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The Effectiveness of Relative Valuation for Firms with Negative Earnings in an IPO Context

BENJAMIN RECKNAGEL
40720@student.hhs.se

PAUL VAN DER HOEK
40755@student.hhs.se

Abstract

This paper analyzes a sample of 246 US initial public offerings (IPOs) from 2013 to 2015 containing solely negative earnings firms. The goal is to investigate the effectiveness of relative valuation for loss making firms in an IPO context and comment on whether the results are similar to those recorded for profit making firms in previous studies. This is most relevant, as recent decades have seen a rise in IPO activity along with a change in firm characteristics of newly listed firms. More specifically, an increasing number of companies featuring negative earnings have been able to access the public equity markets. While IPOs are most commonly valued through relative valuation, the effectiveness of multiple valuation for loss making firms has largely been excluded from the existing literature. This paper attempts to fill this research gap. Our results show that overall multiple valuations are similarly effective for loss making as for profit making firms in an IPO setting. In line with relative valuation for positive earnings firms, forward looking multiples outperform trailing multiples for negative earnings firms. Nevertheless, we also find that several widely used multiples, such as the P/E, the M/B and the EV/EBIT multiple, perform poorly across our entire sample. Furthermore, valuation accuracy varies with certain firm types and industries. While the effectiveness is similar to that for profit making firms in an IPO context, the overall valuation accuracy of multiples is relatively low, indicating that within an IPO setting relative valuation should be complemented with other valuation methods.

Keywords: valuation accuracy, relative valuation, multiples, IPO, negative earnings
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1. Introduction

Comparable company valuation, also referred to as relative or multiple valuation, is among the most commonly used valuation methods for firms entering the world's public equity markets through initial public offerings (IPO). With as many as 63% of US IPOs between 2013 and 2015 featuring firms with negative earnings[1], the issue of applying multiple valuation to loss making firms becomes more and more prominent. Nevertheless, the existing literature on the effectiveness of relative valuation has largely excluded firms with negative earnings. Our study fills this research gap by analyzing the effectiveness of relative valuation for negative earnings firms in the context of an IPO, where effectiveness refers to overall valuation accuracy as well as relative performance between specific multiples. We find that the effectiveness of multiples for negative earnings IPO firms is in fact comparable to that of positive earnings IPO firms, but that the valuation accuracy varies considerably, depending on firm type and industry.

In an IPO setting, firm values are generally determined by investment banks and (or) accounting firms using established valuation methods. The discounted cash flow (DCF) method, the dividend discount model (DDM), the multiple valuation method and the residual income valuation (RIV) thereby reside among the most dominant valuation methods. While some researchers claim that multi period valuation models, such as the DCF or the RIV, are theoretically superior, multiple valuation is argued to be one of the, if not the, most widely used approach to determine firm value in practice. In particular, a 2012 study on French IPOs found that in 87% of cases, IPO valuations are performed using comparable company valuation (Roosenboom 2012).

In the years 2013, 2014 and 2015 a total of 5957 companies entered the world's public equity markets through an IPO. 885 of these IPOs occurred within the US market alone, totaling an aggregated worth of 663 bnUSD in issued shares[1]. It is particularly interesting to note that about 63% of these firms featured negative earnings in the year before the IPO, illustrating that practitioners are increasingly facing the task of valuing IPO firms with negative earnings, which is commonly perceived to be especially challenging.

Despite the increasing number of negative earnings IPO firms, the existing literature on the effectiveness of relative valuation has so far mainly focused on profit making firms, in many cases, excluding loss making firms from statistical samples. Where not excluded, potential differences for loss making firms were noted, but not analyzed in a sample of their own. Consequently, there is little evidence on the functioning of multiples for negative earnings firms. The aim of our research is to provide an analysis of the effectiveness of relative valuation for loss making firms in the context of an IPO and reflect upon how these results compare to those for profit making firms. The high number of IPOs worldwide and the large proportion

[1] Data taken from the Securities data Company (SDC) of Thomson Reuters; as of March 2016; more detailed explanation in section '3.2.1 Descriptive statistics of IPO sample'

of negative earnings IPO firms reemphasize the relevance of our research question and its contribution to both, theory and practice.

In accordance with previous studies, we focus on the median pricing error and the percentage of valuations with a pricing error of less than 15% for our assessment of the effectiveness of relative valuation for loss making firms. We find that the overall valuation accuracy of multiples for firms with negative earnings in an IPO setting is, contrary to common perception, relatively similar to that for firms with positive earnings. As for profit making firms, we find that forward looking multiples outperform trailing multiples for loss making firms over the entirety of our sample. In contrast to previous findings for positive earnings firms and arguments from existing literature on the value relevance of accounting fundamentals, commonly used multiples such as the market to book (M/B)[2], the price / earnings (P/E)[3] and the enterprise value / EBIT (EV/EBIT)[4] multiple deliver poor results across our entire sample. Furthermore, our results indicate that the valuation accuracy of multiples for loss making firms in an IPO context significantly depends on firm and industry characteristics. Additionally, we find that while the effectiveness of relative valuation is generally similar for profit and loss making firms within an IPO setting, the overall valuation accuracy is relatively low. This suggests that multiple valuation should be complemented with other valuation methods in order to enhance confidence in the estimated firm value.

The following sections of the paper will (1) provide an overview of the existing literature on multiple valuation, (2) describe the methodology of our empirical analysis as well as the data collected and (3) present and (4) interpret our results before (5) concluding the study and providing suggestions for further research.

2. Literature review

Research on multiples includes literature on the theoretical background, the common use in practice, the effectiveness of different multiple valuation models and the selection of comparable companies. Previous research on the derivation and theory behind relative valuation is fairly developed and hence only limited space will be devoted to this aspect within this paper. Existing papers on the application of multiples reveal that the method is widely used by practitioners, often more so than other valuation methods. Literature on the analysis of the effectiveness of different multiples and the selection of peer companies overlaps to some extend and shows that choice of model is generally dependent on firm and industry specific characteristics.

[2] M/B = market value of equity (price) / adjusted book value of equity, more detailed explanation in section '2.1.2 Relative valuation: a short introduction to its application'
[3] P/E = market value of equity (price) / net income, more detailed explanation in section '2.1.2 Relative valuation: a short introduction to its application'
[4] EV/EBIT = enterprise value / earnings before interest and tax, more detailed explanation in section '2.1.2 Relative valuation: a short introduction to its application'

Consequently, more extensive explanations are required. This section will address previous research done within these subareas of relative valuation and comment on the identified research gap.

2.1 Existing literature on relative valuation

2.1.1 Common use of relative valuation

With numerous established valuation methods available, several papers advocate that multiple valuation is theoretically inferior to alternative methods. Nevertheless, comparative research on the use of valuation methods shows that comparable company valuation is applied extensively, including a large proportion of IPO valuations.

Corporate valuation is performed in a wide variety of economic circumstances. As mentioned above, the DCF method, the DDM, the relative valuation and the RIV are the most well known valuation methods. Previous research within corporate valuation offers extensive explanations on the theoretical frameworks and theory behind these methods as well as some insights into the accuracy of different models. Penman (2001) and Palepu, Healy and Bernard (2000) argue that multi period valuation models in general, e.g. DCF and RIV, are the theoretically superior valuation models that deliver more accurate estimations of firm value. Where Palepu, Healy and Bernard (2000) support the use of either RIV or DCF and state that, when properly applied, both methods lead to identical valuations, Penman (2001) prefers the RIV. Additionally, Palepu, Healy and Bernard (2000) acknowledge that the choice of valuation model may depend on analyst preference or familiarity. Despite the attributed inferiority to multi period valuation models, relative valuation is widely used in practice (Barker 1999; Bradshaw 2002; Demirakos, Strong and Walker 2004). In fact, it is argued that in practice the most commonly used method to determine firm value is the price earnings multiple (Barker 1999; Demirakos, Strong and Walker 2004). Accordingly, and as previously mentioned, the study on French IPOs by Rosenboom (2007) shows that multiple valuations were used in 87% of the cases. Furthermore, Demirakos, Strong and Walker (2004) argue that even when a multi period valuation model is constructed, it is often only complementing multiple valuation and presented solely to satisfy the client's needs. Research has produced contradicting findings with regards to choice of valuation model for specific industries or firm characteristics. While Demirakos, Strong and Walker (2004) find that the use of comparable company valuation changes with industry, where multiples are more frequently used in industries with stable growth characteristics, such as the beverage sector, Roosenboom (2007) finds that the use changes with firm characteristics, where multiples are more frequently used for high growth and highly profitable firms, as they are found in the technology sector. However, regardless of any contradicting views on when to choose which model, it has been shown that relative valuation is commonly applied. The popularity of multiple valuation surely also stems from its application's simplicity and ease of understanding (Geddes 2003).

2.1.2 Relative valuation: a short introduction to its application

In relative valuation, firm value is determined by multiplying a value driver with the corresponding multiple. This multiple is typically derived as an average or median of the multiples of a set of comparable companies, the so called peer companies. Commonly used value drivers are earnings (net income), EBITDA (earnings before interest, tax, depreciation and amortization), EBIT (earnings before interest and tax) and revenue (sales). Multiples are either set on equity value or enterprise value (EV), where EV is equity value plus net debt (ND)[5], preferred stock and minority interest. For consistency, earnings are generally paired with equity value, while other measures higher in the income statement are paired with EV. By doing so, one can assure that the capital bases are matched with their respective capital flows, e.g. equity value to earnings and EV to EBIT. The arguably most well known multiple is equity value over earnings, often and hereafter simply referred to as price earnings multiple, P/E multiple or P/E ratio. Besides earnings and sales multiples, asset and equity multiples can also be constructed. The most frequently used equity multiple is the market to book (M/B) ratio, which is calculated by dividing market value of equity by book value of equity. Beyond these generally applicable multiples, there is a wide range of industry specific multiples that are calculated as enterprise value over certain industry specific, financial and nonfinancial value drivers. These can also include more specific key performance indicators, such as the number of users of a product or the population of franchise territory for telecommunication firms. However, given the small applicability of these specific multiples, they will generally be ignored in this paper.

2.1.3 Accuracy of simple and complex multiple valuation models

Aside from the usage of multiple valuation, the effectiveness of multiple valuation is also widely researched. The accuracy of relative valuation is dependent on the multiple applied. While commonly used, several papers suggest multiple valuation to be less accurate than other valuation methods such as the DCF method. While no individual (simple) multiple is universally superior, literature suggests that complex multiple models, i.e. weighted averages of different multiples, generally outperform simple multiples. Furthermore, equity value multiples outperform enterprise value multiples and forward looking input figures, such as earnings forecasts, yield more accurate results than trailing inputs.

2.1.3.1 Effectiveness of simple multiples

Kaplan and Ruback (1995) use a simple EV/EBITDA multiple in their assessment of the accuracy of different valuation methods in 51 highly leveraged transactions. Looking at the absolute estimation error, they find EV/EBITDA to perform relatively weak in determining firm value in comparison to the DCF

[5] Net debt is generally defined as the net of debt and excess cash

method. Using the P/E multiple and the DCF method, Berkman, Bradbury and Ferguson (2000) follow Kaplan and Ruback's research with a sample of IPOs in New Zealand and find both models to deliver strong results with a median absolute pricing error of around 20%. Taking a wider approach, Lie and Lie (2002) include ten multiples in their empirical studies, comprising cash adjusted and noncash adjusted versions of P/E, M/B, EV/EBITDA, EV/EBIT and EV/sales multiples across all industries. By means of these wide tests, the authors intend to explicitly assess the overall performance of multiples. They find the respective multiples to largely differ in accuracy and the performance to be dependent on factors such as firm size, profitability and the extent of intangibles on the balance sheet of the company to be valued. Expanding on Lie and Lie, Schreiner (2009) tests a range of 50 multiples, including earnings based, cash flow based, equity and asset based multiples and their effectiveness within different industries. While he finds multiples to generally predict market values reasonably well, he also finds the accuracy to vary between industries. Furthermore, both, Lie and Lie and Schreiner, find equity multiples to outperform enterprise multiples in the majority of cases. Additionally, and in contrast to Berkman, Bradbury and Ferguson (2000) both papers find the P/E multiple to have only modest predictive power and the EV/sales multiple to perform poorly across all industries and firm types. When comparing equity and earnings based multiples, however, the conclusions of Lie and Lie and Schreiner differ. Lie and Lie suggest equity based multiples, in particular the M/B multiple, to be more accurate, whereas Schreiner argues earnings multiples would outperform equity multiples. Lie and Lie and Schreiner also draw different conclusions regarding the most accurate earnings multiple. While Lie and Lie's findings advocate the use of an EV/EBITDA multiple, Schreiner finds the P/EBT[6] multiple to be the most accurate estimator of firm value.

2.1.3.2 Effectiveness of combinations of multiples

Numerous researchers have tested combinations of multiples. This entails that individual multiples are tested in combination with other multiples or other financial or nonfinancial metrics. The conducted research shows lower forecasting errors for these complex models. Penman (1998), Cheng and McNamara (2000) and Schreiner (2009) find that complementing the P/E multiple with the P/B multiple adds to the predictive power of the multiple. Beyond the combination of the P/E multiple and the P/B multiple, other researchers have found that complementing multiples with additional financial and (or) nonfinancial information and combinations of multiples in general produce valuation results superior to those of simple multiple models. For instance, considering different models for various sectors, Keun Yoo (2006) derives a model combining the book value of equity, sales, earnings per share, EBITDA multiple as well as analyst earnings forecasts[7]. He finds the combination of multiples to substantially reduce the estimation errors of trailing stand alone multiples. With regards to including nonfinancial information, Amir and Lev (1996)

[6] EBT refers to earnings before tax

[7] In this case, analyst earnings forecasts comprise the three-year analyst earnings forecasts derived from the two- and five-year earnings forecasts

find the population of the franchise territory to be a value relevant factor adding to the predictive power of simple multiples in their study of the wireless communications industry. There are additional papers analyzing different types of industry-specific, nonfinancial value drivers, however, none of them are sufficiently influential within the multiple literature to be included in this analysis.

2.1.3.3 Trailing versus forward looking multiples

Despite disagreements within the literature on the effectiveness of individual and groups of multiples, research has unanimously found forward looking multiples to outperform trailing multiples (Kim, Ritter 1999; Liu, Nissim and Thomas 2002; Lie, Lie 2002; Schreiner 2009; Keun Yoo 2006; Deloof, De Maeseneire and Inghelbrecht 2009). Kim and Ritter (1999) consider P/E, M/B and P/sales multiples and find an overall low predictive power of trailing multiples in IPO valuations. They discover, however, that results improved notably, when using forecasted data. Reemphasizing the increased performance attributed to the use of forward looking multiples, Liu, Nissim and Thomas (2002) and Keun Yoo (2006) argue that simple forward looking multiples even outperform combinations of different multiples.

2.1.3.4 Effectiveness of relative valuation within different economic circumstances

Some of the research within relative valuation also focused on the effectiveness of multiples in specific circumstances, e.g. highly leveraged transactions (Kaplan, Ruback 1995), bankruptcy (Gilson, Hotchkiss and Ruback 2000) or IPOs (Kim, Ritter 1999). While research on highly leveraged transactions or companies in bankruptcy is rare, several researchers have restricted their samples to IPOs and offer conclusions as to how relative valuation performs in this situation. In their research, Kim and Ritter (1999) link the low predictive power of some of the widely used trailing multiples to the higher number of young firms in IPOs, for which the accounting accruals may have less value relevant content compared those of seasoned firms. Berkman, Bradbury and Ferguson (2000), who find the P/E multiple to perform well in an IPO setting, if the peer multiple is derived from comparable transactions, suggest that IPOs have intrinsic growth or risk features that differentiate them from non-IPO valuations. Similarly, Purnanandam and Swaminathan (2004) propose that pricing in IPOs is more closely related to growth rather than profitability or cash flows. Beyond that, Beatty, Riffe and Thompson (2000) and Deloof, De Maeseneire and Inghelbrecht (2009) argue that the effectiveness of multiples in IPOs is dependent on the timing of the dependent variable price, as deliberate underpricing may impact the offer price. Underpricing has received wide attention in the literature on IPOs and evidence largely supports the claims of Deloof, De Maeseneire and Inghelbrecht (2009)[8]. Accordingly, within the research on the effectiveness of multiples in IPOs this is considered to be a potential driver of pricing errors.

[8] For example: Ritter, Welch 2002

The existing literature does not provide conclusive evidence on the effectiveness of individual multiples. Due to the differences across industries, no individual multiple was found to be universally superior. Consequently, the main conclusions from existing research are that forward looking multiples outperform trailing multiples and that complex models including combinations of multiples outperform individual multiples. Furthermore, the specific circumstances of firms during an IPO appear to influence the effectiveness and functioning of multiples.

2.1.4 Research on the selection of comparable companies

The accuracy of multiple valuations implicitly depends on the method chosen for selecting the peer companies (Cheng, McNamara 2000). Several papers have looked at the effectiveness of different selection criteria, but found mixed evidence. While early research found that defining comparable companies by industry produces the best estimations of market prices, selecting peers based on more detailed factors was later found to yield more accurate valuations.

2.1.4.1 Selection of comparable companies for simple multiples

Numerous papers rely on the industry of the company to be valued as primary criterion for selecting peer companies[9]. Alford (1992) statistically compares this method to the method of defining peers based on risk or earnings growth. He finds industry to create the most accurate valuations. However, Alford (1992) further finds that selecting comparable companies on the basis of both, risk and earnings growth, leads to comparably strong P/E valuations. From this Alford (1992) concludes that industry is a proxy for the combination of growth and risk, which then can be used interchangeably. A similar test is conducted by Bhojraj and Lee in 2002. In addition to industry, growth and risk, they also test the expected cost of capital as basis for defining comparable companies. As opposed to Alford (1992), they find that an integrated measure of these criteria produces sets of comparable companies that lead to more accurate valuations than those with peer groups selected based on industry membership alone. Similarly, Kim and Ritter (1999) find evidence for industry alone being a poor predictor of comparability between companies. They compare the accuracy of selecting peer companies based on industry to the ability of investment boutiques to select appropriate peers in an IPO context and find that investment boutiques' comparable company selection outperforms a simple industry filter. In their conclusion, Kim and Ritter (1999) suggest that the high variance of profitability and growth within a respective industry causes industry on a stand alone basis to be insufficient. Consequently, they advocate that these factors are to be included in the selection of comparables when valuing IPOs. Taking a practitioner's perspective, Koller, Goedhart and Wessels (2005) support Kim and Ritter's findings, stating that defining peer companies based merely on industry is

[9] For example: Kim, Ritter 1999; Lie, Lie 2002; Keun Yoo 2006; Schreiner 2009

insufficient and that profitability and growth should also be taken into consideration. Sahoo and Rajib (2013) provide another perspective and propose that selecting comparable companies based on revenue characteristics, book value and profitability considerably improves the estimation power of the P/E multiple.

2.1.4.2 Selection of comparable companies for complex multiple models

The previous section focuses on the selection of comparable companies for simple multiple models and thus one multiple at a time. Penman (1998) and Cheng and McNamara (2000) extend the research, when using combinations of price earnings and price book value of equity multiples. Whereas Penman (1998) merely suggests that in this combined model, the selection of peers should be based on the ratio of earnings to book value of equity, Cheng and McNamara (2000) suggest different selection methods for different combinations of the multiples. In particular, they find that for P/E and P/B multiples used separately, selecting peers based on return on equity is most accurate. For a combined valuation using P/E and P/B, however, Cheng and McNamara (2000) find filtering by industry to yield most accurate valuations.

Thus the literature on the selection of comparable companies covers a variety of selection filters. The contradicting evidence suggests that the accuracy of the respective selection methods is dependent not only on firm characteristics but also on choice of valuation model. Overall, however, considering industry and further specifying comparable companies based on growth and profitability was found to generally control for these aspects.

2.2 Literature gap

Our literature review shows that the effectiveness of multiples is dependent on firm characteristics as well as economic context of the firm to be valued. However, while various types of firms have been considered in diverse circumstances, loss making firms have mostly been excluded from previous studies[10]. This includes research on IPO valuations, of which a significant proportion features negative earnings (Fama, French 2004). As practitioners largely rely on multiples for these valuations, amongst other reasons due to a lack of reliable financial forecasts for alternative methods (Ritter, Welch 2002), there is a need for research on the effectiveness of multiples for valuing loss making IPO firms.

[10] For example: Alford 1992; Kim, Ritter 1999; Cheng, McNamara 2000; Liu, Nissim & Thomas 2002

2.2.1 Necessity to value IPO firms with negative earnings

Previous research on IPOs has shown that IPO firms often feature different firm characteristics than the overall cohort of firms, mostly with respect to profitability, growth and volatility. Furthermore, the limited availability of financial forecast makes the application of multi period valuation methods fairly difficult. Fama and French (2004) observe that, over time, the number and nature of firms being listed on public exchanges has changed. In particular, they find that in the period from 1973 to 2001 not only the number of new lists per year increased considerably but also the proportion of unprofitable growth firms among these new lists. Additionally, Campbell, Lettau and Malkiel (2001) find that the volatility on individual firm level increased substantially over the 35 years from 1962 to 1997, while the market as a whole did not become more volatile. The larger dispersion of profitability as well as increase in volatility among listed firms can also be attributed to the fact that an increasing number of small and young firms has gone public (Pastor, Veronesi 2003; Klein, Marquardt 2006). Having more IPOs featuring young firms, which are often fairly unknown to the public, increases uncertainty; uncertainty has been found positively related to higher market to book ratios as well as increased stock volatility, i.e. it affects firm valuation (Pastor, Veronesi 2002). The different circumstances present within the context of an IPO support the notion of analyzing the effectiveness of multiples in IPOs separately.

2.2.2 Existing research on the effectiveness of multiples for loss making firms

Several papers that focused on the effectiveness of relative valuation in IPOs have considered the specific firm characteristics in IPOs mentioned above, when drawing conclusions and reflecting upon their findings[11]. However, the large and increasing proportion of negative earnings firms has been excluded from a significant proportion of the studies[12]. Only selected papers included loss making firms in their statistical samples. For instance, while Lie and Lie (2002) consider one sample including and one excluding loss making firms and find the accuracy to be higher in the latter, they do not explicitly test the functioning and effectiveness of multiples for loss making firms. Bartov, Mohanram and Seethamraju (2002) assess the valuation of internet IPO stocks compared to non-internet firms. Even though they include both, positive and negative earnings firms, in their sample, no special attention is given to the accuracy of different multiples for loss making firms. Taking a practitioner's perspective, Damodaran (1999) elaborates on the valuation of loss making firms using comparable company valuation. However, his attempts to solve the issue evolve around the use of forecasted positive earnings, for instance five years from now, or the attempt to estimate what amount of positive earnings a company with similar firm characteristics should have when turning profitable, thereby increasing the uncertainty related to the approach.

[11] For example: Kim, Ritter 1999; Berkman, Bradbury & Ferguson 2000; Purnanandam, Swaminathan 2004
[12] For example: Alford 1992; Kim, Ritter 1999; Cheng, McNamara 2000; Liu, Nissim & Thomas 2002

The lack of literature on multiple valuation for negative earnings firms can presumably be related to the diversity of these among the population of public stock, where firms report negative earnings for a wide variety of reasons. As the population of negative earnings IPO firms is presumably more homogeneous with regards to profitability, growth and firm type, research on relative valuation for negative earnings firms in the context of an IPO promises to provide more accurate results.

2.3 Related research: value relevance of accounting fundamentals

As multiples are essentially a combination of various accounting fundamentals and (or) other financial and nonfinancial information, literature on the value relevance of accounting information is directly related to the research on comparable company valuation. For the purpose of this paper, it can provide insights into the effectiveness of multiples in general as well as specific metrics that could constitute a relevant multiple for loss making firms. The following section shows that value relevance of accounting fundamentals can differ substantially for profit and loss making firms, and that while there is a relationship between earnings and price, the value relevance of earnings has decreased over time, especially for loss making firms.

2.3.1 Value relevance of accounting fundamentals and development over time

Miller and Modigliani as well as Ball and Brown were the first to conduct research within value relevance of accounting fundamentals, in 1961 and 1968 respectively. Both found a relationship between earnings and market value of equity. Miller and Modigliani (1961) state that, for an investor, firm value is based upon the current earning power of a firm's physical assets and the firm's opportunities, if any, to invest in additional real assets that will yield more than the 'normal' market return; hence firm value is mainly based upon the capitalization of future earnings. Ball and Brown (1968) find that the market does in fact look at reported income and that any deviations from expected income result in market reactions. Subsequent research found that current earnings contain information about future net cash flows (Kormendi, Lipe 1987; Ohlson 1991). The evidence found on the existing relation between earnings and firm value supports the notion that firm value can be estimated through relative valuation, in this case mostly referring to the P/E multiple.

2.3.1.1 Relationship between earnings and price for profit and loss making firms

Interestingly, however, in 1997 Burgstahler and Dichev (1997b) find that the relationship between earnings and price is different for profit and loss making firms. For profit making firms, the relationship is positive and for loss making firms, it is negative. This implies that for firms with positive earnings higher earnings correlate to higher firm value and for firms with negative earnings more negative earnings correlate to

higher firm value. Additionally, Barth and Kallapur (1996) find that the relationship of price and earnings also varies with firm size. Collins, Maydew and Weiss (1997) find that over 40 years (1953 to 1993) the value relevance of earnings has decreased and the value relevance of book value of equity has increased, while the combined value relevance of earnings and book value has remained the same. Collins, Maydew and Weiss (1997) argue that much of the loss in value relevance of earnings stems from the increasing frequency and magnitude of one time items, the increasing frequency of negative earnings and changes in average firm size and intangible intensity across time. This is of particular interest for the attempt to identify the most value relevant multiples for loss making firms in an IPO setting: a decrease in the value relevance of the earnings measure may indicate the need for other or complementing multiples and (or) metrics in our model.

2.3.1.2 Value relevance of book value of equity for loss making firms

It is argued that market value of equity is a function of both earnings and book value of equity, where with lower earnings book value of equity becomes more important (Burgstahler, Dichev 1997a). Barth, Beaver and Landsman (1998) support this notion and argue that the weights to be put on earnings and book value depend on the financial health of the firm, after they had analyzed a series of bankrupt firms. This suggested change in relevance of a certain metric is in line with previous literature on multiples described above, where P/E and P/B were attributed different weights depending on firm characteristics (Penman 1998; Cheng, McNamara 2000; Schreiner 2009). Following up on previous research, Collins, Pincus and Xie (1999) show that when incorporating book value of equity into their regression model, the relationship of price and earnings becomes positive over both, profit and loss making firms. Collins, Pincus and Xie (1999) base the value relevance of book value of equity on the notion that it is either a proxy for future normal earnings or a proxy for an abandonment option. Aggarwal, Bhagat and Rangan (2009), however, find that book value of equity does not always show a significant relationship to firm value. Specifically, they find that for loss making internet and technology firms that enter the public equity markets through an IPO, book value of equity was only relevant during the crash period of the .com bubble where it could have been seen as a replacement cost for physical capital.

Literature on value relevance of accounting fundamentals shows that current and expected earnings are key factors for determining firm value, but may have experienced a reduction in value relevance due to changing firm characteristics. Furthermore, there seems to be a major difference with regards to value relevance for profit and loss making firms. While it has been argued that the value relevance of book value of equity has increased, it has also been shown that this may not be applicable to firms in an IPO setting that feature negative earnings.

2.3.2 Value relevance for loss making firms: evidence from fundamentals research

More recent literature provides a deeper understanding of the phenomenon of the negative bivariate relationship of earnings and price for loss making firms and adds additional financial metrics to existing research. The findings indicate that an overall increase in investment expenses has led to a higher number of reported negative earnings over time. While reducing current earnings figures, investors often interpret and value these expenses as future growth options, leading to higher firm values.

2.3.2.1 Value relevant growth options for loss making firms

In 2000, Hand addresses potential growth options embedded in high investment expenses, which had partly led to the increase in negative earnings. Hand (2000) splits earnings into revenue and investment expenses (research and development and marketing) and finds that for loss making firms revenue is only weakly positively related to firm value, whereas both research and development (R&D) and marketing expenses are reliably positively related to firm value, i.e. the higher the investment expense the higher firm value. Hand (2000) suggests that the increase in firm value stemming from investment expenses is in line with the notion that in the future the firm is going to benefit from larger strategic operating options or increasing returns to scale. In 2005, Joos and Plesko's findings support Hand's research; they split up losses into the individual line items and find that only transitory losses with an R&D component are capitalized and valued as assets and that other losses are treated as losses, hence reemphasizing the importance of the nature of the loss component. As the value relevance of R&D expenses relates to the idea of growth options and investment expenses in general, Wu, Fargher and Wright (2010) analyze explorations costs in Australia and find that these are also positively related to firm value, suggesting that for different industries different investment expenses can increase firm value. Interestingly, Franzen and Radhakrishnan (2009) find that R&D expenses are only positively related to equity value for firms with negative earnings.

The findings on investment costs mentioned above indicate that negative earnings imply future growth prospects depending on the individual loss components, with the latter being of potential value relevance. This is also in line with other research on investor perception, which states that investors perceive losses to have a transitory nature and not be permanent (Hayn 1995; Elliott, Hanna 1996; Li 2011). Furthermore, sales have been found only weakly positively related to firm value for the case of loss making firms. The findings on the value relevance of revenue and investment expenses provide valuable insights for understanding the dynamics and relationship of the P/E and sales multiple and firm value for negative earnings firms.

2.3.3 Other factors affecting the value relevance of financial information

Beyond the substantial changes in firm characteristics as well as increase in negative earnings among newly listed firms (Collins, Maydew and Weiss 1997; Fama, French 2004), other factors such as accounting conservatism and earnings management can also impact the value relevance of financial information. In particular, research found an increase in non-recurring items and accelerated depreciation, both distorting the value relevance of related income statement items (Basu 1997; Darrough, Ye 2007). Moreover, Fedyk, Singer and Soliman's (2012) find that managers of high growth firms often focus on managing R&D expenses and sales in order to increase firm value, thereby impacting the value relevance of these variables. While these issues are not focus of this paper and will therefore not receive further attention, it is noteworthy that their presence may affect the performance of individual multiples.

2.4 Contribution to existing literature

We have seen that the existing literature on relative valuation evolves around its theoretical background, its common use, the effectiveness of different multiple valuation models and the selection of comparable companies. Within these areas, a variety of multiples has been assessed and numerous selection criteria for comparable companies tested. Overall, it has become evident that the effectiveness of relative valuation is dependent on firm type, industry characteristics and economic circumstances of the valuation. Most of these subareas have experienced further research and analysis. Loss making firms, however, have not been tested exclusively and have, in many cases, been excluded from statistical samples. Especially in the context of IPOs, where relative valuation is often used and a significant proportion of firms feature negative earnings, making an assessment of the effectiveness of multiples is particularly interesting and insightful for researchers and practitioners. Given the strong increase in IPO activity and newly listed firms with negative earnings, this paper aims to complement existing literature on multiples by analyzing the effectiveness of relative valuation for loss making firms in an IPO setting.

While research on the valuation accuracy of multiples for loss making firms is limited, related research on the value relevance of accounting fundamentals has found relationships of various metrics to be significantly different for profit and loss making firms. This suggests that the valuation of firms with negative earnings is different to that of positive earnings firms and provides a basis for our research.

3. Empirical analysis

The methodology of our empirical analysis is set up analog to that of previous papers researching the effectiveness of various valuation methods, including but not limited to relative valuation. Having

methodologically similar analyses across numerous papers allows for a straightforward comparison of results. At the center of the empirical analysis is the so called pricing error, which is the relative difference between estimated and actual firm value and which constitutes the key measurement metric for valuation accuracy and effectiveness in existing literature.

The data for our sample is collected from several databases and subsequently extended through the calculation of a number of multiples for each firm. For every company in our sample we then select a peer group of five comparable companies. The median multiples of the respective peer groups are referred to as market multiples and later used to estimate firm value. An assessment of the dataset's measures of central tendency and distribution builds the basis for our interpretation of the empirics. Subsequently, we generate the results of our empirical analysis by calculating the pricing errors. We describe and analyze these pricing errors by means of their descriptive statistics and compare these to those from previous studies for profit making firms. We do this for the entire sample as well as a number of subsamples in order to understand the sensitivities of our results. In a final step, we assess the validity of our results with four robustness tests. In particular, we (1) check the effectiveness of alternative multiples, (2) investigate an alternate method of selecting peer companies, (3) recalculate the pricing errors using an altered formula and (4) regress the actual multiples on the estimated market multiples.

The subsection '3.1 Methodology' describes the data collection process as introduced above in more detail before we move on to analyze the resulting data by means of their summary statistics in subsection '3.2 Descriptive statistics and data'. Subsection '3.3 Results' contains the presentation and first analysis of the resulting pricing errors as well as the results of the conducted robustness tests. In section '4 Interpretation of results' we then interpret the pricing errors within our sample by linking them to our analyses of previous research, the underlying data and the application in practice.

3.1 Methodology

As described above, the pricing error is the generally accepted metric used to assess a valuation method's effectiveness in the literature. However, before calculating pricing errors several decisions are to be made. Within relative valuation there is a wide variety of multiples one can test for and several methods one can use to select comparable companies. We choose to test nine different multiples, four based on equity value and five on enterprise value. Four of the nine multiples, two equity value based and two enterprise value based multiples, are built upon forward looking financial information, the rest on trailing. Peer groups are then selected on industry membership, sales level and book value of equity. The following sections describe and motivate our sample selection, data collection, multiple selection and comparable company selection in more detail.

3.1.1 Selection of IPO sample

We obtain our initial sample of 885 US IPOs for the years 2013 to 2015 from the Thomson Financial Securities Data Company database (SDC). The sample is restricted to three years, as market multiples change over time when longer periods are used (Kim, Ritter 1999). With the majority of previous research having been done on the US IPO market, choosing the US market, which also features the highest IPO activity and hence largest sample size, allows for best comparability of results. In line with prior studies[13] and in order to have all required data available in the final prospectus[14], we exclude financial firms[15], best effort offerings, unit offerings, receipts listings, firms that have not existed at least one year at the time of the IPO, offerings with an offer price below 5 USD and offerings with proceeds below 5 mUSD. Furthermore, secondary offerings and over the counter (OTC) listings need to be excluded from the collected SDC data. Additionally, IPO prospectuses must be available for data collection and contain financial information in US dollars to avoid any exchange rate distortions. To allow for proper peer selection, at least four IPOs must have occurred in a given industry (based on 4-digit SIC codes[16]) between 2013 and 2015 for it to be included in our sample. Finally, in order to match the sample to our research question we exclude all firms that reported positive net earnings in the year before the IPO and reach a final sample of 246 operating company IPOs from 2013 to 2015 for the US market. Table 1 illustrates our sample selection process.

Table - 1 -

Sample Selection Criteria	Number of Firms (#)
US IPOs between 2013 and 2015	885
Exclusion of financial firms (commercial bank, credit institutes, investment banks & funds, mortgage bank, other finance, real estate & REIT, Savings & Loans / Thrift, Insurance, comps w/ sole purpose of ownership)	218
Remaining	667
Exclusion of best effort offerings, unit offerings, secondary offerings, receipts, over-the-counter (OTC) offerings	129
Remaining	538
Exclusion of IPOs with an offer price below 5USD and/or proceeds below 5mUSD	66
Remaining	472
Exclusion of firms with positive earnings in the year before the IPO	166
Remaining	306
Exclusion of firms with less than three peer companies in the same 4-digit SIC code, firms younger than one year at the time of the IPO where insufficient data available	60
Final Sample	**246**

[13] For example: Kim, Ritter 1999; Beatty, Riffe & Thompson 2000; Aggarwal, Bhagat & Rangan 2009; Bartov, Mohanram & Seethamraju 2002; Purnanandam, Swaminathan 2004

[14] For instance, best effort offerings do not enable us to calculate the market value at IPO with the prospectus data, as the number of shares outstanding is only known after the offer

[15] The valuation of financial firms, particularly using multiples, was found to be considerably different from operating firms (Lie, Lie 2002). Financial firms include: commercial banks, credit institutes, investment banks & funds, mortgage banks, other finance, real estate & REIT, savings & loans / thrift, insurance, comps w/ sole purpose of ownership

[16] SIC code is the abbreviation for 'Standard Industrial Classification' and refers to the industry classifications provided by the U.S. government

3.1.2 Collection of financial and nonfinancial information

General company information (ticker, industry, SIC code, date founded) as well as market data (issue date, offer price, proceeds) are taken from the SDC database. Any missing or suspicious values are crosschecked with the IPO prospectuses and, if necessary, corrected. We also collect 1st Day closing stock prices from SDC and, when unavailable in SDC, refer to Bloomberg to gather missing data points. We handpick all balance sheet data (stockholders' equity, total assets, net debt, preferred stock, minority interest) as well as total shares outstanding immediately after offering from the IPO prospectuses to ensure a valid and comparable dataset. The historical financials (revenue, EBIT, EBITDA, net income, R&D expense, capital expenditures) are taken from Thomson Reuters Worldscope and, if omitted, crosschecked with the IPO prospectuses. Lastly, we obtain forward looking financials (12 month forward sales, 12 month forward net income) from Thomson Reuters' Institutional Brokers' Estimate System (I/B/E/S).

3.1.3 Selection of multiples

We choose the multiples for our empirical analysis based on this paper's goal to conduct a general assessment of the effectiveness of relative valuation for negative earnings IPO firms that offers first valuable insights as well as a solid foundation for further research within this area. Therefore, we focus on the multiples most widely studied in theory, those found to be successful and those most commonly used in practice. Consequently, the generated results are comparable to previous studies for profit making firms and of practical value. Furthermore, we take into consideration the findings from existing literature on the value relevance of accounting information for negative earnings firms in order to account for the special firm characteristics of our sample. The literature review has shown that a wide variety of multiples has been studied for profit making firms. While earlier papers[17] focused on a few selected multiples, later studies[18] started comparing entire groups of multiples, such as various earnings and balance sheet based multiples. Later on, industry specific multiples and combinations of multiples became the subject of further studies[19]. Given our intention to draw general inferences about multiples for negative earnings IPOs, industry specific multiples will be ignored. Similarly, despite promising results in previous studies, combinations of multiples will not be included. Based on these considerations, the following multiples have been selected:

Price / Net Income: The Price / Net Income, or Price / Earnings (P/E) multiple is included in the vast majority of papers studying the effectiveness of comparable company valuation. Even though its performance differs across studies[20], the P/E multiple resides among the most commonly applied valuation

[17] For example: Alford 1992; Kim, Ritter 1999
[18] For example: Lie, Lie 2002; Schreiner 2009
[19] For example: Amir, Lev 1996; Schreiner 2009
[20] Difference can be observed in Berkman, Bradbury and Ferguson 2000 versus Schreiner 2009 and Lie, Lie 2002

methods. The denominator of the P/E multiples, net income, is negative for all firms in our sample. The literature on the value relevance of accounting information suggests that this negatively impacts the effectiveness of the P/E multiple, however, given its wide application in practice, we include the P/E ratio in our analysis.

Price / 12 mth Forward Sales: The Price / 12 mth Forward Sales (P/forward sales) multiple is theoretically inconsistent, as the numerator relates to equity, whereas sales are a capital flow to all capital providers and thus relate to enterprise value (provided by all capital providers). However, previous studies have shown that theoretically inconsistent multiples can at times generate valuation results that are superior to their theoretically more consistent counterparts[21]. We include this multiple due to the universally strong estimation accuracy of forward looking multiples found in prior studies of profit making firms. Given the comparably large proportion of firms without sales and negative earnings pre-IPO within our sample, we assume the forward looking sales multiples to be particularly feasible for the estimation of firm value. Including both, equity and enterprise value based forward sales multiples, accounts for any effects the capital structure may have on the effectiveness of this value driver.

Price / 12 mth Forward Net Income: In line with the reason for including the trailing P/E multiple and in accordance with the overall superiority of forward looking multiples, the forward looking P/E multiple (P/forward net income) is included in our analysis. With all firms currently featuring negative earnings, firm value is presumably based on expectations of future earnings.

Price / Adjusted Total Equity[22]: Existing literature on the value relevance of accounting fundamentals suggests that with a decrease in the value relevance of net income for a loss making firm its book value of equity increases in value relevance[23]. Hence, given the characteristics of our sample, the Price / Adjusted Total Equity multiple, also called market to book (M/B) multiple, is a viable option for our empirical analysis. This multiple has also been included in a wide range of previous studies on the effectiveness of relative valuation and is used frequently in practice.

Enterprise Value / Sales: The Enterprise Value / Sales (EV/sales) multiple is widely used in practice. However, as sales is the top line item in the income statement, firms with similar sales levels can nevertheless be substantially different, making the application of the multiple theoretically unfeasible. The results of previous studies on the effectiveness of the EV/sales multiple support this notion[24]. We nonetheless include this multiple in our research, as with negative earnings sales may constitute a more comparable firm characteristic than earnings (Liu, Nissim and Thomas 2002).

Enterprise Value / EBIT: The Enterprise Value / EBIT (EV/EBIT) multiple is another earnings multiple frequently used in practice and included in our empirical analysis. In contrast to net income, EBIT represents a capital flow to all capital providers and incorporates all operating expenses. Together with

[21] For example: Liu, Nissim and Thomas 2002; Schreiner 2009

[22] Adjusted equity at IPO = total shareholders' equity (as of last quarter before IPO) plus preferred Stock (as of last quarter before IPO; where forced conversion to common stock at IPO)

[23] For example: Collins, Maydew and Weiss 1997

[24] For example: Lie, Lie 2002; Schreiner 2009

EBITDA, EBIT is considered to be an approximation of free cash flow. To account for different expense structures among the firms in our sample (i.e. items beings expensed versus capitalized and depreciated), we include the EV/EBIT and exclude the EV/EBITDA multiple from our study.

Enterprise Value / 12 mth Forward Sales: In line with the previously discussed role of sales for negative earnings firms and the superior performance of forward looking multiples, the EV / 12 mth Forward Sales (EV/forward sales) multiple is tested in our empirical analysis.

Enterprise Value / 12 mth Forward Net Income: Similar to the P/forward sales multiple presented above, the EV / 12 mth Net Income (EV/forward net income) multiple is inconsistent from an accounting perspective. For the same reasons as above, superiority of forward looking multiples and in cases superiority of inconsistent multiples, we nevertheless test the valuation accuracy of this multiple.

Enterprise Value / Total Assets: Finally, we include the EV / total assets multiple in our study in order to gain insights into the value relevance of an additional balance sheet item. The valuation effectiveness of this multiple has previously been tested for positive earnings firms[25]. Like the other multiples selected, the EV/total assets multiple is commonly applied in practice, however, to various extends for different industries.

In order to test for the information exclusivity of the selected multiples, we conduct a correlation analysis. Table 2 displays the results of this analysis.

- Table 2 -

Correlation Analysis	Price / Net Income	Price / 12 mth Forward Sales	Price / 12 mth Forward Net Income	Price / Adj. Total Equity	EV / Sales	EV / EBIT	EV / 12 mth Forward Sales	EV / 12 mth Forward Net Income	EV / Total Assets
Price / Net Income	1								
Price / 12 mth Forward Sales	(0.003)	1							
Price / 12 mth Forward Net	(0.064)	(0.018)	1						
Price / Adj. Total Equity	(0.021)	(0.067)	0.011	1					
EV / Sales	(0.143)	0.739**	(0.024)	(0.017)	1				
EV / EBIT	0.467**	(0.017)	0.033	(0.005)	(0.186)*	1			
EV / 12 mth Forward Sales	0.003	0.999**	(0.017)	(0.069)	0.723**	(0.009)	1		
EV / 12 mth Forward Net Income	(0.071)	(0.02)	0.991**	0.011	(0.027)	0.04	(0.02)	1	
EV / Total Assets	0.025	0.039	(0.034)	0.138*	0.028	0.014	0.041	(0.037)	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis reveals nearly perfect and statistically significant correlations for the corresponding equity and enterprise value based forward looking multiples. This suggests that these multiples have a considerable amount of shared information, which is in line with our expectation, as they are based on the same value drivers. Similarly, we observe statistically significant correlations between the EV/EBIT and P/E as well as EV/EBIT and EV/sales multiples, also indicating shared information content. However, as none of the correlations are perfect, we chose to include all multiples. Specifically, we anticipate the exclusive parts of the information content of the respective correlated multiples to be of potential relevance in our analysis of subsamples.

[25] For example: Lie, Lie 2002; Schreiner 2009

3.1.4 Selection of peer companies

By definition of relative valuation, firm value is determined based on the valuation of other companies that are deemed similar to the one that is to be valued. Consequently, the selection of comparable companies can have a significant influence on the valuation accuracy of relative valuation. Within our analysis of the effectiveness of various multiples for loss making firms in an IPO setting our focus lies on the overall effectiveness of multiples within this context as well as differences in valuation accuracy among certain multiples. With regards to the peer selection our goal is to choose selection criteria that are in line with the findings of existing literature as well as common practice. The effectiveness of different selection criteria, however, only plays a secondary role in our empirical analysis.

Existing literature has found industry to be a valid selection criterion for comparable companies, as companies within the same industry are generally exposed to similar risks and earnings growth as well as economic factors and cycles, while also featuring comparable business models[26]. Accordingly, a majority of previous research on the accuracy of multiple valuation has used industry as a key determinant for comparable companies. In fact, as mentioned in our literature review, numerous papers solely rely on industry as means of selecting comparable companies[27]. Adding growth and profitability measures to industry as selection criteria has been argued to further improve peer selection and lead to more accurate firm valuations[28]. Controlling for size by pairing companies with similar revenue figures is another selection criterion deemed reasonable, as the relationship of value drivers, in particular the P/E multiple, was found to vary with size[29]. Research has furthermore found IPO pricing to differ from the pricing of established firms in terms of the value relevance of growth, profitability and risk as well as other factors such as underpricing[30]. Therefore, peer companies should be selected from recent IPOs instead of established listed firms.

For our empirical analysis we developed a three-step process for the selection of comparable companies that addresses the criteria described above. We limit our selection of peer companies to our sample of US IPOs between 2013 and 2015. The first selection criterion is the 4-digit SIC code and we require at least four recent IPOs (i.e. three peer companies) within one 4-digit SIC code for an industry to be included in our sample. For industries in our sample that consist of more than five recent IPO companies we move on to selection criterion two, revenue size[31]. While previous literature suggests the use of profitability and revenue growth as selection criteria after industry, we choose revenue size, as all firms within our sample feature negative earnings and about a third had no sales prior to IPO date making profitability and growth

[26] For example: Alford 1992
[27] For example: Kim, Ritter 1999; Lie, Lie 2002; Keun Yoo 2006; Schreiner 2009
[28] For example: Kim, Ritter 1999; Koller, Goedhart and Wessels 2005
[29] Barth, Kallapur 1996
[30] See section '2.1.3.4 Effectiveness of relative valuation within different economic circumstances'
[31] Here revenue size refers to the level of sales in the year before the IPO (last reported full-year sales before the IPO)

unreasonable measures for the selection of peer companies. Sales revenue, however, can adjust for size and in the case of the IPO and young firms also provides a measure that can take different development phases into consideration. That means firms that are still in a stage of zero sales and perform mostly R&D activities are paired together and firms that are already generating revenue are paired together. If more than five companies remain after selecting for revenue size, in particular in the case of multiple firms having zero revenue, we apply the third selection criterion, book value of equity[32]. By nature, book value of equity incorporates effects of profitability, financial health and firm size. Our goal is to select three to five comparable companies for every firm in our sample. The following list offers a short summary of our three-step selection process:

1. 4-digit SIC code: choose peers from the same SIC code (if more than five move to step 2)
2. Sales revenue: choose the five firms with the closest sales figures to the one in question (if more than five with equal sales move to step 3)
3. Book value of equity: choose the five firms with the closest book values of equity to the one in question

Table 3 below depicts the peer selection as performed for Aquinox Pharmaceuticals Incorporated (Aquinox). Aquinox belongs to the industry referred to with 2834 as 4-digit SIC code. As shown below all potential peers are members of the same industry. In this case there are more than five companies that have 2834 as SIC code within our sample (including but not limited to the companies presented in Table 3), hence we move to step 2.

- Table 3 -

Company Name	Industry	SIC Code (4-digit)	Issue Date	Last Year before IPO annual Sales (USD)	Total Adjusted Stockholders' equity before IPO (USD)
Firm to be valued					
Aquinox Pharmaceuticals Inc	**Manufacturing**	**2834**	**06/03/14**	**NA**	**8,386,334**
Peer Selection					
Catabasis Pharmaceuticals Inc	Manufacturing	2834	24/06/15	NA	13,297,000
Egalet Corp	Manufacturing	2834	05/02/14	NA	12,128,000
Ocular Therapeutix Inc	Manufacturing	2834	24/07/14	NA	11,147,000
Aclaris Therapeutics Inc	Manufacturing	2834	06/10/15	NA	10,796,000
Neothetics Inc	Manufacturing	2834	19/11/14	NA	10,525,000
Marinus Pharmaceuticals Inc	Manufacturing	2834	31/07/14	NA	8,038,270
Intec Pharma Ltd	Manufacturing	2834	04/08/15	NA	7,467,000
Vascular Biogenics Ltd	Manufacturing	2834	30/09/14	NA	7,456,000
Auspex Pharmaceuticals Inc	Manufacturing	2834	04/02/14	NA	5,669,000
SteadyMed Ltd	Manufacturing	2834	19/03/15	NA	5,420,000
Axsome Therapeutics Inc	Manufacturing	2834	19/11/15	NA	3,861,294

Illustration of comparable company selection for Aquinox Pharmaceuticals Inc.
The selection of comparable companies follows a three-step process. (1) The sample is filtered for firms within the same industry (4-digit SIC code) as the firm to be valued. (2) Subsequently, if the resulting number of firms in the same industry is higher than five, the firms are filtered based on last full-year sales before the IPO, with the five firms with the closest sales level being selected as peers. (3) In case of firms without sales, the five firms with the most similar adjusted book value of equity in the last quarter before the IPO are selected as comparable companies. The estimated market multiple is then generated as the median of the selected peer companies' multiples.

[32] Here book value refers to adjusted book value of equity at IPO; adjusted book value of equity at IPO = total shareholders' equity (as of last quarter before IPO) plus preferred stock (as of last quarter before IPO; where forced conversion to common stock at IPO)

Aquinox did not generate any revenue before the IPO and is therefore paired with other companies that did not generate any revenue before their IPO (including but not limited to the companies presented in Table 3). With more than five companies remaining as potential peers, we use book value of equity to arrive at our final selection of peer companies for Aquinox (marked with thick borders).

As mentioned above, the effectiveness of different selection criteria goes beyond the scope of our research question. Nevertheless, we also tested selecting peers after industry as criterion one and book value of equity as criterion two. We find no significant changes in valuation accuracy between the two peer selection approaches. We believe our three-step process is more theoretically sound and in line with the findings of existing literature, allowing us to compare our results to those of previous studies and draw relevant and meaningful conclusions based upon our empirical analysis.

3.2 Data and descriptive statistics

The following two sections provide a description of our sample and the data collected. Gaining a more detailed knowledge of the firm as well as IPO characteristics within our sample will allow for a better understanding and interpretation of our results. We find our sample to feature relatively young companies with a considerable proportion of firms not having sales. Beyond that, the sample is fairly concentrated on two major industries, pharmaceuticals and technology.

3.2.1 Descriptive statistics of IPO sample

Tables 4 and 5 present the descriptive statistics of our sample of 246 US IPOs from 2013 to 2015. Roughly half of the IPOs occurred in 2014 (47%), however, firm and IPO characteristics remain stable over all three years of the sample period[33]. Table 4 offers an overview of the distribution of industries in our sample. The vast majority (67%) of IPOs were performed within the manufacturing sector, which within this sample mostly includes pharmaceutical companies. With 24% the technology industry is the second largest industry in our sample and together with the manufacturing industry makes up for roughly 90% of our sample. The remaining industries are healthcare and 'Other', which aggregates retail, transportation, electric services and

- Table 4 -

Firm Distributions	# of Firms	% of Total
Issue Date		
2015	74	30%
2014	116	47%
2013	56	23%
Industry		
Manufacturing	164	67%
Tech	59	24%
Healthcare	8	3%
Other	15	6%
Relevant Firm Characteristics		
Zero Sales before IPO	80	33%
Negative EBIT before IPO	229	93%
Negative Net Income before IPO	246	100%
Negative adj. Equity at IPO	67	27%

[33] Within this section only aggregate descriptive statistics of the IPO sample are shown, yearly overviews are presented in the appendix

restaurant companies. With regards to firm characteristics, it is noteworthy that of the 246 firms in our sample, 80 firms had zero revenue before the IPO, 229 firms had negative EBIT before the IPO and 67 firms reported negative book values of equity at the time of the IPO. The strong presence of negative EBIT and book value of equity figures is no surprise given that the entire sample features negative net earnings for the purpose of our research question.

- Table 5 -

					Percentiles	
(in mUSD, except age)	**Median**	**Max**	**Min**	**Standard Deviation**	25th Percentile	75th Percentile
Firm Data						
Age (in years)	8	113	1	9	6	12
Income Statement Data						
Sales before IPO	32	11,152	0	963	6	84
Sales Growth (1-yr)	39%	3,540%	(100)%	437%	6%	87%
EBIT before IPO	(15)	1,351	(182)	93	(23)	(6)
Net Income before IPO	(17)	0	(458)	44	(28)	(8)
Balance Sheet Data						
Adjusted Equity at IPO	14	1,486	(1,088)	189	(1)	46
Total Assets at IPO	45	34,497	0	2,287	16	88
IPO Data						
Proceeds	75	2,560	7	223	51	106
% of Float	26%	18%	28%	16%	33%	20%
Market Value at IPO	286	14,162	25	1,428	155	532
Enterprise Value at IPO	270	31,766	26	2,373	150	500
Market Value Closing Day 1	344	22,687	22	1,912	155	739

Descriptive statistics of IPO sample
Age (in years) = refers to firm age at the time of the IPO
Sales before IPO = annual sales of the last full fiscal year before the year of the IPO
Sales Growth (1 yr) = annual sales growth in the last full fiscal year before the IPO
EBIT before IPO = annual EBIT of the last full fiscal year before the year of the IPO
Net Income before IPO = annual net income of the last full fiscal year before the year of the IPO
Adjusted Equity at IPO = book value of total shareholders' equity (as of last quarter before IPO) plus preferred stock (as of last quarter before IPO; where forced conversion to common stock at IPO)
Total Assets at IPO = total assets (as of last quarter before IPO)
Proceeds = total proceeds received from initial public offering
% of Float = percentage of proceeds to firm value at IPO
Enterprise Value at IPO = market value at IPO plus net debt before IPO
Net Debt before IPO = total debt (as of last full fiscal year before IPO) plus preferred stock (as of last quarter before IPO; where no forced conversion to common stock at IPO) plus minority interest (as of last quarter before IPO) minus cash and cash equivalents (as of last quarter before IPO)
Market Value at IPO = total shares outstanding immediately after offering multiplied by offer price
Market Value Closing Day 1 = total shares outstanding immediately after offering multiplied by stock price closing day 1

Table 5 shows the median, min, max, standard deviation, 25th- and 75th- percentiles and averages of selected firm, income statement, balance sheet and IPO data of our sample. While about a third of the firms in our sample have no reported sales before the IPO, the firms that do featured a median of 39% in sales growth. Combined with a median age of eight years at the time of the IPO among all firms, the firms in the sample

can be characterized as young growth firms[34]. The median sales figure across the sample is 32 mUSD with a maximum of 11.2 bnUSD. Median EBIT and net income are (15) mUSD and (17) mUSD, respectively. Total equity at IPO has a median of 14 mUSD across all firms and a standard deviation of 189 mUSD, while total assets have a median of 45 mUSD and a much larger standard deviation of 2.3 bnUSD. A median of 26% of firm ownership was transferred at the IPO across all firms, resulting in median proceeds of 75 mUSD and median market values at IPO of 286 mUSD. The standard deviations of proceeds and market value at IPO are 223 mUSD and 1.4 bnUSD, respectively. Enterprise values at IPO have a median of 270 mUSD with a standard deviation of 2.4 bnUSD. These descriptives indicate comparably broad distributions for the total assets, market values and enterprise values of the firms in our sample. Taking into consideration the 75th-percentile as well as the maximum values of these variables, however, we see that the bulk of firms have assets, market values and enterprise values that are relatively close to the respective medians. This suggests that our sample contains extreme outliers. The median underpricing for the firms in our sample, here calculated as the relative difference between offer and first day trading closing price, is 9% with a standard deviation of 21%[35]. The presence of underpricing may have implications for the effectiveness of relative valuation and will be discussed in more detail in our interpretation.

3.2.2 Actual versus market multiples

Following the selection of peer companies for our sample of 246 US IPOs, we compare the descriptive statistics of our estimated market multiples, i.e. the median multiples of comparable companies for all firms in our sample, with those of the actual multiples of the IPO valuations, to gain some first insights for our empirical analysis. Table 6 offers an overview of this comparison.

In general, the estimated market multiples are slightly higher than the actual multiples which indicates that our results may turn out to be slightly biased. The exceptions are the EV/EBIT, the P/forward sales and the EV/forward sales. While the EV/EBIT multiple is the only multiple where on an aggregated level our estimated market multiples are lower than the actual multiples, both forward sales multiples (EV and Price) seem to generally be substantially larger than the actual multiples. The differences between estimated market values and actual multiples are our first indications of where we ultimately expect to see pricing errors and for what type of multiple we expect these to be relatively small or large. However, these differences are to be interpreted with caution. A large difference between estimated median market multiple and corresponding median actual market multiple across the entire sample can indicate two things. First, the multiple in question is ineffective in predicting firm value over the entire sample, and second, a certain subsample (e.g. a specific industry) of firms cannot effectively be valued through the use of this multiple while other subsamples can, still resulting in an aggregated median which is distorted away from the median

[34] This assessment is based on a comparison to the average age of S&P 500 firms in 2011 of 18 years (Innosight 2012)
[35] Following Berkman, Bradbury and Ferguson (2000), underpricing is calculated as (1st day closing price – offer price) / offer price

of the actual multiples. Accordingly, on an aggregated level similar estimated market and actual multiples can indicate that either the multiple works well across the entire sample or that the effectiveness of the multiple is different for several or all subsample of our population of firms, i.e. some are valued relatively accurately and others relatively inaccurately.

- Table 6 -

	Actual Multiples				Market Multiples			
			Percentiles				Percentiles	
	Median	**Standard Deviation**	25th Percentile	75th Percentile	**Median**	**Standard Deviation**	25th Percentile	75th Percentile
At IPO								
Price / Net Income	(18.6)x	670.2x	(37.1)x	(9.8)x	(17.4)x	124.2x	(26.8)x	(11.6)x
Price / 12 mth Forward Sales	6.0x	2,409.9x	3.8x	25.1x	10.1x	1,336.6x	4.2x	50.8x
Price / 12 mth Forward Net Income	(6.9)x	110.2x	(13.8)x	(4.3)x	(6.6)x	31.6x	(11.8)x	(4.9)x
Price / Adj. Total Equity	7.8x	170.1x	(3.8)x	17.6x	8.7x	71.9x	5.2x	13.1x
EV / Sales	9.8x	3,208.8x	5.3x	43.5x	11.8x	1,017.2x	6.3x	32.6x
EV / EBIT	(16.4)x	426.5x	(32.6)x	(9.0)x	(16.8)x	53.5x	(23.6)x	(11.5)x
EV / 12 mth Forward Sales	6.0x	2,383.6x	3.8x	21.3x	10.3x	1,328.5x	4.2x	48.6x
EV / 12 mth Forward Net Income	(6.5)x	116.8x	(12.8)x	(3.9)x	(6.1)x	35.4x	(11.6)x	(4.4)x
EV / Total Assets	6.9x	77.7x	3.9x	12.5x	7.5x	29.1x	5.1x	11.1x
1st-Day Closing								
Price / Net Income	(22.0)x	818.3x	(45.0)x	(10.9)x	(19.1)x	131.8x	(38.8)x	(12.5)x
Price / 12 mth Forward Sales	8.1x	2,500.9x	3.9x	29.6x	11.4x	1,437.7x	5.2x	50.5x
Price / 12 mth Forward Net Income	(8.2)x	131.9x	(18.6)x	(4.3)x	(7.7)x	44.8x	(15.6)x	(5.1)x
Price / Adj. Total Equity	9.5x	175.4x	(3.5)x	23.5x	10.5x	70.6x	5.8x	14.9x
EV / Sales	13.0x	3,290.3x	6.0x	58.8x	13.6x	944.9x	7.4x	43.3x
EV / EBIT	(17.5)x	443.4x	(40.3)x	(9.9)x	(18.2)x	64.9x	(32.3)x	(12.0)x
EV / 12 mth Forward Sales	8.4x	2,466.7x	4.2x	27.4x	10.6x	1,427.7x	5.0x	48.3x
EV / 12 mth Forward Net Income	(7.3)x	138.2x	(18.0)x	(4.1)x	(6.9)x	48.8x	(15.5)x	(4.6)x
EV / Total Assets	8.7x	78.1x	4.6x	16.1x	8.9x	21.8x	6.1x	12.3x

Descriptive statistics of calculated actual and market multiples
The actual multiples are the multiples as observed from the actual valuations of the firms in our sample. The market multiples are the median multiples of the five selected comparable IPOs for the firms in the sample. The multiples at IPO are based on actual IPO valuations as calculated by multiplying the number of shares outstanding immediately after offering with the offer price. The multiples as of closing on the first day of trading are based on the closing share price and the number of shares outstanding immediately after the offering.

The standard deviations are lower for the estimated market multiples than the actual multiples, which is in line with our expectation, as the estimated market multiples are medians of the selected peer companies which reduces the effect of extreme outliers on the standard deviation. Remarkably high standard deviations are shown for all multiples that include any kind of sales measure. For our sample, we see sales also as an indicator for the development stage of a firm, i.e. whether a firm is not yet selling any good or service, has just begun to sell its offerings or is an established company with continuous and stable sales revenues. Having firms with close to zero sales and firms with fairly high sales volumes within our sample leads to the extreme standard deviations we can observe for the multiples.

Addressing individual multiples at the time of the IPO, the 12 mth forward net income multiples (both on EV and price) as well as the EV/EBIT multiple offer medians that are closest to the medians of the actual multiples. The P/E and EV/total assets also show estimated market multiples fairly close to actual multiples. All estimated market sales multiples, especially multiples including forward looking sales multiples, are not within close range of the actual multiples, which may seem surprising, given that previous

literature has argued for sales to be almost the only relevant multiple to be used for firms with negative earnings. Similar to the sales multiples, the median of the estimated market M/B (Price/adj. total equity) multiples is relatively far away from the median of the actual M/B multiples, which is contradicting to the increase in value relevance of book value of equity for negative earnings firms found in previous research. However, as described above, a mere comparison between aggregated median estimated market multiples and aggregated median actual multiples should not be over interpreted and may be due to different effectiveness of the multiples for diverse subsamples of our population of firms. When comparing estimated market equity and enterprise multiples in general, we observe no difference in deviation from actual multiples across our sample.

With regards to the comparison of medians of estimated market multiples and actual multiples at the closing of the first day of trading, the difference between the two on an aggregated level is slightly lower than for the offer price, potentially indicating that multiples can provide marginally more accurate explanations for end of first day trading prices than for offer prices. With the exception of the EV/sales multiple, which at the closing of the first trading day produces a median of the estimated market multiples much closer to the median of the actual multiples than for the IPO valuations, the effectiveness of the individual multiples seems to be fairly in line with the effectiveness of multiples at the time of the IPO. The marginal differences observed between the time of the IPO and the end of the first trading day may be due to the presence of underpricing, as recorded in the descriptive statistics of our sample.

3.3 Results

Table 7 summarizes the pricing errors for our sample of 246 US IPOs resulting from the valuation process described in '3.1 Methodology'. The pricing errors are calculated in percentages as the absolute difference between the actual market values at IPO and the firm values derived from our comparable company valuation relative to the actual market values. This calculation follows Liu, Nissim and Thomas (2002) and allows for straightforward interpretation and allows us to compare the results of this study to previous findings. The focus of our analysis will be on the median pricing errors as well as the percentage of the predicted values within 15% of the actual IPO valuations. The prior serves as an indicator of the overall performance of the selected valuation methods, while mitigating the effect of outliers, some of which take fairly extreme values as shown in the previous section. The latter is an important performance measure for valuation methods, as in existing literature a pricing error of below 15% is perceived to be an acceptable approximation of firm value.

The results of our empirical analysis show that the overall effectiveness of the selected multiples for our sample is comparable to that for positive earnings IPOs, but lower than that for multiples in others contexts

and other valuation methods recorded in previous studies. With regards to individual multiples, forward looking multiples outperform their trailing counterparts.

- Table 7 -

	Pricing Errors Offer Price								
	Price / Net Income	Price / 12 mth Forward Sales	Price / 12 mth Forward Net Income	Price / Adj. Total Equity	EV / Sales	EV / EBIT	EV / 12 mth Forward Sales	EV / 12 mth Forward Net Income	EV / Total Assets
Total Sample									
Median	59%	56%	46%	71%	56%	61%	46%	45%	57%
Percentage of Pricing Errors Below 15%	12%	17%	18%	9%	13%	11%	16%	19%	13%

Pricing errors at IPO for total sample
The depicted pricing errors are calculated as the absolute difference between the actual and estimated multiple divided by the actual multiple. All multiples are as of the time of IPO, i.e. they are based on the offer price. The median pricing errors and the percentages of pricing errors below 15% are shown for the total sample of firms.

As presented in Table 7, the median pricing errors for the selected multiples range from 45% to 71%. The corresponding percentages of observations with a pricing error below 15% are between 9% and 19%. Comparing these results to those of previous studies, we recognize that the proportion of valuations with pricing errors below 15% is considerably lower than the 37% found by Kaplan and Ruback (1995). However, as Kaplan and Ruback studied highly leveraged transactions, Kim and Ritter's (1999) sample of 190 positive earnings operating company IPOs in the US market offers a more feasible comparison. Kim and Ritter find the respective values to be between 12% and 22% and hence relatively similar to ours. When considering the performance of individual multiples in our study, the M/B multiple is found to perform worst across our sample with only 9% of the predicted values lying within 15% of the actually observed values. Therefore, while some of the literature on the value relevance of earnings and equity found the value relevance of equity to increase with lower earnings (Collins, Maydew and Weiss 1997; Aggarwal, Bhagat and Rangan 2009), we find this relationship to not hold for our sample of IPO firms. The performance of the P/E multiple, however, is in line with the expectations from previous literature. The results indicate that the P/E ratio is not a good value estimator for negative earnings firms, valuing a mere 12% of firms within 15% of their actual value. Similar to the M/B and the P/E multiple, the EV/sales multiple produces pricing errors of below 15% for only 13% of valuations. This is contrary to the assumption of Liu, Nissim and Thomas (2002) stating that for negative earnings firms the EV/sales multiple yields the most accurate valuations, but in line with Hand's (2000) results showing only a weak positive relationship for revenue and firm value for negative earnings firms. Analog to the P/E, M/B and EV/sales multiples, the EV/EBIT and EV/total assets multiples display relatively inaccurate results, despite their common application in practice and the indications from our initial comparison of actual and market multiples in the previous section. In accordance with the findings of previous research on multiples for profit making firms, our results indicate that forward looking multiples outperform trailing multiples. This also supports Lie and Lie's (2002) notion that forward looking multiples are particularly more relevant when valuing low earnings firms. Among the forward looking multiples, those based on forward looking net income outperform those based on forward looking sales, with 18% (P/forward net income) and 19% (EV/forward net income) of

the predictions being within 15% of the actual values. It is noteworthy that the multiples with superior performance among the forward looking multiples are inconsistent from a theoretical accounting perspective[36]. While surprising, as mentioned previously, Liu, Nissim and Thomas (2002) and Schreiner (2009) already observed superior performance of theoretically inconsistent multiples, where the P/EBITDA outperformed the EV/EBITDA multiple.

Overall we find the performance of multiples for negative earnings IPO firms in our sample to be low in absolute terms. In relative terms, however, the results are very comparable to those for positive earnings IPOs, yielding pricing errors of similar magnitude as previously found by Kim and Ritter (1999). Furthermore, the results show that forward looking multiples outperform trailing multiples, which is in line with existing research. To gain further insights into the pricing errors found and the factors they depend on, the results have been tested for their sensitivity to firm age, size, industry as well as sales and equity levels. The detailed assessments are discussed in the following section.

3.3.1 Variation in performance across firm types

The variation in performance of the chosen multiples across different types of firms provides additional insights into the effectiveness of the given multiples and enhances the understanding of the underlying value drivers. Table 8 below summarizes the pricing errors for the various subsamples.

3.3.1.1 Variation in performance between young and old firms

When separating the firms in our sample into portfolios of firms younger (young) and equal to or older (old) than ten years, differences show in the performance of several multiples across these subsamples. While the trailing and forward looking net income multiples appear to be similarly value relevant for older and younger firms, the three sales based multiples are considerably more accurate for younger firms. In contrast, the simple EV/EBIT multiple performs better for older firms than for younger firms. Similarly, the EV/total assets multiple, which performs poorly for the entire sample of firms with only 13% of the valuations within 15% of the offer price, shows a significant improvement when applied to older firms compared to younger firms, with 17% versus 10% of pricing errors below 15%, respectively. It is important to note that despite the differences in performance between older and younger firms, the effectiveness of the respective multiples is still relatively low. Looking at the effectiveness of the multiples in general, we note that the median pricing errors and the percentage of pricing errors below 15% are slightly lower and higher, respectively, for younger firms. This is in accordance with the findings of Kim and Ritter (1999) for

[36] The respective capital flows, sales and net income, should in theory be related to the capital providers that they would flow to. For instance, as sales flow to all capital providers, the enterprise value would be the appropriate capital base. Accordingly, as net income is the capital flow to all equity holders, it should theoretically be put in relation to equity value.

the majority of the multiples tested in their study, but contrary to expectations expressed by Lie and Lie (2002), who suggest that the valuation accuracy of multiples is higher for established firm than for their younger counterparts.

3.3.1.2 Variation in performance between small and large firms

In line with the classifications of Lie and Lie (2002), we assess the differences in multiple valuation effectiveness between firms with a book value of assets equal to and below (small) and above (large) 100 mUSD. Unlike the marginal differences between the young and old firms, as discussed in the previous paragraph, the valuation accuracy of the selected multiples is considerably higher for small firms for all but the EV/sales multiple. Accordingly, the median pricing error is lower in the majority of cases. The observed difference is most significant for the four forward looking multiples. While none of the multiples in the results discussed above yielded pricing errors below 15% in more than 19% of cases, we find that the EV/forward net income multiple does so in 23% of cases for small firms. This value lies above that of the highest performing multiple for the full sample of profit making firms as recorded by Kim and Ritter (1999). Nevertheless, with median pricing errors between 38% and 58% for these four forward looking multiples, half of the observations remain relatively inaccurate. The pricing errors for the portfolio of large firms are widely dispersed and overall with medians ranging from 49% for the P/forward sales multiple to 97% for the P/forward net income multiple of low accuracy.

3.3.1.3 Variation in performance between firms with and without sales

Given the relatively large amount of firms without revenues in the last fiscal year before the IPO in our sample, we assess the difference in the valuation accuracy of multiples between firms with and without sales. Even more so than for the differentiation between small and large firms, the differentiation between sales and non-sales firms reveals considerable differences in medians and percentages of pricing errors below 15%. We find that net income related multiples, particularly those using the 12 months earnings forecasts, are particularly useful for firms without revenues. More specifically, 36% of the valuations conducted with the EV/forward net income multiple are within 15% of the actual IPO valuations. Beyond that, 50% of these valuations yield a pricing error of below 29%. This result resembles the performance found by Kaplan and Ruback (1995) for the comparable company valuation of highly leveraged transactions (50% of pricing errors below 25%), which is one of the most accurate recorded in previous studies. While the sales based multiples in our study yield more accurate valuations for firms with sales, none of the percentages of pricing errors below 15% exceed 18%. Furthermore, the accompanying medians indicate that in the best case (EV/forward sales), 50% of the valuations have pricing errors of 45% or more, which can be considered a poor result. Finally, the two balance sheet based multiples (M/B and EV/total assets)

perform similarly weak for companies with and without sales in our sample, both being marginally more accurate for firms without sales.

3.3.1.4 Variation in performance across industries

As further sensitivity analysis, we have assessed two subsamples containing the firms in the largest two industries within the sample, the manufacturing and technology companies[37]. For both industries certain multiples display superior or inferior performance. For the manufacturing firms the P/forward net income and the EV/forward net income multiples outperform all other multiples, with 21% and 24% of the pricing errors being below 15%, respectively. While the medians and percentages of pricing errors below 15% are in both cases more accurate than for the entire samples of IPO firms, they do not reach the levels found in the assessment of sales versus non-sales firms. Furthermore, the P/E, the M/B and the EV/EBIT multiple, all of which are widely used in practice, yield more accurate valuations for manufacturing companies than for our entire sample of firms. For technology firms, however, these multiples show inferior performance with as little as 3% of the pricing errors being below 15% for the M/B multiple. In contrast, the three sales related multiples yield fairly accurate estimations of firm value, when applied to technology firms. More specifically, 32% of pricing errors of the P/forward sales multiple are below 15% and 50% of pricing errors are below 25%. Similarly, the valuations using the EV/forward sales multiple are within 15% of the actual values in 29% of cases with a median pricing error of 26%. Beyond that, as the average pricing error of 37% is relatively close to the median of 26%, the dispersion of the pricing errors using the EV/forward sales multiple is comparatively low for the subsample of technology firms.

3.3.1.5 Variation in performance between positive and negative book value of equity firms

As our analysis of existing literature suggests that for negative earnings firms the value relevance of book value of equity is higher than for profit making firms, we further investigate any differences in valuation accuracy of the selected multiples depending on the level of book value of equity. In particular, we differentiate between firms with positive and negative book value of equity. We observe that the median pricing error is lower for firms with positive book value of equity for all multiples. Accordingly, the percentage of pricing errors below 15% is higher for firms with positive equity for most of the multiples; more specifically, for all but the three sales based multiples. For the P/forward sales and the EV/forward sales multiple the percentages of pricing errors below 15% are above 20% and thus higher than for all multiples of the subsample of firms with positive book value of equity.

[37] The industry classifications from the Securities Data Corporations database were used for the creation of the two subsamples. Technology companies within SDC are denoted with 'pers/bus/serv'.

- Table 8 -

	Pricing Errors Offer Price								
	Price / Net Income	Price / 12 mth Forward Sales	Price / 12 mth Forward Net Income	Price / Adj. Total Equity	EV / Sales	EV / EBIT	EV / 12 mth Forward Sales	EV / 12 mth Forward Net Income	EV / Total Assets
Old Firms (Age>=10 Yrs)									
Median	62%	52%	50%	81%	57%	67%	45%	48%	53%
Percentage of Pricing Errors Below 15%	12%	17%	19%	5%	12%	13%	13%	19%	17%
Young Firms (Age<10 Yrs)									
Median	55%	58%	44%	65%	56%	56%	55%	40%	61%
Percentage of Pricing Errors Below 15%	13%	18%	18%	11%	15%	10%	19%	19%	10%
Small Firms (Total Assets=<100mUSD)									
Median	57%	58%	39%	67%	57%	55%	54%	38%	54%
Percentage of Pricing Errors Below 15%	15%	20%	22%	10%	13%	13%	19%	23%	14%
Large Firms (Total Assets>100mUSD)									
Median	65%	49%	94%	81%	56%	72%	42%	97%	59%
Percentage of Pricing Errors Below 15%	5%	10%	7%	4%	14%	5%	10%	7%	11%
Firms without Sales									
Median	49%	95%	34%	49%	-	49%	95%	29%	61%
Percentage of Pricing Errors Below 15%	18%	10%	29%	11%	-	13%	10%	36%	15%
Firms with Sales									
Median	64%	51%	53%	80%	56%	66%	45%	51%	53%
Percentage of Pricing Errors Below 15%	10%	18%	13%	7%	13%	10%	17%	11%	12%
Manufacturing Firms (SDC Classification)									
Median	55%	74%	43%	62%	62%	55%	71%	41%	61%
Percentage of Pricing Errors Below 15%	15%	11%	21%	12%	12%	14%	10%	24%	12%
Technology Firms (SDC Classification)									
Median	65%	25%	53%	89%	36%	68%	26%	51%	46%
Percentage of Pricing Errors Below 15%	7%	32%	14%	3%	21%	8%	29%	13%	15%
Remaining Industries (SDC Classification)									
Median	48%	74%	94%	67%	84%	89%	65%	86%	39%
Percentage of Pricing Errors Below 15%	9%	5%	10%	0%	0%	0%	10%	5%	17%
Firms with Positive Adj. Total Equity									
Median	55%	50%	46%	58%	55%	60%	44%	44%	50%
Percentage of Pricing Errors Below 15%	14%	16%	19%	11%	13%	12%	14%	20%	15%
Firms with Negative Adj. Total Equity									
Median	71%	74%	50%	127%	64%	67%	65%	48%	70%
Percentage of Pricing Errors Below 15%	7%	22%	16%	3%	14%	7%	22%	17%	9%

Pricing errors at IPO for various subsamples
The depicted pricing errors are calculated as the absolute difference between the actual and estimated multiple divided by the actual multiple. All multiples are as of the time of IPO, i.e. they are based on the offer price. The median pricing errors and the percentages of pricing errors below 15% are shown for the different subsamples. The respective subsamples are based on specific values of the variables described in tables 4 and 5.

3.3.1.6 Timing considerations

An important aspect of IPO valuations is timing. As discussed in previous parts of this paper, newly listed stocks experience large price movements, especially within the first day of trading. In contrast to the offer price, which is determined by selected investors, investment bankers and other inside stakeholders, the trading price is determined entirely by the market. Therefore, we also generate and investigate the pricing errors for the market values at closing of the first trading day[38]. Table 9 shows selected summary statistics of these pricing errors.

[38] First day trading pricing errors imply predicting the market values at closing of the first day of trading using actual firm values at closing of first trading day of recent comparable IPOs for the comparable company valuation

The medians of the pricing errors on the first day of trading range from 43% to 64% for the selected multiples. The corresponding percentages of pricing errors below 15% lie between 11% and 22%. Consequently, considering these two metrics of performance measurement the multiples deliver slightly more accurate valuations for the closing market values of the first day of trading compared to the offer price. The difference in valuation accuracy between the two points in time is most significant for the P/forward net income, the EV/EBIT, the EV/forward sales and the EV/forward net income multiple. In particular, the P/forward net income and the EV/forward net income multiple generate valuations within 15% of the actual first day closing prices in 22% of cases compared to 18% and 19% at the offer price, respectively. Assessing the pricing errors in more detail we find that the difference between the valuation accuracy for younger and older firms remains marginal at closing of the first day of trading. However, it appears that enterprise value based multiples are more effective for the valuation of younger firms whereas equity value based multiples are more effective for older firms at this point in time. Furthermore, and in line with the results for the overall sample, the entire range of pricing errors is lower for both younger and older firms, when estimating firm value at closing of the first trading day. Similar to the patterns observed for younger and older firms, we see that the overall results for both, small and large firms, improve and that the valuation accuracy for small firms is substantially higher. With percentages of pricing errors below 15% ranging from 12% to 27% for small firms across all multiples, the P/forward net income performs most accurate. For small and large firms, the most and least effective multiples do not change between the closing price on first day of trading and the offer price. However, the effectiveness of the EV/forward sales multiple improves substantially, when estimating the first day closing price of large firms. For the portfolio of firms with and without sales the valuation accuracy patterns remain the same at the closing of the first trading day as for the offer price. However, differences in valuation accuracy between the two firm types become smaller for the individual multiples. The net income based multiples for firms without sales yield, with median pricing errors of 32% and 29%, values that are among the best in both, our sample and subsamples. For manufacturing firms, the difference in valuation accuracy of the selected multiples between the offer price and the market valuation (day one closing) is relatively small; only a slight improvement in the effectiveness of the sales based multiples as well as the EV/EBIT multiple are visible. The offer prices of technology firms are best valued using sales based multiples, when focusing on the first day of trading, however, the performance of net income based multiples improves considerably. The resulting percentages of pricing errors below 15% are between 20% and 29% for the four forward looking multiples after the first day of trading, compared to 13% to 32% at the time of IPO. Finally, we observe differences between the valuation accuracy at IPO and after the first day of trading, when comparing firms with positive and negative book value of equity. While estimating the IPO price yields more accurate estimations for firms with negative book value of equity for both forward looking sales multiples, only the EV/forward sales multiples yielded more precise valuations for firms with negative book value at the end of the first day of trading. Thus, at closing of the first trading day most multiples show superior performance when applied to firms with positive book value of equity.

- Table 9 -

	Pricing Errors Closing Price First Trading Day								
	Price / Net Income	Price / 12 mth Forward Sales	Price / 12 mth Forward Net Income	Price / Adj. Total Equity	EV / Sales	EV / EBIT	EV / 12 mth Forward Sales	EV / 12 mth Forward Net Income	EV / Total Assets
Total Sample									
Median	51%	51%	43%	64%	48%	54%	46%	43%	52%
Percentage of Pricing Errors Below 15%	15%	16%	22%	11%	15%	16%	20%	22%	15%
Old Firms (Age>=10 Yrs)									
Median	58%	49%	47%	68%	45%	54%	45%	47%	49%
Percentage of Pricing Errors Below 15%	16%	17%	24%	12%	14%	14%	21%	19%	17%
Young Firms (Age<10 Yrs)									
Median	50%	51%	40%	62%	19%	54%	59%	41%	53%
Percentage of Pricing Errors Below 15%	15%	15%	21%	10%	15%	17%	20%	24%	14%
Small Firms (Total Assets=<100mUSD)									
Median	52%	54%	37%	62%	51%	53%	54%	37%	52%
Percentage of Pricing Errors Below 15%	16%	19%	27%	12%	17%	17%	20%	26%	15%
Large Firms (Total Assets>100mUSD)									
Median	51%	47%	80%	68%	47%	62%	40%	77%	52%
Percentage of Pricing Errors Below 15%	12%	10%	7%	9%	10%	12%	20%	7%	14%
Firms without Sales									
Median	45%	89%	32%	44%	-	47%	90%	29%	53%
Percentage of Pricing Errors Below 15%	19%	15%	28%	18%	-	18%	15%	33%	14%
Firms with Sales									
Median	58%	48%	49%	70%	48%	58%	43%	50%	51%
Percentage of Pricing Errors Below 15%	13%	16%	20%	8%	15%	15%	21%	16%	16%
Manufacturing Firms (SDC Classification)									
Median	51%	73%	37%	61%	53%	52%	71%	37%	57%
Percentage of Pricing Errors Below 15%	16%	14%	24%	10%	12%	20%	14%	24%	13%
Technology Firms (SDC Classification)									
Median	55%	33%	59%	78%	36%	56%	31%	59%	44%
Percentage of Pricing Errors Below 15%	14%	23%	21%	15%	23%	8%	29%	20%	19%
Remaining Industries (SDC Classification)									
Median	40%	62%	86%	57%	68%	101%	59%	77%	26%
Percentage of Pricing Errors Below 15%	17%	5%	14%	9%	4%	9%	24%	14%	17%
Firms with Positive Adj. Total Equity									
Median	48%	48%	41%	48%	45%	53%	42%	42%	45%
Percentage of Pricing Errors Below 15%	17%	19%	24%	12%	14%	19%	24%	22%	15%
Firms with Negative Adj. Total Equity									
Median	63%	78%	45%	114%	53%	63%	76%	46%	66%
Percentage of Pricing Errors Below 15%	10%	9%	17%	7%	16%	9%	9%	21%	15%

Pricing errors based on closing price on first day of trading

The depicted pricing errors are calculated as the absolute difference between the actual and estimated multiple divided by the actual multiple. All multiples are as of the first day of trading, i.e. are based on the closing share price on the first trading day. The median pricing errors and the percentages of pricing errors below 15% are depicted for the total sample as well as various subsamples. The respective subsamples are based on specific values of the variables described in tables 4 and 5.

In line with our expectations from the analysis of the descriptive statistics of the actual and market multiples, we find the overall valuation accuracy to be slightly higher for the closing prices of the first trading day. Additionally, we observe that the differences between our subsamples remained but decreased in magnitude.

3.3.2 Robustness of reported results

The results of our study are subject to decisions made in the methodology of our empirical analysis, e.g. the selection of multiples, the selection of comparable companies and the calculation of pricing errors. Furthermore, we focus on measures of central tendency, while the conclusions drawn may be different when taking into account the variation of valuations. In the following section we report further steps that

have been taken in order to test the influence of the decisions made on our reported findings and to gain a more sophisticated understanding of their validity.

3.3.2.1 Selection of multiples

As described in section '3.1.3 Selection of multiples', our selection of multiples is largely based on the theories from existing literature as well as the application in practice. To prevent the omission of any unanticipated results, we have also tested a larger variety of multiples.

The EV/R&D and the EV/CapEx are among the further multiples tested and are based upon R&D expenses and capital expenditures, respectively. Our review of the existing literature on the value relevance of accounting fundamentals has shown that these multiples are worth investigating. Research suggests that for negative earnings firms certain investment expenses are valued positively by the markets and seen as options for future growth and profitability. However, the quality of the data obtained and publicly available for these data points did not satisfy our quality requirements. Crosschecks with IPO prospectuses revealed that in the databases both, R&D expenses and capital expenditures, often referred to different line items in income or cash flow statement for the various firms. Consequently, we presume that the results are of limited validity and therefore remain unreported.

3.3.2.2 Selection of comparable companies

The existing literature on the effectiveness of multiples has covered a wide range of methods for the selection of comparable companies. For our choice of method, we have incorporated existing literature on the effectiveness of different selection methods as well as common practices. The selection method has a potentially large impact on our findings, as it determines the comparable companies and consequently the market valuations derived. Therefore, we performed additional empirical analyses adjusting specific parts of the valuation process. In particular, the selection rules were changed from (1) same 4-digit industry membership, (2) comparable sales level and (3) comparable adjusted book value of equity level to (1) same 4-digit industry membership and (2) comparable adjusted book value of equity level. This was done, as some previous literature suggests an increase of the value relevance of book value of equity for loss making firms. While this adjustment had a substantial impact on the selected peer companies in most of the cases (e.g. all five peers different to first selection), it did not lead to considerable differences in the resulting pricing errors. With the exception of the M/B multiple the percentage of pricing errors below 15% was lower for all multiples, when ignoring sales in the selection of comparable companies. The improvement for the M/B multiple can simply be explained by the selection focus on book value of equity, inherently making the firms more comparable with regards to equity levels and thereby decreasing the pricing errors

for the corresponding multiple. In a second step, the requirement of all comparable companies having to be in the respective industry has been loosened in order to understand its impact on our results. In the case of less than six firms in a given industry, the remaining comparable companies were then selected based on book value of equity. This adjustment also had a slightly negative impact on the performance of the selected multiples. As both adjustments are unlikely to be used in practice and deliver results inferior to those of our three-step process, we are confident our original selection method is theoretically as well as practically relevant.

3.3.2.3 Calculation of pricing errors

The previous discussion of the valuation accuracy of multiples for our sample and subsamples of IPO firms showed a fairly wide dispersion for all multiples. Accordingly, the fact that the median differs from the average (unreported) in all cases indicates that the distribution of the pricing errors is skewed. While the magnitude of the difference between the average and median varies, it is generally substantial for all multiples in our sample. Part of the skewedness arises from the fact that pricing errors are downward bound, with a maximum error of 100%, while there is no upward boundary. As we focus on a measure of central tendency (median) in the discussion and interpretation of our results, we recalculate the pricing errors with an alternative formula used by Kim and Ritter (1999) and Kaplan and Ruback (1995). Thereby, we can assess the impact of our chosen method for calculating the pricing errors on our findings. In their research, the previously mentioned authors calculate pricing errors as the natural logarithm of the estimated market valuation over the actual market valuation[39]. While the resulting pricing errors cannot be interpreted as easily as the pricing errors previously reported in this paper, taking the logarithm of a ratio decreases the dependence on the absolute magnitude of the values and evens out highly skewed distributions (Speed 2000).

When using the natural logarithms, we anticipate an approximately normal distribution of pricing errors with mean and median equal to zero. Any deviations would provide an indication of a potential upward or downward bias of our valuation errors. Furthermore, a comparison of the resulting percentages of pricing errors within 15% with those generated with our calculation method acts as a robustness test for our overall findings.

The results from calculating pricing errors with the natural logarithm are in line with those from our approach and the relative performance of the selected multiples remains the same over our total sample. Nevertheless, and contradicting to our expectations from the analysis of market versus actual multiples, we

[39] This method is mathematically equal to taking the natural logarithm of the estimated market valuation minus the natural logarithm of the actual market valuation

observe a marginal negative bias for most of our multiples, which means that the comparable company valuation of our empirical analysis undervalues slightly more than half of the firms in our sample.

3.3.2.4 Analysis of measures of central tendency

In our analysis of the empirical results we focus on median pricing errors as well as percentage of pricing errors below 15%. This is in accordance with existing literature on the accuracy of valuation techniques and allows us to compare and interpret our results. However, this ignores the possibility that multiples may on average successfully predict firm values, but perform poorly in predicting variations in IPO valuations and vice versa. We therefore conduct a regression analysis similar to Kaplan and Ruback (1995). The results of the regression confirm the results reported in the previous sections. We run regressions for the nine selected multiples according to the following model:

$$Actual\ Multiple_{\ i} = \alpha + \beta(Estimated\ Market\ Multiple)_{i,\,comp} + \varepsilon_i$$

where $Actual\ Multiple_i$ is the actual respective multiple at IPO for a given firm in the sample, α is the constant, β is the estimated regression coefficient, $Estimated\ Market\ Multiple_{i,comp}$ is the respective median market multiple from the comparable companies and ε_i is the regression error term for the respective firm. In order to account for the effects of firm size on our regression results we regress actual on estimated market multiples instead of absolute on estimated firm values. To improve the validity of our results and in order to approximately fulfill the normality requirements underlying the regression[40], we exclude the top and bottom 5% of the actual and the market multiples. If, in our model, the estimated market multiples are accurate predictors of the actual IPO values, the intercept and the regression coefficient take the values zero and one, respectively. In all of our regressions, however, the intercept differs significantly from zero and the coefficient significantly from one, indicating that the valuation errors are not consistent across the full range of multiples. Furthermore, the different distributions of the actual and the market multiples, arising from the use of medians for the latter, cause some of the residual distributions to show signs of heteroscedasticity[41]. This may potentially impact the validity of our results. However, as the normality requirement appears to be approximately met for all variables, we still consider the results of our regressions in our robustness tests[42]. The results of our regression analysis are in line with those of our previous empirics. The forward looking multiples perform best in explaining the variation in company values in general as indicated by the R-square values (see Table 10). More specifically, the regression shows that the P/forward sales and EV/forward sales explain up to 26% and 24% of the variation of valuations,

[40] See frequency histograms in the appendix for the resulting distributions for each multiple

[41] The use of medians, when estimating market multiples, mitigates the effect of outliers, thereby making the distribution of market multiples more narrow. Consequently, the variance of the error term increases as the values of the independent variable, the actual multiple, increases.

[42] This is in line with Richard Williams' guide on dealing with heteroscedasticity (Williams 2015)

respectively. Surprisingly, according to our results the simple EV/sales multiple explains 20% of the variation. Again, our results are comparable to the results of Kaplan and Ruback (1995), who find R-square values of 0.22 to 0.34 for the comparable company valuations for their sample of highly leveraged transactions. As the results from our regressions are largely in line with those from our analysis of pricing errors, the regression analysis confirms our previous findings and supports their robustness.

- Table 10 -

	Linear Regression Results								
	Price / Net Income	**Price / 12 mth Forward Sales**	**Price / 12 mth Forward Net Income**	**Price / Adj. Total Equity**	**EV / Sales**	**EV / EBIT**	**EV / 12 mth Forward Sales**	**EV / 12 mth Forward Net Income**	**EV / Total Assets**
Intercept									
Constant	(18.04)*	15.20*	(3.06)*	0.60*	28.46*	(16.63)*	13.67*	(2.56)*	6.01*
Slope									
Coefficient	0.45*	0.53*	0.61*	0.65*	0.56*	0.43*	0.54*	0.66*	0.37*
T-statistic	(4.33)	(6.31)	(4.31)	(2.94)	(4.69)	(3.58)	(5.53)	(3.94)	(6.42)
Model									
R^2	0.06	0.26	0.18	0.13	0.20	0.03	0.24	0.22	0.07
N	198	140	209	204	139	207	142	207	205

*. Value is significant at the 0.05 level (2-tailed).

Regression results for selected multiples
Linear ordinary least squares regression with the actual market multiples as dependent and the estimated market multiples as independent, explanatory variables. The input variables are based on our sample of US IPOs firms meeting the criteria in table 1 in the years 2013, 2014 and 2015. Of the data available the highest and lowest 5% of multiples have been removed from all variables in order to mitigate the effect of extreme outliers (see appendix for distributions of residuals). The reported t-statistics for the slope coefficient are calculated as the difference between the coefficient and one divided by the standard error in order to test whether the null hypothesis that the respective coefficients are equal to one to one can be rejected with statistical significance.

4. Interpretation

The results of our empirical analysis show that while the valuation accuracy is generally lower for the relatively young IPO firms than for the more established listed firms, the valuation accuracy for loss making IPO firms is similar to that of profit making IPO firms[43]. Furthermore, forward looking multiples outperform trailing multiples across the entire sample and, for some subsamples, e.g. for technology firms or firms without sales, deliver reasonably accurate result. The assessment of various subsamples of firms indicates that, as for positive earnings firms, for negative earnings firms in an IPO setting the validity of relative valuation is dependent on chosen multiple, firm characteristics and industry classification.

Several clear patterns emerged during the detailed analysis of our empirical results, most dominantly, the superiority of forward looking multiples with regards to valuation accuracy. Trailing multiples, such as the P/E, the EV/EBIT and the M/B multiple, show low valuation accuracy across all subsamples. Despite its popularity, the weak performance of the P/E multiple was anticipated, as selected previous research on

[43] Based upon a comparison of our pricing errors to those of Kim, Ritter 1999

positive earnings IPO firms already recorded poor valuation accuracy for the P/E multiple[44]. Given negative earnings and nonexistent sales for a large number of firms within our sample, trailing net income and EBIT often become a proxy for total expenses. As described in the literature review, previous research suggests that certain expense components are value relevant in specific industries[45] and can act as indicators of future growth and (or) enhanced profitability[46]. However, this does not seem to apply to the trailing multiples within our sample, which may be due to the rapid development of the firms in our sample, where solely valuing past expenses would fail to take current as well as already planned future projects into consideration. The poor performance of the M/B multiple may be attributable to the substantial balance sheet changes often occurring around the time of the IPO as consequence of the public listing[47]. As for the P/E and EV/EBIT multiple, the weak performance of the M/B multiple may then be linked to the specific type of firms performing IPOs, young firms with high growth and in the case of our sample negative earnings. Previous research for profit making firms on the remaining trailing multiples, namely the EV/sales and EV/total assets, showed varying results, independent of the specific economic situation and firm type considered[48]. In our empirical analysis for loss making firms the pricing errors for these multiples are relatively high across all subsamples and offer only one clear takeaway, the application of these multiples in practice would most likely cause significant errors.

As stated above, forward looking multiples outperform trailing multiples for the entirety of our sample as well as most subsamples. Previous literature on the effectiveness of relative valuation for profit making firms unanimously agreed on the superiority of forward looking multiples, regardless of economic circumstances. It seems, however, that this is particularly applicable to the young high growth IPO firms with negative earnings present in our sample. Our empirical results show that for firms without sales and firms in the technology sector, the EV/forward net income and the P/forward sales multiple estimate market value remarkably well. The percentages of pricing errors below 15% are 36% and 32%, respectively, even comparable to those recorded for established positive earnings firms[49], which indicates that especially for these subsamples multiple valuation is in fact practically relevant. It is noteworthy that for a large proportion of the firms in our sample the 12 month earnings forecasts are negative. The strong valuation accuracy is thus presumably attributable to the nature of the negative earnings and some of its loss components rather than future positive earnings, i.e. the losses are deemed transitory and relevant proxies for future growth options as well as profitability prospects. With regards to equity and enterprise value based multiples our results show no significant differences.

[44] For example: Lie, Lie 2002; Schreiner 2007

[45] In reference to the literature review: industries requiring substantial investments before revenue generation, e.g. technology, pharmaceuticals or mining

[46] For example: Hand 2000; Joos, Plesko 2005; Franzen, Radhakrishnan 2009

[47] In several observed cases large parts of the capitalization (e.g. preferred stock, warrants) are subject to a forced conversion to equity in the case of an IPO

[48] For example: Lie, Lie 2002; Schreiner 2007

[49] As presented in the results of Lie, Lie 2002

The detailed analysis of the results for our subsamples provides further insights into the factors that impact the valuation accuracy of multiples for loss making firms in an IPO context. While firm age appears to have no considerable effect on the effectiveness of multiples, our results indicate that firm size does. Within our sample all but the EV/sales multiple perform substantially better for small firms, i.e. firms with total assets equal to or below 100 mUSD, than for their larger counterparts. This is in contrast to previous research done on profit making firms[50], where the valuation accuracy was found to be superior for larger firms, i.e. firms with assets above 100 mUSD. We believe the difference in findings stems from a lower degree of comparability among the larger firms in our sample. While the size limit of the smaller firms is bound by zero book value of assets, the size of the larger firms is unbound towards higher book values of assets and hence more dispersed. Consequently, the selected peer companies of small firms are more likely to be similar to the one in question than those of larger firms. Additionally, we find that firm value for firms without sales can be estimated more accurately than that for firms with sales. Again, we observe that the diversity of firms with sales is larger than that of firms that do not generate any revenue. Accordingly, the difference in valuation accuracy for firms with and without sales may also stem from varying degrees of comparability. As illustrated above, forward looking multiples outperform trailing multiples across all subsamples. With regards to industries, our results suggest that technology firms are best valued with forward looking sales multiples, while pharmaceutical firms are best valued with forward looking net income multiples. We believe that this could be due to the respective business characteristics, as technology firms often already generate revenues during the development phase, whereas pharmaceutical companies are subject to extensive R&D phases before collecting any revenues. Both industries make up a large part of our sample, which indicates that our findings are in fact widely applicable to negative earnings US IPO firms.

In addition to the detailed analysis of the subsamples, the calculation of the pricing errors for the market values at closing of the first trading day provides us with further insights. We find that the overall valuation accuracy is slightly higher for the closing prices of the first day of trading than for the offer price. Furthermore, the previously observed differences among our subsamples remain, but decrease in magnitude. The difference in valuation accuracy between the offer price and the first day of trading can most likely be attributed to the presence of underpricing, as recorded in the descriptive statistics of our sample. As the degree of underpricing is set on individual firm level, it can be assumed different for the firm to be valued and its comparable companies in the majority of cases, thereby negatively impacting the valuation accuracy. While the differences in pricing errors are rather small, knowledge of these can still be of practical relevance for investors considering an investment in recently listed firms.

From the interpretation of our results it becomes apparent that firm characteristics and industry classification are important determinants of the effectiveness of relative valuation for negative earnings

[50] Lie, Lie 2002; Schreiner 2007

firms in an IPO setting. Within our sample the largest subsamples, i.e. pharmaceutical firms, technology firms and firms without sales, deliver the highest performance. We believe this superior performance stems from a higher degree of comparability among these firms, inherently enhancing the valuation accuracy of multiples. With the largest subsamples representing over 90% of our total sample, our findings are also applicable to negative earnings US IPO firms in general. Furthermore, as the distribution of pricing errors for relative valuation can be wide, we advocate for the common practice of complementing multiple valuations with other valuation methods in order to enhance confidence in the estimated firm values.

5. Conclusion

Our empirical analysis shows that the accuracy of relative valuation for negative earnings IPO firms is comparable to that of positive earnings IPO firms. While the overall valuation accuracy of multiples is relatively low within the context of an IPO, our results show that, for the most common firm types and industries among negative earnings IPOs, specific multiples can in fact yield reasonably accurate results. More specifically, we find that forward looking multiples outperform trailing multiples across all subsamples and deliver reasonable estimates of firm value. Nevertheless, we also find that, independent of firm type and industry, several widely used multiples, such as the P/E, the M/B and the EV/EBIT multiple, perform poorly across the entirety of our sample. Our findings therefore suggest that the effectiveness of relative valuation for negative earnings firms in an IPO setting is dependent on industry and firm type to be valued as well as multiple chosen.

This paper represents a relevant contribution to existing research on the effectiveness of relative valuation and the application of multiples in practice. Our findings discourage the argument that multiple valuation is substantially different for profit and loss making firms. Furthermore, our findings provide valuable evidence for the application of IPO valuations in practice, as our research is consistent in that all data used would similarly be available to practitioners, and offer a solid base for further research within this area.

Given our methodology as well as sample selection criteria our findings are subject to certain limitations. As our sample of IPOs is confined to the US market, our conclusions are also restricted to the US market and a global generalization would require the analyses of further public equity markets. Similarly, our findings are limited to the selected set of multiples and different conclusions may emerge, when further individual or combinations of multiples are tested. Moreover, the distributions of our valuations are slightly negatively biased and the nature of certain firms in our sample leads to fairly extreme values in some of our data points, potentially distorting our results. These limitations are to be taken into consideration.

While our research is applicable on a stand alone basis, there are opportunities to further complement our study. In line with the overall literature on the effectiveness of multiples, a more detailed study on the

impact of different selection methods of comparable companies can enhance the understanding of the drivers of the valuation accuracy of multiples for negative earnings firms. While we have tested the impact of our selection method by recalculating our results using alternative selection criteria, there is room for an in depth analysis of further methods. Similarly, extending our research through the inclusion of additional multiples, including combinations of multiples, which have been found to yield more accurate valuations for profit making firms, can add further insights. Beyond that, testing the value relevance of nonfinancial information for specific industries may contribute to existing research, as our findings indicate that the valuation accuracy of multiples is dependent on firm type and industry. The latter also advocates for the assessment of further subsamples, such as alternative industries or firm characteristics. Additionally, subsequent research may investigate how well and to what extent relative valuation for loss making firms can or should be complemented with other valuation methods.

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Appendix

1. Descriptive statistics of IPO sample (year by year)

- Table 11 -

2013					Percentiles	
(in mUSD, except age)	**Median**	**Max**	**Min**	**Standard Deviation**	25th Percentile	75th Percentile
Firm Data						
Age (in years)	8	113	2	14	6	12
Income Statement Data						
Sales before IPO	29	331	0	80	10	82
Sales growth (1-yr)	38%	3,540%	(98)%	709%	15%	137%
EBIT before IPO	(17)	0	(85)	19	(28)	(10)
Net Income before IPO	(17)	(1)	(90)	19	(30)	(9)
Balance Sheet Data						
Adjusted Equity at IPO	6	128	(167)	48	(3)	29
Total Assets at IPO	42	993	0	145	19	71
IPO Data						
Proceeds	75	1,820	7	238	64	105
% of Float	24%	13%	13%	13%	33%	21%
Market Value at IPO	317	14,162	54	1,900	192	489
Enterprise Value at IPO	310	13,841	57	1,857	177	441
Market Value Closing Day 1	412	22,687	56	3,079	189	723

- Table 12 -

2014					Percentiles	
(in mUSD, except age)	**Median**	**Max**	**Min**	**Standard Deviation**	25th Percentile	75th Percentile
Firm Data						
Age (in years)	8	55	1	8	6	13
Income Statement Data						
Sales before IPO	29	3,855	0	606	4	84
Sales growth (1-yr)	38%	1,500%	(100)%	272%	3%	81%
EBIT before IPO	(13)	156	(90)	30	(22)	(5)
Net Income before IPO	(17)	0	(226)	33	(27)	(7)
Balance Sheet Data						
Adjusted Equity at IPO	12	1,486	(1,088)	201	0	42
Total Assets at IPO	41	5,995	0	771	16	88
IPO Data						
Proceeds	70	890	9	128	50	101
% of Float	28%	17%	36%	17%	33%	20%
Market Value at IPO	250	5,308	25	767	153	495
Enterprise Value at IPO	236	7,558	26	1,079	142	458
Market Value Closing Day 1	290	7,781	22	1,027	155	659

- Table 13 -

2015					Percentiles	
(in mUSD, except age)	**Median**	**Max**	**Min**	**Standard Deviation**	25th Percentile	75th Percentile
Firm Data						
Age (in years)	8	26	1	5	4	11
Income Statement Data						
Sales before IPO	41	11,152	0	1,669	4	133
Sales growth (1-yr)	46%	1,517%	(96)%	290%	6%	72%
EBIT before IPO	(14)	1,351	(182)	165	(22)	(6)
Net Income before IPO	(16)	(1)	(458)	67	(29)	(7)
Balance Sheet Data						
Adjusted Equity at IPO	25	1,476	(827)	231	2	63
Total Assets at IPO	55	34,497	2	4,047	17	117
IPO Data						
Proceeds	76	2,560	14	311	52	132
% of Float	24%	18%	36%	18%	34%	22%
Market Value at IPO	320	14,064	39	1,768	152	603
Enterprise Value at IPO	295	31,766	37	3,777	144	583
Market Value Closing Day 1	389	13,845	37	1,834	154	907

2. Pricing errors of unreported multiples

- Table 14 -

	Pricing Errors Offer Price										
	Price / Sales	**Price / EBITDA**	**Price / EBIT**	**Price / R&D expense**	**Price / CapEx**	**Price / Total Assets**	**EV / EBITDA**	**EV / Net Income**	**EV / R&D expense**	**EV / CapEx**	**EV / Adj. Total Equity**
Total Sample											
Median	62%	63%	60%	58%	88%	56%	65%	59%	54%	87%	73%
Percentage of Pricing Errors Below 15%	15%	11%	11%	9%	7%	14%	11%	14%	13%	11%	8%
Old Firms (Age>=10 Yrs)											
Median	62%	73%	66%	55%	79%	54%	69%	60%	49%	84%	79%
Percentage of Pricing Errors Below 15%	17%	11%	11%	9%	6%	15%	12%	10%	13%	9%	5%
Young Firms (Age<10 Yrs)											
Median	61%	56%	57%	59%	92%	58%	59%	57%	56%	91%	67%
Percentage of Pricing Errors Below 15%	13%	12%	12%	9%	8%	14%	10%	16%	13%	12%	10%
Small Firms (Total Assets=<100mUSD)											
Median	59%	57%	57%	58%	87%	54%	58%	56%	53%	87%	70%
Percentage of Pricing Errors Below 15%	14%	14%	14%	9%	7%	15%	13%	12%	13%	9%	8%
Large Firms (Total Assets>100mUSD)											
Median	71%	88%	74%	59%	91%	59%	83%	65%	57%	86%	85%
Percentage of Pricing Errors Below 15%	16%	4%	4%	12%	7%	11%	4%	18%	12%	18%	5%
Firms without Sales											
Median	NA	46%	47%	61%	94%	60%	47%	50%	57%	93%	54%
Percentage of Pricing Errors Below 15%	NA	19%	20%	13%	1%	16%	13%	18%	10%	1%	13%
Firms with Sales											
Median	62%	77%	68%	56%	79%	54%	75%	61%	50%	78%	82%
Percentage of Pricing Errors Below 15%	15%	8%	7%	7%	9%	13%	10%	12%	15%	15%	5%
Manufacturing Firms (SDC Classification)											
Median	64%	55%	54%	56%	94%	60%	56%	56%	54%	93%	66%
Percentage of Pricing Errors Below 15%	12%	14%	13%	11%	3%	12%	14%	14%	17%	7%	10%
Technology Firms (SDC Classification)											
Median	38%	92%	66%	61%	57%	49%	89%	63%	52%	54%	94%
Percentage of Pricing Errors Below 15%	23%	8%	8%	5%	14%	20%	7%	8%	4%	17%	3%
Remaining Industries (SDC Classification)											
Median	94%	57%	92%	63%	82%	47%	58%	48%	55%	84%	67%
Percentage of Pricing Errors Below 15%	4%	0%	9%	0%	13%	13%	0%	22%	0%	22%	4%
Firms with Positive Adj. Total Equity											
Median	58%	58%	57%	48%	85%	49%	60%	56%	48%	86%	63%
Percentage of Pricing Errors Below 15%	16%	11%	14%	11%	8%	17%	11%	14%	14%	12%	9%
Firms with Negative Adj. Total Equity											
Median	78%	75%	71%	72%	91%	68%	73%	62%	69%	90%	124%
Percentage of Pricing Errors Below 15%	12%	12%	6%	5%	5%	7%	10%	12%	11%	8%	3%

3. Pricing errors calculated with natural logarithm

- Table 15 -

	Pricing Errors Offer Price								
	Price / Net Income	Price / 12 mth Forward Sales	Price / 12 mth Forward Net Income	Price / Adj. Total Equity	EV / Sales	EV / EBIT	EV / 12 mth Forward Sales	EV / 12 mth Forward Net Income	EV / Total Assets
Total Sample									
Median	%	4%	(5)%	(18)%	9%	(11)%	4%	(9)%	7%
Percentage of Pricing Errors Below 15%	12%	17%	21%	11%	15%	11%	17%	21%	13%
Old Firms (Age>=10 Yrs)									
Median	15%	14%	(1)%	(30)%	16%	(4)%	21%	(5)%	5%
Percentage of Pricing Errors Below 15%	12%	17%	21%	7%	13%	12%	13%	19%	13%
Young Firms (Age<10 Yrs)									
Median	(12)%	(9)%	(7)%	(18)%	(4)%	(23)%	(10)%	(12)%	8%
Percentage of Pricing Errors Below 15%	13%	18%	20%	14%	17%	10%	20%	22%	13%
Small Firms (Total Assets=<100mUSD)									
Median	1%	3%	(4)%	(19)%	10%	(5)%	1%	(11)%	(2)%
Percentage of Pricing Errors Below 15%	15%	20%	23%	13%	16%	13%	18%	24%	13%
Large Firms (Total Assets>100mUSD)									
Median	0%	9%	(9)%	2%	7%	(43)%	12%	13%	42%
Percentage of Pricing Errors Below 15%	5%	10%	10%	5%	14%	2%	14%	8%	12%
Firms without Sales									
Median	(2)%	%	(2)%	7%	NA	(12)%	(5)%	(11)%	(3)%
Percentage of Pricing Errors Below 15%	18%	10%	29%	12%	NA	15%	10%	29%	14%
Firms with Sales									
Median	6%	4%	(9)%	(46)%	9%	(9)%	5%	(7)%	10%
Percentage of Pricing Errors Below 15%	10%	18%	16%	10%	15%	8%	18%	16%	12%
Manufacturing Firms (SDC Classification)									
Median	(2)%	(3)%	(4)%	(10)%	11%	(16)%	1%	(12)%	6%
Percentage of Pricing Errors Below 15%	15%	11%	22%	14%	14%	11%	11%	22%	11%
Technology Firms (SDC Classification)									
Median	18%	6%	(9)%	(60)%	5%	(8)%	1%	(6)%	8%
Percentage of Pricing Errors Below 15%	7%	32%	19%	6%	23%	9%	25%	17%	17%
Remaining Industries (SDC Classification)									
Median	(26)%	16%	2%	(39)%	38%	(7)%	50%	8%	13%
Percentage of Pricing Errors Below 15%	9%	5%	12%	%	%	9%	19%	18%	13%
Firms with Positive Adj. Total Equity									
Median	(10)%	(9)%	(9)%	(18)%	4%	(21)%	1%	(12)%	11%
Percentage of Pricing Errors Below 15%	14%	16%	21%	12%	15%	12%	14%	21%	15%
Firms with Negative Adj. Total Equity									
Median	21%	14%	1%	(24)%	31%	14%	9%	5%	(16)%
Percentage of Pricing Errors Below 15%	7%	22%	18%	8%	16%	6%	24%	18%	6%

4. Regression

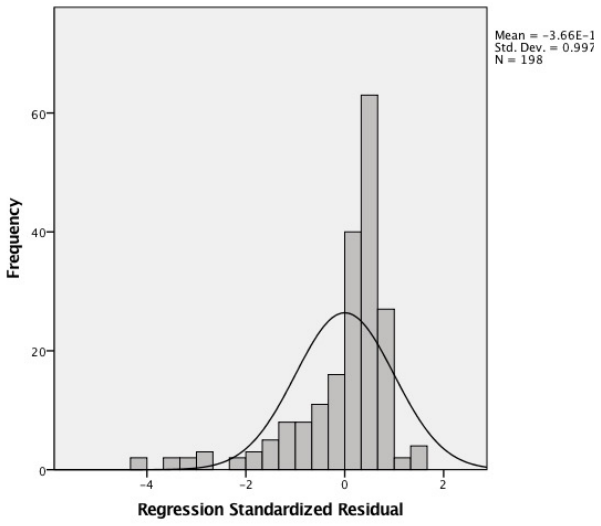

Figure 1: Histogram standardized residuals P/E

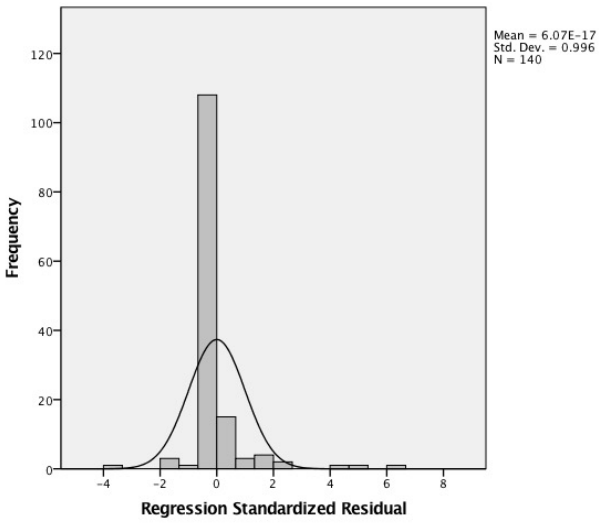

Figure 2: Histogram standardized residuals P/forward sales

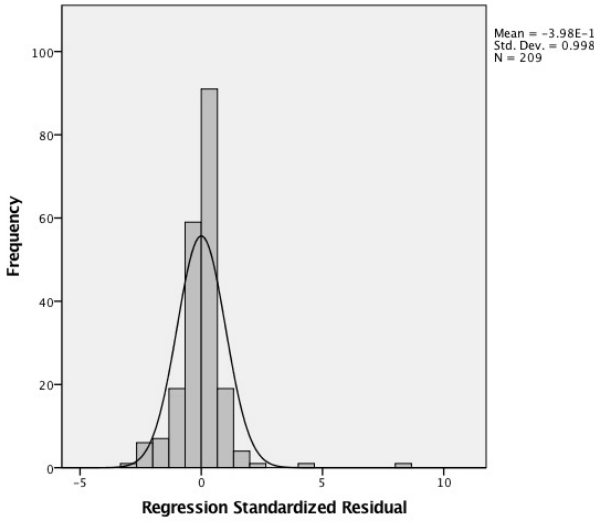

Figure 3: Histogram standardized residuals P/forward net income

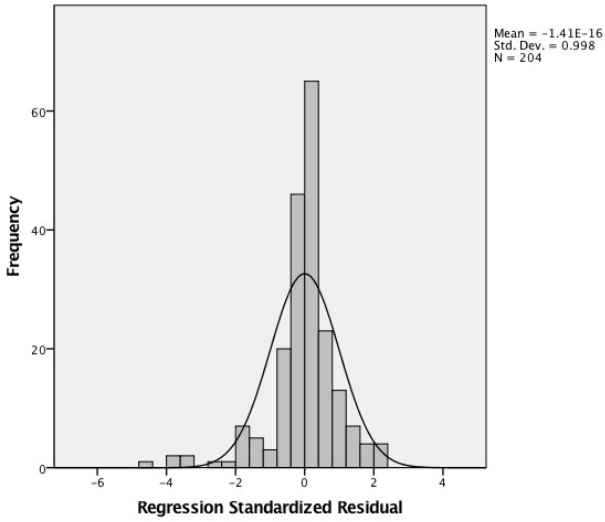

Figure 4: Histogram standardized residuals M/B

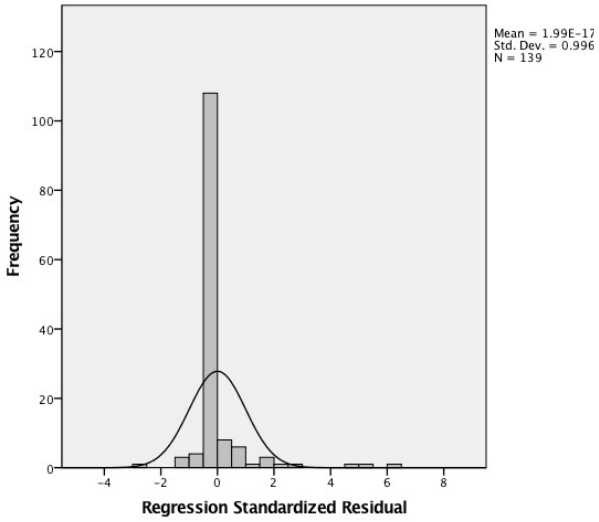

Figure 5: Histogram standardized residuals EV/sales

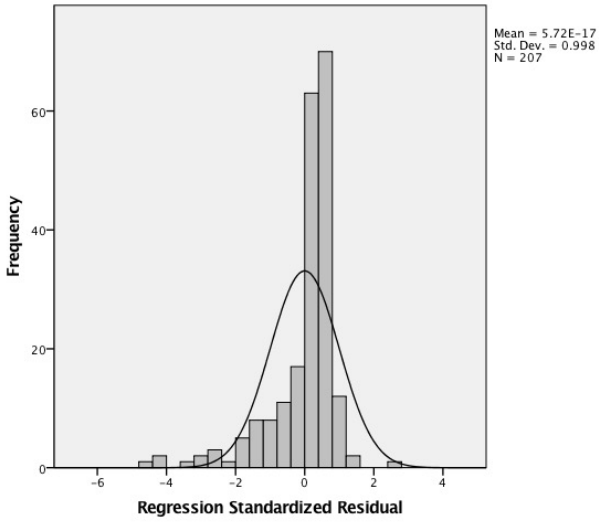

Figure 6: Histogram standardized residuals EV/EBIT

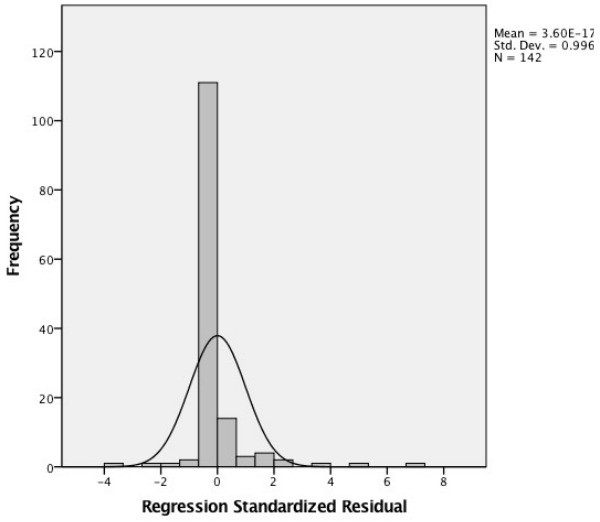

Figure 7: Histogram standardized residuals EV/forward sales

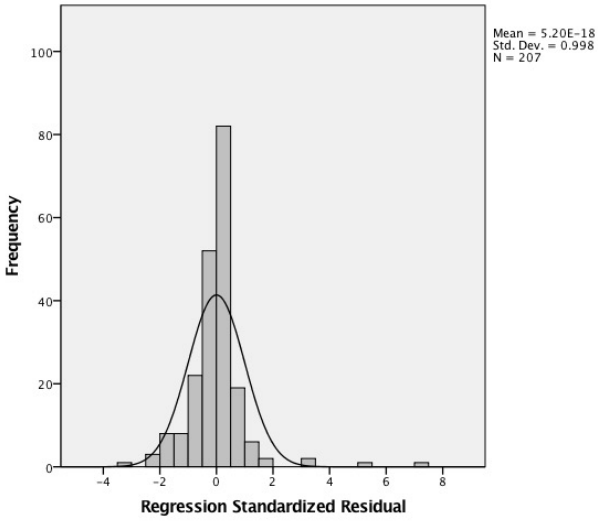

Figure 8: Histogram standardized residuals EV/forward net income

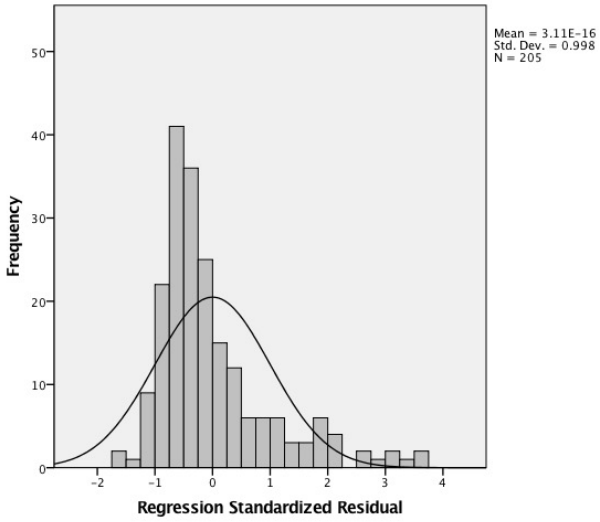

Figure 9: Histogram standardized residuals EV/assets

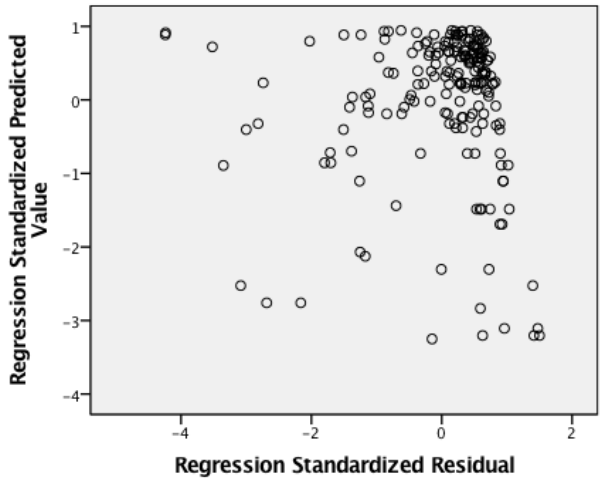

Figure 10: Scatterplot standardized residuals P/E

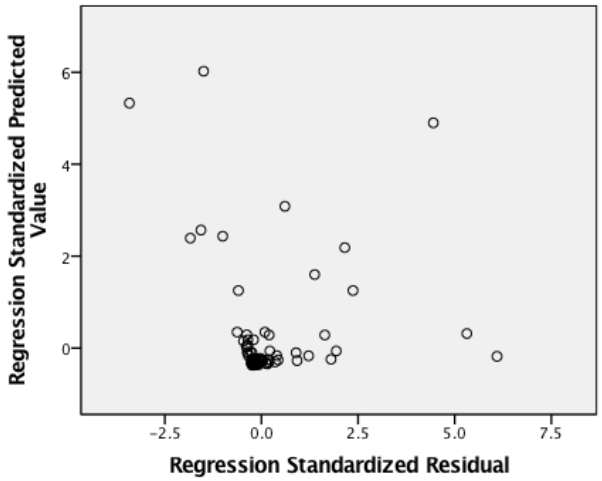

Figure 11: Scatterplot standardized residuals P/forward sales

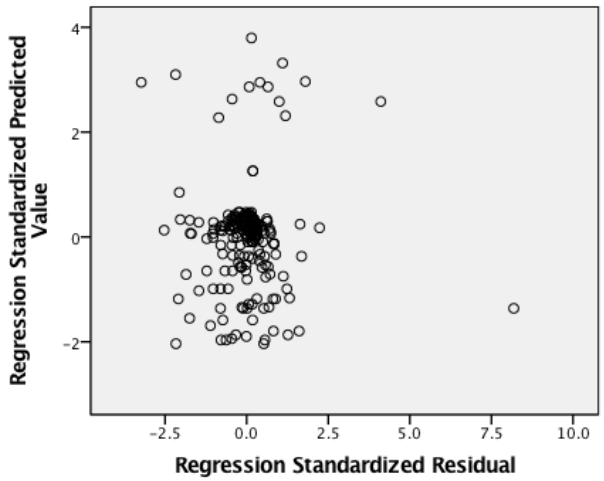

Figure 12: Scatterplot standardized residuals P/forward net income

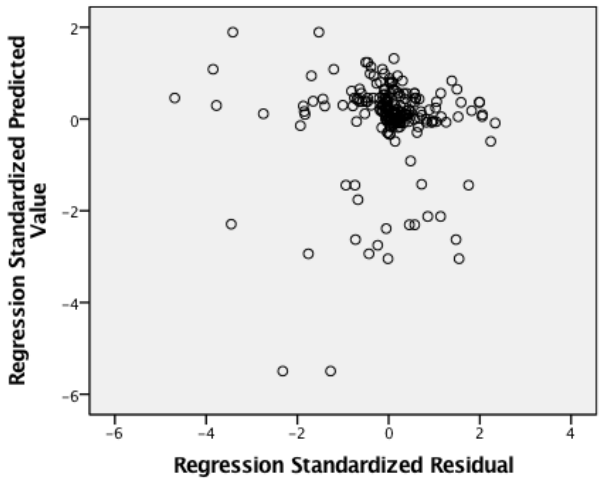

Figure 13: Scatterplot standardized residuals M/B

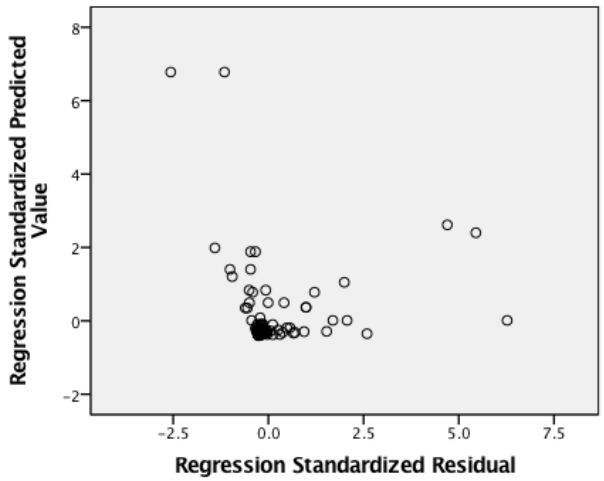

Figure 14: Scatterplot standardized residuals EV/sales

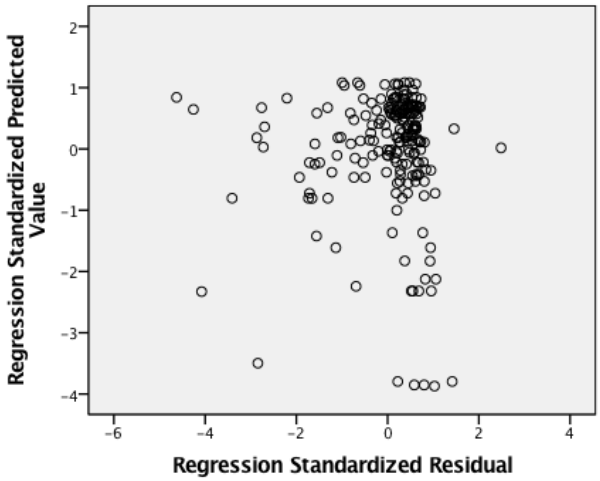

Figure 15: Scatterplot standardized residuals EV/EBIT

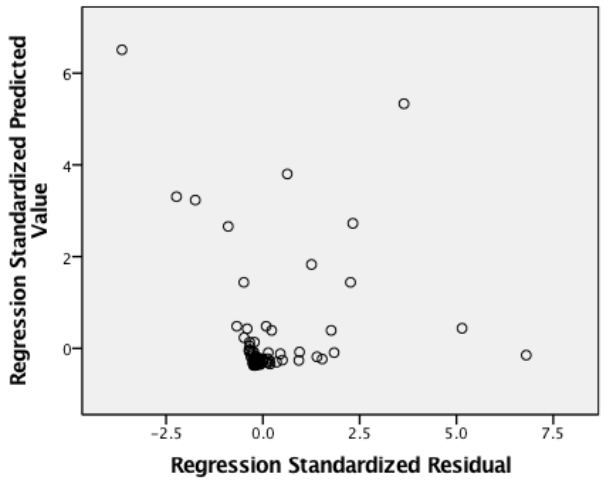

Figure 16: Scatterplot standardized residuals EV/forward sales

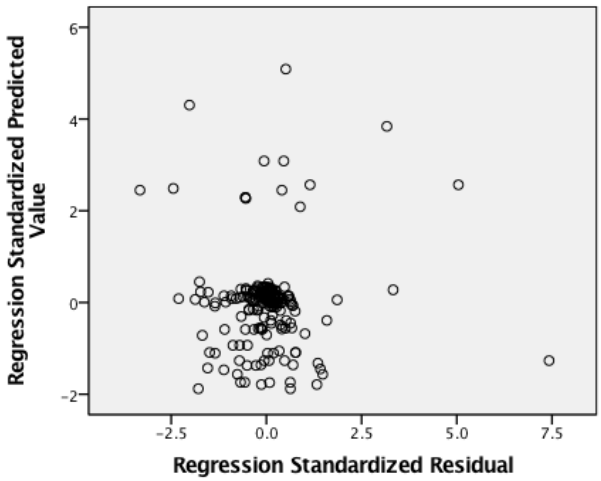

Figure 17: Scatterplot standardized residuals EV/forward net income

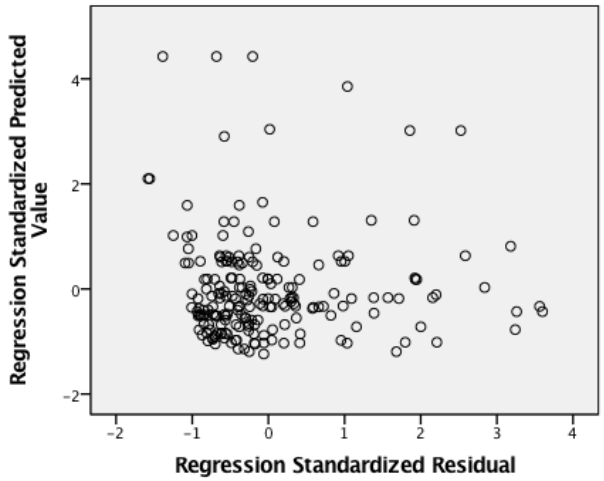

Figure 18: Scatterplot standardized residuals EV/total assets