Stockholm School of Economics
Department of Accounting

Spring 2016
Bachelor Thesis

Forecasting earnings growth

Does a forecast model incorporating payout ratio generate more accurate forecasts than univariate models solely based on historical growth?

Abstract: Estimating future earnings growth is an essential part of company valuation. Often, only historical earnings growth is used in the estimation process, despite several studies showing little correlation between past and future earnings growth. The aim of this study is to investigate whether a multivariate forecast model incorporating payout ratio can generate more accurate earnings growth forecasts compared to two univariate models which solely incorporate historical growth. These models are used to estimate earnings growth of Swedish companies listed on Nasdaq Stockholm for the time period 2010-2014. The results show that the multivariate model explains observed earnings growth and thus has the ability to forecast earnings growth. Although the multivariate model to some extent generates smaller forecast errors than the univariate models, it cannot be statistically proven whether the model is superior to the univariate models.

Keywords: Earnings growth, forecast models, payout ratio

Authors: Alexandra Roos (23155) and Sofia Markovic (22726)

Tutor: Stina Skogsvik

Date: May 16, 2016

Table of contents

1 Introduction

1.1 Problem area

Forecasting future earnings growth is an important part when valuing a company, as it provides a summary measure of the firm's performance as well as future cash-flow prospects (e.g. Elliott, 2006). To make predictions about the growth in a company, financial analysts and investors often use historical growth values to extrapolate future growth. However, using merely historical growth as input has been highly criticized. Several studies have found that there is little correlation between past and future earnings growth. According to Chan, Karceski and Lakonishok (2003) *"there is no persistence in long-term earnings growth beyond chance"*. This implies that using historical values might not be the optimum method of predicting future growth.

Finding more accurate ways of forecasting earnings growth has been a popular subject in research (Bathke, Lorek and Willinger, 2006). Therefore recent empirical findings on the relationship between payout ratio and earnings growth are in the interest of academics and practitioners. In contradiction to conventional financial theory, recent studies has shown empirical evidence of a strong positive relationship between payout ratio and earnings growth. This raises the question of whether the payout ratio can be used to explain and predict future earnings growth.

In light of these recent findings this thesis aims to investigate whether a forecast model incorporating the payout ratio of Swedish listed companies can generate more accurate forecasts of earnings growth than univariate models using only historical growth as input. The most notable forecast model within this field of research is the multivariate regression model developed by Zhou and Ruland (2006), and thus, this model will be the focus of this study (hereby referred to as the Z&R model).

1.2 Aim of study

The aim of this study is first to investigate whether the multivariate regression model developed by Zhou and Ruland (2006), with payout ratio as the key independent variable, can be used to predict future earnings growth. This will be examined by comparing the forecasted values of earnings growth to the observed values. The second aim of this study is to investigate whether the Zhou and Ruland multivariate regression model generates more accurate forecasts of earnings growth than two univariate models incorporating only historical earnings growth as the independent variable. This will be examined by comparing the forecast errors of the three models.

This study thus aims to answer the following question:

Can the multivariate regression model developed by Zhou and Ruland predict future earnings growth in Swedish listed companies and does it generate more accurate forecasts than univariate models solely incorporating historical growth?

1.3 Contribution

There are numerous studies covering the topic of forecasting earnings growth as well as studies examining the relationship between payout ratio and earnings growth. The Zhou and Ruland regression model has been replicated in several countries in order to investigate if the positive relationship between payout and future earnings growth holds. However there are no studies of our knowledge with the focus of evaluating the Zhou and Ruland regression model as a model for forecasting future earnings growth. Furthermore, the research on earnings growth forecasts on Swedish data is rather limited.

The contribution to the research on this topic will be to examine the forecasting ability of the multivariate regression model by Zhou and Ruland on Swedish data and to compare it to two univariate forecast models solely incorporating historical growth.

1.4 Scope of research

This study is limited to investigating data from the time period 1993-2015 on the Swedish stock market. The sample group includes companies that have been listed at least two consecutive years on the main list on Nasdaq Stockholm at some point during the period 1993-2015. Furthermore, the study excludes companies in the financial and utility sectors in order to improve the comparability between the companies, in line with Zhou and Ruland. As companies in these sectors can exhibit very different accounting ratios, such as capital structure, excluding these sectors leads to more accurate forecasts (Fama and French, 2002).

The focus of this thesis is to examine whether the multivariate regression model by Zhou and Ruland incorporating payout ratio can generate more accurate forecasts for earnings growth compared to using two univariate models incorporating only historical earnings growth on Swedish data. This study does not aim to explain the potential discrepancy between empirical evidence and theory. Neither does this thesis aim to examine whether the chosen models are the optimum models for forecasting earnings growth in a general setting.

1.5 Outline

Following this introduction, a summary of relevant theoretical framework and previous literature within the subject is presented in section two. The study's hypotheses are presented in section three, followed by a description of the methodology and forecasting models used for testing the hypotheses. This will be followed by section five where the descriptive statistics and results from the regression analysis and statistical tests will be presented. In section six, the results obtained in the previous section will be analyzed. Finally, the last section comprises the outcome of the tests of hypotheses and conclusion of the study. Furthermore, a sensitivity analysis will be presented and the validity, reliability and generalizability of the study will be discussed along with suggestions for future research.

2. Previous research and theory

The following section begins with theory and research concerning the importance of earnings growth as an input in valuation models. Next, common forecast models are presented, followed by a description of literature on the forecasting of earnings growth. The section is concluded by literature and research on the relationship between earnings growth and the payout ratio, and how this relationship can be applied to forecasting earnings growth.

2.1 Earnings growth

A firm's earnings contain information about what value the company creates and about its future prospects. Thus, when valuing a company, the future growth rate in earnings is an important input. Projected growth rates have substantial effects on, for example, the estimated cost of capital, and popular valuation ratios such as price-to-earnings and price-to-book ratios (e.g. Gebhardt, Lee, and Swaminathan, 2001 and Ohlson and Juettner-Nauroth, 2005).

2.2 Forecasting

Forecasting is used in a wide range of areas, for example, in accounting to predict future levels of key financial ratios. When producing a forecast, a natural starting point is looking at historical values and relationships between different variables. Forecast models based on historical data can consist of one explanatory variable (univariate model) or several explanatory variables (multivariate model).

2.2.1 Martingale

One of the simplest forecasting models is assuming a variable follows a martingale process. According to probability theory, if a sample of observations follows a martingale process, the expected value of the observation in the next period is the same as the observed value in the current period. Thus, a process, y, is a martingale sequence if it fulfills the following equation:

$E(y_{t+1}|y_t, y_{t-1},...,y_0) = y_t$ for all $t \geq 0$ (Wooldridge, 2012)

Because of the simplicity, cost effectiveness and practical use of the martingale model, it can provide a good benchmark for evaluating other forecasting models.

2.2.2 Univariate regression models

A univariate regression model, or a simple regression model, can be used to study the relationship between two variables. A univariate model has the following structure:

$$y = \alpha + \beta_1 + u$$

Where y is the predicted variable, x is the explanatory variable and u is the error term.

The primary disadvantage of using univariate regression models for forecasting is that it is very difficult to draw ceteris paribus conclusions about how x affects *y.* (Wooldridge, 2012) However, like martingale models, univariate models can also provide a good benchmark for other forecast models due to their simplicity.

2.2.3 Multivariate regression models

A multivariate model allows for the simultaneous control of several factors that may affect the dependent variable. Therefore, multivariate regression analysis can be used to build more accurate models for predicting the dependent variable. (Wooldridge, 2012)

Research shows that forecasts of key ratios and earnings can be substantially improved by using multivariate regression models rather than univariate. This research is mostly centered around earnings and changes in earnings rather than earnings growth but is still deemed to be relevant in a general forecasting setting. For example, Freeman et al. (1982) showed that forecast models based on accounting information generate more accurate earnings forecasts compared to models based on the assumption that earnings follows a martingale procedure. In addition to this research, Ou (1990) concluded that including additional accounting information and explanatory variables, allows for the generation of more accurate earnings forecasts.

2.3 Forecasting earnings growth

If analysts and investors did not believe that future earnings growth could be forecasted, all companies would have the same predicted growth rate. As this is not the case, analysts and investors must believe that it is possible to forecast earnings (Chan, Karceski and Lakonishok, 2003). However, there are numerous studies showing that analysts are often incorrect in their forecasts. Nevertheless, these predictions are still very important to investors (Dechow & Sloan, 1997).

There is extensive literature that attempts to identify predictable changes in earnings and profitability. However, the literature focusing on earnings growth is more limited and tends to focus on examining the persistence of growth, as well as the ability of analysts to forecast growth. Recently, there has also been an increased focus on examining whether the payout ratio can provide information about a company's future growth prospects (e.g. Arnott and Asness, 2003 and Zhou and Ruland, 2006).

2.3.1 Forecasting based on historical growth

A common way to forecast future earnings growth is to construct a simple univariate model based on historical growth. However, there have been several studies finding little correlation between past and future earnings growth.

One of the earlier studies on this subject is the work by Lintner and Glauber (1967) who aim to explain differences in growth in one period with the difference in growth in the previous period. Their results showed no evidence of a relationship between past and future growth. Chan, Karceski and Lakonishok (2003) used another method to test the correlation between past and future growth, which involved ranking companies depending on earnings per share growth and then examining the number of times a firm was in the top or bottom half of the sample for a consecutive number of years. Both studies showed that there was no statistical evidence of persistence in earnings growth.

According to basic economic intuition, persistence, and thereby predictability in future earnings growth should not exist in competitive markets. The lack of persistence in growth is in line with microeconomic theory of perfect competition. This theory implies that competitive pressure will even out periods of high and low earnings growth for companies (Chan, Karceski and Lakonishok, 2003). However, there are several assumptions that need to be fulfilled for a market to be perfectly competitive, meaning that there may still be markets where firms display persistence in growth. Consequently, historical growth rates may still be relevant to use when predicting future growth in markets that are not perfectly competitive.

2.4 Relationship between payout ratio and future earnings growth

The payout ratio is a central input in many valuation models and has long attracted the attention from researchers and practitioners (Vivian, 2006). Ever since the middle of the 20th century the consensus in literature on the subject has been that there should prevail a negative relationship between payout ratio and future earnings growth. This can be understood intuitively by the reasoning that firms that pay out a larger portion of their earnings have less funds available to invest in projects contributing to future earnings growth (e.g. Gordon, 1962 and Myers, 1984). Consequently, when predicting future earnings growth, firms with low payout ratios should have higher growth forecasts. However, recent empirical studies show that future earnings growth is positively correlated with the payout ratio, contradicting previous theory. This section will explore the relevant research and theory in the area supporting both the negative and positive relationship between payout and future earnings growth.

2.4.1 Conventional views

Gordon Growth Model

The payout ratio has been the subject of extensive theoretical modeling and is believed to be negatively correlated with future earnings growth. A well-known model that describes this relationship is Gordon's constant growth model which was developed to value listed companies, and is commonly written as:

$$P = \frac{D}{r - g}$$

Where P is the current stock price, g is the constant growth rate for earnings and dividends in perpetuity, r is the required rate of return and D is the dividend (Gordon, 1962). Rewriting this model, it is observed that expected return equals the dividend yield plus the constant expected growth variable.

$$R = \frac{D}{P} + g$$

Rewriting this equation further, growth can be expressed as a function of the payout ratio and the earnings yield:

$$g = r - \frac{D}{E} * \frac{E}{P}$$

If it is assumed that dividend policy does not affect the expected return and that the payout ratio is constant over time, a low payout ratio must be offset either by a high E/P or by high-expected growth. Thereby, there should be a negative relationship between the payout ratio and future earnings growth.

Modigliani and Miller

Companies that retain a large portion of their earnings are believed to have higher future earnings growth prospects as they have more cash to spend on profitable investments. This inverse relationship can also be interpreted as an intertemporal extension of the Modigliani and Miller theorem of dividend irrelevance. For example, if we consider an instantaneous and pervasive change in dividend policy, current earnings do not change and according to Modigliani and Miller, the price should not change. Therefore the task of keeping expected return constant is left to growth. A decrease in payout ratio would then need to be offset by an increase of expected growth (Arnott and Asness, 2003).

$$V_t = \frac{1}{1 - r_t} * (E_t - I_t + V_{t+1})$$

Where V is the company's total equity value, I is the level of investments, E is earnings, r is the cost of capital and t is the time period.

The above equation shows that the value of a company is unaffected by the dividend policy, and therefore there should be an inverse relationship between payout ratio and earnings growth. It is important to note that the model assumes perfect capital markets where for example investment policy is not affected by the amount of dividends paid.

2.4.2 Empirical research

Arnott and Asness

In 2003, Arnott and Asness published their article “Surprise! Higher Dividends = Higher Earnings Growth” and gained a lot of attention when they found that empirically, there was a strong positive relationship between payout ratio and future earnings growth, thereby contradicting the conventional views. The authors examined the relationship on an index level and their study included 130 years of data from the American stock exchange.

Arnott and Asness also examine several hypotheses in order to try to explain this negative relationship. One hypothesis is that managers are loath to cut dividends, as this may signal that the management is not confident about the future prospect of the company (Lintner, 1956). Another possible explanation is that due to managers’ desire for empire building, too much earnings are retained in the company. As a result, inefficient empire building leads to poor future earnings growth (Jensen, 1986).

Arnott and Asness have since then inspired several similar studies examining the payout-earnings relationship both on an index and company level. Gwilym et al. (2006) replicated the study using data from 10 countries on an index level, arriving at similar results. Vivian (2006) also examined the relationship on a company level but focused on how the relationship varied across different industries in the UK, also supporting previous findings.

Zhou and Ruland

Following the research by Arnott and Asness (2003), Zhou and Ruland (2006) investigated the subject, also looking at American stock data but at a company level. The disadvantage of conducting the study at an index level is that, as companies are weighted based on size, the results may be dominated by a small number of large companies. Thus, Zhou and Ruland’s results are interesting as they show whether the relationship can be applied on a company level, and therefore can be valuable in an individual company valuation context.

Zhou and Ruland developed a multivariate regression model for earnings growth with payout ratio as the independent variable. In line with Arnott and Asness, they presented evidence that high dividend payout companies experience stronger future earnings growth compared to firms with lower payout ratios. The model developed by Zhou and Ruland has since been tested in several research papers examining the relationship in other countries than the US, also presenting results in line with previous findings. The model developed by Zhou and

Ruland has been tested on Swedish stock data in a few recent thesis studies, however there has not been any studies examining the ability of this model to forecast future earnings growth on Swedish data.

3. Hypotheses

3.1 Hypothesis A

Hypothesis A aims to test the significance of the Zhou and Ruland regression model on Swedish data. This hypothesis will be tested by performing regression tests on the forecasted and the observed values in order to examine whether the regression model can explain earnings growth.

H0: The Z&R model has the ability to forecast earnings growth in Swedish listed companies

H1: The Z&R model does not have the ability to forecast earnings growth in Swedish listed companies

3.2 Hypothesis B

Hypothesis B will examine whether the Z&R model generates more accurate forecasts of future earnings growth compared to two univariate models. The quality of the forecasts will be assessed by comparing forecast errors between the Z&R model and each of the two univariate models. This will be tested with a two-sided hypothesis. The hypothesis is set to be two-sided since there is no theoretical evidence regarding which model gives the most accurate results. When comparing each univariate model to the model, the null hypothesis is that the forecast errors are the same, and thus no model generates more accurate forecasts. This is tested against the alternative that the forecast errors are higher or lower in one of the models, and thus one model generates more accurate forecasts.

Hypothesis B.1: The Z&R model generates more accurate forecasts than Univariate 1

H0: Forecast error Z&R = Forecast error Univariate 1

H1: Forecast error Z&R ≠ Forecast error Univariate 1

Hypothesis B.2: The Z&R model generates more accurate forecasts than Univariate 2

H0: Forecast error Z&R = Forecast error Univariate 2

H1: Forecast error Z&R ≠ Forecast error Univariate 2

4. Methodology

In section 4 the study's methodology will be explained. First, the study's main regression model and its variables will be presented. This will be followed by a presentation of the two univariate models tested. The Fama MacBeth regression method is then described. After this, the process of data collection and selection of firms will be presented. The section will end with a discussion of the study's hypotheses and the statistical tests used to test the hypotheses.

4.1 Definition of future earnings growth

Earnings growth in this study refers to growth in a company's net income after taxes. An alternative earnings growth measure is growth in earnings per share (E.g. Arnott and Asness, 2003, Gwilym et al, 2006). However, using earnings per share creates problems due to accreditation/dilution, as the growth may be a result of a change in the number of shares. Therefore, in line with Zhou and Ruland, the one-year growth in total net income will be used as the independent variable in this study, measured as:

$$EG_{0,t} = \frac{Earnings_1 - Earnings_0}{Earnings_0}$$

Where $Earnings_1$ refers to earnings for year 1 and $Earnings_0$ refers to earnings for year 0.

4.2 Zhou and Ruland regression model

This study investigates the multivariate regression model constructed by Zhou and Ruland:

$$EG_{0,t} = \alpha_0 + \beta_1 Payout + \beta_2 Size + \beta_3 ROA + \beta_4\, E/P + \beta_5 LEV + \beta_6 PEG_{-t,0} + \beta_7 AG_{0,t}$$

The model includes the following variables:

<u>Dependent variable</u>

EG: Earnings growth, measured as net earnings growth from Year 0 to Year t.

<u>Independent variable</u>

Payout: Dividend payout, measured as Year 0 dividends divided by Year 0 earnings.

Control variables

Size: Company size, measured as natural logarithm of market value of equity at end of Year 0.

ROA: Return on assets, measured as earnings for Year 0 divided by total assets at end of Year 0.

E/P: Earnings yield, measured as earnings for Year 0 divided by the end of the year market value of equity.

LEV: Leverage, measured as the book value of debt to total assets at end of Year 0.

PEG: Past earnings growth, measured as earnings growth from Year -t to Year 0 (same procedure as for the EG variable).

AG: Growth in total assets from Year 0 to Year t.

The variable AG in the Z&R regression model is based on forward looking data. As this study aims to use the regression model to produce forecasts, control variables that require forward looking data cannot be used. However, as the AG variable has been proven to be significant in past studies, the study will still include a modified version of the variable. Therefore, the AG variable will be modified so that it examines past asset growth (growth in total assets from year -t to year 0). This modified asset growth variable will be denoted *PAG*, and the modified Z&R model is presented below:

$$EG_{0,t} = \alpha_0 + \beta_1 Payout + \beta_2 Size + \beta_3 ROA + \beta_4\, E/P + \beta_5 LEV + \beta_6 PEG_{-t,0} + \beta_7 PAG_{-t,0}$$

4.2.1 Discussion of the Zhou and Ruland variables

The independent variable *Payout* will either have a negative coefficient and thus support the conventional theories that low earnings growth follows high payout, or have a positive coefficient and thus be consistent with the results presented by Arnott and Asness (2003). That is, a high payout ratio is followed by high earnings growth.

When controlling for company size, Z&R reasoned that large companies are more established and mature and thus less likely to experience strong earnings growth. This is in line with the study by Chan, Karceski and Lakonishok (2003) who found that larger firms reported slower growth in sales and operating income. Thus *Size* is expected to be inversely correlated with future earnings growth and a negative coefficient is expected.

Furthermore, Zhou and Ruland controlled for return on assets based on the assumption that when profitability is already high, other factors being equal, companies should find it difficult to demonstrate strong earnings growth. Consequently, ROA is expected to be negatively correlated to future earnings growth.

In accordance with Arnott and Asness, *E/P* is used in order to control for earnings yield. Under the assumption that the market is reasonably efficient, Arnott and Asness expected investors to pay more for a dollar of current earnings if future earnings growth is high, implying a higher P/E ratio. Thus they predict *E/P*, the inverse of P/E, to be negatively correlated with future earnings growth.

In line with Fama and French (2002), *LEV* is used as a control variable based on the expectation that companies with high leverage will tend to make large investments and thus achieve higher earnings growth. Consequently *LEV* is predicted to be positively correlated with future earnings growth.

Past earnings growth, *PEG,* is included in the model in order to control for mean reversion in earnings. If mean reversion is prevailing, a company with high or low earnings should experience a conversion of earnings towards the industry average (Fama and French), thus the *PEG* coefficient is expected be negatively correlated to future earnings growth.

Furthermore, Z&R controls for future asset growth with the variable AG. Based on the expectation that large companies report higher earnings than small companies, and that growing companies will observe higher earnings growth, a positive coefficient for AG should be observed. The same is expected for the lagging growth variable PAG.

4.3 Univariate comparison models

In Hypothesis B the Z&R model will be compared to two univariate forecast models. These comparison models are based on the assumption that future earnings growth can be explained solely by previous earnings growth. The choice of these two models is motivated in section 2.

Univariate 1: $EG_t = EG_{t-1}$

Univariate 2: $EG_t = \alpha + \beta EG_{t-1}$

4.4 Fama MacBeth regression

When estimating the regression coefficients for the multivariate regression model by Z&R, Fama and MacBeth's 1973 two-step regression procedure will be used in line with Zhou and Ruland (2003). The observations used to forecast the Z&R model consist of panel data that is cross sectional data from 185 companies over a time period of 16 years. An alternative method for estimating regression coefficients for panel data is to use a pooled data set, however, as this study strives to replicate the Z&R model, the Fama MacBeth procedure will be used.

The Fama MacBeth procedure involves performing a two-step panel regression. An advantage of using this procedure is that it controls for cross sectional correlation (Fama and MacBeth, 2002). In the first step, a least squares regression is performed for each time period separately, and from this, estimated coefficients for each variable are obtained. That is $\beta_{0t}, \beta_{1t}, \beta_{2t} \dots \beta_{7t}$ for t=1,…, T. In this study, T is 16 years and thus for every variable 16 estimated coefficients will be obtained. For every cross sectional time period a coefficient of determination, R^2 will also be obtained.

In the second step, the final coefficient estimates are obtained as an average of the coefficients that were measured in the first step. The standard errors of the coefficients are then calculated as illustrated below:

$$\hat{\beta}_i^{FMB} = \bar{\hat{\beta}}_i = \frac{1}{T}\sum_{1}^{T}\hat{\beta}_{it}$$

$$SE\left(\hat{\beta}_i^{FMB}\right) = \sqrt{\frac{1}{T}\sum_{1}^{T}\frac{\left(\hat{\beta}_{it} - \hat{\beta}_i^{FMB}\right)^2}{T-1}}$$

Where *i:1-7, t:1-16, T=16*

In the second step, it is required that the estimated yearly beta coefficients follow a normal distribution. According to the central limit theorem, the mean of a variable drawn from a population with any probability distribution will approximately follow a normal distribution given a sufficiently large sample size. In practice, it is assumed that 20 observations is sufficient (Newbold, 2013). Since this study only involves an estimation period of 16 years the assumption of a normal distribution may not be valid. However, in order to follow Z&R's method and generate comparable results, this study will use the same regression method.

Since this may affect the results of the study, a pooled panel regression will also be used to estimate the Z&R model and is presented in the sensitivity analysis in section six.

Pooled regression methods are common when analyzing panel data. An advantage of using a pooled data set is that pooling the data increases the sample size since it combines the cross sectional data from several time periods (Wooldridge, 2012). An important difference between the Fama MacBeth method and the pooled method is the treatment of weights of the individual observations. The Fama MacBeth method puts equal weight on each time period regardless of the number of observations. Thus, in periods with a small number of observations, the observations will have a larger weight and impact on the calculation of the average regression coefficient. However, if observations are equally distributed over the time, periods both methods will generate similar regression coefficients.

Furthermore, in order to be consistent and improve comparability between the investigated models in the study, the univariate regression model (Univariate 2) will also be estimated using the Fama MacBeth procedure. However, in the sensitivity analysis in section six where the alternative Z&R model based on pooled data is presented, the univariate regression model will also be estimated on pooled data.

4.5 Data selection

4.5.1 Selection of time period

This study contains data from 29 years in total, from 1993-2015. The data from 1993-2009 is used to estimate the Z&R model and Univariate 2, referred to as the estimation period. Since measuring earnings growth for year t requires data for year t+1 and the variables *PEG* and *PAG* for year t requires data from year t-1, the estimation period decreases to 16 years and ranges from 1994-2009. The model will then be used to forecast values for future earnings growth for the sample companies in the period 2010-2014 (the forecast period).

An alternative forecast method is to use rolling forecasts where the regression models are estimated for several estimation periods. An advantage of this method is that it enables the control of time period specific differences. However, as this thesis aims to use the Fama MacBeth method, requiring at least 20 years of data, and is limited to estimating the regression model from only 16 years of data, a single forecast period will be used to maximize the data for the estimation period.

4.5.2 Selection of firms

In line with the research done by Zhou and Ruland (2006) and Fama and French (2001) this study has the following requirements for the included companies:

- Has to report dividend for year 0
- Positive earnings for year 0
- Book value of equity over 2 million SEK or total assets over 4 million SEK
- No financial or utility firms

Table 1: Selection of firms (# of firms)

All companies listed on main list	631
Financial and utility firms	-124
Foreign companies	-60
Missing data	-131
Equity or assets is too small	-
Did not report dividend	-59
Reported negative earnings	-27
Total companies	**230**

4.5.3 Data collection

The data in this study has been gathered from Factset, comprising data on Swedish companies listed on Nasdaq Stockholm at some point in time from 1993-2015. Only Swedish companies listed on the main market of the Stockholm stock exchange are included. Further, companies have only been included for the years that they have been listed, meaning delisted companies have been removed after their delisting. Companies are only required to have been listed for two consecutive years, and therefore, the survivorship bias is deemed to be limited.

The data that has been collected includes net income, paid dividends, market value of equity, book value of equity, book value of debt, book value of assets and EBIT. All variables have been taken at year end.

4.5.4 Outliers

The data has been adjusted for effects of outliers in line with Zhou and Ruland (2006):

- The variables *EG*, *ROA*, *LEV, E/P*, *PEG* and *PAG* are adjusted for the effects of outliers by removing the top and bottom one percent of observations.
- *Payout* is adjusted by removing the top one percent of observations.

4.6 Hypotheses testing

4.6.1 Forecasting ability

Earnings growth is forecasted by the Z&R model and the two univariate models for the period 2010-2014. In Hypothesis A, the forecasting ability of the Z&R model will be evaluated. In Hypothesis B the Z&R model's forecasting ability will be compared to that of the two univariate models.

Hypothesis A

In Hypothesis A the forecasting ability of the Z&R model will be examined through a regression test with the observed value of earnings growth as dependent variable and the forecasted value generated by the Z&R model as independent variable. The aim is to statistically determine whether the Z&R model can explain earnings growth. This is tested by running a regression with observed earnings growth as the dependent variable and the forecasted Z&R value as the independent variable.

$$EG_{observed} = \alpha + \beta EG_{Z\&R}$$

Hypothesis B

In Hypothesis B, the Z&R model will be compared to the two univariate models respectively. In order to assess the forecasting ability of the models the forecast errors will be compared. The simple forecast error is defined as the difference between observed earnings growth and forecasted earnings growth. This method is commonly used for evaluating forecast models. For example Yohn et al. 2012 use the method to test forecast models of ROE.

$$Forecast\ error = EG_{observed} - EG_{forecast}$$

Following the method of Yohn et al. (2012), this study will measure the forecast error in two different ways. The first way involves comparing the squared errors. The squared errors are examined as this procedure puts more weight on larger errors giving a more accurate view of the magnitude of forecast errors. In the second approach a relative forecast error will be obtained by dividing the error by the forecasted value. The relative error is converted to an absolute value to avoid possible negative values deteriorating the results.

$Squared\ error = Forecast\ error^2$

$Relative\ error = \left|\frac{Forecast\ error}{Forecast}\right|$

4.6.2 Statistical tests

Hypothesis A

In the regression test the aim is to examine whether the independent variable can be explained by the dependent variable. First it is investigated whether the estimated coefficient is significantly different from zero. The size of the coefficient and the R^2 value will also be examined in order to evaluate the strength of the relationship between observed and forecasted earnings growth.

If the estimated coefficient differs from zero, it is of interest to compare the results with regression tests of the two univariate models. In order to assess the relationship between observed earnings growth and forecasted earnings growth, the hypothesis that the estimated coefficient significantly differs from one will be tested for the different models. If the coefficient is close to or equal to one this implies that the volatility of observed and forecasted earnings coincide on average. This implies that the forecast model accurately predicts and explains the difference in observed earnings growth. The null hypothesis is thus:

$H0: \beta_{EG\ forecast} = 1$

$H1: \beta_{EG\ forecast} \neq 1$

The hypothesis is formulated as a two sided hypothesis since there is no consensus in theory regarding the outcome of the test (Wooldridge, 2012). In order to test the hypothesis a t-test will be used. The t-statistic is calculated as:

$$T_{obs} = \frac{\beta_{EG\ forecast} - \beta_{H0}}{SD/\sqrt{n}}$$

Where β_{H0} is the coefficient under the null hypothesis and equal to one, SD is the standard error of the coefficient, n+k-1 is the number of degrees of freedom, n is the number of observations and k+1 is the unknown parameters. In the test there are thus 547 degrees of freedom. The critical t value is obtained from the student's t-distribution (Wooldridge, 2012).

The decision rule is set as follows:

Reject the null hypothesis if $|t_{obs}| > t_{n-k-1,\propto/2}$

The critical value at 547 degrees of freedom and a 5% significance level is 1.96. The null hypothesis will thus be rejected if $|t_{obs}| > 1.96$.

Hypothesis B

In order to test whether any of the examined models is superior to the others, the forecast errors of the different models will be compared. This will be examined by using two different tests; a Student's paired t-test, which is a parametric test based on means, and a Wilcoxon signed rank test, which is a nonparametric test based on medians. Since a test of medians is less sensitive to the effect of outliers it is interesting to compare to a test of means.

Student's paired t-test

When examining the means of the forecast errors, a Student's t-test for matched pairs is used. This is a parametric test and is used when paired observations from two populations are obtained and the data follows a normal distribution. Since the sample contains more than 30 observations, it can be approximated to follow a normal distribution. Furthermore, since this is a parametric test the five Gauss Markov[1] assumptions need to be fulfilled (Wooldridge, 2012).

The tested null hypothesis is whether the difference between the population means is zero, that is, if there is no difference between the mean of forecast errors between the models. This will be tested against a two-sided alternative since there is no clear indication of the outcome of the test.

As mentioned previously the forecast errors will be measured both as squared forecast errors and absolute relative errors in order to put more weight on larger forecast errors and make sure that negative and positive errors do not cancel out each other. Thus four different tests will be performed.

[1] The five Gauss-Markov assumptions are the following: 1. Linear parameters. 2. The observations are obtained by random sampling. 3. The sample outcomes in the independent variable cannot be identical. 4. The error terms have an expected value of zero for any given value of the independent variable. 5. The error terms has the same variance for any given value of the independent variable.

Hypothesis B.1

$H0$: Mean forecast error$_{Z\&R}$ – Mean forecast error$_{\text{Univariate 1}} = 0$

$H1$: Mean forecast error$_{Z\&R}$ – Mean forecast error$_{\text{Univariate 1}} \neq 0$

Hypothesis B.2

$H0$: Mean forecast error$_{Z\&R}$ – Mean forecast error$_{\text{Univariate 2}} = 0$

$H1$: Mean forecast error$_{Z\&R}$ – Mean forecast error$_{\text{Univariate 2}} \neq 0$

The decision rule is set as follows*: Reject the null hypothesis if*

$$|T_{obs}| = \frac{d - D_0}{SD/\sqrt{n}} > t_{n-1,\propto/2}$$

Where d and SD is the observed sample mean and standard deviation for the *n* differences. The significance level is set at 5% and the critical value is obtained from the Student's t distribution. With 548 degrees of freedom[2] the critical value is 1.96 and the null hypothesis will thus be rejected if $|T_{obs}|> 1.965$.

Wilcoxon signed rank test

When examining the medians of the forecast errors the Wilcoxon signed rank test is used. This test is similar to the t-test but is a nonparametric test for the medians. Since this is a nonparametric test it does not require a normal distribution, however it does require that the compared observations are symmetrical and come from the same population. This test has been used in similar studies where difference in forecast errors has been compared such as Fairfield et al. (1996), Yohn et al. (2012) and Esplin et al (2014).

The Wilcoxon signed rank test can be used when a random sample of matched pairs of observations is available. Since this is a nonparametric test, a normal distribution is not required. However, it is required that the population distribution of the differences between the paired samples is symmetric and that the null hypothesis aims to test whether the distribution is centered around zero. In this study, this corresponds to testing if the difference between forecast errors of the different models is zero (Newbold, 2013).

[2] The computer program STATA generated the t-statistic and corresponding p-value.

The forecast errors from the Z&R model are thus paired with the forecast errors of the Univariate 1 and Univariate 2 model respectively, and the errors of one model are then subtracted from the errors of the comparison model. Then, the absolute differences between the paired forecast errors are ranked in ascending order based on size, discarding the pairs for which the difference is zero. The sums of the ranks corresponding to positive and negative differences are calculated and the smaller of these sums is the Wilcoxon signed rank statistic T.

As in the procedure of the Student's t-test, the forecast errors will be measured both as squared forecast errors and absolute relative errors and thus 4 different tests will be performed. The null hypothesis is set as a two sided hypothesis since there is no indication of which model would generate the more accurate forecasts.

Hypothesis B.1

$H0$: Median forecast error$_{\text{Z\&R}}$ − Median forecast error$_{\text{Univariate 1}}$ = 0

$H1$: Median forecast error$_{\text{Z\&R}}$ – Median forecast error$_{\text{Univariate 1}}$ $\neq 0$

Hypothesis B.2

$H0$: Median forecast error$_{\text{Z\&R}}$ − Median forecast error$_{\text{Univariate 2}}$ = 0

$H1$: Median forecast error$_{\text{Z\&R}}$ – Median forecast error$_{\text{Univariate 2}}$ $\neq 0$

These hypotheses test whether the difference of medians of the forecast errors significantly differs from zero. Since the sample size is larger than 30 observations the population is assumed to approximately follow a normal distribution. The test statistic is calculated as follows:

$$Z = \frac{T - \mu_T}{\sigma_T}$$

Where T is the Wilcoxon signed rank statistic, μ_T is the expected value of the Wilcoxon signed rank statistic and σ_T is the standard error of the Wilcoxon signed rank statistic. With a two sided hypothesis the decision rule is as follows:

Reject H0 if $|z_{obs}| > z_{\alpha/2}$

The significance level is set at 5% and thus the null hypothesis is rejected if $z_{obs}|>1.96$.

5. Results

Below the descriptive statistics for the data used for estimation of the regression coefficients as well as forecasts are presented. This is followed by a presentation of the regression for the Z&R model and Univariate 2. Lastly, the forecast errors of the models are presented.

5.1. Descriptive statistics

In table 2, observations for the 185 companies in the estimation period, years 1994-2009, are presented. In total there are 1,094 observations available for the forecast period. As mentioned earlier, all data has been downloaded from FactSet. Although there is data available for the complete period, the number of observations in the 1990s is substantially less than in the 2000s. The data in the 1990s is also skewed toward larger companies, and the data available for companies that had been delisted during the 1990s was limited.

Table 2: Descriptive statistics of estimation period

	Nr. obs.	*Mean*	*Std. dev.*	*Median*	*Min*	*Max*
EG	1094	0.0831	1.0601	0.074	-4.5432	7.32
Payout	1094	0.5057	0.4995	0.3625	0.0115	6.0588
Size	1094	8.0157	1.8868	7.7996	3.2165	13.8615
ROA	1094	0.0734	0.0423	0.0649	0.0034	0.2684
E/P	1094	0.0785	0.044	0.0693	0.0045	0.2991
LEV	1094	0.2114	0.1376	0.2027	0	0.5475
PEG	1094	0.1964	1.1395	0.1131	-5.1057	9.714
PAG	1094	0.1456	0.2376	0.0902	-0.2451	1.6254

The standard deviations for all variables are quite high which may be explained by the large variation in company size in the sample.

Earnings growth varies from -454% to 732%, even after the elimination of outliers. The extreme growth rates can be explained by there being instances where firms have gone from reporting a very low net income to reporting a significantly increased net income or recording a large loss. The median for earnings growth is 7.4% which is lower than the findings of Zhou and Ruland with a median of 12.6%.

The median payout ratio is 36.3%, which is in line with the results of Zhou and Ruland who observed a median payout ratio of 39.8%. The standard deviation for the payout ratio is 0.4995, implying that there is a lot of variation concerning companies' dividend policies.

The median size of companies is 7.8 while Zhou and Ruland had a median size of 4.9. These variables are however not comparable as Zhou and Ruland calculated size as the natural logarithm of the book value of equity in USD while our data was measured in SEK.

The median leverage of firms is 0.203, which is substantially lower than the finding of Zhou and Ruland showing a median of 0.468, suggesting that American firms are generally more geared than Swedish firms.

The variables *ROA*, *E/P* and *PEG* are all in line with the results of Zhou and Ruland.

Table 3: Descriptive statistics of forecast period

	Nr. obs.	*Mean*	*Std. dev.*	*Median*	*Min*	*Max*
EG	549	0.4439	8.8207	0.0799	-72.0667	180.5439
Payout	549	1.0663	4.2092	0.5451	0.0397	74.7193
Size	549	8.1264	2.0253	7.8149	3.8818	13.1780
ROA	549	0.0794	0.06	0.0657	0.0003	0.6324
E/P	549	0.0641	0.0303	0.0605	0.0004	0.2367
LEV	549	0.1722	0.1453	0.1505	0	0.6433
PEG	549	0.2363	2.6227	0.0717	-28.1106	33.6667
PAG	549	0.1036	0.2151	0.0549	-0.4356	1.8631

The data set used for the estimation period differs from the forecast period as outliers have not been eliminated in the forecast period. Thus, the descriptive statistics from the estimation period is more comparable to Zhou and Ruland's findings where the same method for eliminating outliers has been used. However, most of the median values of the variables are at similar levels when comparing the forecast period and the estimation period. The median is believed to be the most applicable for comparisons as it is less affected by outliers than the average. The median payout ratio is around 50% higher in the estimation period, indicating that there might be time specific differences between the estimation and forecast period. This may negatively affect the accuracy of forecasts generated by the regression models.

5.2 Forecast models

5.2.1 Zhou and Ruland regression model

In table 4, the estimated regression coefficients are presented. All of the coefficients have been estimated using the Fama MacBeth method, meaning the coefficients are averages of the yearly regression coefficients (see section 4.2.2).

Table 4: Regression coefficients for Z&R

	Coefficient	*Std. dev.*	*t-stat*	*p-value*		
Intercept	0.4789	0.9349	2.0489	0.0584*	***R^2***	0.2478
Payout	0.3043	0.5548	2.1939	0.0444**	***Adjusted R^2***	0.1655
Size	-0.0102	0.0640	-0.6356	0.5346		
ROA	-1.2174	3.9421	-1.2353	0.2357	***Nr. observations***	1094
E/P	-4.8242	4.7403	-4.0707	0.0010*		
LEV	0.0151	1.1145	0.0542	0.9575		
PEG	-0.0083	0.1031	-0.3207	0.7528		
PAG	-0.1522	0.8864	-0.6868	0.5027		

**** $p<0.01$, ** $p<0.05$, * $p<0.1$*

The table above shows that the variables *Payout*, *E/P* and the intercept are significant. The remaining five control variables are not statistically significant. However, since this thesis aims to replicate the Z&R model, these variables have not been removed from the model.

All of the variables have the expected coefficient sign. Zhou and Ruland estimated a positive coefficient for *PEG* when looking at a one-year horizon, however, for two and three-year's growth, *PEG* was negatively correlated with future earnings growth, in line with the results of this. The coefficient for *PEG* was expected to be negative due to mean reversion (Fama and French, 2002), however, as *PEG* is not significant, no conclusions of this can be drawn in this study.

It is expected that larger companies, with higher current profitability and higher earning yields should have lower future earnings growth (Zhou and Ruland, 2006). Therefore, the negative coefficients of *Size*, *ROA* and *E/P* are in line with expectations. With a t-value of -4.070, *E/P* is significant at a 1% level. *Size* and *ROA* are however not significant.

The results also show that earnings growth is positively correlated with *Payout* and *LEV* thus, supporting earlier literature (e.g. Arnott and Asness 2003, Zhou and Ruland 2006). Companies with higher leverage tend to have more aggressive investment policies, which may results in higher future earnings growth (Fama and French, 2002). The positive coefficient of *LEV* supports this statement, however with a p value of .9575, these results are not significant. Companies with higher asset growth are also expected to grow more as they have more assets to generate future earnings. The results show that earnings growth is negatively correlated with the new variable *PAG*, however, these results are not significant.

The adjusted R^2 value for the regression model is 16.55%, implying that roughly 17% of earnings growth can be explained by the variables in the model. This is slightly lower than the results of Zhou and Ruland who had an R^2 value of 20.0% for one year-earnings growth.

However, the Z&R model is modified from the original study with regards to the *AG* variable which in this study is replaced with *PAG*. Thus the estimated regression model is to some extent less comparable to Zhou and Ruland's findings. It is also important to note that Zhou and Ruland had 40,968 company years as the base for their regression results while this study is limited to a data set of 1,094 observations.

5.2.2 Univariate model 2

Table 5: Regression coefficients for Univariate 2

	Coefficients	*Std. dev.*	*t-stat*	*p-value*		
Intercept	0.1182	0.3304	1.4316	0.1728	R^2	0.0259
PEG	-0.1297	0.1652	-3.1391	0.0068***	*Adjusted* R^2	0.0106

**** p<0.01, ** p<0.05, * p<0.1*

The coefficient for *PEG* in Univariate 2 is negative, in line with the *PEG* variable in the Z&R model. The coefficient is significant at a 1% level. However, the adjusted R^2 value is very low at 1.06%.

5.3 Forecast errors

In the following tables, the forecast errors generated by the three compared forecast models are presented. They are presented first as simple forecast errors calculated by subtracting the forecast from the observed growth value, than as absolute errors and lastly as, previously defined, squared and relative errors (see section 4.6.1).

Table 6: Zhou and Ruland forecast errors

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	0.1441	8.1678	-0.0418	-85.6121	157.3467
Abs error	1.2213	8.0771	0.2523	0.0004	157.3467
Squared error	66.6120	1103.7833	0.0637	0.0000	24757.9967
Relative error	4.6586	15.5601	1.5887	0.0025	291.3111

Table 7: Univariate 1 forecast errors

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	0.2075	9.2497	-0.0617	-71.0763	181.5382
Abs error	1.8849	9.0577	0.4237	0.0001	181.5382
Squared error	85.4448	1426.1157	0.1795	0.0000	32956.1149
Relative error	7.3551	48.4177	1.3202	0.0089	983.6451

Table 8: Univariate 2 forecast errors

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	0.3563	8.8208	-0.0071	-72.3133	180.2967
Abs error	1.3062	8.7306	0.2940	0.0006	180.2967
Squared error	77.7913	1407.0400	0.0864	0.0000	32506.9005
Relative error	46.3020	787.4929	2.3913	0.0043	18401.9555

The Z&R model generates the lowest mean forecast error when it comes to all four measurements. Z&R also generates the lowest median forecast error for all methods except when measuring the median simple error, where Univariate 2 generates a lower median error. The standard deviation for the errors is slightly lower for the Z&R model, but generally around the same levels for all three models. The standard deviations are high for all three models, showing that the models estimate growth within a very wide range. For example, the simple errors of the Z&R model range from -85.612 to 157.3467.

5.4 Statistical tests

5.4.1 Hypothesis A: Regression test

In table 9 the results from the regression tests are presented for each model. Further, the t-statistics from the simple t-test and the corresponding significance levels are presented.

Table 9: Regression test

	Nr. obs	*a*	*p-value*	*B*	*p-value*	*R^2*	*Adjusted R^2*	*t-test*	*p-value*
Z&R	549	-0.6280	0.0530*	3.5752	0.0000***	0.2963	0.2950	t=10.9302	0.0000***
Uni 1	549	0.4589	0.2256	-0.0636	0.6584	0.0004	-0.0015	t=-7.3978	0.0000***
Uni 2	549	0.4009	0.3032	0.4905	0.6584	0.0004	-0.0015	t=-0.4594	0.6461

**** $p<0.01$, ** $p<0.05$, * $p<0.1$*

In the regression tests, only the Z&R model has a significant coefficient and intercept. The coefficient differs from zero and is significant at a 1% level and the intercept at a 10% level. The coefficient for Z&R is 3.5752, and the corresponding value is -0.0636 and 0.4905 for Univariate 1 and Univariate 2, respectively. The coefficients and intercepts for the univariate models are insignificant for both models, both regressions also have very low adjusted R^2 values while Z&R has an adjusted R^2 value of 29.50%. A t-test is used to test the null hypothesis that the coefficients are equal to one, against the alternative hypothesis that the coefficients differ from one. H0 is rejected at a 5% significance level if $|t|> 1.96$. H0 can be rejected for the Z&R model and Univariate 1, but cannot be rejected for Univariate 2.

5.4.2 Hypothesis B: Student's t-test and Wilcoxon test

Student's t-test

In table 10 the results from the Student's t-test between Z&R and Univariate 1 are presented. The test gives a t statistic of -1.1878 for the squared forecast errors and -1.2871 for the relative errors. In table 11 the results for the test between Z&R and Univariate 2 are presented. The t-value from the test of squared errors is -0.7594 and that of the relative errors is -1.2387.

The significance level under hypotheses B is set at 5% and thus the null hypothesis will be rejected if |t|>1.96. Hence none of the null hypotheses can be rejected. This implies that there is no statistically significant difference between the mean errors, measured as both squared and relative, of the compared models.

Table 10: Student's t-test: Z&R compared to Univariate 1

	Squared errors			*Relative errors*		
Variable	***Obs***	***Mean***	***Std. dev.***	***Obs***	***Mean***	***Std. dev.***
Z&R	549	66.6120	1103.783	549	4.658636	15.56008
Univariate 1	549	85.4448	1426.116	549	7.355148	48.41768
Difference	549	-18.8327	371.4845	549	-2.696512	49.08659
Degrees of freedom: 548	T= - 1.1878	H0: mean(diff)=0	H1: Pr(|T| > |t|) = 0.2354	T=- 1.2871	H0: mean(diff)=0	H1: Pr(|T| > |t|) = 0.1986

Table 11: Student's t-test: Z&R compared to Univariate 2

	Squared errors			*Relative errors*		
Variable	***Obs***	***Mean***	***Std. dev.***	***Obs***	***Mean***	***Std. dev.***
Z&R	549	66.61202	1103.783	549	4.658636	15.56008
Univariate 2	549	77.79135	1407.04	549	46.30197	787.4929
Difference	549	-11.17932	344.9345	549	-22.0277	787.6771
Degrees of freedom: 548	T=- 0.7594	H0: mean(diff)=0	H1: Pr(|T| > |t|) = 0.4479	T=- 1.2387	H0: mean(diff)=0	H1: Pr(|T| > |t|) = 0.2160

Wilcoxon signed rank test

In the tables below the results from the Wilcoxon signed rank test for the difference between medians of forecast errors are presented. In table 12 the results from the test between the Z&R model and Univariate 1 are presented. The z-value from the test of squared errors gives a z-value of -8.445 and that of relative errors gives a z-value of -0.426. In table 13 the results from the test between the Z&R model and Univariate 2 are presented. The z-value for the squared errors is -3.348 and that of the relative errors is -7.726.

Table 12: Wilcoxon signed rank test: Z&R compared to Univariate 1

	Squared errors				*Relative errors*		
Sign	***Obs***	***Sum ranks***	***Expected***	***Sign***	***Obs***	***Sum ranks***	***Expected***
positive	197	44087	75487.5	***positive***	266	73904	75487.5
negative	352	106888	75487.5	***negative***	283	77071	75487.5
zero	0	0	0	***zero***	0	0	0
Total	549	150975	150975	***Total***	549	150975	150975
z=-8.445	p=0.0000	Null hypothesis		***z=-0.426***	p=0.6702	Null hypothesis	

	is rejected			is not rejected			

Table 13: Wilcoxon signed rank test: Z&R compared to Univariate 2

Squared errors				*Relative errors*			
Ssign	***Obs***	***Sum ranks***	***Expected***	***Sign***	***Obs***	***Sum ranks***	***Expected***
positive	241	63039	75487.5	***positive***	196	46759	75487.5
negative	308	87936	75487.5	***negative***	353	104216	75487.5
zero	0	0	0	***zero***	0	0	0
Total	549	150975	150975	***Total***	549	150975	150975
z=-3.348	p= 0.0008	Null hypothesis is rejected		***z=-7.726***	p=0.0000	Null hypothesis is rejected	

The significance level is set at 5% and thus the null hypothesis will be rejected if $|z|>1.96$. Hence the null hypothesis is rejected for all hypotheses except for when comparing the medians of relative errors between Z&R and Univariate 1. This implies that the difference between median errors significantly differs from zero for squared errors of the Z&R model compared to Univariate 1, and for both the squared and relative errors of the Z&R model compared to Univariate 2. However there is no significant difference between the median of relative errors of Z&R and Univariate 1.

6. Analysis

In order to answer the hypotheses of the study, the following section will analyze the results presented in the previous section. First the outcome from the regression tests used to test Hypothesis A will be examined. This will be followed by an evaluation of the outcome from the tests regarding Hypothesis B. Lastly, a sensitivity analysis of the results is presented.

6.1 Analysis of results

6.1.1 Hypothesis A: Z&R regression model

In table 9 the results from the regression tests are presented. The aim is to investigate whether the forecasts generated by the Z&R model have a significant relation with observed earnings growth. The results are presented in comparison to regression tests of the two univariate models since these are used as a benchmark. The results show that only the coefficient in the regression test for the Z&R model is significant, while the coefficients for both univariate models are insignificant. This means that only Z&R has a significant relationship with observed earnings growth. This is in line with previous research showing that multivariate forecast models are more accurate than univariate models. (Ou, 1990)

Further, a t-test is used to evaluate the Z&R model's suitability as a forecast model. This test has a null hypothesis that β=1, tested against the hypothesis that $\beta \neq 1$. A coefficient equal to one implies that the forecast model follows the volatility of observed earnings growth perfectly. As described in the results section, H0 is rejected for Z&R and Univariate 1 but cannot be rejected for Univariate 2. This implies that neither the Z&R model nor Univariate 1 correlate perfectly with observed earnings growth. It cannot be statistically concluded whether Univariate 2 follows observed earnings growth perfectly and the results regarding Univariate 2 are inconclusive.

Furthermore the coefficient of determination is examined. The R^2 and adjusted R^2 are at 29.63% and 29.50% respectively for the Z&R model. The corresponding values for both univariate models are at 0.04% and -0.15% respectively. This implies that the univariate models explain very little of observed earnings growth.

With regards to the regression tests and t-tests, it can be concluded that the Z&R model is deemed to be useful as a forecast model for future earnings growth. This conclusion is based on the results of a significant coefficient in the regression test as well as relatively high coefficients of determination compared to the univariate models.

6.1.2 Hypothesis B: Comparison of models

In order to examine Hypothesis B, the forecast errors of the different models are compared and evaluated. This will be followed by an analysis of the results from the Student's t-test for matched pairs and the Wilcoxon signed rank test

Forecast errors

As described in the results section, the Z&R model has the lowest mean forecast errors when it comes to all four different measurements. The mean simple error for Z&R is half of that for Univariate 1 and a third of Univariate 2. Z&R also has the lowest median forecast error for all measurements except for the simple error. Further, Z&R has a lower standard deviation, suggesting that the model estimates earnings growth within a narrower interval.

The mean simple error for all models has a positive sign, which suggests that the models on average underestimate earnings growth. However, when examining the median, which is less affected by outliers, the signs are mostly negative, suggesting the opposite. Thus, due to the large standard deviation, no real conclusions can be drawn concerning whether the models under- or overestimate earnings growth.

Student's t-test

The Student's t-test is used to investigate whether the difference between the means of the compared models is significantly different from zero. The tables 10-11 in section 5 show that none of the null hypotheses can be rejected at a 5% significance level. Hence there is no statistically significant difference between the model's forecasting ability with regards to the mean.

Since the mean difference has been calculated by subtracting the mean forecast error of the univariate models from the Z&R forecast error, a negative difference implies that the Z&R model generates smaller forecast errors. All tests generate negative differences implying that the Z&R model generates smaller forecast errors than the two univariate models, however this cannot be statistically concluded since none of the tests were significant.

Wilcoxon signed rank test

The Wilcoxon signed rank test is used to investigate whether the difference between the medians of the compared models is significantly different from zero. The tables 12-13 in section 5 shows that all null hypothesis except for the test of relative errors between Z&R and Univariate 1 can be rejected at a 5% significance level. Hence there is a significant difference between the forecasting ability of the Z&R model compared to Univariate 2, and when measuring squared errors there is a significant difference between the ability of Z&R and Univariate 1. However the results suggest that there is no significant difference between Z&R and Univariate 1 when comparing relative errors.

The difference between the forecast errors of the compared models has been calculated by subtracting the forecast error of the univariate model from the forecast error of Z&R model. Thus a negative z-value implies that the Z&R model generates fewer and smaller forecast errors compared to the univariate model. All tests generate negative z-values, indicating that the Z&R models has a better forecasting ability compared to the univariate models, both measured as squared and relative errors. This is in line with previous research showing that a multivariate regression model generates more accurate results (Ou, 1990). However it cannot be statistically concluded that there is a difference of forecasting ability between Z&R and Univariate 1 measured in relative errors.

To conclude, taking into account that the Z&R model generates smaller forecast errors, both measured as means and medians, coupled with the results from the Wilcoxon signed rank test, the Z&R model is perceived to be superior to Univariate 2. However, none of the null hypotheses tested with the paired t-test could be rejected. Since a nonparametric test has lower statistical strength than a parametric test, the results from the Wilcoxon signed rank test, indicating that the Z&R model has a better forecasting ability, may be limited. However, since the data sample has large outliers the nonparametric test comparing the medians of the errors might be more accurate to use. Thus the results are inconclusive and it cannot be statistically proven that the Z&R model is superior to any of the univariate models.

6.2 Sensitivity analysis

To test the robustness of the study's findings, it is examined whether the results are affected by multicollinearity and heteroscedasticity. Further, a variety of sensitivity tests have been conducted. The first sensitivity test involves replacing net earnings with EBIT as an alternative earnings measure. The second sensitivity test examines the effect of not eliminating any outliers. Lastly, the regression coefficients are calculated using a pooling regression method instead of the Fama MacBeth method.

6.2.1 Multicollinearity

Multicollinearity refers to the phenomenon when two independent variables are highly correlated. This does not reduce the reliability of the model as a whole but may affect the individual coefficients of the variables. As all variables of the Z&R model measure quite different accounting ratios, the model is not expected to be subject to multicollinearity. In the appendix a correlation matrix is presented, which shows that none of the variables are significantly correlated, as none of the variables have a coefficient close to one.

6.2.2 Heteroscedasticity

The existence of heteroscedasticity may invalidate the statistical tests of significance when evaluating regression models, as these assume that the modelling errors are uncorrelated and uniform. Thus, the homoscedasticity assumption is needed in order to use normal t-tests. The existence of heteroscedasticity does however not affect the coefficients of determination.
To test the data for heteroscedasticity, the model was estimated with White-Huber robust standard errors. The results, which are shown in the appendix, show that the majority of the variables' standard errors are smaller, thereby strengthening their significance.

6.2.3 Alternative earnings measure

As a part of the sensitivity analysis earnings before interest and taxes (EBIT) is used as an alternative measure for earnings, in line with Zhou and Ruland (2006). The variables *EG*, *E/P*, *PEG* and *ROA* were modified so that they were based on EBIT instead of net earnings.
The coefficient for *Payout* is still positive but considerably smaller and no longer significant compared to the Z&R model estimated with net earnings. *Size* and *PEG* change signs in the new regression, and size is not significant but PEG is. Furthermore E/P is still significant at the 1% significance level. The coefficients of determination has also decreased substantially with a new R^2 of 17.14% and adjusted R^2 of 7.08%, implying that the modified model based on EBIT as earnings measure does not accurately explain earnings growth.

In the regression test, the Z&R model no longer has a significant intercept or coefficient and the R^2 and adjusted R^2 have decreased to 0.00% and -0.18% respectively. The regression test of the univariate models generates similar results when based EBIT compared to net earnings. This suggests that the univariate models are robust to an alternative earnings measure.

It cannot be concluded statistically whether the positive relationship between payout and future earnings growth holds when EBIT is used as earnings measure. The regression test no longer generates a significant coefficient for the Z&R model and the simple t-test indicates that none of the models' forecast follows the variation in earnings growth. Thus the study's results are not deemed to be robust in the use of EBIT as an alternative earnings measure and it is not believed to be of interest to continue the investigation with further tests on the forecasting ability of the models.

6.2.4 Alternative elimination of outliers

In order to investigate how the results of the study are affected by the elimination of outliers, the regression model has been estimated from data that is not truncated. The positive relationship between *Payout* and future earnings growth still holds, however, the coefficient for *Payout* is substantially larger than in the original model and the significance level is now 10% compared to the previous significance at a 5% level. The variables *ROA* and *PEG* changes signs, *ROA* is not significant but *PEG* is now significant at a 10% significance level compared to previously being insignificant. Furthermore *E/P* goes from being significant at 1% level to being insignificant.

When performing a regression test, the coefficient is still significant and the R^2 and adjusted R^2 are 30.22% and 30.09%, respectively. These results are thus in line with the results from the regression tests of the original model. The regression test of Univariate 1 is the same as previously since it is not affected by this sensitivity test. The regression test of Univariate 2 is similar to the previous results and the coefficient is still insignificant.

In tables 22-23 the forecast errors for the modified Z&R model and Univariate 2 are presented. For the Z&R model the mean and median simple errors are larger in magnitude than the errors in the original model. However the mean of the squared errors is smaller with the non-truncated model. Furthermore, the mean and median relative errors of Univariate 2 have decreased substantially. The mean and median errors are no longer the lowest for the Z&R model except for means of absolute and squared errors. When not eliminating outliers Univariate 2 has the lowest mean of simple and relative errors and the lowest median of absolute and squared errors. Univariate 2 has the lowest median measured as simple and relative errors.

As shown in tables 24-25, based on the Student's t-tests, none of the null hypotheses are rejected at a 5% significance level except for the test of relative errors of the Z&R model compared to Univariate 2. Thus, except for the test of relative errors between the Z&R model and Univariate 2, the results are in line with the original study. The substantial decrease in the mean relative forecast error of Univariate 2 may be a reason to why there is now a significant difference between the forecasting ability of the models. The differences between means and thus the t-values are negative for all tests except for the test between relative errors of the Z&R model and Univariate 2. This suggests that the Z&R model may still generates smaller forecast errors than Univariate 1 and smaller squared errors than Univariate 2. However it can be statistically concluded that Univariate 2 generates smaller relative errors compared to the Z&R model.

As shown in tables 26-27, based on the Wilcoxon signed ranked test, all null hypotheses are rejected at a 5% significance level and all tests generate a negative z value except for the test of relative errors between the Z&R model and Univariate 2. This may be explained by the substantial decrease of the median relative error of Univariate 2. This implies that Univariate 2 generates smaller relative errors compared to the Z&R model.

To conclude, although some of the coefficients of the Z&R model change when outliers are not eliminated, the regression tests still generate similar results. The Z&R model no longer generated the smallest forecast errors except for the means of absolute and squared errors. The Student's t-test provided similar results as when truncating the data except that it now generates significant evidence of Univariate 2 being superior to the Z&R model when measuring relative errors. Furthermore, regarding the Wilcoxon signed rank test, the results are in line with previous results except for generating a positive z-values for the test of relative errors of the Z&R and Univariate 2. Thus it appears that the Z&R model may still generate fewer and smaller errors than Univariate 1, while Univariate 2 now appears to be superior to the Z&R model. The results of the study are thus not deemed to be robust to an alternative elimination of outliers.

6.2.5 Alternative regression method

In this section the effect of using the pooling method for estimating the regression coefficients for the Z&R model is analyzed. The *Payout* coefficient is still positive and is now significant at 1% level compared to the 5% level in the original Fama MacBeth estimated model. Also *E/P* and the intercept are still significant but now both at a 1% significance level. Furthermore, all coefficients are similar to the previous results except for *LEV* which changed sign and is now negative, however the variable is still insignificant. The coefficients of determination R^2 and adjusted R^2 are at 9.15% and 8.56%, both significantly lower compared to the results in the original model.

The regression test on the Z&R model generates similar results with both regression methods. R^2 and adjusted R^2 are now both at 29% and the coefficient is still significant. The regression test for Univariate 2 estimated on pooled data is also in line with previous results.

In tables 30-31 the forecast errors for the Z&R model and Univariate 2 are presented when estimated from pooled data. These results are consistent with the results of the original model.

As shown in tables 32-33, based on the Student's t-tests, the only null hypothesis that can be rejected at a 5% significance level is for the test comparing the relative errors of the Z&R model to Univariate 2. Furthermore, all tests generate negative t-values, implying that the Z&R model still generates smaller forecast errors compared to the univariate models when an alternative regression method is used. However it can only be statistically concluded that the Z&R model is superior to Univariate 2 when measuring relative errors.

In tables 34-35 the results from the Wilcoxon signed rank tests are presented for the null hypothesis that the difference between errors of the compared models is zero. The null hypothesis is rejected at a 5% significance level for all tests except for testing the relative errors of Z&R and Univariate 1. Furthermore all z-values are negative, implying that the Z&R model provides fewer and smaller forecast errors.

To conclude, the coefficients of the modified Z&R model are similar to the results from the original model where the Fama MacBeth method is used, and the regression tests still generate similar results. However, contrary to the findings using the Fama MacBeth method, the Student's t-test provides evidence that the Z&R model is superior to Univariate 2 when measuring relative errors. The Wilcoxon signed rank test gave the same results as with the Fama MacBeth method. Both the Student's t-test and the Wilcoxon signed rank test provides statistical evidence that there is a significant difference between the Z&R model and Univariate 2 when measuring relative errors. Thus, to some extent using a pooled regression method generates additional evidence that the Z&R model is superior to Univariate 2 when measuring relative errors. The study's findings are thus deemed to be robust to an alternative regression method.

7. Conclusion

7.1 The conclusion of the study

This study aimed to test whether the multivariate regression model developed by Zhou and Ruland could predict earnings growth in Swedish listed companies, and whether it could generate more accurate forecasts than two simple univariate models based solely on historical earnings growth.

Based on the regression test it can be concluded that the Z&R model is applicable as a forecast model of future earnings growth on Swedish listed companies. The model has a significant coefficient in the regression test and a high coefficient of determination compared to the univariate models.

When examining whether the Z&R model is superior to the univariate models in a forecasting context, the results are inconclusive. A comparison of forecast errors based on four different measures shows that the Z&R model has both smaller median and average forecast errors for all measures except for median simple errors. From the Wilcoxon test, it can be concluded that the Z&R model generates smaller squared and relative forecast errors than Univariate 2, and smaller relative errors than Univariate 1. However, no statistical conclusions can be drawn from the Student's t-test.

The study can therefore not significantly conclude that the Z&R model generates more accurate forecasts than the two univariate models. Further, the results are not robust when it comes to alternative measures of earnings or an alternative method for eliminating outliers. However, the results are deemed to be robust in regards to using an alternative regression method.

7.2 Validity

Validity refers to the study's ability to measure what it is intended to measure. This study has used the multivariate regression model developed by Zhou and Ruland (2006) to forecast earnings growth. A major difference from Zhou and Ruland's study is the size of the sample. First of all, this study uses data from the years 1993-2015 while Zhou and Ruland use observations from 1950-2003. A second major difference is that this study uses data from the Swedish stock exchange where substantially fewer companies are listed compared to the American stock exchanges. These differences may have a significant impact on the comparability between the two studies, as well as the validity of the results of this study.

The validity of the study may also have been affected by the requirement that all companies needed to report a positive net income and a dividend for the first year. This resulted in the elimination of a large group of observations. However, the sample was still deemed to be of sufficient size for the purpose of this study.

The Fama MacBeth regression method requires that the means of the yearly coefficients follow a normal distribution. In order to make this assumption, a sample size of at least 20 observations is needed. The study only had 16 years in the estimation period, and therefore the means may not have followed a normal distribution. This may have affected the validity of the results. However the results are robust to the alternative pooled regression method.

Zhou and Ruland's (2006) method for eliminating outliers was used in this study. Many of the variables, such as the dependent variable earnings growth, still displayed large variance after the removal of outliers. This may suggest that there is a more effective way of controlling for the effects of outliers. Furthermore, the results from the sensitivity analysis when not eliminating outliers showed that the mean relative forecast error for Univariate 2 substantially decreased, among other improvements, which may imply that a non-truncated estimation period is a more suitable base for estimating the regression model.

A number of sensitivity tests have been performed to test the robustness of the study. This includes investigating the effects of an alternative earnings measure, an alternative elimination of outliers and an alternative regression method.

7.3 Reliability

Reliability describes the accuracy of the results of the study, meaning that the study should generate the same results if replicated, regardless of who replicates the study.

All of the data used in the study was downloaded from FactSet. Therefore, the reliability of FactSet's database is of great importance to the study. To control the reliability of the data in FactSet, random checks have been made where certain variables have been compared to the corresponding value in the company's annual report and no errors were found.

Furthermore, the reliability of the data can also have been affected by changes in accounting standards. For example, in 2005, all companies on the Swedish stock exchange became required to follow IFRS. This may affect the comparability of data over time, as for example, the IFRS differs from GAAP in the treatment of what can be included in net earnings.

Changes in tax rates may also have affected the reliability of the data as the dependent variable of this study is net income after taxes.

7.4 Generalizability

Generalizability refers to the extent to which the results of the study can be applied to another setting or context, for example another country or time period. Zhou and Ruland's regression model has been tested and validated in other countries, however, to our knowledge the models ability to predict earnings growth has not been tested previously. Thus, it is reasonable to assume that similar results of the regression model would be seen in other markets.

The time period tested in this study includes data from 1993-2015. Thus, the results of this study cannot be applied to any other time period. Neither can it be assumed that the results hold for all sub-periods during 1993-2015.

7.5 Discussion of further research

This thesis examines whether Zhou and Ruland's regression model can be used to predict earnings growth on Swedish data, and whether the forecasts are more accurate than those derived from simple univariate models. Due to time restraints, earnings growth was only forecasted over a one year horizon, and thus only one year historical data was used in the regression model. It would be interesting to forecast earnings growth over a longer time horizon, such as over 3 and 5 years, and use the compounded annual earnings growth for the corresponding time period. This would be suitable to compare to the findings of Zhou and Ruland (2006) where they also estimate the Z&R model over longer time horizons. It would also be interesting to compare the results across different company sectors in order to examine how differences in sector standards, such as leverage or dividend policy, may affect the accuracy of the model.

8. References

Arnott, R. D., and C. S. Asness (2003). "Surprise! Higher Dividends = Higher Earnings Growth." Financial Analysts Journal 59.1, 70-87. Web.

Chan, L. K. C., Karceski, J., & Lakonishok, J. (2003). ”The Level and Persistence of Growth Rates.” The Journal of Finance, 58(2), 643–684. Web.

Dechow, P. M., & Sloan, R. G. (1997). “Returns to contrarian investment strategies: Tests of naive expectations hypotheses.” Journal of Financial Economics, 43(1), 3–27. Web.

Elliott, W. B., (2006). “Are Investors Influenced by Pro Forma Emphasis and Reconciliations in Earnings Announcements?” The Accounting Review, 81(1), 113–133. Web.

Esplin, A., Hewitt, M., Plumlee, M. & Yohn, T.L. (2014), "Disaggregating operating and financial activities: implications for forecasts of profitability", Review of Accounting Studies, vol. 19, no. 1, pp. 328-362. Web.

Fama, E.F., French, K.R., (2001). “Disappearing dividends: changing firm characteristics or lower propensity to pay?” Journal of Financial Economics 60, 3–44. Web.

Fama, E. F., French, K. R., (2002). “The Equity Premium”. The Journal of Finance, 57(2): 637–659. Web.

Fama, E. F., MacBeth, J. D, (1973). “Risk, Return and Equilibrium: Empirical Tests, Journal of Political Economy”, Vol. 81, No. 3, 607-636. Web.

Fairfield, P.M.; Sweeney, R. J.; and Yohn, T.L. (1996). “Accounting classification and the predictive content of earnings”. Accounting Review 71 (July): 337-55. Web.

Freeman, R.; J. A. Ohlson; and S. H. Penman, (1982). “Book Rate-of-Return and Prediction of Earnings Changes: An Empirical Investigation.” Journal of Accounting Research, 639-653. Web.

Gebhardt, W.; Lee, C.; and B. Swaminathan, (2001). "Toward an Implied Cost of Capital." Journal of Accounting Research, 39, 135-176. Web.

Gordon, M. J. (1962). “The Investment Financing and Valuation of the Corporation”. Homewood, IL: Richard D. Irwin. Web.

Gwilym, O. Ap, Seaton, J., Suddason, K., and Thomas, S. (2006). "International Evidence on the Payout Ratio, Earnings, Dividends, and Returns." Financial Analysts Journal 62.1, 36-53. Web.

Jensen, M. C. “Agency Cost of Free Cash Flow”, Corporate Finance, and Takeovers. SSRN Electronic Journal SSRN Journal. Web.

Lintner, J., and R. Glauber, (1967), “Higgledy, piggledy growth in America, presented to the Seminar on the Analysis of Security Prices, University of Chicago, May 1967”, reprinted in: J. Lorie and R. Brealey, eds., 1978, Modern developments in investment management, 2nd ed. (Dryden, Hinsdale)

Lintner, J., (1956). “Distribution of Incomes of Corporations among Dividends, Retained Earnings and Taxes.” American Economic Review, vol. 46, no. 2 (May), 97–113. Web.

Lorek, K. S., Willinger, G. L., & Bathke, A. W. (2007). “Statistically based quarterly earnings expectation models for nonseasonal firms.” Rev Quant Finan Acc Review of Quantitative Finance and Accounting, 31(1), 105–119. Web.

Miller, M, and Modigliani, F. (1961). “Dividend Policy, Growth and the Valuation of Shares.” Journal of Business, vol. 34, no. 4 (October), 411–433. Web.

Myers, S. (1984). The Capital Structure Puzzle. *Journal of Finance*(39), 572-592. Web.

Newbold, P., Carlson, W. L., & Thorne, B. M. (2013). *Statistics for business and economics*. Harlow: Pearson Education.

Ohlson, J. A. & Juettner-Nauroth, B. E., (2005), “Expected EPS and EPS Growth as Determinants of Value”, Review of Accounting Studies, 10, 349-365. Web.

Ou, J. A. (1990): "The Incremental Information Content of Non-Eamings Accounting Numbers as Earnings Predictors". Journal of Accounting Research, Vol. 28, No. 1, Spring, s. 144-163.

Skogsvik, S. (2002), "Redovisningsmått, värderelevans och informationseffektivitet" Akademisk Avhandling. Stockholm School of Economics. Stockholm: EFI.

Vivian, Andrew, (2006). "The Payout Ratio, Earnings Growth and Returns: UK Industry Evidence." University of Durham. Research Gate. Web.

Wooldridge, J. M., (2003). “Introductory econometrics: a modern approach.” Australia: South-Western College Pub. Web.

Yohn, T.L., Esplin, A.M., Hewitt, M.R., Plumlee, M.A. (2012). ”Disaggregating Operating and Financing Activities: Implications for Forecasts of Profitability”. Unpublished manuscript, Kelley School of Business. Web.

Zhou, P., & Ruland, W., (2006). “Dividend Payout and Future Earnings Growth.” Financial Analysts Journal, 62(3), 58–69. Web.

9. Appendix

Table 14: Correlation matrix to test for multicollinearity

	EG	*Payout*	*Size*	*ROA*	*E/P*	*LEV*	*PEG*	*PAG*
EG	1							
Payout	0.2060	1						
Size	0.0050	0.0224	1					
ROA	-0.1310	-0.2804	0.0580	1				
E/P	-0.2585	-0.2754	-0.1433	0.2149	1			
LEV	-0.0206	-0.0645	0.0670	-0.4068	0.0637	1		
PEG	-0.0989	-0.2475	-0.0275	0.2438	0.1499	-0.0414	1	
PAG	-0.0490	-0.1932	-0.0731	0.0533	-0.0834	0.1225	0.1372	1

Table 15: White- Hubert test for heteroscedasticity

	Coefficient	*Robust Standard errors*	*t-stat*	*p-value*
Intercept	0.4789	0.8802	2.1761	0.0459**
Payout	0.3043	0.6655	1.8289	0.0874*
Size	-0.0102	0.2627	-0.1548	0.8790
ROA	-1.2174	3.2672	-1.4905	0.1568
E/P	-4.8242	3.8880	-4.9631	0.0002***
LEV	0.0151	0.9587	0.0630	0.9506
PEG	-0.0083	0.1611	-0.2053	0.8401
PAG	-0.1522	0.6930	-0.8785	0.3935

**** p<0.01, ** p<0.05, * p<0.1*

Sensitivity analysis: Alternative measure of earnings

Table 16: Z&R model with EBIT

	Coefficient	*Std. dev.*	*t-stat*	*p-value*	*Nr. observations*	*1090*
Intercept	0.2543	0.7960	1.2778	0.2208	***R^2***	0.1714
Payout	0.0506	0.2816	0.7192	0.4831	***Adjusted R^2***	0.0708
Size	0.0011	0.0375	0.1169	0.9085		
ROA	-0.2887	2.0205	-0.5715	0.5761		
E/P	-2.2328	3.0289	-2.9486	0.0010***		
LEV	0.1416	0.6669	0.8494	0.4090		
PEG	0.1014	0.1879	2.1583	0.0475**		
PAG	-0.0953	0.5086	-0.7496	0.4651		

**** p<0.01, ** p<0.05, * p<0.1*

Table 17: Univariate 2 with EBIT

	Coefficient	*Std. dev.*	*t-stat*	*p-value*	*Nr. observations*	*1090*
Intercept	0.0439	0.2113	0.8305	0.4193	***R^2***	0.0476
PEG	0.0643	0.2161	1.1898	0.2526	***Adjusted R^2***	0.0327

Table 18: Regression test with EBIT

	Nr. obs	*a*	*p-value*	*B*	*p-value*	*R^2*	*Adjusted R^2*	*t-test*	*p-value*
Z&R	549	0.0680	0.3680	-0.0103	0.9432	0.0000	-0.0018	t=-6,9632	0.0000***
Uni 1	549	0.0673	0.3599	-0.0026	0.8726	0.0000	-0.0018	t=-61.61	0.0000***
Uni 2	549	0.0691	0.3563	-0.0406	0.8726	0.0004	-0.0015	t=-4.1106	0.0000***

**** p<0.01, ** p<0.05, * p<0.1*

Sensitivity analysis: Alternative method for the elimination of outliers

Table 19: Z&R model without elimination of outliers

	Coefficient	*Std. dev.*	*t-stat*	*p-value*	*Nr. observations*	*1351*
Intercept	-0.7373	1.8803	-1.5686	0.1376	***R^2***	0.4450
Payout	1.2800	2.6613	1.9239	0.0736*	***Adjusted R^2***	0.3901
Size	-0.0518	0.2244	-0.9236	0.3703		
ROA	6.8234	16.5017	1.6540	0.1189		
E/P	-3.9734	14.7405	-1.0782	0.2980		
LEV	2.5299	6.4634	1.5657	0.1383		
PEG	0.0565	0.1188	1.9035	0.0763*		
PAG	-0.8000	5.0799	-0.6299	0.5382		

**** p<0.01, ** p<0.05, * p<0.1*

Table 20: Univariate 2 without elimination of outliers

	Coefficient	*Std. dev.*	*t-stat*	*p-value*	*Nr. observations*	*1094*
Intercept	0.0439	0.2113	0.8305	0.4193	***R^2***	0.0476
PEG	0.0643	0.2161	1.1898	0.2526	**Adjusted R^2**	0.0327

Regression test

Table 21: Regression tests without elimination of outliers

	nr. obs	*a*	*p-value*	*B*	*p-value*	*R^2*	*Adjusted R^2*	*t-test*	*p-value*
Z&R	549	-0.3305	0.3003	0.9006	0.0000	0.3022	0.3009	t=-1.6979	0.0901*
Uni 1	549	0.4589	0.2256	-0.0636	0.6584	0.0004	-0.0015	t=-7.3978	0.0000***
Uni 2	549	0.2842	0.5861	0.1515	0.6584	0.0004	-0.0015	t=-2.4782	0.0135**

**** p<0.01, ** p<0.05, * p<0.1*

Forecast errors

Table 22: Forecast errors: Z&R without elimination of outliers

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	-0.4159	7.3877	-0.1176	-126.9579	85.7715
Abs error	1.4007	7.2654	0.4579	0.0019	126.9579
Squared error	54.6520	774.7401	0.2097	0.0000	16118.2962
Relative error	4.8677	27.4944	1.2383	0.0039	585.5765

Table 23: Forecast errors: Univariate 2 without elimination of outliers

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	-0.1583	4.8410	-0.0362	-90.9918	42.7708
Abs error	1.9820	8.6653	1.0511	0.0133	178.9730
Squared error	78.8785	1388.0603	1.1048	0.0002	32031.3259
Relative error	1.7382	6.5247	0.9625	0.0171	113.9313

Student's t-test

Table 24: Student's t-test: Z&R vs Univariate 1

	Squared errors			Relative errors		
Variable	***Obs***	***Mean***	***Std. dev.***	***Obs***	***Mean***	***Std. dev.***
Z&R	549	54.6520	774.7401	549	4.8677	27.4944
Univariate 1	549	85.4448	1426.116	549	7.3551	48.4177
Difference	549	-30.7927	1203.506	549	-2.4875	54.3023
		T=-0.5995	H1: Pr(|T| > |t|) = 0.5491		T=-1.0733	H1: Pr(|T| > |t|) = 0.2836

Table 25: Student's t-test: Z&R vs Univariate 2

	Squared errors			Relative errors		
Variable	***Obs***	***Mean***	***Std. dev.***	***Obs***	***Mean***	***Std. dev.***
Z&R	549	54.652	774.7401	549	4.8677	27.4944
Univariate 1	549	78.8785	1388.06	549	1.7382	6.5247
Difference	549	-24.2264	1158.461	549	3.1295	28.2213
		T=-0.4900	H1: Pr(|T| > |t|) = 0.6243		T=2.5983	H1: Pr(|T| > |t|) = 0.0096

Wilcoxon signed rank test

Table 26: Wilcoxon test: Z&R vs Univariate 1

	Squared errors			Relative errors		
Sign	***Obs***	***Sum ranks***	***Expected***	***Obs***	***Sum ranks***	***Expected***
positive	278	68823	75487.5	258	65881	75487.5
negative	271	82152	75487.5	291	85094	75487.5
zero	0	0	0	0	0	0
Total	549	150975	150975	549	150975	150975
Z	-1.792	Prob > |z| = 0.0731		-2.583	Prob > |z| = 0.0098	

Table 27: Wilcoxon test: Z&R vs Univariate 2

	Squared errors			Relative errors		
Sign	***Obs***	***Sum ranks***	***Expected***	***Obs***	***Sum ranks***	***Expected***
positive	123	31041	75487.5	323	103103	75487.5
negative	423	119934	75487.5	226	47872	75487.5
zero	0	0	0	0	0	0
Total	549	150975	150975	549	150975	150975
Z	-11.953	Prob > |z| = 0.0000		7.427	Prob > |z| = 0.0000	

Sensitivity analysis: Alternative regression method

Table 28: Z&R model pooled regression method

	coefficient	*Std. dev.*	*t-stat*	*p-value*	*Nr. observations*	*1094*
Intercept	0.6332	0.1820	3.4787	0.0005***	***R^2***	0.0915
Payout	0.2543	0.0687	3.7028	0.0002***	***Adjusted R^2***	0.0856
Size	-0.0163	0.0168	-0.9737	0.3304		
ROA	-1.1566	0.8817	-1.3117	0.1899		
E/P	-5.2744	0.7645	-6.8987	0.0000***		
LEV	-0.0914	0.2569	-0.3557	0.7221		
PEG	-0.0195	0.0285	-0.6858	0.4930		
PAG	-0.1759	0.1361	-1.2929	0.1963		

**** p<0.01, ** p<0.05, * p<0.1*

Regression test

Table 29: Sensitivity analysis: Regression tests with pooled regression method

	Nr. obs	*a*	*p-value*	*B*	*p-value*	*R^2*	*Adjusted R^2*	*t-test*	*p-value*
Z&R	549	-0.8203	0.0127	4.1665	0.0000	0.2921	0.2908	t=11.4184	0.0000***
Uni1	549	0.4589	0.2256	-0.0636	0.6584	0.0004	-0.0015	t=-7.3978	0.0000***
Uni2	549	0.3890	0.3272	0.6913	0.6584	0.0004	-0.0015	t=-0.1975	0.6461

**** p<0.01, ** p<0.05, * p<0.1*

Forecast errors

Table 30: Forecast errors: Z&R with pooling regression method

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	0.1405	8.2585	-0.0717	-83.5253	160.9425
Abs error	1.2299	8.1675	0.2533	0.0003	160.9425
Squared error	68.0988	1146.5769	0.0641	0.0000	25902.4883
Relative error	5.3493	33.9852	1.4508	0.0007	733.3485

Table 31: Forecast errors: Univariate 2 with pooling regression method

	Mean	*Std. dev.*	*Median*	*Min*	*Max*
Simple error	0.3645	8.8194	0.0014	-72.2589	180.3512
Abs error	1.2927	8.7316	0.2762	0.0009	180.3512
Squared error	77.7728	1407.8267	0.0763	0.0000	32526.5617
Relative error	11.1987	49.1900	2.8666	0.0088	936.1988

Student's t-test

Table 32: Student's t-test: Z&R vs Univariate 1

	Squared errors			***Relative errors***		
Variable	***Obs***	***Mean***	**Std. dev.**	***Obs***	***Mean***	**Std. dev.**
Z&R	549	68.0988	1146.577	549	5.3493	33.9852
Univariate 1	549	85.4448	1426.116	549	7.3551	48.4177
Difference	549	-17.346	320.9967	549	-2.0058	57.8865
		T=-1.2661	H1: Pr(|T| > |t|) = 0.2060		T=-0.8119	H1: Pr(|T| > |t|) =0.4172

Table 33: Student's t-test: Z&R vs Univariate 2

	Squared errors			Relative errors		
Variable	***Obs***	***Mean***	**Std. dev.**	***Obs***	***Mean***	**Std. dev.**
Z&R	549	68.0988	1146.577	549	5.3493	33.9852
Univariate 1	549	77.7728	1407.827	549	11.1987	49.19
Difference	549	-9.674	294.4514	549	-5.8494	59.1334
		T=-0.7698	H1: Pr(|T| > |t|) =0.4417		T=-2.3178	H1: Pr(|T| > |t|) =0.0208

Wilcoxon signed rank test

Table 34: Wilcoxon test: Z&R vs Univariate 1

	Squared errors			Relative errors		
Sign	***Obs***	***Sum ranks***	***Expected***	***Obs***	***Sum ranks***	***Expected***
positive	201	44655	75487.5	254	69979	75487.5
negative	348	106320	75487.5	295	80996	75487.5
zero	0	0	0	0	0	0
Total	549	150975	150975	549	150975	150975
Z	-8.292	Prob > |z| = 0.0000		-1.481	Prob > |z| = 0.1385	

Table 35: Wilcoxon test: Z&R vs Univariate 2

	Squared errors			Relative errors		
Sign	***Obs***	***Sum ranks***	***Expected***	***Obs***	***Sum ranks***	***Expected***
positive	256	68162	75487.5	160	35015	75487.5
negative	293	82813	75487.5	389	115960	75487.5
zero	0	0	0	0	0	0
Total	549	150975	150975	549	150975	150975
Z	-1.970	Prob > |z| = 0.0488		-10.884	Prob > |z| = 0.0000	