indices cover all companies in your study. The conclusion of using industry classifications actually provide contradictory results to Hernandez (2002) statement of multiples being debatable due to large dispersion.

In his dissertation, Schreiner (2007) provides some evidence which do not correspond with theory. Earlier studies included in this thesis have only put EBITDA and EBIT in relation to enterprise value. Schreiner extends this research by also putting EBITDA and EBIT in relation to the stock price and the outcome is quite surprising. As earlier mentioned, economic theory suggests that the nominator for a multiple should be matched with the denominator, i.e. a financial measurement that corresponds with the equity or the entity holder's level. However, he states that the estimation of market value of net debt (which is included in EV) contains considerable noise, creating a trade off when choosing between stock price or enterprise value in the nominator even for denominators at an entity holders level. Earlier studies within this area have concluded that equity multiples yield more accurate results than do entity multiples (Alford, 1992, Liu et al, 2002), but these results only hold for multiples where both the nominator and the denominator are at an equity holders level (e.g. P/E), i.e. those results are in line with the matching theory. Schreiner (2007) primarily use Kaplan and Rubacks (1995) fraction within 15 % method and concludes with the following results: For all observations equity multiples, even with a financial measurement defined at an entity holders level in the denominator, outperform entity multiples in 93,75 % of all cases and for the fraction of estimates that are within 15 % (up or down) from the market values, equity outperform entity in 62,5 % of the cases. Schreiner explains this finding with noise in the estimation procedure of enterprise value, coming from the net debt part. Again, a result not corresponding with the matching theory.

2.3 Market efficiency hypothesis

In order to test the accuracy of our proposed valuation method, a "true" price to compare our estimations with must be defined. As the reader could observe in the previous section, there are different ways of comparing the estimated values. However, since the data set used in this thesis spans over a longer period of time, using for instance values from actual transactions concerning all the shares in one company will be very hard. Assuming a *fully* efficient market and the multiples including the markets contemporaneous expectations, our valuation errors would be close to zero. Naturally, we, like others, will obtain valuation errors and therefore it is also interesting to discuss the market efficiency and mispricing theory and tie those to our empirical findings. This section revisits the latter studies concerning the market efficiency hypothesis and discusses the proof for, and against, its existence, followed by a mispricing section discussing in particular the variables that will be tested against our valuation errors.

According to Fama (1970), the capital markets most central role is to allocate the funds available in an economy. Markets are, according to the market efficiency hypothesis, supposed to adapt to all information available which on the stock markets is reflected in the stock prices through stock returns. Investors should be able to make fully informed decisions concerning their investments with regards to information about the company, i.e. all information about the company's future prospects and threats should be available. As Fama states, "when prices on a market *fully reflect* all information available the market is *efficient*". The theory of market efficiency is very difficult to really test, because how do you actually test if a market *fully* reflect all information? In the early stages, when the market efficiency hypothesis was developed, it was believed that if the stock prices followed a random walk process (i.e. the stock prices was independent) the market was in fact efficient (Fama, 1970). If prices where in fact unpredictable, i.e. no historical information could predict tomorrows price, only the treatment of changed circumstances actually determined tomorrows stock price. However, if this random walk model (also called the "fair game" model) is supposed to hold, one must assume that information is reflected by expected return.

There are also different kinds of market efficiency. Obviously, a completely efficiency market that incorporates *all* information available is hard to imagine. However, a semi strong efficient or a weak efficient market is easier to imagine. According to Fama (1970), a semi efficient market incorporates all *publicly* available information while a weak efficient market only depends on *historically* available information. In the weakly efficient market, it is

supposed to be impossible to create excess returns in the long run only by only looking at historical price patterns.

2.3.1 Support and criticism of the market efficiency hypothesis

Despite the problems with testing, attempts have been made in several ways. Fama revisits the market efficiency hypothesis in 1998 and still argues that it holds, at least on a long-term basis. Furthermore, he states that as long as there is no proof supporting an alternative hypothesis, it is against scientific rules to reject it.

According to Malkiel (2003) many patterns rejecting the MEH seem to disappear after they are published in the finance literature. Schwert (2001) provides two explanations to this fact. First, scientists often try hard and frequent to challenge an existing theory or hypothesis, and considering the amount of research where the market efficiency has been widely accepted, scientists will now and then find some small significant test rejecting it. Moreover, Schwert (2001) also states that it is a data related problem since financial researches often has a mountain of data available, and working with the "wrong" sample could yield "wrong" results. Schwerts (2001) other explanation has to do with arbitrage, an explanation which is supported by Malkiel (2003). Malkiel (2003) exemplifies with the so-called "January effect" where stock prices rose early in the year, but when this fact became public knowledge, this phenomenon instantly disappeared. This also supports the MEH, at least in the semi strong form, since it implicates that as soon as something becomes public knowledge, the market adapts to it and the chance of creating abnormal returns disappears. Short time correlations in returns are often an argument against the MEH according to Malkiel (2003). But what happens in the long run? Are the correlations consistent over time? Fama (1998) and Poterba and Summers (1998) both find stock returns to be mean reverting on a long time horizon, i.e. a short period of increased returns are followed by a period of decreased returns suggesting that the market adapts to new information, at least at some point. But what causes the short-term deviations? De Bondt and Thaler (1985) provides one possible explanation connected to behavioral finance theory. According to their study investors suffer from positivism and pessimism which cause share prices to deviate from the fundamental value, and then mean revert later on. In addition, Kahneman and Tversky (1979) states that investors are overconfident in forecasting a company's future earnings. Combining these theories, some support to the contrarian strategy is provided, where investors should buy stock with poor performance during the last couple of years in order to create returns on the mean reversion,

i.e. when they bounce back to their normal return stage. Finally, regarding mean reversion, Fluck et al (1997) performed a large simulation where they bought stocks with particularly poor or strong, returns for the last two to three years spanning over a 13 year long period. They found that stocks that previously had experienced low returns had higher returns for the next period and vice versa, thereby confirming the *statistical* significance over return reversals. Nevertheless, they found that a contrarian strategy for gaining excess returns was not present since returns for both groups during the next period cancelled this opportunity, i.e. the underperforming stocks return rise was cancelled by the decrease in returns for the strong ones. All in all, their results provided statistical evidence of mean reversion in stock returns, but no evidence of market inefficiency in the sense that investors could create excess returns.

2.4 The fundamental stock price – behavioral finance and mispricing

According to widely accepted theory among economists, a stock price is supposed to reflect the present value of all future cash flows (e.g. dividend discount model) discounted with a factor representing the risk in the cash flows (Kaplan and Ruback, 1995). But does it? In order for a market to be efficient and if one assume cash flow is the proper valuation method, this should be the case, provided that all information is available. A great deal of research has been performed in this area. Friedman (1953) argued that stock prices must reflect fundamental values for arbitrary reasons. He claimed that even if irrational investors miss valued a security, more rational investors would trade, and profit, on the miss valuation and push the price back to reflect its fundamentals. For instance, Shiller (1981) argues that stock prices are too volatile in order for the price to reflect only fundamental values. Furthermore, according to West (1988), if a stock should be priced in relation to its future cash flow production, the volatility of the stock should match the volatility of the cash flow streams. If the volatility of the stock price exceeds the volatility for cash flow, he states that stock prices are more volatile than the cash flow theory can explain. According to Shiller (2003), the fact of excess volatility is the one thing which Fama cannot explain in his criticism of the MEH criticizers. So what should we believe? Are financial markets efficient or inefficient? Shiller (2003) concludes that one should be careful with ruling market efficiency out of the question, at least on a long-term basis. Nevertheless, one should be careful in the shorter term because MEH may lead to very wrong interpretations with regards to, for instance, a crisis. Researchers like Shiller (1981) and Fama (1970) have provided supporting evidence for and against, but nothing is carved in store. Shillers (2003) excess volatility statement has caught our attention, thus the variable volatility will be tested against our valuation errors in order to

see if there is a connection, i.e. if increased/decreased volatility over time affect the valuation error in some direction.

But what causes the stock price to deviate from fundamentals? What other than future cash flow could be a determinant for the stock price? Shiller (2003) discusses the well known, however not so well investigated, feedback theory. This theory essentially accuses investors of being naive and believing in hypes that do not reflect fundamental values, with the internet bubble as a good example. Investors overreacted heavily regarding the internet's ability to create new rules for the market. Shiller (2003) also discusses the smart money versus ordinary investors, where more informed investors exploit the ignorance and information lack ordinary investors possess. However, this argument could be connected to Friedman's (1953) hypothesis that stocks actually are reflecting fundamentals. Schleifer (2000) provides yet another explanation relating to transaction costs. He argues that if the trading costs exceed the potential investment profits, mispricing would comprise in a persisting manner. Sadka and Scherbina (2007) have another approach on mispricing and discuss analyst disagreements, transaction costs and liquidity. According to the authors, earlier results has determined that stocks are overpriced when a high level of disagreement regarding future earnings exist among analysts. But, when the actual earnings are released, the stock price converges back to its fundamental value. However, the time of convergence differ, depending on the liquidity of the stock and the transaction cost involved. Even though the time of convergence differs, Sadka and Scherbina (2007) are able to establish a significant conjunction between liquidity and mispricing due to analyst disagreement and the same for transaction costs.

To summarize a bit before we start to deriving variables suspected of causing mispricing, we like to further clarify the market efficiency's connection to our valuation study. If one assumes that markets are efficient on a long-term basis which previous researchers have problems of ruling out, deviations occurring in the short run, both positive and negative, should have a tendency of canceling each other out in the long run. However, one more assumption has to be made if this argument is to hold true, namely that of the multiples approach being a well functioning estimator of corporate value which in our case remains to be seen. Moreover, prior research indicates that short-term inefficiencies and market price deviations from fundamentals occur in the short run. For this reason we will try to connect short-term deviations between corporate value estimations created by our model and market value to variables suspected of causing mispricing.

2.4.1 Market to book, R&D and firm size in relation to mispricing

Bloomfield and Michaely (2004) use experiments on professionals from Wall Street to assess how they view different variables, like market to book ratio and firm size, in relation to valuation, risk and mispricing. The professionals consist of investment bankers, research analysts and traders. The authors use two different experiments on the test groups where the subjects get to answer questions regarding their view on the future behavior for a stock given special characteristics, e.g. firm size or a high market to book ratio. According to their test group, market to book ratio is a strong indicator for mispricing and risk. A high market to book ratio is a sign of overvaluation and risk, while a low ratio is a sign of the opposite. With regards to firm size, the test group does not expect returns to be larger or smaller but they do believe that large firms carry less risk implying lower future expected return. The authors also divide the test group into sub groups, where the senior analysts view firm size to be a sign of mispricing (overvaluation) but this fact does not hold for the entire sample. In addition, Fama and French (1992) establish a significant conjunction between firm size, market to book ratio and security returns for non financial firms. Their results are supported by a study performed Barber and Lyon (1997) where they find similar results for financial firms. Thus, Bloomfield and Michaely (2004) is supported also in a quantitative way, at least in the sense that the market interprets firm size and market to book as determinants of the stock/firm development. Combining the results of those studies we suspect there might be a relation between those variables and the valuation error obtained from our investigation, particularly if investors suffer from being overly optimistic, and pessimistic, as suggested by De Bondt and Thaler (1985). An over optimistic market could exaggerate the information built in those variables and cause the stock price to further deviate from its fundamental value. To connect to valuation theory, by assuming that a high (low) market to book ratio is a sign of over (under) valuation, should lead to valuation models under (over) valuing companies with a high (low) market to book ratio, since multiple valuation models do not take this variable into account.

Anagnostopoulou (2008) provides a review on R&D and its relation to firm valuation. According to her review, there have been two arguments proposed by the literature regarding the positive relation between R&D expenditure and subsequent market performance. Either, there is an increased risk due to R&D expenditure for which investors require a higher return or there is a mispricing mechanism buried (Chan et al, 2001). A number of studies have investigated which one (risk compensation or mispricing) bears the explanation. Chambers et al (2002) provide findings supporting the risk compensation explanation by investigating how

investors interpret increased R&D spending. Do investors "see through" a decrease in profits due to increased R&D spending, or do they simply view decreased profits as a deterioration of the operations. According to the results, an increased return is experienced, and persistent, after increases in R&D which would point towards risk compensation. Nevertheless, they cannot rule out the mispricing mechanism completely. Eberhart et al (2004) provide additional support for this finding, however they conclude that the market reacts slowly to increased R&D spending and that the mispricing that occurs in the beginning gradually fades away. Lev et al (2005) provides contradictory evidence. They report systematic overvaluation for firms that capitalize their R&D, which yields less impact on the profitability since the asset is amortized. For firms that expense their R&D, which affects profitability measures to a greater extent, systematic undervaluation is reported. These results suggest mispricing due to over interpretation of profitability measures by the market. Even though the relation is not entirely clear in prior research, we intend to test if R&D could help explain our valuation errors.

2.5 Comments on prior research

To summarize this quite extensive section we would like to further discuss our expectations of the results. Kaplan and Ruback (1995) obtained a valuation error of (-)16,6 % for their multiples method using EV/EBITDA, while Lie and Lie (2002) obtained a valuation error of (-)11,9 % using the same multiple. This suggests either an increased use of the multiples approach when valuing companies or an increased efficiency in the markets, at least with regards to the US market. We expect a similar result to Lie and Lie (2002) considering that the Nordic markets lies within countries with a similar development standard to the US. However, we do expect the results to vary on a long and a short-term basis with larger deviations in the short run which are smoothed out in the long run. This expectation comes from the quite convincing results of mean reversion in stock returns combined with previous results of multiples yielding quite good corporate value estimates. Regarding error determinants, we highly suspect a connection between the valuation errors and one or more of the independent variables, in particular the market to book ratio, which has been given much attention from academics in relation to mispricing. Having summarized the theoretical background, we move over to describing the methodology from which we will obtain estimates of corporate value and tests to proper evaluate the error determinants.

3 Method

In this section we begin by shortly describing the theoretical research approach, followed by the multiple estimation methodology from which we will obtain estimations of corporate value. Finally, we describe the econometric approach used when testing for error determinants.

3.1 Research approach

According to Bryman and Bell (2007) a quantitative method is a research approach that emphasizes quantification in regards to gathering data and performing analysis on the gathered data. The other alternative, qualitative, instead stresses the importance of words. Valuing companies using historical multiple data is a clear example of a quantitative approach were the gathering of data as well as the analysis emphasizes quantification. Our data set consists of historical observations on e.g. EBITDA, EBIT and Enterprise Value. Furthermore, the study originates from a deductive theory where our aim to test valuation multiples is supported and, or, rejected by previous research. Earlier empirical studies conducted have yielded more or less different results and these results will be compared to obtained results from our empirical investigation. Hypothesizes the investigation wishes to answer has to do with the accuracy of valuation methods and whether the valuation errors can be explained by a set of variables. These hypothesizes are derived both from literature and from earlier research. Previous studies regarding multiples have only used a one year estimation period while this study uses a five year estimation period for each observation. This way, the result will mirror not only the present state of the company, but also its development during the last five years creating a more comprehensive view on the multiples used.

3.2 Estimating corporate value

In this investigation the following multiples will be used:

Entity multiples:	**Equity multiples:**
Enterprise Value/EBIT	Stock Price/EBIT
Enterprise Value/EBITDA	Stock Price /EBITDA
Enterprise Value /Sales	Stock Price /Sales
Enterprise Value /Total assets	Stock Price /Total Assets
Enterprise Value/Earnings (Net income)	Stock Price /Earnings (Net income)

Baker and Ruback (1999) discuss three implementation problems with the multiples technique when valuing an individual company. First of all, the appropriate multiple should be chosen. For instance using EBITDA to EV instead of EBIT makes the model more cash flow like. Further, as Schreiner (2007) discussed, are you looking at the company from an equity or entity holder's perspective? Second, should the average or median multiple be used in the estimations? In this thesis both will be used for comparison. The third issue is the choice of comparables and in this thesis the NASDAQ OMX Nordics own classification will be used. This is in line with recommendations from Eberhart (2004) that argues in favor of large market making institutions industry classifications.

First, an average and median multiple for each industry is calculated using the previous five years (time t-1 to t-5) as estimation period, yielding industry multiple at time t. The industry multiples are then multiplied with the denominator at time t for each multiple which gives the estimate for corporate value (equity or entity) at time t. Our total sample period is 17 years, where the first five years only functions as estimation period for the sixth year. After that, a rolling window including six years is used, i.e. five years estimation period and one year for comparison, creating twelve comparison years (2000-2011). As the reader can observe, the same approach as used in previous studies, for instance Lie and Lie (2002), is used. However, previous researchers have only used one year as their estimation period. We include five years of historical data for every observation which should give us more information about the evolution for the firm, as well as the markets interpretation of the multiple. Our estimations of corporate value will be compared to the quoted stock price/enterprise value, i.e. stock price for equity multiples and enterprise value for entity multiples.

The comparison will be carried out by calculating the valuation error by applying the same formula as Eberhart (2004) and Lie and Lie (2002) did, namely to take the natural logarithm of the ratio of the estimated value and the market value;

$$Valuation\ Error = \ln\left(\frac{EV*}{EV}\right) \qquad \textit{(Formula 1.1)}$$

When all estimations of corporate value on an individual firm level for each multiple is obtained, the last step is to calculate an average valuation error for industry overall, followed

by an average for all industries, again for each multiple. Those average valuation errors will serve as our estimates of valuation accuracy for each multiple.

In order for us to really assess the adequacy of the multiples valuation accuracy, a comparison to other models must be performed. Kaplan and Ruback (1995) compared their estimations with results obtained from option pricing models, while we in turn will compare our valuation accuracy to their estimates. Being published in a highly venerable Journal as the Journal of Finance, we argue that their study make out a good benchmark for us when assessing whether our model creates adequate value estimations.

3.3 Error determinants

In excess of the accuracy investigation, we will also try to find the underlying causes for the valuation errors. This will be done by building a regression model in EViews, where the valuation error for each multiple work as the dependent variable, and the independent variables derived from the theoretical framework will be the following:

- ln(Total assets) *($X_{1,i}$)*
- Market/Book *($X_{2,i}$)*
- Volatility *($X_{3,i}$)*
- R&D intensity *($X_{4,i}$)*

This will lead us to the following expression:

$$valuation\ error_{it} = \alpha + \beta_1 * X_{1,it} + \beta_2 * X_{2,it} + \beta_3 * X_{3,it} + \beta_4 * X_{4,it} + u_{it}$$

When analyzing error terms, one can chose between using the actual obtained errors, absolute errors or squared errors. Since we are interested in which direction the variables affect the valuation errors, i.e. under/overvaluation, we will use the actual obtained errors.

The interpretation of a panel data model does not differ from any other model, however, when working with panel data it is likely that the error terms vary both cross-sectionally and over time. When testing our equations, one single, pooled regression on all the observations together is performed. Basically this implies that we drop the time subscript from the original equation and pretend that it is a cross-sectional regression. This is the simplest way to perform analysis on the data, however this approach has some limitations. When pooling the data, one

assumes that the average, in our case valuation error, and the relationship between the valuations errors are constant, both over time as well as across all the companies. This is of course not optimal and often not the case when working with real life data. However, the limitations when pooling the data are outweighed by the advantages. First, it is possible to deal with a wider range of issues and one are able to analyze more complex problems, using panel data then would be possible with ordinary data, which most of the time presents information for a number of entities for a single year, or for one entity for multiple years. Secondly, it could be interesting to analyze how the variables and the relationship between the dependent variable and the independent variables changes over time. Third, if one is able to structure the data and the model appropriate, you will be able to remove any unwanted impacts biasing the regression results (Brooks, 2008).

3.4 Correctly specified model

When analyzing the result, one must take into consideration if the data set is finalized after running the pooled regression, or if one should use either the fixed or the random effects models, or neither. Using fixed effects, is basically the same as introducing a different intercept terms for each cross sectional unit (in our case each company). An alternative to the fixed effects model is to use the random effects model (Brooks, 2008).

When deciding whether to use the fixed effects model or the random effects model one have to perform two tests. First, we run the pooled regression and then change the setting to fit the fixed effects model. In order to check if the fixed effects model is correctly specified, we have to perform a redundant fixed effects test. If the p-value regarding the F-test is $< 0,05$ we can conclude that there is significant heterogeneity and that the pooled regression is miss specified, which tells us that the fixed effects model is preferred. However, if the Hausman specification test for the random effects model shows that the random effects model is well specified, then this is the proper model to use. If the p-value is $> 0,05$ when performing the Hausman test, it implies that we cannot reject the null hypothesis of the model being well specified, which is why the random effects model is preferred (Brooks, 2008).

3.5 Diagnostic testing

When we have checked which model that is the proper one to use, there are different diagnostic test that are relevant to perform when working with panel data. After we settle for one model we first have to check if we have heteroscedasticity in our sample. This is done

using the residuals from each regression and test if the squared residuals are dependent of the independent variables, used in the original regression. If the F-test is significant we have to use standard errors on the regression, otherwise no adjustments have to be done to the data set. Before deciding which one of the eight available standard error transformations we shall use, we have to check if the residual regression shall be evaluated as a cross-section and/or fixed effects model. This test is performed in the same way as when testing which model that is the most accurate for our valuation errors, but this time you change the specification for the regression regarding the squared residuals as dependent and the independents from the original regression. After deciding for the "right" model, we re-specify the original regression and change the specification to either use White period or White cross-sectional standard errors. Furthermore, a non-normality test has to be performed, which is done by checking for normality within the residuals. If the residuals have the pattern of non-normality one could either delete possible outliers that possibly cause the rejection of normality or, if the sample is large enough, as in our case, ignore the problem. Ignoring the problem is possible since even if the test statistics shows pattern of non-normality, the financial data will still, at least, asymptotically follow the desired distribution of normality. Last, we have to check for multicollinearity within the sample. This test is done by setting up a correlation matrix of the independent variables. If the correlation between two or more independent variables is > 0,80 we have problem with multicollinearity. The problem with multicollinearity is that we will get a biased result. Possible modifications we will concern if the problem occurs, is either to ignore it, drop one of the collinear variables, or transform the highly correlated variables into ratios (Brooks, 2008).

Testing if we shall use the pooled regression, fixed effects model or the random effects model is done for each multiple, making it a total of ten different regressions. Furthermore, the diagnostic tests are of course performed on each regression, and any changes in the originally specified model are done according to the text above, if necessary.

3.6 Data

The data used in the investigation is collected from Thomson Reuters DataStream, and there will be data ranging from 1995-2011, leading to an investigation in total of 12 years (the first five years is used to calculate the historical multiples). Since the data consist of both time series and cross-sectional element, i.e. data for a number of companies for a multiple of years,

the data set is thereby known as Panel Data. The characteristics of such data are that it provides information for both time and space (Brooks, 2008).

The data set is collected data from the NASDAQ OMX Nordic Large Cap, holding in total 108 listed companies. Due to lack of data in some cases and because Swedish companies are allowed to use different share classes, the original sample is narrowed down to 91 companies. In order to be able to make any comparisons, a classification for each sector (9 in total) is done. The tenth sector is excluded due to lack of data, though there only where one single company in the entire sector. Furthermore, Eberhart (2004) provides evidence of major market institutions industry classification being the most accurate industry classification when using the multiples valuation approach.

3.7 Methodological discussion

In this discussion will apply the concepts of reliability and validity on our study in order to view the study from a critical point of view. Validity refers to the methodological way in which the measurements, in our case the valuation accuracy and the error determinants, are obtained and how well this measurement corresponds with theory. Reliability stresses the stability and repeatability of the obtained results and is of great importance for a quantitative study (Bryman and Bell, 2007).

3.7.1Validity

The measurement regarding valuation accuracy has been used before by several researchers all published in highly reputable journals, suggesting that the measurement conceptualizes valuation accuracy very well. With regards to external validity, i.e. can our results be generalized beyond the specific research context (Bryman and Bell, 2007), we do believe that our results can be generalized to the entire Nordic market even though our sample consists of companies listed on Large Cap. This belief originates from Large Cap being the most liquid market, indicating that it reflects the behavior and interpretations from Nordic investors. However, our results may not be applicable to for instance the entire Europe region. Internal validity can mainly be applied on or regressions, i.e. if x causes y, can we be sure that this relationship is not a spurious one (Bryman and Bell, 2007)? Because of no multicollinearity concerning our independent variables combined with the strong significance of our results, we believe that our study carries a high internal validity.

3.7.2 Reliability

Being a quantitative study, reliability is highly related to our data set and the way the data set is handled and analyzed. Our procedure of data collection is clear, having used a highly credible source (DataStream) to gather information needed to measure valuation accuracy as well as data needed to test for error determinants. The decision of excluding companies listed on the NASDAQ OMX Nordic Large Cap is only related to lack of data. If one were to repeat the study, we are convinced that the repeater would end up with the same data set, and hence obtain the same result using the same methodology. However, extending our study to include companies listed on also Mid and Small Cap could cause the results to change considering those markets are less liquid. We choose to use Large Cap due to lack of data on both Mid and Small Cap available in DataStream, as well as because of the belief that Large Cap make out a good representation of investor behavior on the Nordic market as a whole. The choice of going with the OMX industry classification was made due to support of large market institutions classifications being the proper ones to use in multiple valuations (Eberhart, 2004). Finally, perhaps the use of forward looking multiples could have enhanced the P/E multiples predictability as suggested by Lie and Lie (2002) but considering the large data sample we were unable to find sufficient amount of data to include forward looking multiples.

4 Empirical findings

In this section, our results regarding the valuation accuracy and error determinants will be presented. The results will be presented trough tables with associated texts explaining the contents of the tables. In addition, the results will be compared to previous studies and the comparisons will be further discussed in the analysis section.

4.1 Valuation accuracy

Beginning with the valuation accuracy (presented in table 1), the reader can observe that the accuracy and the tendency of the valuation error differ between using the average and the median multiple. Kaplan and Ruback (1995) obtained an average valuation error of (-)16,6 %, using median industry multiples of the EV/EBITDA. We obtain a valuation error of (-)12,02 % using the same multiple when using industry median. But, using the industry average yields an even lesser error (5,90 %) but on the other hand with a larger standard error. Using average multiples generally yields upward biasness in the results, while the opposite condition can be applied on median multiples. This result is supported by Lie and Lie (2002), who obtained the same results. Furthermore, median multiples generally yield more accurate results, considering both the valuation accuracy and the standard errors in the estimates. However, worth noting is that for the EV/EBIT and the EV/EBITDA multiples, which are closely related to the DCF methodology, using an average industry multiple outperforms using a median. This fact will be discussed further in the analysis. The remaining entity multiples yield relatively small valuation errors, but on the other hand, the standard error is larger. Regarding the equity (price) multiples, using the median multiple is always preferred because it provides more accurate results in all cases regarding both valuation accuracy and standard errors. Price/Earnings is the best performing multiple, both among equity multiples as well as overall, with a valuation error of (-)2,19 % and a standard error of 12 %. Price/Total assets, or market to book, yields a small valuation error of (-)2,9 % but with a large standard error of 47 %, implying a very unstable measure for corporate value. The remaining equity multiples all induce large valuation errors combined with large standard errors.

Table 1. Summary Statistics

n=91 (per multiple) t=12 years	Valuation error (Using average)	Valuation error (Using median)	
EV/EBIT	**-0,86 %**	-11,35 %	*Val. error*
	(24 %)	(10 %)	*Std. error*
P/EBIT	80,39 %	**-35,08 %**	
	(103 %)	(36 %)	
EV/EBITDA	**5,90 %**	-12,02 %	
	(28 %)	(18 %)	
P/EBITDA	70,40 %	**-24,77 %**	
	(94 %)	(52 %)	
EV/Sales	47,09 %	**4,92 %**	
	(54 %)	(29 %)	
P/Sales	116,07 %	**-14,65 %**	
	(88 %)	(36 %)	
EV/Total Assets	28,17 %	**5,77 %**	
	(23 %)	(23 %)	
P/Total Assets	124,54 %	**-2,90 %**	
	(85 %)	(47 %)	
EV/Earnings	101,90 %	**14,31 %**	
	(66 %)	(46 %)	
P/Earnings	38,39 %	**-2,19 %**	
	(30 %)	(12 %)	

Note: The error for each multiple is calculated as the average for all the industries combined, using both the average and the median to calculate the historical multiples, on which we base our projections on. To clarify, using the average industry multiple, EV/EBIT yields a valuation error of 0,86 % on average in relation to the actual quoted enterprise value over the time period 2000-2011. Furthermore, for each multiple, the best way to calculate the equity/entity multiple is highlighted in bold. For comparison between equity and entity multiples for each industry, see Appendix 3.

Table 2 presents an overview over which nominator, enterprise value or stock price that yields the most accurate results. In his dissertation, Schreiner (2007) concluded that equity multiples generally provide more accurate estimates. We provide contradictory results more in line with the theory of matching the nominator with the denominator, e.g. EV with EBIT(DA) and Price with Earnings, at least with regards to profitability multiples. Sales and Total assets can be viewed from both equity and an entity holder's perspective so the relationship is a little unclear.

Table 2. Comparison between equity value and entity value multiples

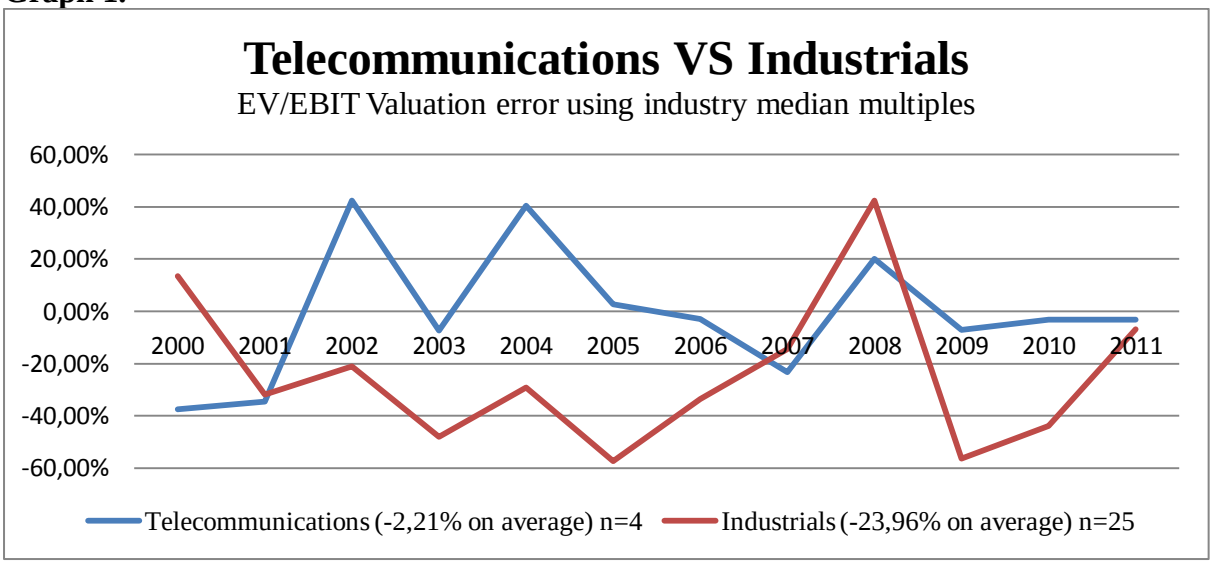
	Lowest absolute Valuation error (Using average)	Lowest absolute Valuation error (Using median)
X/EBIT	**EV**	**EV**
X/EBITDA	**EV**	**EV**
X/Sales	**EV**	**EV**
X/Total Assets	**EV**	**Price**
X/Earnings	**Price**	**Price**

Note: For comparison between equity and entity multiples for each industry, see Appendix 4.

4.1.1 Small versus large industries

Graph 1 displays the difference between the valuation error for the Telecommunication industry and the Industrials industry. As can be observed, the number of companies included in each comparables group when using NASDAQ OMX Nordics industry classification can vary a lot between groups. In our case, four companies are labeled Telecommunication and 25 companies are labeled Industrials.

Graph 1.



The first observation worth noting is the difference in average valuation error, where Telecommunications ((-)2,21 %) clearly have lower errors than Industrials ((-)23,96 %). This result implies a better accuracy for industries where there are fewer companies included. There are examples of the opposite relation in our sample, but overall this relation holds in

most cases as suggested by Schreiner (2007). Often this result is caused by companies in smaller industries being more alike, regarding the expected return and risk factor. To clarify, consider Industrials where companies can be involved in very different product areas where the future prospects can differ substantially, while in Telecommunications the comparable companies are involved in activities more reflecting the same future opportunities.

4.2 Error determinants

Having reported our results regarding valuation accuracy, we continue by first declaring the technical part of the econometrics used when testing the error determinants followed by the obtained results.

4.2.1Fixed effects VS random effects model and diagnostic testing

Regarding which model that is the proper one to use, we got the same result for all entity multiples, namely that we shall use the *period random effects model* in these regressions. For the equity multiples, the tests showed that the *cross-sectional random effects model* is the proper one to use for the equity multiples regressions. Furthermore, the error terms in the entity multiple regressions do not suffer from heteroscedasticity, while the error terms from all the equity multiple regressions do. To correct for heteroscedasticity, the Whites cross-sectional effects model, which use robust standard errors is used on the equity multiple regressions. All of the regressions showed pattern of non-normality, but as previous discussed, financial data asymptotically still follows the normal distribution and non-normality can thus be ignored. Finally, as can be observed in table 3, the correlation between our independent variables is very low, implying no multicollinearity within our data set. An important finding, since multicollinearity could lead to spurious regressions.

Table 3. Correlation between the independent variables

	ln(TA)	**M/B**	**Volatility**	**R&D**
ln(TA)	1,0000	-0,1167	-0,0030	0,1155
M/B	-0,1167	1,0000	0,0036	0,1580
Volatility	-0,0030	0,0036	1,0000	0,0797
R&D	0,1155	0,1580	0,0797	1,0000

Note: As can be seen in the table above, the variables are correlated ≤ 0.800, which implies that the data does not suffer from multicollinearity. When we removed the R&D variable, none significant differences were detected.

4.2.2 Results

As discussed in the theoretical background, we have derived a set of variables that are believed to have a connection with our valuation errors. Financial theory have, in different ways, established connection between stock returns/mispricing mechanisms and firm size, market to book ratio, volatility and R&D (Fama and French, 1992, Shiller, 1981 and Lev et al, 2005). Beginning with the R&D variable, when included in the original regression, the results showed that we lost many observations due to lack of data and it will therefore be excluded. In addition, when the variable was included in the original regression, it had no explanatory power to the valuation errors, or any affect on the other independent variables.

Table 4. Summary statistics (from the regression analysis for the R&D variable)

		C	**R&D**	
EV/EBIT		-0,0909	-0,0005	*Coefficient*
Period random effects		(0,0677)	(0,0126)	*Std. Error*
n=564	R^2*=0,0000*	0,180	0,968	*P-value*
EV/EBITDA		-0,0506	-0,0226	
Cross-section random effects		(0,1717)	(0,0196)	
n=571	R^2*=0,0024*	0,769	0,249	
EV/S		-0,1005	0,0086	
Cross-section random effects		(0,1735)	(0,0174)	
n=586	R^2*=0,0004*	0,563	0,620	
EV/TA		-0,2696	0,0438	
Cross-section random effects		(0,1695)	(0,0169)	
n=597	R^2*=0,0112*	0,112	0,169	
EV/E		0,1548	-0,0414	
		(0,1212)	(0,0182)	
n=526	R^2*=0,0001*	0,2022	0,2340	
P/EBIT		-0,4623	0,0388	
Period random effects		(0,0885)	(0,0163)	
n=563	R^2*=0,0000*	0,000	0,217	
P/EBITDA		-0,5148	0,0379	
Period random effects		(0,0872)	(0,0162)	
n=580	R^2*=0,0000*	0,000	0,157	
P/S		-0,4006	0,0119	
Cross-section random effects		(0,2110)	(0,0200)	
n=598	R^2*=0,0006*	0,058	0,544	
P/TA		-0,4992	0,0433	
Cross-section random effects		(0,2219)	(0,0213)	
n=598	R^2*=0,0069*	0,025	0,236	
P/E		0,0181	-0,0078	
Period random effects		(0,0990)	(0,0080)	
n=534	R^2*=0,0009*	0,855	0,320	

Note: To clarify for the reader, e.g. a negative coefficient indicates an increasing undervaluation as the coefficient increases, compared to the "true value", using the multiple valuation approach.

Table 4 shows summary statistics for the R&D variable when tested alone against the valuation errors. In all cases, the variable is insignificant implying no relationship between R&D and the obtained valuation errors. Furthermore, the sign of the coefficients is random when considering equity or entity multiples. Finally, the drop in number of observations can be observed as well as a very low R^2 value.

Table 5 (next page) shows the results from the regressions performed on the valuation errors, with firm size, market to book ratio and volatility as independent variables. The amount of observations differ slightly among the multiples but this is simply due lack of complete data sets in some cases. In general, one can observe that firm size and the market to book ratio has a significant impact on the valuation errors, in all cases except two for each variable. Considering this fact, we can assume that those two variables have explanatory power regarding the obtained valuation errors from using the multiples approach. Volatility is only significant in three cases, suggesting an overall low explanatory power. Furthermore, the coefficients for firm size and market to book ratio are negative for the entity multiples, suggesting that large firms and firms considered being growth firms will be undervalued using the multiple valuation approach. As for market to book, the relation is the same for equity multiples but instead, overvaluation is suggested for large firms.

Regarding the R^2, one can observe that it is relatively low as for many panel data regressions, but stable, for the multiples in general. Considering this fact, one has to take into account the idiosyncratic factor, which the multiples approach does not account for suggesting some errors are random. As stated before, the model assumes comparable companies to reflect the same expected return and risk, which in reality is not always the case. For instance, Industrials have larger errors due to more different business activities implying this comparable group should be narrowed down to include more similar companies.

Table 5. Summary statistics from the regression analysis

t= 12		C	ln(TA)	M/B	Volatility	
EV/EBIT		2,398	-0,149	-0,007	-4,462	*Coefficient*
Period random effects		(0,342)	(0,020)	(0,005)	(3,929)	*Std. Error*
n=892	R^2*=0,0605*	0,000	**0,000**	0,165	0,256	*P-value*
EV/EBITDA		2,567	-0,159	-0,009	-2,232	
Period random effects		(0,344)	(0,019)	(0,005)	(3,961)	
n=893	R^2*=0,0692*	0,000	**0,000**	**0,047**	0,573	
EV/S		2,053	-0,127	-0,012	7,564	
Period random effects		(0,352)	(0,020)	(0,005)	(3,187)	
n=945	R^2*=0,0495*	0,000	**0,000**	**0,020**	**0,018**	
EV/TA		0,619	-0,044	-0,017	11,554	
Period random effects		(0,324)	(0,019)	(0,005)	(2,927)	
n=952	R^2*=0,0338*	0,056	**0,018**	**0,000**	**0,000**	
EV/E		7,811	-0,467	-0,007	6,600	
		(0,831)	(0,049)	(0,005)	(2,445)	
n=848	R^2*=0,104*	0,000	**0,000**	0,191	**0,007**	
P/EBIT		-2,578	0,134	-0,010	-3,415	
Cross-section random effects		(1,196)	(0,078)	(0,003)	(5,746)	
n=895	R^2*=0,0211*	0,031	0,086	**0,001**	0,553	
P/EBITDA		-3,194	0,166	-0,011	-1,836	
Cross-section random effects		(1,278)	(0,080)	(0,004)	(4,726)	
n=904	R^2*=0,0292*	0,013	**0,037**	**0,007**	0,698	
P/S		-3,882	0,211	-0,014	3,514	
Cross-section random effects		(1,091)	(0,067)	(0,005)	(4,896)	
n=956	R^2*=0,0616*	0,000	**0,002**	**0,007**	0,473	
P/TA		-4,251	0,243	-0,015	6,412	
Cross-section random effects		(1,205)	(0,069)	(0,006)	(4,771)	
n=957	R^2*=0,0936*	0,000	**0,000**	**0,015**	0,179	
P/E		1,590	-0,099	-0,021	7,492	
Cross-section random effects		(1,186)	(0,081)	(0,006)	(6,962)	
n=853	R^2*=0,0356*	0,181	0,224	**0,001**	0,282	

Note: The highlighted p-values are for the significant variables, i.e. the variables that do affect the valuation errors (p-values < 5 %). To clarify for the reader, e.g. a negative coefficient on ln(TA) indicates an increasing undervaluation as the firm size increases, compared to the "true value", using the multiple valuation approach.

5 Analysis and discussion

This section will contain an analysis of our results beginning by an assessment of the valuation accuracy which is further put in relation to previous research, followed by an analysis of the error determinants which are discussed in relation to behavioral finance and mispricing.

5.1 Valuation accuracy

Considering the values in table 1, the median multiples generally yield more accurate results than do average. Nevertheless, in most cases they are negatively biased as also suggested by previous research (Lie and Lie, 2002). Furthermore, the average multiples consequently overvalue the company except in the EV/EBIT case. Using average multiples are also dismissed by previous research (Kaplan and Ruback, 1995, Lie and Lie, 2007 and Schreiner, 2007), a fact supported by our results since the valuation errors are larger than when using median multiples, along with higher standard errors. However, looking at EV/EBIT and EV/EBITDA, two popular and frequently used multiples in reality (Hernandez, 2002), the choice between average and median does not affect that much. Actually, using average multiples yield smaller valuation errors considering EV/EBIT and EV/EBITDA according to our data set. But, it is worth observing the considerably larger standard error for the average multiples suggesting median estimations to be more reliable.

Schreiner (2007) provided evidence of equity multiples being superior to entity multiples in all cases, even though theory suggest entity multiples to be superior when a value driver defined at an entity holders level serve as denominator, e.g. EBITDA. Our empirical findings instead support theory. For instance P/EBITDA, which according to Schreiner performs better than EV/EBITDA, has a valuation error of (-)24,77 % with a standard error of 52 % which is far worse than our EV/EBITDA estimate of (-)12,02 % with a standard error of 18 %. Taking into account the theoretical motivation our results are more intuitive. However P/E, our overall best performing multiple with a low valuation error as well as standard error, support findings from e.g. Alford (1992) that equity multiples, when correctly defined, provide more accurate estimations of corporate value than entity multiples. But, when performing a valuation one must bear in mind the motivation for the valuation, i.e. do you need an estimation of enterprise value (entity) or an estimation of share price (equity), and use a multiple which reflects the motive even though another multiple yield a more accurate

estimate. So, when you need an estimation of equity value, use for instance Price/Earnings where earnings account for profits attributable to equity holders.

Regarding the overall result for the multiple valuation technique, our results are quite similar to those of Kaplan and Ruback (1995) and Lie and Lie (2002), which are our benchmark studies. As mentioned, Kaplan and Ruback (1995) obtained a valuation error of (-)16,2 % using EV/EBITDA and median multiples while Lie and Lie (2002) obtained a valuation error of (-)11,9 %. Using the same valuation method, we obtain a valuation error of (-)12,02 % for the EV/EBITDA multiple. Furthermore, comparing our results for EV/EBIT with Lie and Lie (2002) our results are more accurate with a valuation error of (-)11,35 % compared to (-)13,5 %. To summarize, according to both our and Lie and Lie (2002) EV/EBIT and EV/EBITDA have a similar valuation accuracy and both are better than Kaplan and Ruback (1995). Moreover, According to Lie and Lie (2002), EV/EBITDA is preferred over EV/EBIT while our results suggest the opposite. However, the difference is very small making it hard to actually point out an overall preferred multiple between the two entity multiples.

When discussing the remaining multiples, only median multiples will be considered because the average multiples carry very large valuation errors (as well as large standard errors for the estimates). Among the remaining multiples, a few things are worth discussing. Regarding the asset multiples, i.e. EV/Total assets and P/Total assets, both yield small valuation errors. Lie and Lie (2002) concluded that asset multiples generate more precise and less biased estimates than both sales and earnings multiples, particularly for large companies. In the case of entity multiples, we obtain the same relation between asset and earnings multiples. However, EV/Sales posses less valuation error compared to EV/Total assets but carry a higher standard error indicating a quite similar performance for those two multiples. Since our sample consists of companies from NASDAQ OMX Nordic Large Cap, in general, we provide support of the finding of asset multiples performing well for large companies regarding entity multiples. For equity multiples, the same relation is hard to establish due to very large standard error of 47 % for the asset multiple. Finally, regarding the earnings multiples, where the equity multiple is frequently used in reality (Hernandez, 2002), we obtain a small valuation error of (-)2,19 % with a low standard error of 12 %. This result is also supported by Lie and Lie (2002), who obtained their most accurate corporate value estimate from the P/E multiple ((-)5,8 %). Again, we can highlight the importance of correctly defining the multiple on an equity/entity level,

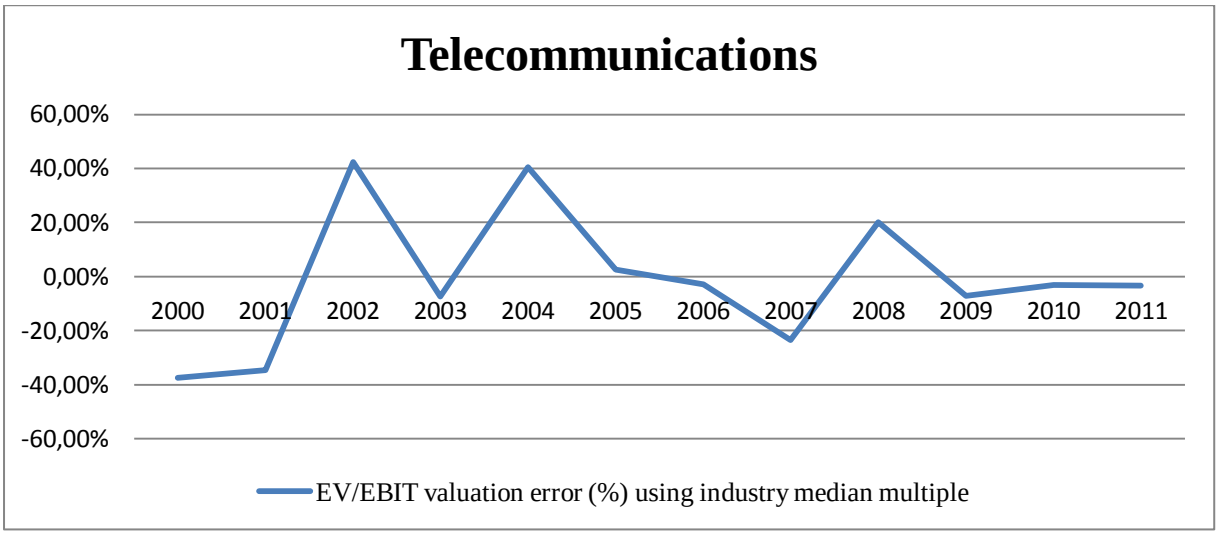
with a large valuation error (combined with a high standard error) when using a measure of entity value in relation to profits on an equity level (EV/Earnings).

5.1.1 Multiples versus the DCF

Kaplan and Rubacks (1995) original intention is to test the valuation accuracy of the DCF using it to estimate takeover value, i.e. entity value, while EV/EBITDA is included because of this multiples close relation to the DCF through its cash flow nature. On average, their valuation error for the DCF is 8,0 % when using the firm beta in the WACC compared to (-)16,6 % using the multiple approach. Even though our valuation error using average multiples outperforms both the DCF and their EV/EBITDA result we will apply our median estimates when comparing, because of the large support for median multiples in theory (Kaplan and Ruback, 1995, Lie and Lie, 2002 and Schreiner, 2007). Considering our median multiples, we obtain lower valuation errors with our EV/EBITDA estimate ((-)12,02 %) although it is still higher than their DCF valuation error, implying that the DCF is superior. A possible reason for this could be the DCFs more thorough consideration of the firm's capital structure through the WACC. While the multiples approach possess a built in discount factor regarding the comparable groups' risk, the DCF also accounts for idiosyncratic risk factors. Sure, Price/Earnings do produce a lower valuation error than the DCF, but since Kaplan and Ruback (1995) use the DCF to measure takeover (entity) value the comparison here is not entirely fair.

5.1.2 Long versus short-term accuracy

Graph 2.



In graph 2 the reader can observe a graph over the valuation accuracy for the Telecommunications industry regarding the EV/EBIT multiple. As can be seen, the valuation accuracy varies between being negative and positive as well as large and small over the time period. The multiple valuation technique is supposed to reflect contemporaneous market expectations (Kaplan and Ruback, 1995). If this was the case, combined with a *fully* efficient market, the valuation error obtained by our model would be close to zero. By viewing graph 2 the reader can immediately observe that this is not the case which brings us to the theory of efficient markets and mispricing. In the theoretical background, market efficiency both on a long-term and a short-term basis is addressed. Fama (1998) argues that the market is still efficient and he is supported by Schwert (1998) and Malkiel (2003). Furthermore, Poterba and Summers (1998) argue that stock returns, and thereby also the stock price, are mean reverting on a long-term basis. However, they all state that deviations from the fundamental stock price occur on a short-term basis, perhaps occurring from investors' over/under reacting to news (De Bondt and Thaler, 1985) or by excessive transaction costs (Schleifer, 2000). Another explanation was provided by Sadka and Scherbina (2007), pointing out analyst disagreements and the liquidity factor. So, what do our valuation errors actually stem from? Does it stem from an inefficient market and mispricing mechanisms, or from the multiple valuation technique being a "poor" valuation method? Considering the average valuation error for the Telecommunications industry, which amounts to (-)2,21 %, actually a "good" valuation accuracy, one could argue for an efficient market, at least on a long-term basis. Further, you could argue that the valuation errors in the short run are caused by for instance, investor over/under reacting, transaction costs or liquidity. Considering the fact that the Nordic stock market probably is less liquid and carry more transaction costs than the US stock market, this could be a highly valid argument in our case. Even though we experience some large short-term valuation errors, could the multiples approach be a good valuation tool? Kaplan and Ruback (1995) concluded that their DCF model performed relatively well and where satisfied with an estimation error of 8,0 %. In addition, they use a performance measure that considers the fraction with a valuation error less than 15 %, implying that value estimations with a valuation error less than, or equal to, 15 % is satisfying. So, if we assume that a valuation error of fifteen percent on average is a good performance, eight out of ten multiples (using industry median) actually perform in a satisfying manner. Furthermore, as discussed in relation to graph 1, perhaps one could further strengthen the predictability in individual cases by narrowing down large comparables groups where the characteristics differ. At last, by establishing a connection between the valuation errors and particular variables, one could

perhaps further enhance the models predictability by somehow taking those variables into account leading us to the investigation of error determinants.

5.2 Error determinants

From the mispricing theory, we derived a set of variables that is believed to have connection to the valuation errors. According to previous research, firm size, market to book ratio and R&D are suspected of causing over interpretation and mispricing (Fama and French, 1992, Barber and Lyon, 1997 Bloomfield and Michaely, 2004 and Lev et al, 2005). In addition, excess volatility is one of the main arguments against the market efficiency hypothesis (Shiller, 1981) which is why we chose to also include this variable. Considering the results in table 5 one can observe that firm size and market to book ratio are significant in the vast majority of cases, implying there is a relation between those variables and the valuation errors. As discussed in the empirical findings section, R&D is excluded from the main regression due to lack of data, and when it was included it had no significant affect on either the obtained results or on the other independent variables. Considering the lack of significance, R&D does not help explain the mispricing in relation to our valuation method, adding some support for the risk compensation theory evidence provided by Chambers et al (2002). With regards to the volatility variable and its insignificance in all but three cases and this result is interpreted in the following way: increasing or decreasing volatility does not affect the valuation error with regards to under/overvaluation compared to the quoted enterprise value/stock price.

Returning to the variables that do have a connection to the valuation errors beginning with firm size, a few interesting interpretations can be made. Before starting to analyze the results we want to make one thing clear: the results can be assessed either assuming the multiples approach being the “true” corporate value or by assuming that the market value is the “true” corporate value. For the entity multiples and the P/E multiple, increasing firm size causes increasing undervaluation by using the (our) multiples approach when assuming the market value is “true”. But, according to Bloomfield and Michaely (2004), analysts believe large firms carry less risk, implying a lower required return. This could be connected to the systematic undervaluation of large firms for our entity multiples and the P/E multiple, implying that the (our) multiples approach underestimate the risk for large firms. Or, you accept the view from the *senior analysts* in Bloomfield and Michaely (2004) who believe that the market systematically overvalue large firms, implying the multiples approach to yield the

"true value". For the equity multiples, the relation are the opposite i.e. increasing firm size causes increasing overvaluation when assuming the market value is "true". So, one could apply the exact opposite relation between valuation error and firm size regarding equity multiples.

The market to book ratio has a negative sign and is significant in all but two cases suggesting a systematic undervaluation for firms with a high market to book ratio, according to the (our) multiples method. According to Bloomfield and Michaely (2004) analysts view market to book ratio to be a sign of mispricing and risk, a view we provide additional support to. However, their sample of analysts regard a high market to book ratio to be a sign of overvaluation, while our result suggest a high market to book ratio to be a sign of undervaluation. This result can be interpreted in different ways. Either you assume the quoted enterprise value/stock price to be the true value leading to the multiples approach systematically undervaluing firms with high market to book ratio. Hence, multiples underestimate growth firms' ability to create value. Or, you assume the multiples estimate to be the true value and thereby support the theory of high market to book ratio firms being overvalued by the markets.

If we further assume that investors overreact according to De Bondt and Thaler (1985), one could raise an argument of the multiples approach being the true value. Yes, a large part of the valuation errors are random, probably for idiosyncratic reasons, but we do provide evidence that mispricing variables cause our estimations to deviate from the market value. This indicates that the market consequently do overreact to information built in the variables firm size and market to book ratio. Combining this with the overall long-term accuracy of the multiples approach the argument is further strengthened. However, regardless of what you assume is the "true" value, by using our established conjunction between firm size/market to book ratio and valuation errors obtained from the multiples approach, one could get closer to the market value of equity/entity value by somehow accounting for the effects caused by the variables.

6 Conclusions and further research

This section concludes by discussing the empirical findings and the analysis followed by recommendations for further research.

6.1 Conclusion

This thesis has three hypothesizes to answer. First, investigating whether the multiples valuation technique provides estimations of corporate value in line with the DCF, which is a widely accepted valuation methodology among economists. Second, if the performance differs between multiples defined at an equity holder and an entity holder's perspective. Third, if the miss valuations can be explained by a set of variables derived from the market efficiency and mispricing theory.

Beginning with our first hypothesis, we compare our results with two standards. Kaplan and Ruback (1995) obtained an average valuation error of 8.0 % using the DCF. In addition, they use a performance measure where the fraction with a valuation error less than or equal to 15 % is considered. Combining those standards, and our obtained valuation errors along with standard errors, the multiples approach do yield relatively good estimates of corporate value compared to the DCF, since eight out of ten multiples has a valuation error less than 15 % on a long-term basis (using industry medians). Four of the multiples actually outperform the DCF, while four lies between 8 and 15 %. However, for EV/EBITDA which is the closest related multiple to the DCF, the DCF perform better estimates of entity value.

Moving on to our second hypothesis, the equity multiple P/E provides the best estimate of firm value taking both the valuation error and standard error into account supporting earlier studies conclusion regarding superiority of equity multiples, when correctly defined. However, when considering for instance a complete takeover where the purchaser is interested in both equity and debt holder claims, EV/EBIT(DA) should be used considering the low valuation errors and stability within the estimates. As stated before, when performing multiple valuations it is important to match the nominator with the denominator according to the equity holder versus entity holder argument, an argument supported by our findings.

Finally, we find significant conjunctions between firm size/market to book ratio and our obtained valuation errors in all cases but two for each variable, suggesting a strong connection

between these two variables and mispricing occurring when using the multiples valuation technique.

Putting our results into a greater context, we believe that our study could have implications for the way the multiples valuation approach is viewed on, and applied, in the Nordic market. First, we provide support to Lie and Lie (2002) study in the US market, by establishing similar results to the Nordic market, a comparable market to the US since it lies within countries with similar development standards. Moreover, this implies a similar application of the model in the Nordic market as in the US market.

At last, regarding the error determinants, the performance of the model could be enhanced by in some way accounting for the affect caused by those variables. Considering this fact, we believe that we have contributed to the understanding of multiples valuation by connecting the market efficiency theory and mispricing mechanisms to valuation theory.

6.2 Further research

As we see it, the most obvious suggestion for further research is to build on our findings of mispricing variables being connected to valuation errors caused by the model. Perhaps there could be more variables that we have not included that are connected to the valuation errors, and if there are, one could further contribute to the understanding of multiples valuation. Furthermore, this relation is only established on the Nordic market and to perform a similar study on the US market would be very interesting in order to support/reject our findings. As mentioned in the conclusion, there should be a way of enhancing the models performance with regards to forecasting future corporate value by somehow accounting for the effects caused by firm size and market to book ratio. So, a recommendation would be to find a model that somehow account for these effects.

One could also build on our investigation with regards to the data set, by including companies also listed on Mid and Small Cap. However, we believe this task would take a considerable amount of time concerning the data gathering as well as have limited affect on the results because of the Large Cap probably being a good representative for the Nordic market.

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Data sources

Thomson Reuters DataStream

Appendices

Appendix 1.List of contractions regarding branch classification

BM	Basic Materials
CG	Consumer Goods
CS	Consumer Services
Fin	Financials
HC	Health Care
Ind	Industrials
OG	Oil & Gas
TC	Telecommunications
Tech	Technology
Uti	Utilities *(excluded due to lack of sufficient number of companies)*

Appendix 2. Excluded firms (n=14)

Basic Materials:	Lunding Mining and Semafo
Consumer Goods	Autoliv
Consumer Services	Hennes & Mauritz
Financials:	Old Mutual and Wallenstam
Health Care:	AstraZeneca and Pfizer
Industrials:	ABB, D/S Norden, G4S and YIT Oyj
Oil & Gas:	*None*
Telecommunications:	Millicom
Technology:	*None*
Utilities:	Fortum Oyj

Appendix 3. Comparison within each industry

Valuation Error (n=91)	EV/EBIT		EV/EBITDA		EV/Sales		EV/Total Assets		EV/E	
	Average	Median	Average	Median	Average	Median	Average	Median	Average	Median
BM (n=7)	5,28%	-26,37%	10,97%	-14,03%	24,24%	0,88%	4,78%	0,10%	59,00%	-5,90%
CG (n=11)	-3,45%	-8,11%	-3,41%	-12,21%	-0,70%	-39,69%	-3,80%	-25,31%	85,29%	10,53%
CS (n=6)	14,58%	-11,85%	47,23%	-3,64%	70,77%	-6,10%	54,33%	5,41%	25,14%	-25,74%
Fin (n=22)	28,05%	-3,69%	20,41%	-2,84%	29,59%	27,01%	24,75%	20,13%	244,86%	-31,35%
HC (n=10)	-22,12%	-0,33%	14,71%	-0,10%	16,61%	5,26%	30,87%	9,69%	58,03%	-8,74%
Ind (n=25)	-4,30%	-23,96%	-2,07%	-28,90%	22,34%	-36,79%	9,63%	-32,41%	127,98%	19,25%
OG (n=4)	-47,86%	-21,80%	-54,02%	-7,26%	178,43%	34,34%	48,60%	21,66%	58,41%	2,28%
TC (n=4)	-4,91%	-2,21%	-4,32%	-50,86%	27,16%	23,52%	21,05%	11,02%	112,94%	47,83%
Tech (n=3)	27,02%	-3,80%	23,56%	11,67%	55,34%	35,88%	63,31%	41,60%	145,46%	120,59%
Average	-0,86%	-11,35%	5,90%	-12,02%	47,09%	4,92%	28,17%	5,77%	101,90%	14,31%
Median	-3,45%	-8,11%	10,97%	-7,26%	27,16%	5,26%	24,75%	9,69%	85,29%	2,28%

Pricing Error (n=91)	P/EBIT		P/EBITDA		P/Sales		P/Total Assets		P/E	
	Average	Median	Average	Median	Average	Median	Average	Median	Average	Median
BM (n=7)	38,09%	-23,22%	33,40%	-29,28%	66,92%	-19,10%	52,22%	-6,79%	8,69%	-19,15%
CG (n=11)	44,01%	-50,46%	59,17%	-42,19%	58,76%	-25,35%	176,95%	-41,07%	28,97%	-17,36%
CS (n=6)	37,96%	4,48%	34,39%	17,60%	50,88%	9,35%	41,80%	25,14%	18,01%	-13,09%
Fin (n=22)	103,65%	-8,22%	71,50%	-8,19%	73,76%	5,87%	106,72%	61,90%	61,04%	3,26%
HC (n=10)	-18,25%	-7,36%	63,13%	-3,51%	46,18%	-10,35%	80,95%	-6,74%	17,53%	-0,78%
Ind (n=25)	111,82%	-73,35%	73,30%	-110,77%	203,11%	-90,79%	147,79%	-77,02%	41,68%	15,38%
OG (n=4)	19,60%	-15,17%	-75,27%	-7,99%	184,09%	10,51%	119,52%	34,28%	40,48%	0,34%
TC (n=4)	51,30%	-35,35%	89,81%	54,51%	67,71%	28,54%	76,12%	36,47%	106,22%	-1,44%
Tech (n=3)	335,31%	-107,06%	284,16%	-93,11%	293,26%	-40,57%	318,80%	-52,23%	22,88%	13,11%
Average	80,39%	-35,08%	70,40%	-24,77%	116,07%	-14,65%	124,54%	-2,90%	38,39%	-2,19%
Median	44,01%	-23,22%	63,13%	-8,19%	67,71%	-10,35%	106,72%	-6,74%	28,97%	-0,78%

Appendix 4. Which multiples is best within each industry

Lowest |Valuation| Error (n=91)	X/EBIT		X/EBITDA		X/Sales		X/Total Assets	
	Average	Median	Average	Median	Average	Median	Average	Median
BM (n=7)	EV	Price	EV	EV	EV	EV	EV	EV
CG (n=11)	EV	EV	EV	EV	EV	Price	EV	EV
CS (n=6)	EV	Price	Price	EV	Price	EV	Price	EV
Fin (n=22)	EV	EV	EV	EV	EV	Price	EV	EV
HC (n=10)	Price	EV	EV	EV	EV	EV	EV	Price
Ind (n=25)	EV	EV	EV	EV	EV	EV	EV	EV
OG (n=4)	Price	Price	EV	EV	EV	Price	EV	EV
TC (n=4)	EV	EV	EV	EV	EV	EV	EV	EV
Tech (n=3)	EV	EV	EV	EV	EV	EV	EV	EV
Average	EV	EV	EV	EV	EV	EV	EV	Price
Median	EV	EV	EV	EV	EV	EV	EV	EV