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Valuation Accuracy of the RIV Model

Is it possible to improve the valuation accuracy of the RIV model when taking both conservative measurement bias and business goodwill/badwill into account?

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Abstract

The residual income valuation model (RIV) presented by Ohlson (1995) relies on unbiased accounting. The presence of conservative accounting, however, has been well recognized within research (e.g. Mora and Walker, 2015; Barker, 2015). This thesis aims to investigate if it is possible to improve the valuation accuracy of the RIV model when taking both firm specific conservative measurement bias and business goodwill/badwill into account. We examine two versions of the RIV model, operationalized as Method I and Method II. In Method I we aim to capture the market's implicit estimate of goodwill at the horizon point in time and incorporate it into the terminal value calculation. In Method II we estimate a conservative measurement bias parameter, which enables us to use unbiased accounting in the RIV model. The relative valuation accuracy of the two models is examined by comparing them with the valuation accuracy of a base model. The thesis is based on a sample of companies listed on the stock exchange in Sweden, Finland, Norway and Denmark. We find that Method I exhibits better valuation accuracy compared to the base model, whereas Method II does not exhibit better valuation accuracy. In addition, we elaborate upon the methodological choices made for Method I and Method II. The results indicate that further improvements in valuation accuracy could be obtained.

Keywords: Equity valuation, residual income, conservative accounting, valuation accuracy

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1. INTRODUCTION

The development of new fundamental equity valuation models, such as the residual income valuation model (RIV) and the abnormal earnings growth model (AEG), has resulted in the emergence of a new branch of research (Lundholm and O'Keefe, 2001). These studies compare the valuation accuracy of the newer models with more traditional equity valuation models, such as the dividend discount model (DDM) and the discounted cash flow model (DCF). Criticism has been directed towards this type of research for its lack of theoretical foundation. Critics stress that all four valuation models are theoretically equivalent and should yield the same valuation (Lundholm and O'Keefe, 2001, Penman, 1998). However, the complexity in a real world setting makes it difficult to consistently apply the same assumptions across all models (Francis, Olsson and Oswald, 2000). Hence, studies comparing the valuation accuracy between different equity valuation models provide practitioners with guidance on how the models perform empirically. The results from these studies show that the RIV model outperforms many of its valuation counterparts (Bernard, 1995; Penman and Sougiannis, 1998; Courteau, Kao and Richardson, 2000; Francis, Olsson and Oswald, 2000; Jorgensen, Lee and Yoo, 2011). Even though the relative valuation accuracy of the RIV model has been found to be superior, its absolute valuation accuracy is not unblemished (Jorgensen, Lee and Yoo, 2011). A tendency towards negatively biased estimates of firm value has been a common pattern when empirically implementing the RIV model (Choi, O'Hanlon and Pope, 2006).

The RIV model relies on unbiased accounting (Ohlson, 1995). Given today's accounting practices, however, the financial statements are not expected to be free from bias (Barker, 2015). Rather, the presence of conservative accounting is something that has been well recognized within research and researchers have tried to incorporate conservative accounting into the RIV model (e.g. Feltham and Ohlson, 1995; Runsten, 1998; Myers, 1999; Choi, O'Hanlon and Pope, 2006). Integrating conservative accounting, however, appears to be a difficult task as this type of research has not managed to improve the valuation accuracy of the RIV model considerably (see e.g. Myers, 1999; Choi, O'Hanlon and Pope, 2006). Further research is hence motivated.

This thesis aims to investigate if it is possible to improve the valuation accuracy of the RIV model when taking both firm specific conservative measurement bias and business goodwill/badwill into account. Moreover, we are interested in a RIV model with a short explicit forecast horizon, which indicates that the firm may not have reached a steady state at the horizon point in time. Excess profitability, business goodwill, or losses, business badwill, is thus likely to still exist and that needs to be considered in the terminal value calculation. What distinguishes this thesis from previous studies is the procedure used to estimate the potential conservative measurement bias and business goodwill/badwill. More specifically, reverse engineering is applied with the belief that market values contain value relevant information about the conservative measurement bias and business goodwill/badwill. Two different adaptations of the RIV model, Method I and Method II, are implemented. In Method I we solve for a parameter, q(TOT), intended to capture the value of both conservative measurement bias and business goodwill/badwill at the truncation point in time. In Method II, the accounting inputs used in the RIV model are corrected for conservative accounting biases using a correction parameter, q(CMB). q(CMB) is, unlike q(TOT), supposed to solely capture the effect of conservative accounting. The relative valuation accuracy of the two models is examined by comparing them with the valuation accuracy of a base model.

The remainder of the thesis is structured in the following way. In chapter 2, theory and findings from previous research about the RIV model, conservative accounting and business goodwill/badwill are presented. In turn, chapter 3 goes through the specifications of Method I and Method II and the performance measures used to evaluate the models. The data selection criteria and the final sample are thereafter described in chapter 4. In chapter 5, our results are presented and analyzed. Lastly, our conclusions are drawn in chapter 6.

2. LITERATURE REVIEW

In this chapter, the reader will get an introduction to the RIV model and its underlying assumptions. Thereafter, goodwill and its two components, business goodwill/badwill and conservative measurement bias, will be discussed. Special interest is devoted to conservative accounting. In order to link the two subjects together, a section on how previous research has tried to incorporate conservative accounting into the RIV model will be presented. The literature review will end with a short discussion, positioning our thesis in relation to previous research.

2.1. THE RESIDUAL INCOME VALUATION MODEL

2.1.1. THE RIV MODEL AND ITS UNDERLYING ASSUMPTIONS

The dividend discount model (DDM) is claimed to be the simplest equity valuation model (Damodaran, 2012). The DDM states that a firm's value is equal to the present value of all future expected dividends. This reasoning relies on the belief that any asset is worth its present value of future expected cash flows and an investor that holds a share in a company, will receive cash flows in terms of dividends (Damodaran, 2012).

$$V_0 = \sum_{t=1}^{\infty} \frac{Div_t}{(1 + r_E)^t} \tag{1}$$

Where,
V_0 = intrinsic value of owners' equity at time $t = 0$,
Div_t = expected dividend at time t,
r_E = required rate of return on owners' equity.

The DDM provides a simplistic way to estimate firm value and the forecasting procedure is facilitated by the stability of dividends over time (Penman, 2013). The relevance of the DDM, however, has been questioned. The dividend irrelevance theorem presented by Miller and Modigiliani (1961) suggests that dividend policies are irrelevant when determining firm value. Penman (2013) further emphasized this point by highlighting that a profitable firm does not necessarily have to pay dividends and that firms actually can borrow money in order to distribute dividends. Penman (2013) concluded that "dividends are distributions of value, not the creation of value" (p. 114). In addition, previous research has also investigated the dividends' ability to explain the movements in stock prices. Researchers have found that dividends seem to be too stable to be able to explain the volatility in stock prices (e.g. Shiller, 1981; Jiang and Lee, 2005). The critique towards the DDM model has encouraged the development of other equity valuation models and one alternative model that has emerged is the RIV model.

The RIV model originates from the DDM but focuses, in contrast to the DDM, on value generating activities (Penman, 1998). The structure of the RIV model can be traced all the way back to Preinreich (1938) and Edwards and Bell (1961), but it was when Ohlson (1995) published his contribution that the model got increased academic recognition (Lee, 1999). The RIV model is a reformulation of the DDM and enables the analyst to focus on book values and earnings, instead of dividends. That is, the RIV model rests upon the same theory as the DDM but offers a framework which links accounting figures to firm value (Frankel and Lee, 1998; Jiang and Lee, 2005).

$$V_0 = BV_0 + \sum_{t=1}^{\infty} \frac{RI_t}{(1 + r_E)^t} \tag{2}$$

Where,
BV_0 = book value of owners' equity at time $t = 0$,
RI_t = residual income at time t.

The RIV model demonstrates that firm value is equal to the sum of its current book value of owners' equity and the present value of its future residual income. The book value of owners' equity is the reported value attributable to the shareholders. If the firm is expected to earn excess profits in the future, residual income, the present value of those should be added in order to obtain the firm value. The present value of future expected residual income is also referred to as goodwill (Ohlson, 1995; Feltham and Ohlson, 1995). Goodwill is presumed to explain the difference between the book value of owners' equity and the market value. Goodwill will be discussed in more detail in section 2.2. A firm that is not expected to make any residual income in the future is valued to its book value of owners' equity.

As a measure of value creation, earnings are not considered to be a good estimate. Value is not created until the return on investments exceeds the required rate of return (Penman, 2013). Residual income is thus defined as earnings less a charge for the use of capital, Eq. (3).

$$RI_t = Earn_t - BV_{t-1} \times r_E \tag{3}$$

Where,
$Earn_t$ = earnings at time t.

Underlying Assumptions

The RIV model is based on two main assumptions: (1) firm value is equal to the present value of future expected dividends, and (2) the clean surplus relation (CSR) holds, where dividends reduce the book value of owners' equity and do not impact current period's earnings (Ohlson, 1995). If assumption (1) and (2) hold, one can mathematically derive the RIV model from the DDM. Additionally, Ohlson (1995) introduced a third assumption to the RIV model, namely, (3) linear information dynamics of residual income, with residual income approaching zero in the long run. Besides these three assumptions, the RIV model as stated in Eq. (2) also implies an assumption about going concern as residual income is forecasted into infinity. Each of the three main assumptions are discussed in more detail below.

Assumption 1: Firm Value is Equal to the Present Value of Expected Dividends

The value of a security is equal to the present value of all future expected cash flows received from owning that security (Berk and DeMarzo, 2014). An investor that owns a share in a company can receive future cash flows in two ways: either as dividends or, potentially, as a capital gain if the investor decides to sell the share (Damodaran, 2012; Berk and DeMarzo, 2014). The investor is assumed to receive dividends until the share is sold at time *T*.

$$P_0 = \sum_{t=1}^{T} \frac{Div_t}{(1 + r_E)^t} + \frac{P_T}{(1 + r_E)^T} \tag{4}$$

Where,

P_0 = market price for the share at time $t = 0$,

P_T = market price for the share at the horizon point in time, *T*.

Berk and DeMarzo (2014) demonstrate that the amount of time the investor holds a share is irrelevant when determining its value. With a going concern assumption, a share can be held forever and thus the investor will only receive future expected cash flows in terms of dividends. As a result, the value of a share can be written as the present value of future expected dividends when the time horizon approaches infinity, Eq. (5).

$$P_0 = \sum_{t=1}^{\infty} \frac{Div_t}{(1 + r_E)^t} \tag{5}$$

Assumption 2: Clean Surplus Relation (CSR)

In order to derive the RIV model from DDM, the CSR must hold. If the CSR holds, the RIV model and the DDM are mathematically equivalent (Ohlson, 1995). The CSR is crucial as it allows dividends to be substituted with earnings and book values.

$$BV_t = BV_{t-1} + Earn_t - Div_t \tag{6}$$

The CSR implies that the change in book value of owners' equity from one period to another is explained by current year's earnings and dividends.[1] The CSR implies that all changes in book values, except transactions with owners, must pass through the income statement (Stowe et al.,

[1] Cash dividends are commonly used within accounting research (Jiang and Lee, 2005). However, Jiang and Lee (2005) emphasize the importance of a broader definition of dividends which also includes other cash transactions with shareholders, such as share repurchases and new issues.

2007). Even though the CSR is assumed to hold within RIV research, it is seldom the case in practice (Lo and Lys, 2000; Stowe et al., 2007). Lo and Lys (2000) examined, for example, if the CSR tends to hold on the US market and they concluded that deviations from the CSR can be considerable.[2] In order not to violate the CSR, other comprehensive income should be used instead of earnings found in the income statement (Lo and Lys, 2000; Stowe et al., 2007). Lundholm (1995) claimed, however, that even though there may be violations of the CSR, the CSR is still a reasonable assumption. What is important in a RIV setting is that the forecasted changes in book value of owners' equity are in line with the CSR (Bernard, 1995; Lo and Lys, 2000).

Assumption 3: Linear Information Dynamics

Ohlson's (1995) contribution to the RIV model is largely attributable to the third assumption about linear information dynamics, which allows for a simplistic closed form valuation (Lo and Lys, 2000). The RIV model as presented in Eq. (2), requires forecasts of future residual income into infinity, but provides little guidance on how to perform these forecasts. The linear information dynamics presented by Ohlson (1995) addresses this forecasting dilemma (Lee, 1999).

Ohlson (1995) explains the time-series behavior of future residual income as a linear function of current residual income and other information, Eq. (7) and Eq. (8). The linear information dynamics allows residual income to be forecasted based on current information, and does not require explicit forecasts of future values (Lee, 1999; Lo and Lys, 2000).

$$RI_{t+1} = \omega RI_t + v_t + \varepsilon_{t+1} \tag{7}$$

$$v_{t+1} = \gamma v_t + \varepsilon_{t+1} \tag{8}$$

Where,

RI_t = residual income at time *t*,

ω = persistence parameter for residual income with a constant value,

v_t= other information at time *t*,

γ = persistence parameter for other information with a constant value,

ε_{t+1} = disturbance term with a zero mean.

Ohlson (1995) assumes that the persistence parameters, ω and γ, are known and have non-negative values less than one ($0 \leq \omega < 1$; $0 \leq \gamma < 1$). This assumption implies that residual income will erode to zero over time. Other information is not defined to any great extent by Ohlson (1995). Rather, Ohlson (1995) states that it "should be thought of as summarizing value relevant events that have yet to have an impact on the financial statements" (p. 668). The integration of other information into the RIV model ensures that all value relevant information is included in the model. Empirically, information from analysts' forecasts have been commonly used as a base to approximate other information (see e.g. Frankel and Lee, 1998; Dechow, Hutton and Sloan, 1999; Choi, O'Hanlon and Pope, 2006).

[2] The analysis was conducted on a US sample with data from 1962-1997. The CSR violation was measured as the difference between comprehensive income and earnings reported in the income statement, dividend by comprehensive income.

Dechow, Hutton and Sloan (1999) were especially interested in the linear information dynamics assumption and elaborated on the persistence parameters ω and γ. They estimated the persistent parameters using regressions on historical data and confirmed that residual income and other information seem to follow a mean reverting process.[3] Dechow, Hutton and Sloan (1999) found that the persistent parameter for residual income, ω, was 0.62, while the persistent parameter for other information, γ, was 0.32.[4] These findings are consistent with the linear information dynamics presented by Ohlson (1995). Bar-Yosef, Callen and Livnat (1996) also aimed to study the linear information dynamics. They did not include other information in their study, but rather chose to solely focus on accounting numbers. In contrast to Dechow, Hutton and Sloan (1999), Bar-Yosef, Callen and Livnat (1996) did not find support for the one period lagged linear information dynamics. Lo and Lys (2000) criticized Bar-Yosef, Callen and Livant's (1996) methodology and claimed that their selection criteria created a small sample and also that their sample may not be representative for the population as a whole. They concluded that it is not possible to draw any clear conclusions from the results presented by Bar-Yosef, Callen and Livnat (1996). Myers (1999) also analyzed the RIV model with the linear information dynamics and tried to incorporate other information into the model in terms of order backlog. Myers (1999) investigated if the valuation accuracy of the RIV model improved when doing so but found that the valuation accuracy did not improve significantly compared to when the RIV model was only based on past realizations.

To summarize, there are ambiguous results about the one period lagged linear information dynamics presented by Ohlson (1995). There are studies that question the empirical validity of the linear information dynamics, while others find support for it. The empirical applications of the RIV model also demonstrate that other information is estimated in various ways and is sometimes not included in the RIV model at all.

2.1.2. EMPIRICAL APPROACHES OF THE RIV MODEL

Two types of applications of the RIV model have emerged within research. Begley and Feltham (2002) refer to these applications as the historical approach and the forecast approach. The historical approach often uses the linear information dynamics when estimating the intrinsic equity value. In the forecast approach, on the other hand, residual income is usually forecasted over a finite time horizon together with a computation of a terminal value.

The Historical Approach

If the linear information dynamics assumption is incorporated into the RIV model as stated in Eq. (2), the intrinsic equity value can be estimated by the following equation (Ohlson, 1995):

$$V_t = BV_t + \alpha_1 RI_t + \alpha_2 v_t \tag{9}$$

Where,

$\alpha_1 = \dfrac{\omega}{(1 + r_E - \omega)} \geq 0$

[3] A mean reverting process means that the variable exhibits a propensity to approach the average over time (Penman, 2013).

[4] Dechow, Hutton and Sloan (1999) used information from analysts' forecasts to estimate other information.

$$\alpha_2 = \frac{(1 + r_E)}{[(1 + r_E - \omega)(1 + r_E - \gamma)]} > 0$$

Eq. (9) allows for an equity valuation based on current accounting variables, rather than on forecasts of the future and arbitrary terminal value computations.[5] Dechow, Hutton and Sloan (1999), Myers (1999), Ahmed, Morton and Schaefer (2000) and Choi, O'Hanlon and Pope (2006) are examples of studies that use the historical approach when investigating the RIV model.

The Forecast Approach

The RIV model does not necessarily require the linear information dynamics (Ohlson, 2001). As an alternative approach, researchers have used explicit forecasts in combination with a terminal value calculation. Studies embracing the forecast approach are among others, Frankel and Lee (1998), Penman and Sougiannis (1998), Francis, Ohlson and Oswald (2000), Courteau, Kao and Richardson (2001) and Jorgensen, Lee and Yoo (2011).

The RIV model with a going concern assumption requires residual income to be forecasted into infinity. It is, however, difficult to conduct realistic forecasts for the long term future (Frankel and Lee, 1998; Penman, 2013). Frankel and Lee (1998) acknowledged the forecasting issue and concluded that forecasting errors are likely to grow worse the longer the forecast horizon. In order to facilitate the forecasting procedure, the forecast horizon is usually divided into two parts: an explicit forecast horizon and a terminal value calculation (Penman, 1998). The terminal value calculation allows for simplified assumptions regarding the future, and instead of making forecasts into infinity, it is possible to use a short explicit forecast horizon. But an early truncation comes at a price. The terminal value calculation implies that the firm has reached a steady state with constant long term growth (Koller, Goedhart and Wessels, 2010; Penman, 2013). This is not always the case in a simplified setting with a short forecast horizon. Even though Frankel and Lee (1998) stated that the errors in the forecasts are likely to increase with the forecast horizon, a short explicit forecast horizon with a terminal value calculation could also generate errors. Ohlson and Zhang (1999), for example, found that errors in terms of valuation accuracy decrease as the explicit forecast horizon is extended.

Brief and Lawson (1992) show how the RIV model can be restated with a terminal value, Eq. (10).

$$V_0 = BV_0 + \underbrace{\sum_{t=1}^{T} \frac{RI_t}{(1 + r_E)^t}}_{\substack{Explicit\ forecast \\ horizon}} + \underbrace{\frac{V_T - BV_T}{(1 + r_E)^T}}_{\substack{Terminal \\ Value}} \tag{10}$$

Eq. (10) expresses firm value as the sum of current book value of owners' equity, the present value of residual income up to time T and a terminal value. The terminal value represents the future expected goodwill at time T, discounted to its present value. Goodwill at time T is the difference between the expected market value and book value of owners' equity at time T. Nothing has

[5] The persistent parameters ω and γ used to compute α_1 and α_2, refer to the parameters presented in Eq. (7) and Eq. (8).

changed with the fundamentals in Eq. (10) compared to Eq. (2), the only difference is that the forecast horizon has been split into two parts where a terminal value has been introduced.

2.2. GOODWILL

In accounting, goodwill is referred to as benefits that emerge from acquired assets, but that is not "individually identified and separately recognized" (IFRS 3.A). In other words, goodwill is a balance sheet item that shows up when a firm has made an acquisition. In the RIV literature, however, goodwill is referred to as the present value of future expected residual income (Feltham and Ohlson, 1995). Goodwill can represent two things in the presence of conservative accounting, business goodwill/badwill and conservative measurement bias (Feltham and Ohlson, 1995; Skogsvik, 1998).

2.2.1. BUSINESS GOODWILL/BADWILL

In order for a firm to create value, its rate of return has to exceed the cost of capital (Penman, 2013). If true, the firm can expect positive residual income. The present value of residual income that arises because of excess profitability is referred to as business goodwill (Skogsvik, 1998). Business goodwill is, however, not expected to persist forever.

The time-series dynamics of residual income presented by Ohlson (1995) suggests that residual income will approach zero over time. This reasoning relies on the economic theory that excess profitability is expected to be competed away in the long run and that firms will only earn their required rate of return in a competitive equilibrium (Porter, 1980; Fama and French, 2000). A profitable industry will incentivize competitors to make additional investments and attract new entrants to the industry, which increase competition. It can also be assumed that a successful product, service or concept will eventually be copied by a rival (Fama and French, 2000).

Firms can also have a rate of return less than the required rate of return. If these firms do not manage to improve the allocation of their resources, they will eventually go out of business as investors will invest their money elsewhere (Porter, 1980). Hence, the convergence towards the required rate of return can be expected among low performing firms as well. The present value of negative future residual income is referred to as business badwill (Skogsvik, 2002).

Business Goodwill/Badwill and Residual Income

Residual income was defined in Eq. (3) as earnings less a charge for the use of capital. If both sides of Eq. (3) are divided by the opening balance of owners' equity, residual income can be rewritten as:

$$RI_t = BV_{t-1}(ROE_t - r_E) \tag{11}$$

In a competitive equilibrium, a firm's return on equity (ROE) is expected to be equal to the required rate of return. In this situation, the firm is not expected to generate any business goodwill or badwill, hence the residual income is zero.

2.2.2. CONSERVATIVE MEASUREMENT BIAS

Given today's accounting practices, goodwill is not expected to only represent business goodwill/badwill (Feltham and Ohlson, 1995). Residual income can also occur because of a bias in the accounting caused by conservative accounting practices.[6] In contrast to business goodwill/badwill, the conservative measurement bias is expected to persist over time (Skogsvik, 2002).

The purpose of the financial statements is to, in a fair and structured way, present a firm's performance and financial position (IAS, 1). However, the financial reporting has long been characterized by prudence, or conservatism (FASB, 1980; Lawrence, Sloan and Sun, 2012). FASB (1980) defines conservatism as "a prudent reaction to uncertainty to try to ensure that uncertainty and risks inherent in business situations are adequately considered". The estimation of assets and liabilities are surrounded by uncertainty, which means that it is possible for measurement errors to occur (FASB, 1980). Measurement errors that lead to understatements have historically been regarded as preferable compared to measurement errors that lead to overstatements (APB, 1970). This prudent approach has created a bias in the accounting.[7]

In practice, conservative accounting results in book values on average being understated (Feltham and Ohlson, 1995; Zhang, 2000; Penman and Zhang, 2002). For example, intangible assets such as brand and knowledge competence are usually not recorded on the balance sheet (Penman and Zhang, 2002; Penman, 2013). Moreover, some assets are depreciated faster than what would reflect their real economic value (Penman, 2013). Conservative accounting can also have an impact on the reported earnings, but its impact on earnings is not as straight forward. The difference between earnings under conservative accounting and under unbiased accounting is the change in the conservative measurement bias from one period to another (Zhang, 2000; Penman and Zhang, 2002). Zhang (2000) demonstrates that growth is an important influencer on how conservative accounting affects earnings. In the presence of growth, the change in the conservative measurement bias is expected to be positive and create a negative bias in earnings. If there is no growth, the conservative measurement bias will stay constant, hence not affecting earnings at all. This implies that earnings under conservative accounting will on average be equal to their economic value when the conservative measurement bias is constant (Zhang, 2000). It is, however, not only growth that can cause a change in the conservative measurement bias and thus influence earnings. Factors such as inflation, change in investment patterns and changes in accounting principles also have an impact on the magnitude of the conservative measurement bias (Runsten, 1998; Zhang, 2000). The change in the conservative measurement bias can also be negative and create a positive bias in earnings.

Even though conservative accounting is regarded as a prudent way of reporting, it usually creates higher returns on book values (Zhang, 2000; Penman, 2013). This is opposite to what could be

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[6] Feltham and Ohlson (1995) define conservative accounting and unbiased accounting in the following way: "unbiased (conservative) accounting obtains if, on average, the market value equals (exceeds) the book value" (p. 692).

[7] Conservatism interferes with other desirable qualitative characteristics in the financial reporting such as neutrality and faithful representation (FASB, 1980). 'Prudence' was removed from the *Conceptual Framework for Financial Reporting* in 2010, but IASB is considering to reintroduce the concept (IFRS, 2015).

considered as conservative since the firm will appear to be more profitable than it actually is (Penman, 2013). Zhang (2000) concluded that the returns on book values are likely to be overstated both in the presence of growth and in the absence of growth. If the firm experiences growth, both earnings and book values will be negatively biased. According to Zhang (2000), however, the bias in book values is likely to be more dominant and thus, even in a growth situation generate overstated rates of returns. Still, there can be situations where the return on book value is less than what would be the case with unbiased accounting. The effect on the return on book value is determined by the growth in owners' equity when the conservative measurement bias is larger than zero (Skogsvik, 1998). If the growth rate is larger than the unbiased ROE, the biased ROE will be lower than the unbiased ROE. Although a growth rate higher than the unbiased ROE is not likely to persist in the long run, it can occur in the short run.

Conservative Measurement Bias and Residual Income

As explained in the section above, conservative accounting is likely to bring a positive bias in ROE. This implies that ROE is expected to be larger than the required rate of return even in a competitive equilibrium when the firm is expected to only earn its required rate of return. Eq. (11) demonstrate that residual income will not converge to zero in the presence of conservative accounting. Furthermore, residual income is also a function of book values of owners' equity, and not just indirectly through ROE. In the presence of conservative accounting, book values are expected to be understated (Zhang, 2000; Penman and Zhang, 2002).

Clarifications

In section 2.2.2. it is assumed that the measurement bias in the accounting is related to solely conservative accounting practices. Other factors could, however, create a measurement bias in the accounting as well. The accounting could, for example, be overstated rather than prudent. However, conservative accounting has been well recognized within research (e.g. Feltham and Ohlson, 1995; Myers, 1999; Penman, 2013; Barker, 2015) and prudence has also historically been included in the Conceptual Framework for Financial Reporting as one of the characteristics that makes the reporting useful (IFRS, 2015). We will hence keep our narrow definition that the measurement bias in the accounting is related to conservative accounting.

2.2.3. THE GOODWILL EQUATION

The relative goodwill of owners' equity at time *t* is defined in Eq. (12).

$$q(TOT)_t = \frac{V_t - BV_t}{BV_t} \tag{12}$$

As explained in the section above, goodwill can represent both business goodwill/badwill and conservative measurement bias in the presence of conservative accounting, Eq. (13).

$$q(TOT)_t = q(BG)_t + q(CMB)_t \tag{13}$$

Where:

$q(TOT)_t$ = relative goodwill of owners' equity at time *t*,

$q(BG)_t$ = relative business goodwill/badwill of owners' equity at time *t*,

$q(CMB)_t$ = relative conservative measurement bias of owners' equity at time *t*.

Skogsvik (1998) underlined the advantage of decomposing goodwill into two components. In a competitive equilibrium, which is often assumed to occur at the horizon point in time, business goodwill/badwill is assumed to be competed away and can thus be expected to be negligible. Conservative accounting, on the other hand, is expected to persist. In the presence of conservative accounting, the conservative measurement bias parameter q(CMB) is expected to be positive (Skogsvik, 1998). The notation in Eq. (13) will be used in this thesis to separate relative total goodwill, relative business goodwill/badwill and relative conservative measurement bias.

2.3. ADJUSTING THE RIV MODEL FOR CONSERVATIVE ACCOUNTING

Researchers that have empirically tested the RIV model have found that the RIV model tends to underestimate the value of equity (see e.g. Dechow, Hutton and Sloan, 1999; Myers, 1999; Choi, O'Hanlon and Pope, 2006). The effects of conservative accounting when using the RIV model has been studied as a possible explanation of the tendency to undervalue (e.g. Myers, 1999; Choi, O'Hanlon and Pope, 2006).

2.3.1. THE HISTORICAL APPROACH AND CONSERVATIVE ACCOUNTING

In the RIV model presented by Ohlson (1995), next period's residual income is assumed to be a linear function of current period's residual income and other information. In the presence of conservative accounting, book values are expected to be understated and rates of return are likely to be overstated (Zhang, 2000). If that is the case, the accounting inputs used in the model are biased, which can presumably have an impact on the valuation accuracy of the RIV model. To account for this bias, Feltham and Ohlson (1995) made an extension of the RIV model by introducing a correction term for conservative accounting in book values. More specifically, Feltham and Ohlson (1995) separated the firm's assets into financial and operating. They reasoned that financial assets are in expectation equal to their market values and are not associated with any value creation. Operating assets, on the other hand, are on average expected to be valued less than their market values and are related to value creation. Goodwill is only believed to be attributable to the operating assets, which motivates the separation.

Myers (1999) elaborated on the models presented by Ohlson (1995) and Feltham and Ohlson (1995). Myers (1999) tested the RIV model empirically both by including other information and by adjusting for conservative accounting. Myers (1999) argued that a single parameter that corrects for conservatism in book values, as the one proposed by Feltham and Ohlson (1995), may not be sufficient since conservative accounting can have an impact on both book values and earnings. Myers (1999) therefore introduced two correction terms for conservative accounting, one for the income effect of conservatism and one for the book value effect of conservatism. Myers (1999) concluded, however, that the extended RIV models he examined still underestimated the value of owners' equity.

Choi, O'Hanlon and Pope (2006) also built on Feltham and Ohlson's (1995) model and used similar modifications to the RIV model as Myers (1999) did. Choi, O'Hanlon and Pope (2006) tried to include both other information based on analysts' forecasts, as well as a correction term for conservative accounting in book values. They found that the bias in value estimates can be improved, but that the models did not yield considerable better valuation accuracy.

Even though not explicitly adapting the historical approach, Skogsvik and Juetter-Nauroth (2013) approached the discussion from a more theoretical point of view and investigated to what extent the linear information dynamics can handle conservatism. One of their findings was that the RIV model can manage conservatism under certain conditions.[8] Even though Skogsvik and Juetter-Nauroth's (2013) research suggests that the linear information model should be able to handle accounting conservatism, the empirical findings from Myers (1999) and Choi, O'Hanlon and Pope (2006) demonstrate failures to identify conservatism in the linear information dynamics.

2.3.2. THE FORECAST APPROACH AND CONSERVATIVE ACCOUNTING

Researchers using the forecast approach have also tried to incorporate conservatism into the RIV model (e.g. Penman, 1998; Skogsvik, 1998; Runsten, 1998). These researchers have devoted special interest to the terminal value.

Penman (1998) underlined that a lot of value in an equity valuation model can be attributable to the terminal value and that conservative accounting can create errors in the terminal value estimate. To correct for conservative accounting in the terminal value, Penman (1998) discussed a 'measurement error parameter', K, which gives different weights to earnings respective book values in the terminal value depending on if the accounting is conservative or not. Skogsvik (1998) also discussed how one can adjust the terminal value calculation for conservative accounting. If the forecast horizon is long enough, so that the firm has reached a steady state with a competitive equilibrium, goodwill can be expected to only consist of conservative measurement bias. Skogsvik (1998) showed how the numerator in the terminal value can be restated as book value of owners' equity at the end of the forecast horizon multiplied with a correction parameter for conservative measurement bias, similar to Eq. (14).

Both Penman's (1998) and Skogsvik's (1998) studies point to the necessity in being able to detect the conservative measurement bias. Runsten (1998) developed industry specific permanent measurement bias (PMB) coefficients to account for the conservatism in the accounting.[9] Runsten (1998) tried to estimate the conservative measurement bias by carefully looking into the financial statements to estimate the size of conservative measurement bias each balance sheet item holds. Different assets and liabilities on the balance sheet are expected to generate conservative measurement biases of different magnitude, but firms in the same industry are likely to have similar characteristics and hence similar values of the PMB coefficient (Runsten, 1998). These PMB coefficients can be incorporated into the terminal value calculation in the RIV model, see Eq. (14). Anesten, Möller and Skogsvik (2015) investigated the valuation accuracy of a RIV model with

[8] The change in the conservative measurement bias was not allowed, for example, to be too large in the first forecasting period. See Skogsvik and Juetter-Nauroth (2013) for further specifications.

[9] Note, the PMB coefficient is similar to the q(CMB) parameter introduced in section 2.2.3.

Runsten's PMB coefficients, but still found that the RIV model generates a majority of undervaluations.

$$V_0 = BV_0 + \sum_{t=1}^{T} \frac{BV_{t-1}(ROE_t - r_E)}{(1 + r_E)^t} + \frac{BV_T \times PMB}{(1 + r_E)^T} \tag{14}$$

Where,
PMB = relative conservative measurement bias of owners' equity.

2.4. CONTRIBUTION

The RIV model enables the analyst to focus on accounting inputs and provides a desirable linkage between accounting figures and firm value (Frankel and Lee, 1998; Jiang and Lee, 2005). The RIV model is dependent upon accounting numbers, but the accounting numbers are likely to be distorted by conservative accounting practices. Several researchers have tried to incorporate conservatism into the RIV model (e.g. Myers, 1999; Choi, O'Hanlon and Pope, 2006), but these adjustments have in general provided weak improvements in regard to valuation accuracy. Further investigation in the field is hence motivated.

The historical approach with its linear information dynamics has been well elaborated upon. Researchers have introduced different conservative correction parameters into the autoregressive model, but have found little evidence for improvements in terms of valuation accuracy (e.g. Myers, 1999; Choi, O'Hanlon and Pope, 2006). We believe that the forecast approach, with its explicit forecasts and terminal value, offers more room for further investigation. The terminal value, for example, is a component that is likely to contain a lot of noise (Francis, Olsson and Oswald, 2000). 21% - 31% of the intrinsic equity value has been found to be attributable to the terminal value calculation (Francis, Olsson and Oswald, 2000; Jorgensen, Lee and Yoo, 2011; Anesten, Möller and Skogsvik, 2015). This suggests that errors in the terminal value calculation could have a large impact on the value estimate. With a short explicit forecast period, the value of future expected goodwill at the horizon point in time can be large. Goodwill forecasts are accompanied with uncertainty and better estimations of its value could potentially improve the overall valuation accuracy.

This thesis aims to investigate if it is possible to improve the valuation accuracy of the RIV model when taking both firm specific conservative measurement bias and business goodwill/badwill into account. What distinguishes this thesis from previous studies is the procedure used to estimate the potential conservative measurement bias and business goodwill/badwill. For example, Runsten (1998) estimated the conservative measurement bias by a close investigation of the financial statements, a demanding and time consuming task. We believe that there is a need for a more simplistic way to estimate the conservative measurement bias. Reverse engineering is used in this thesis with the belief that market values contain value relevant information that could be used to improve the valuation estimates. With our estimation procedure we hope to obtain better valuation accuracy for the RIV model.

3. RESEARCH DESIGN

This chapter will start with a brief introduction to Method I, Method II and our base model. Thereafter follows a more detailed description of Method I and Method II and how the methods are operationalized. The chapter will end with a presentation of the valuation performance measures and the statistical tests.

3.1. MODEL NOTATIONS AND OVERVIEW

In this thesis, we investigate if it is possible to improve the valuation accuracy of the RIV model. Special interest is devoted to the goodwill parameter, which can be divided into conservative measurement bias and business goodwill/badwill. We use two methods in order to incorporate goodwill into the RIV model.[10] These two methods are benchmarked to our base model, a RIV model with Runsten's (1998) PMB coefficients.

Model notations

The following notations are used when presenting the models.[11]

$BV_{i,t}$	= book value of owners' equity ex-dividend for firm *i* at time *t*
$Div_{i,t}$	= dividend for firm *i* in period *t*
$E[R_{Mkt}]-r_f$	= market risk premium
$Earn_{i,t}$	= earnings for firm *i* in period *t*
$g_{i,t}$	= growth in book value of owners' equity for firm *i* at time *t*
$MV_{i,t}$	= market value of owners' equity for firm *i* at time *t*
$p\text{-}fail_{i,t}$	= probability of failure for firm *i* at time *t*
PMB_j	= permanent measurement bias coefficient for industry *j*
$ps_{i,t}$	= payout share for firm *i* in period *t*
$q(CMB)_i$	= relative conservative measurement bias of owners' equity for firm *i*
$q(TOT)_{i,t}$	= relative goodwill of owners' equity for firm *i* at time *t*
r_f	= risk-free rate
$r^*_{E,i}$	= required rate of return on owners' equity adjusted for bankruptcy risk for firm *i*
$r^{RE}_{E,i}$	= reverse engineered required rate of return on owners' equity for firm *i*
$ROE_{i,t}$	= book return on equity for firm *i* in period *t*
$V_{i,t}$	= intrinsic equity value for firm *i* at time *t*
β_i	= beta for firm *i*
ω_i	= persistence parameter of residual income for firm *i*
δ_i	= $\omega(1+g)$ for firm *i*
δ_i^{RE}	= reverse engineered δ_i for company *i*

Additionally, some of the variables above are denoted CB or UB. CB stands for conservatively biased and UB stands for unbiased. CB and UB are used in situations that require a separation of

[10] The methods have been developed through discussions with Kenth Skogsvik, professor at Stockholm School of Economics.

[11] In this chapter the variables are notated with *i* and *t* in the formulas. However, to facilitate the reading, these notations are in most instances dropped when referring to the variables in the text.

variables that are biased by conservative accounting from those that are not. If nothing else is stated, the variable is conservatively biased.

Overview of the Models

Method I aims to capture the market's implicit estimate of goodwill at time *T*. This estimate, q(TOT), is incorporated into the terminal value calculation, see Eq. (15).

$$V_{i,0} = BV_{i,0} + \sum_{t=1}^{T} \frac{BV_{i,t-1}\left(ROE_{i,t} - r^{*}_{E,i}\right)}{(1 + r^{*}_{E,i})^{t}} + \frac{BV_{i,T} \times q(TOT)_{i,T}}{(1 + r^{*}_{E,i})^{T}} \tag{15}$$

In Method II, firm specific q(CMB) parameters are estimated which enables estimations of unbiased ROE values and unbiased book values of owners' equity. This allows for a RIV valuation with accounting variables that are not distorted by conservative accounting practices, Eq. (16).

$$V_{i,0} = BV^{CB}_{i,0}(1 + q(CMB)_{i}) + \frac{BV^{CB}_{i,0}(1 + q(CMB)_{i}) \times (ROE^{UB}_{i,1} - r^{RE}_{E,i}))}{(1 + r^{RE}_{E,i}) - \delta^{RE}_{i}} \tag{16}$$

The valuation accuracy of Method I and Method II are benchmarked against our base model, a RIV model with Runsten's (1998) PMB coefficients, Eq. (14).[12] Eq. (14) is hereafter referred to as our base model.

$$V_{i,0} = BV_{i,0} + \sum_{t=1}^{T} \frac{BV_{i,t-1}\left(ROE_{i,t} - r^{*}_{E,i}\right)}{(1 + r^{*}_{E,i})^{t}} + \frac{BV_{i,T} \times PMB_{j}}{(1 + r^{*}_{E,i})^{T}} \tag{14}$$

The intrinsic equity values obtained from Method I, Method II and our base model are compared to the actual market value in order to determine the valuation accuracy of each model.

3.2. METHOD I

3.2.1. MODEL SPECIFICATIONS – METHOD I

A terminal value calculation presumes that the value driver, in this case residual income, grows at a constant rate (Koller, Goedhart, Wessels, 2010). In other words, the firm has reached its steady state. If the steady state is also a competitive equilibrium, goodwill is expected to only include conservative measurement bias (Skogsvik, 1998). Skogsvik (1998) presented a RIV model with a correction term to account for the conservative measurement bias in the terminal value calculation. However, when applying a valuation model with a short explicit forecast horizon, a steady state assumption at the horizon point in time is hard to justify. In this situation, goodwill is not only expected to include conservative measurement bias, but business goodwill/badwill is also likely to be present. The correction term presented by Skogsvik (1998) is thus not adequate in this setting.

Method I aims to address this problem by incorporating a correction term accounting for both conservative measurement bias as well as business goodwill/badwill in the terminal value

[12] PMB coefficients have been assigned to firms based on matching industry SIC codes to Runsten's (1998) industry classification.

calculation. Method I is based on the idea that historical market values include information about investors' expectations of the future development of business goodwill/badwill as well as the persistent effect of conservative measurement bias. If this information is incorporated into the correction parameter, we hope to obtain a terminal value that gives a better reflection of the future.

The terminal value in the RIV model can be stated as (Brief and Lawson, 1992):

$$\frac{V_{i,T} - BV_{i,T}}{(1 + r^*_{E,i})^T} \tag{17}$$

Where (V_T - BV_T) is the firm's goodwill at the end of the explicit forecast horizon, *T*. If the book value of owners' equity is moved outside the brackets in the numerator, the following expression is obtained:

$$\frac{BV_{i,T} \times (V_{i,T}/BV_{i,T} - 1)}{(1 + r^*_{E,i})^T} \tag{18}$$

Furthermore, (V_T/BV_T - 1) is the firm's relative goodwill of owners' equity and is defined as $q(TOT)_T$ (Skogsvik, 2002). A substitution results in:

$$\frac{BV_{i,T} \times q(TOT)_{i,T}}{(1 + r^*_{E,i})^T} \tag{19}$$

The terminal value as shown in Eq. (19) can be incorporated into the RIV model as follows:

$$V_{i,0} = BV_{i,0} + \sum_{t=1}^{T} \frac{BV_{i,t-1}\left(ROE_{i,t} - r^*_{E,i}\right)}{(1 + r^*_{E,i})^t} + \frac{BV_{i,T} \times q(TOT)_{i,T}}{(1 + r^*_{E,i})^T} \tag{15}$$

3.2.2. MODEL INPUTS AND ASSUMPTIONS – METHOD I

If historical market prices and accounting numbers are inserted into Eq. (15), it is possible to estimate the value of q(TOT) by reverse engineering. Method I requires estimations and forecasts of the following variables: q(TOT), ROE, ps, BV and r_E.

Relative Goodwill of Owners' Equity, q(TOT)

The estimation of goodwill in a parsimonious setting is surrounded by a great amount of uncertainty. Each firm has its own composition of assets and liabilities and exhibits different profitability. This suggests that each firm has its own specific q(TOT) parameter. Instead of making arbitrary estimations of q(TOT), we use reverse engineering and solve for the market's implicit estimate of goodwill in historical years when market values and accounting numbers are known.

Our assumption is that historical values of q(TOT) can serve as good estimates of the current year's q(TOT). In order to minimize year specific variations, an average of the three consecutive years is used to conduct our forecast of q(TOT).

$$\overline{q(TOT)}_{i,t} = \frac{q(TOT)_{i,t-1} + q(TOT)_{i,t-2} + q(TOT)_{i,t-3}}{3} \tag{20}$$

Return on Equity, ROE

ROE is defined as earnings divided by opening value of owners' equity available to common shareholders (Beaver and Ryan, 2000; Johansson and Runsten, 2005).

$$ROE_{i,t} = \frac{Earn_{i,t}}{BV_{i,t-1}} \tag{21}$$

Earnings before extraordinary items is in this thesis used to calculate ROE. This may be regarded as a violation of CSR (Lo and Lys, 2000; Stowe et al., 2007). However, in line with Dechow, Hutton and Sloan's (1999) reasoning, extraordinary items should be nonrecurring and its inclusion is not assumed to strengthen our forecast ability. Furthermore, even though managers may be more willing to classify bad news as nonrecurring and good news as recurring (Schilit and Perler, 2010), negative and positive extraordinary items should in expectation cancel each other out in the long run.

Historical realizations are used to forecast next period's ROE (Penman and Sougiannis, 1998; Frankel and Lee, 1998).[13] In accordance with Skogsvik (2008), a historical average of the three preceding years is used to make predictions about the future. Other researchers have based their average on longer time periods (see e.g. Anesten, Möller and Skogsvik, 2015). However, we argue that a three year period is sufficient to avoid year specific fluctuations, while also lowering the risk of using outdated values that are no longer good representations of the firm's future performance. Longer historical time series could also increase the risk of survivorship bias as the firm would be required to be listed on the stock exchange for longer periods in order to be part of the sample.

$$\overline{ROE}_{i,t} = \frac{ROE_{i,t-1} + ROE_{i,t-2} + ROE_{i,t-3}}{3} \tag{22}$$

Payout Share, ps

Payout share is defined as dividends divided by the opening balance of owners' equity:

$$ps_{i,t} = \frac{Div_{i,t}}{BV_{i,t-1}} \tag{23}$$

A commonly used payout measure is the payout ratio, defined as dividends divided by earnings (Frankel and Lee, 1998; Jorgensen, Lee and Yoo, 2011). However, using book value of owners' equity in the denominator instead could be regarded as advantageous since it avoids the issue when earnings are negative. Also, temporary fluctuations in earnings could distort the payout ratio. As Penman (2013) expresses it "although the dividend payout ratio suggests that dividends are paid out of earnings, they are really paid out of book value" (p. 266).

[13] There is a discussion about the validity of using historical realizations as forecasts of the future. For example, Damodaran (2007) emphasized that volatility in earnings causes return ratios to change over time. Also, as the firm grows and becomes larger, return rates usually decrease. Even if that is the case, the persistence of past realized returns have been found to be quite stable (Damodaran, 2007).

In line with Frankel and Lee (1998) and Jorgensen, Lee and Yoo (2011), the firm's future payout policy is determined by the most recent year's accounting numbers. If dividend data is not available in the database at that time, data from the year before is used. A historical average is not calculated in this case. An average would decrease our sample since information about dividends for historical years is limited in the database for our specific sample. Also, the payout share is held constant in each valuation. These decisions are motivated since dividend policies are normally quite stable over time (Penman, 2013).

Book Value of Owners' Equity, BV

Under the assumption of CSR, future values of book value of owners' equity are calculated as in Eq. (24).

$$BV_{i,t} = BV_{i,t-1} + \left(\overline{ROE}_{i,t} \times BV_{i,t-1}\right) - \left(ps_{i,t} \times BV_{i,t-t}\right) \tag{24}$$

Required Rate of Return on Owner' Equity, r_E

The required rate of return on owners' equity is estimated based on the Capital Asset Pricing Model, CAPM.

$$r_{E,i} = r_f + \beta_i \times \left(E[R_{Mkt}] - r_f\right) \tag{25}$$

The 10-year government bond for each market serve as an estimate of the risk-free rate, r_f.[14] The government bond for each market is used since the risk-free rate should be stated in the same currency as the firm's cash flows (Koller, Goedhart and Wessels, 2010). Furthermore, firm specific beta values, β, are estimated. Fama and French (1997) claim that industry specific rates are superior to firm specific. However, previous research has found that industry specific and firm specific discount rates generate similar results in practice (Francis, Olsson and Oswald, 2000; Courteau, Kao and Richardsson, 2001). The beta values are estimated by regressing the stock's return against the market's return.[15] Adjusted stock prices are used in order to avoid volatility created by e.g. stock splits and dividend payments. At least 30 monthly returns over a 36 month period are used in the regression (Liu, Nissim and Thomas, 2002; Jorgensen, Lee and Yoo, 2011; Berk and DeMarzo, 2014). The market risk premium, ($E[R_{Mkt}]-r_f$), is set to 5.5% for all markets.[16]

The estimated r_E is also adjusted for bankruptcy risk (Skogsvik, 2006). Our forecasts are conditional on survival and it is hence reasonable to incorporate bankruptcy risk into the model.

$$r^*_{E,i} = \frac{r_{E,i} + p_{fail,i}}{1 - p_{fail,i}} \tag{26}$$

[14] This thesis uses a sample of firms from the Swedish, Norwegian, Finnish and Danish market.

[15] The market return for each market is approximated by the following indexes: OMX Stockholm 30, OMX Copenhagen 20, OMX Helsinki 25 and Financial Times Norway.

[16] The market risk premium is chosen based on the findings from Fernandez (2015) research. Fernandez (2015) reports the average market risk premium used by approximately 60 analysts for each of the four markets in 2015. The market risk premiums range between 5.4% - 5.7% for the Swedish, Finnish, Norwegian and Danish market.

Several accounting based bankruptcy prediction models have emerged within research (e.g. Beaver, 1966; Altman, 1968; Ohlson, 1980; Skogsvik, 1990). However, in order to adjust r_E for bankruptcy risk, the bankruptcy prediction model needs to generate probabilities of failures. This is something that the models presented by Ohlson (1980) and Skogsvik (1990) do. Skogsvik's (1990) model is deemed to be most appropriate for this thesis since the parameters in Skogsvik's (1990) model are estimated based on a Swedish sample, rather than on a US sample.[17] A Swedish sample is more in line with the Swedish, Finnish, Norwegian and Danish firms used in this thesis.

The p-fail received from Skogsvik's (1990) model is in general overstated. The percentage of failing firms in the sample Skogsvik (1990) used is larger than the percentage of failing firms in the economy as a whole. This implies that the coefficients in Skogsvik's (1990) model could be biased and thus overstate the probability of failure. To correct for this we apply the Skogsvik and Skogsvik (2013) correction equation.[18]

Potential measurement errors in combination with low risk-free rates generate a few negative estimates of r_E^* in our sample. These negative r_E^* are set to 0.5%. The cost of equity is held constant under each valuation period.

3.3. METHOD II

3.3.1. MODEL SPECIFICATIONS – METHOD II

If the accounting is conservative, book values will on average be understated and ROE is likely to be positively biased (Zhang, 2000; Penman, 2013). The latter implies that there will be positive residual income even in a competitive equilibrium. This intervenes with the assumption that residual income will erode to zero over time. Conservative accounting could hence be problematic as the RIV model relies on unbiased accounting (Ohlson, 1995).

In contrast to Method I, the effect of conservative measurement bias is isolated in Method II. This makes it possible to obtain unbiased input variables that are corrected for conservative accounting. More specifically, if the conservative measurement bias is estimated and the growth in the conservative measurement bias is determined, an unbiased return on equity, ROE^{UB}, can be solved for (Skogsvik, 1998), Eq. (27).

$$ROE_{i,t}^{UB} = \frac{ROE_{i,t}^{CB} + q(CMB)_i \times g_{i,t}}{1 + q(CMB)_i} \tag{27}$$

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[17] The parameter diff($R_L^{(n)}$) is ignored when calculating the bankruptcy risk according to Skogsvik's (1990) model. The computation of the parameter requires mean values and standard deviations of the interest expense, calculated based on values from the four preceding years. This data requirement would restrict our sample size even more. The choice of ignoring the parameter diff($R_L^{(n)}$) is further supported by its low impact on the bankruptcy risk estimate.

[18] The following correcting formula is used: $p(fail)_{POP} = p(fail)_{EST} \times \frac{\varphi \times (1-prop)}{prop \times (1-\varphi) + p(fail)_{EST} \times (\varphi - prop)}$ where prop = number of failure companies in relation to total number of companies in the sample (13.46%), φ = proportion of failure companies in the population of companies. We assume φ = 2%. $p(fail)_{EST}$ = the probability of failure in the sample, $p(fail)_{POP}$= the probability of failure in the population.

Furthermore, an unbiased book value of owners' equity can also be calculated if the conservative measurement bias is estimated, Eq. (28).

$$BV_{i,t}^{UB} = BV_{i,t}^{CB}(1 + q(CMB)_i) \tag{28}$$

The unbiased return on equity and unbiased book value of owners' equity can be inserted into the RIV model as follows:

$$V_{i,0} = BV_{i,0}^{CB}(1 + q(CMB)_i) + \sum_{t=1}^{\infty} \frac{BV_{i,t-1}^{CB}(1 + q(CMB)_i) \times (ROE_{i,t}^{UB} - r_{E,i}^{*})}{\left(1 + r_{E,i}^{*}\right)^{t}} \tag{29}$$

Since we are using accounting numbers adjusted for conservative measurement bias in Eq. (29), the assumption that residual income will fade away over time is more realistic. The fade away factor of the residual income is denoted ω and is allowed to range between $0 \leq \omega < 1$ (Ohlson, 1995). Furthermore, we assume that the book value of owners' equity grows at a constant rate, g.

$$V_{i,0} = BV_{i,0}^{CB}(1 + q(CMB)_i) + \sum_{t=1}^{\infty} \frac{BV_{i,t-1}^{CB}(1 + q(CMB)_i)(1 + g_i)^{t-1} \times {\omega_i}^{t-1}(ROE_{i,t}^{UB} - r_{E,i}^{*})}{(1 + r_{E,i}^{*})^{t}} \tag{30}$$

Since we are interested in a RIV model with a short explicit forecast horizon, Eq. (30) is restructured to allow for a terminal value calculation, where $\delta = \omega(1 + g)$, see Eq. (31). The terminal value is based on the Gordon growth formula (see Gordon and Shapiro (1956) and Appendix A for a mathematical derivation). In this setting, δ is restricted to not be larger than $(1 + r_E^*)$. If that would be the case, the denominator would become negative and the forecasted residual income would not make economic sense.

$$V_{i,0} = BV_{i,0}^{CB}(1 + q(CMB)_i) + \frac{BV_{i,0}^{CB}(1 + q(CMB)_i) \times (ROE_{i,1}^{UB} - r_{E,i}^{*})}{(1 + r_{E,i}^{*}) - \delta_i} \tag{31}$$

In Method II, we solve for the market's implicit value of r_E^* by reverse engineering. This choice is motivated by the critique raised towards CAMP through the years. For example, Fama and French (1992) questioned if the estimated beta values are appropriate to explain market risk premiums. Furthermore, reverse engineering is also applied to obtain the value of δ.

$$V_{i,0} = BV_{i,0}^{CB}(1 + q(CMB)_i) + \frac{BV_{i,0}^{CB}(1 + q(CMB)_i) \times (ROE_{i,1}^{UB} - r_{E,i}^{RE}))}{(1 + r_{E,i}^{RE}) - \delta_i^{RE}} \tag{16}$$

3.3.2. MODEL INPUTS AND ASSUMPTIONS – METHOD II

In order to estimate the conservative measurement bias, we assign different plausible values to the q(CMB) parameter and analyze which q(CMB) value that would historically result in the most accurate valuation for each firm. Reverse engineering is hence used to identify the best performing value of the conservative measurement bias. Method II requires estimations and forecasts of the following input variables: q(CMB), ROE^{UB}, r_E^{RE} and δ^{RE}.

Relative Conservative Measurement Bias of Owners' Equity, q(CMB)

Runsten (1998) estimated industry specific PMB coefficients and found that the average conservative measurement bias among industries varies between 0.28 and 1.74. The conservative measurement bias for individual firms is thus expected to vary between a larger span. In this thesis, firm specific q(CMB) values are estimated and we assume that a reasonable conservative measurement bias can vary between 0 and 4.

The q(CMB) parameter is assigned values between 0 and 4, with an interval of 0.2. For each q(CMB) value we solve for ROE^{UB}, r_E^{RE} and δ^{RE} using reverse engineering. This means that each of the 21 potential q(CMB) values has its own specific combination of ROE^{UB}, r_E^{RE} and δ^{RE}. The 21 different combinations are then evaluated by investigating which combination that would historically generate the most accurate valuation. The combination that gives the most accurate valuation is assumed to contain the most accurate conservative measurement bias and is thus used in the actual valuation of the firm.

Unbiased Return on Equity, ROE^{UB}

ROE^{UB} is one of the input variables in Eq. (16). However, this unbiased measure is not found directly in the financial statements. Eq. (32) shows how ROE^{UB} can be estimated.

$$ROE_{i,t}^{CB} = ROE_{i,t}^{UB} + q(CMB)_i\left(ROE_{i,t}^{UB} - g_{i,t}\right) \tag{32}$$

We assume that the conservative measurement bias is expected to persist and that its relative size to owners' equity is constant over time. Hence, the growth in the measurement bias is approximated by the growth in owners' equity $(g_t = [(BV_t - BV_{t-1})/BV_{t-1}])$. Eq. (32) can now be rewritten as:

$$ROE_{i,t}^{UB} = \frac{ROE_{i,t}^{CB} + q(CMB)_i\left[\left(BV_{i,t}^{CB} - BV_{i,t-1}^{CB}\right)/BV_{i,t-1}^{CB}\right]}{(1 + q(CMB)_i)} \tag{33}$$

All of the 21 potential q(CMB) values are inserted into Eq. (33). The conservatively biased book values of owners' equity and ROE^{CB} are found in the financial statements. This allows us to calculate a ROE^{UB} for each specific q(CMB) value, resulting in a total of 21 different ROE^{UB}.

Similar to the forecast of ROE in Method I, ROE^{UB} will be forecasted based on an average of the three consecutive years.

$$\overline{ROE}_{i,t}^{UB} = \frac{ROE_{i,t-1}^{UB} + ROE_{i,t-2}^{UB} + ROE_{i,t-3}^{UB}}{3} \tag{34}$$

Eq. (34) implies that we need to repeat the procedure for Eq. (33) for three historical years in order to obtain a $\overline{ROE}^{UB}$. Once again, each q(CMB) value has its own corresponding $\overline{ROE}^{UB}$.

Estimation of $\mathbf{r_E^{RE}}$ and $\boldsymbol{\delta}^{\mathbf{RE}}$

Eq. (35.a) and Eq. (35.b) are similar to Eq. (16). However, these two equations are not used to estimate the current market value of owners' equity. Rather, reverse engineering is once again used and historical market values are inserted into Eq. (35.a) and Eq. (35.b). Historical market values and conservatively biased book value of owners' equity are known. Furthermore, $\overline{\mathrm{ROE}}^{\mathrm{UB}}$ has been estimated as stated in the section above. We assume that $\mathrm{r_E^{RE}}$ and δ^{RE} for two subsequent years are rather stable. Hence, by combining information from two historical consecutive years, we can solve for the unknown parameters $\mathrm{r_E^{RE}}$ and δ^{RE}.

$$
\begin{cases}
MV_{i,-2} = BV_{i,-2}^{CB}(1 + q(CMB)_i)\left(1 + \dfrac{\overline{ROE}_{i,-2}^{UB} - r_{E,i}^{RE}}{(1 + r_{E,i}) - \delta_i^{RE}}\right) & (35.a) \\[2ex]
MV_{i,-3} = BV_{i,-3}^{CB}(1 + q(CMB)_i)\left(1 + \dfrac{\overline{ROE}_{i,-3}^{UB} - r_{E,i}^{RE}}{(1 + r_E) - \delta_i^{RE}}\right) & (35.b)
\end{cases}
$$

In accordance with the estimation of $\overline{\mathrm{ROE}}^{\mathrm{UB}}$, individual $\mathrm{r_E^{RE}}$ and δ^{RE} are estimated for each of the 21 potential q(CMB) values.

Determination of Firm Specific q(CMB)

All estimations can be summarized as in Figure 1. Figure 1 illustrates that each of the 21 different q(CMB) values has its own specific estimate of $\overline{\mathrm{ROE}}^{\mathrm{UB}}$, $\mathrm{r_E^{RE}}$ and δ^{RE}. Furthermore, each firm has its own set of 21 q(CMB) combinations.

Figure 1

Summary of Estimation Procedure - Method II

q(CMB)	$\overline{ROE}^{UB}$	r_E^{RE}	δ^{RE}
0.0	$\overline{ROE}_{0.0}^{UB}$	$r_{E,0.0}^{RE}$	$\delta_{0.0}^{RE}$
0.2	$\overline{ROE}_{0.2}^{UB}$	$r_{E,0.2}^{RE}$	$\delta_{0.2}^{RE}$
0.4	$\overline{ROE}_{0.4}^{UB}$	$r_{E,0.4}^{RE}$	$\delta_{0.4}^{RE}$
…	…	…	…
3.6	$\overline{ROE}_{3.6}^{UB}$	$r_{E,3.6}^{RE}$	$\delta_{3.6}^{RE}$
3.8	$\overline{ROE}_{3.8}^{UB}$	$r_{E,3.8}^{RE}$	$\delta_{3.8}^{RE}$
4.0	$\overline{ROE}_{4.0}^{UB}$	$r_{E,4.0}^{RE}$	$\delta_{4.0}^{RE}$

The 21 combinations are evaluated based on their ability to generate accurate valuations. However, not all 21 combinations are evaluated. Combinations that do not meet one or both of the criteria below are removed as these combinations are not considered realistic.

Criteria 1: $0.005 \leq r_E^{RE} < 0.40$
Although it is not certain for all types of firms, the equity cost of capital is normally expected to be higher than the risk-free rate.[19] In recent years, the risk-free rate, approximated by the 10 year governmental bond, has approached 0% (EY, 2015). Damodaran (2016) investigated the industry average required rate of return on owners' equity for the European market. He found that the industry averages ranged between 2.45% and 17.27%. Other researchers have solved for the equity cost of capital using equity valuation models. Both Francis et al. (2004) and Botosan and Plumlee (2005) found that the highest levels of equity cost of capital were around 30%.[20] With these findings as a base, we restrict the cost of capital to range between 0.5% and 40%.

Criteria 2: $0 \leq \delta^{RE} < (1 + r_E^{RE})$
δ is a function of the fade away factor and growth in book value, $\delta = \omega(1 + g)$. The fade away factor, ω, is assumed to be non-negative and less than one (Ohlson, 1995).[21] Growth on the other hand can be negative, but not smaller than -1. A growth of -100% implies financial distress as the firm's book value is reduced to zero. These two conditions combined reveal that δ^{RE} cannot obtain a value less than 0.

The upper bound $\delta^{RE} < (1 + r_E^{RE})$ is based on the logic presented by Gordon and Shapiro (1956). If δ^{RE} would be larger than $(1 + r_E^{RE})$, the terminal value would become infinite or negative. In this scenario, the model would not even be defined.

All combinations that meet both criteria, are inserted into Eq. (16) to analyze which combination that generates the most accurate valuation. This is done by comparing the obtained equity value estimate with the market value one year before the valuation date. The combination with the lowest absolute valuation error ($|V_{i-1}\text{-}MV_{i-1}|$) is assumed to represent the best estimate of q(CMB) and its corresponding $\overline{ROE}^{UB}$, r_E^{RE} and δ^{RE}. That combination is finally used when making the actual valuation at the valuation point in time. The procedure is done for each individual firm.

3.4. VALUATION SPECIFICATIONS

The Explicit Forecast Horizon

An explicit forecast horizon of one year is used for Method I and the base model, while an immediate truncation is necessary for Method II.

The Valuation Date

Two valuation periods are examined when evaluating the valuation accuracy of the models. Valuations are performed in 2004 and 2015 respectively. Data from 1997-2003 is used for the first period to estimate the variables needed, while data from 2008-2014 is used for the second period. The valuation is ex-dividend and takes place immediately after the dividend has been distributed

[19] Negative beta values can occur. In these situations, the expected required rate of return on owners' equity will be less than the risk-free rate.
[20] Francis et al. (2004) estimated the equity cost of capital based on data about dividends and price targets. They found that yearly mean cost of equity varies between 12.41 % and 33.19 % during 1975 and 2001 on the US market. Botosan and Plumlee (2005) used different equity valuation models to solve for the equity cost of capital. They estimated a risk premium (= cost of capital – risk free rate) of 28.4% for the 99% percentile in their sample.
[21] See section 2.1.1.

to the shareholders. For firms not paying any dividends or where information about dividend payout date is missing in the database, the valuation date is set to the first trading day in June. The date is chosen to assure that all stock prices are ex-dividend. With the publications of Q2 reports in July, choosing a later date would increase the risk of new information about the firm being available.

Determination of Market Value

The intrinsic equity estimates obtained from Method I, Method II and the base model are compared to the market value in order to determine the valuation accuracy of the models. Market value is defined as:

$$MV_{i,t} = Stock\ price_{i,t} \times\ Number\ of\ outstanding\ shares\ to\ common\ shareholders_{i,t} \qquad (36)$$

Since intrinsic equity values are compared to market values, it is presumed that the market is efficient. Studies investigating the market's reaction on new information have however documented a post-earnings announcement drift (Bernard and Thomas, 1989; Bartov, Lindahl and Ricks, 1998). This drift is evidence against the market efficiency hypothesis. Even so, market efficiency is a common assumption when investigating valuation accuracy (see e.g. Penman and Sougiannis, 1998; Francis, Olsson and Oswald, 2000; Courteau, Kao and Richardson, 2001).

3.5. VALUATION PERFORMANCE MEASURES

This thesis aims to investigate if it is possible to improve the valuation accuracy of the RIV model when taking both firm specific conservative measurement bias and business goodwill/badwill into account. The accuracy measure MAPE, mean absolute prediction error, is therefore central. In order to shed more light to the results, the models' bias and spread are also analyzed. When looking at the combined result of all measures, we refer to it as the models' valuation performance.

The Mean Absolute Prediction Error, MAPE

The mean absolute prediction error (MAPE) measures the accuracy of the valuation (Dechow, Hutton and Sloan, 1999). The MAPE is computed as the average of the absolute difference between the estimated intrinsic equity value and the market value, divided by the market value.

$$MAPE_t = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{V_{i,t} - MV_{i,t}}{MV_{i,t}}\right| \qquad (37)$$

The absolute prediction error disregards the sign of the valuation error, hence undervaluations and overvaluations are not differentiated. A smaller value on the MAPE indicates higher valuation accuracy.

The Signed Prediction Error, SPE

The signed prediction error (SPE) is calculated as the difference between the estimated intrinsic equity value and the market value, divided by the market value.

$$SPE_{i,t} = \frac{V_{i,t} - MV_{i,t}}{MV_{i,t}} \tag{38}$$

A negative SPE indicates an undervaluation of the intrinsic equity value, while a positive SPE implies an overstatement of the intrinsic equity value. Deviations closer to zero signal higher valuation performance. A potential weakness with the SPE is that positive and negative deviations may cancel each other out when a mean is computed. This could give the appearance of a better valuation accuracy than what is actually true. Even so, the mean SPE is relevant as it shows the bias in the forecasts (Dechow, Hutton and Sloan, 1999). Mean, median and standard deviations are reported for the SPE.

The 15%APE

The 15%APE reports the percentage of valuations that have an absolute prediction error of more than 15% (Kim and Ritter, 1999). The 15%APE illustrates the spread in valuation accuracies, where a lower figure indicates better valuation performance.

$$15\%APE_t = \frac{1}{n}\sum_{i=1}^{n}\left[Absolute\ prediction\ error_{i,t} > 15\%\right] \tag{39}$$

The Interquartile Range, IQRPE

The interquartile range (IQRPE) measures the difference between the third and first quartiles of SPE (Liu, Nissim and Thomas, 2002). The IQRPE is a measure of spread in valuation accuracies and a lower value on IQPER indicates better valuation performance.

$$IQRPE_t = Q_3(SPE)_t - Q_1(SPE)_t \tag{40}$$

3.6. STATISTICAL TESTS

A Z-test and a signed test for paired samples are used to statistically determine if it is possible to improve the valuation accuracy of the RIV model when taking firm specific conservative measurement bias and business goodwill/badwill into account.[22]

Z-test

The central limit theorem states that any distribution is approximately normal when the sample size is large (Newbold, Carlson and Throne, 2010). Given the size of the sample in this thesis, the central limit theorem is applicable and the Z-test can be used.[23] The Z-test is used to test the mean of the differences in absolute prediction error (APE) between the base model and Method I/Method II.[24]

[22] The statistical tests require the following assumptions to be fulfilled: (1) the dependent variable is measured on an ordinary or continuous scale, (2) the independent variables are composed of matched pairs, (3) the matched pairs are independent from each other, and (4) the differences of matched pairs come from a continuous distribution. We conclude that these assumptions hold.

[23] According to Newbold, Carlson and Throne (2010), a sample size of 25 observations is regarded as sufficient.

[24] APE(base model)$_{i,t}$ – APE(Method I)$_{i,t}$ and APE(base model)$_{i,t}$ – APE(Method II)$_{i,t}$.

$$Z = \frac{\bar{X} - \mu_X}{\sigma_{\bar{X}}} \; approx \sim N(0{,}1) \tag{41}$$

Where,
$\overline{X}$ = the sample mean of a random sample,
μ_X = the population mean,
$\sigma_{\bar{X}}$ = the sample standard deviation of a random sample.

The following hypothesis are tested:

$$H_0: Mean_{Diff} \leq 0$$

$$H_1: Mean_{Diff} > 0$$

The null hypothesis states that the mean of the differences in APE between the base model and Method I/Method II is equal to or less than zero. The alternative hypothesis states that the mean of the differences in APE between the base model and Method I/Method II is greater than zero. If the mean of differences in APE is not significantly greater than 0, it is not possible to reject the null hypothesis that Method I/Method II does not exhibit better valuation accuracy compared to the base model. The test is conducted on a significance level of 5%, $\alpha = 0.05$, hence the null hypothesis is rejected if the p-value is less than α.

Sign Test for Paired Samples

The Z-test is sensitive to outliers as they can have an impact on both the mean and standard deviations used to conduct the Z-score. In the presence of outliers, the result from the Z-test can be misleading. We observe that both Method I and Method II, in particular Method II, generate a large spread in valuation accuracy.[25] Therefore, a singed test for paired samples is also performed as a complement to the Z-test. The signed test for paired samples is a nonparametric test and is hence distribution-free (Newbold, Carlson and Throne, 2010). However, a drawback with the sign test for paired samples is that it relies on limited information. The test only takes into account the sign of the differences and ignores the size of the differences (Newbold, Carlson and Throne, 2010).

$$Z = \frac{S^* - \mu}{\sigma} \; approx \sim N(0{,}1) \tag{42}$$

Where,
$\mu = 0.5n$
$\sigma = 0.5\sqrt{n}$
$S^* = S + 0.5$
S = number of matched pairs with a positive difference.

[25] Outliers are not removed at this stage as they are believed to arise because of the valuation models' characteristics rather than coming from a different population.

The signed test for paired samples is used to test whether the mean of the differences in absolute prediction error between the base model and Method I/Method II is equal to or less than zero.[26]

$$H_0: P \leq 0.5$$

$$H_1: P > 0.5$$

Where,
P = the proportion of non-zero APE difference in the population that are positive.

The null hypothesis states that the mean of the differences in APE between the base model and Method I/Method II is smaller or equal to zero. That is, there is no indication that Method I/Method II is better than the base model. The alternative hypothesis states that the mean of the difference in APE between base model and Method I/Method II is larger than 0.5. Suggesting that over 50% of the valuations are better with Method I/Method II compared to the base model. Similar to the Z-test, the statistical test is performed on a significance level of 5%, $\alpha = 0.05$. The null hypothesis is rejected if the p-value is less than α.

4. DATA

This chapter will give the reader an overview of the sample studied. A presentation of the selection criteria, missing data and extreme values as well as the final sample will follow.

4.1. SELECTION CRITERIA

The data is collected from Compustat. The following restriction criteria are used to obtain the sample.

1. The firm is listed on the stock exchange in Sweden, Finland, Norway or Denmark.
2. Firms classified as "Finance, Insurance and Real Estate" are excluded.
3. The firm's fiscal year coincides with the calendar year.
4. Firms with negative equity are excluded.
5. The annual report needs to be disclosed in the same currency as its stock price.
6. The firm needs to be listed on the stock exchange for at least 7 years in a row.

The sample includes firms listed on the Swedish, Finnish, Norwegian and Danish stock exchange according to Compustat.[27] This classification does not only capture firms listed on Small-, Mid- and Large Cap, it also includes smaller growth firms listed on e.g. First North. In accordance with other RIV studies, financial firms are excluded from the sample (see e.g. Ahmed, Morton and Schaefer, 2000). Financial firms are usually exposed to additional regulations that may have an impact on the link between stock values and accounting numbers (Ahmed, Morton and Schaefer, 2000). The third criterion makes sure that the data pertains to the time period studied. The fourth criterion facilitates the interpretation and analysis of the results (Frankel and Lee, 1998; Zhang,

[26] $APE(\text{base model})_{i,t} - APE(\text{Method I})_{i,t}$ and $APE(\text{base model})_{i,t} - APE(\text{Method II})_{i,t}$.
[27] Icelandic firms were initially supposed to be part of the study. However, the majority of the Icelandic firms did not fulfill all the selection criteria and the few that did were later removed due to shortfall in required input data.

2000). For example, negative equity values in combination with negative earnings could provide misleading ROE ratios. Negative equity is also an indication of financial distress. The fifth condition, regarding currency, facilitates the determination of valuation accuracy. The intrinsic equity value obtained from the RIV models is compared to the market values, hence the accounting figures and stock prices should be stated in the same currency. The currency criterion also ensures that companies have not changed their reporting currency during the investigation period.[28] Furthermore, since we are estimating many of the input variables based on historical averages, the firm needs to be listed on the stock exchange for at least seven years in a row.

4.2. MISSING DATA AND EXTREME VALUES

After applying the selection criteria, our sample is further reduced because of missing data in the database, elimination of extreme observations and removal of firms for which we forecast negative book value of owners' equity.

Observations that miss data for the variables needed to conduct our thesis are removed from our sample. Missing data refers both to accounting data as well as stock price data. Furthermore, extreme observations are eliminated from our sample in order to get rid of observations that are not representable for the population studied and that could undesirably skew the results. To facilitate the identification of extreme values, we look further into the 1% most extreme values for our estimated variables.[29] Looking into the 1% most extreme values is in line with previous research in this field (Dechow, Hutton and Sloan, 1999; Choi, O'Hanlon and Pope, 2006). Before excluding any extreme values, the potential extreme values are investigated. Firstly, the extreme observations are compared to the original data source in order to detect potential recording errors in the database. Secondly, it is decided if the extreme observation can be regarded as representable for the population being studied. This procedure results in an exclusion of 42 respective 35 observations pertaining to 6 firms in the first period and 5 firms in the second period. Additionally, 5 more firms are excluded from our sample in 1997-2003 as these firms have experienced low performance before the valuation date, resulting in forecasts of negative book value of owners' equity. Negative book values are an indication of financial distress and our equity valuation models are not intended to be used to value this type of scenario.

4.3. FINAL SAMPLE

The size of the final sample is presented in Table 1. Before the data was processed, the sample contained 6139 observations for period 1997-2003 and 7458 observations for period 2008-2014. The selection criteria, missing data and extreme values result in a final sample of 1106 observations attributable to 158 individual firms in 1997-2003 and 1638 observations belonging to 234 firms in 2008-2014.

[28] The Finnish currency change from FIM to EUR is considered.

[29] The 1% most extreme observations are determined as the observations with the largest deviation from the mean. Extreme observations are identified for our estimated variables: $\overline{ROE}$, r_E^* and ps.

Table 1

Final Sample

Year 1997-2003		Year 2008-2014	
Number of observations available	6 139	Number of observations available	7 458
Selection Criteria		*Selection Criteria*	
Financial firms	-1 178	Financial firms	-1 354
Broken fiscal year	-536	Broken fiscal year	-555
Negative equity	-88	Negative equity	-171
Currency adjustment	-286	Currency adjustment	-659
Firms not listed 7 years in a row	-2112	Firms not listed 7 years in a row	-1282
Sum	-4 200	Sum	-4 021
Missing Data and Extreme Observations		*Missing Data and Extreme Observations*	
Missing accounting data	-224	Missing accounting data	-1 729
Missing stock price data	-532	Missing stock price data	-35
Extreme observations	-42	Extreme observations	-35
Prediction of bankruptcy	-35	Prediction of bankruptcy	0
Sum	-833	Sum	-1 799
Final number of observations available	1 106	Final number of observations available	1 638
Final number of firms	158	Final number of firms	234

Table 1 shows the data reduction that the selection criteria, missing values and extreme observations result in. The selection criteria is used to identify the firms we aim to study. Missing data and extreme observations reduce our sample further. Extreme observations refer to the 1% most extreme observations for our estimated input variables, $\overline{ROE}$, r_E^* and ps. Prediction of bankruptcy refers to firms that have experienced low performance before the valuation date, resulting in forecasts of negative book value of owners' equity. These firms are eliminated from our sample as negative book values are an indication of financial distress and our equity valuation models are not intended to be used to value this type of scenario.

The final sample constitutes of 54.7% Swedish firms, 19.5% Finnish firms, 15.4% Norwegian firms, and 10.4% Danish firms. For an industry distribution see Appendix B.

5. EMPIRICAL RESULTS & ANALYSIS

This chapter will start with a presentation of descriptive statistics and an analysis of the forecasted input variables used in Method I and Method II. Thereafter follows an analysis of valuation accuracy. Lastly, to investigate if the valuation accuracy of each model can be further improved we will make two adjustments to Method I and two adjustments to Method II.

5.1. DESCRIPTIVE STATISTICS

When looking closer into the descriptive statistics of key variables presented in Table 2, one can observe a large spread in many of the variables. The standard deviation is large and there are also substantial differences between mean and median values. These findings reflect the variation of companies included in our sample, ranging from relatively small firms up to bigger firms listed on

Table 2

Descriptive Statistics

1997 - 2003

	Mean	Standard Deviation	Q1	Median	Q3
Revenue (MSEK)	18 492	39 157	1 073	3 791	17 532
Yearly Growth in Revenue (%)	29.1%	262.2%	-4.5%	6.4%	19.5%
EBIT (MSEK)	1 490	5 331	27	224	907
Book Value (MSEK)	6 964	18 037	377	1 489	5 368
Market Cap (MSEK)	18 729	72 708	802	2 709	8 738
Book-to-Market Ratio	0.77	1.214	0.366	0.622	0.972
ROE	16.0%	136.6%	0.8%	11.9%	22.4%
ps	5.8%	6.7%	0.0%	4.2%	8.3%
r_E^*	9.9%	3.7%	7.2%	9.1%	11.8%
β	0.98	0.67	0.48	0.83	1.38
Bankruptcy Risk	0.2%	0.9%	0.0%	0.0%	0.2%

2008 - 2014

	Mean	Standard Deviation	Q1	Median	Q3
Revenue (MSEK)	19 007	58 049	685	2 433	14 118
Yearly Growth in Revenue (%)	7.5%	47.3%	-3.1%	3.8%	12.9%
EBIT (MSEK)	2 203	12 313	30	148	999
Book Value (MSEK)	8 387	25 645	241	859	5 617
Market Cap (MSEK)	20 149	63 123	482	1 927	13 618
Book-to-Market Ratio	0.65	0.58	0.28	0.46	0.80
ROE	17.4%	25.8%	5.9%	13.8%	23.9%
ps	11.3%	11.4%	3.8%	8.2%	15.1%
r_E^*	4.9%	2.7%	3.2%	4.7%	6.6%
β	0.70	0.56	0.37	0.69	1.04
Bankruptcy Risk	0.1%	0.3%	0.0%	0.0%	0.0%

Table 2 reports descriptive statistics for our sample. To provide comparability, the data has been converted into MSEK. The yearend exchange rate for each individual year has been used to convert the numbers. The descriptive statistics is supposed to give an overview of the variables used in our study and may refer to various number of years in the specific time period. For example, as explained in the research design, the payout share is estimated based on information from one or two years back in time, whereas ROE is calculated for all seven years.

Large Cap. Comparing our data with previous studies, the following observations are made. The reported median revenue and median market cap are lower than what Anesten, Möller and Skogsvik (2015) reported in their study. However, Anesten, Möller and Skogsvik (2015) chose to only look at larger firms listed on Mid- and Large Cap. Furthermore, the ROE levels are similar to the levels presented in previous studies (Frankel and Lee, 1998; Jorgensen, Lee and Yoo, 2011). Comparing our r_E^* estimates for the two periods, one can observe that r_E^* is lower in 2008-2014. The decrease in r_E^* is to a large extent attributable to the low risk-free rate during that period as well as on average lower beta values.[30] Additionally, the mean and median payout share increase in the second period.

5.2. ANALYSIS OF ESTIMATED INPUT VARIABLES

5.2.1. INPUT VARIABLES - METHOD I

Table 3 discloses descriptive statistics of $\overline{\text{q(TOT)}}$, $\overline{\text{ROE}}$, r_E^* and residual income that are estimated for the valuations carried out in 2004 and 2015. Both the mean and median values of $\overline{\text{q(TOT)}}$ are in line with the magnitude of the PMB coefficients that Runsten (1998) presented. However, in contrast to Runsten's (1998) PMB coefficients, $\overline{\text{q(TOT)}}$ is not only supposed to capture conservative measurement bias, but also business goodwill/badwill. Hence, a larger spread in the $\overline{\text{q(TOT)}}$ coefficient is to be expected. The minimum $\overline{\text{q(TOT)}}$ in 2004 is -0.74 and -0.71 in 2015. The negative values indicate that these firms are expected to generate business badwill, since the conservative measurement bias is projected to be non-negative (Skogsvik, 1998). The maximum $\overline{\text{q(TOT)}}$ values of 8.29 and 18.76, on the other hand, suggest that these firms are expected to earn a relatively large amount of business goodwill in the future.

Table 3

Input Variables - Method I

2004

	Mean	Standard Deviation	Min	Median	Max
$\overline{q(TOT)}$	1.11	1.64	-0.74	0.56	8.29
$\overline{ROE}$	4.1%	18.3%	-54.7%	6.9%	48.7%
r_E^*	9.9%	3.7%	1.9%	9.1%	24.2%
Residual Income_1	-0.04	0.13	-0.91	-0.01	0.48

2015

	Mean	Standard Deviation	Min	Median	Max
$\overline{q(TOT)}$	1.54	2.21	-0.71	1.02	18.76
$\overline{ROE}$	16.7%	16.8%	-23.2%	13.7%	105.1%
r_E^*	4.9%	2.7%	0.5%	4.7%	12.9%
Residual Income_1	0.03	0.07	-0.30	0.03	0.45

Table 3 reports descriptive statistics of key variable estimated for Method I. $\overline{\text{q(TOT)}}$ and $\overline{\text{ROE}}$ are both estimated based on averages of past realizations from the three consecutive years. The reported r_E^* is identical to r_E^* reported in Table 2. The residual income is scaled by market value.

The mean and median values of the estimated residual income scaled by market value are negative in 2004, but positive in 2015. The mean and median $\overline{\text{ROE}}$ are lower than the r_E^* in the first period, signaling a rather unprofitable period. The mean and median $\overline{\text{ROE}}$ are, on the other hand, higher

[30] The January 2015 risk-free rates, approximated with the 10 year governmental bond for each market, range between 0.64% - 1.53% for the markets studied compared to 4.27% - 4.66% in January 2004 (Trading Economics, 2016).

than the r_E^* in the second period. Since $\overline{ROE}$ is determined based on an average of historical ROE values, an investigation of the historical ROE levels can be useful to understand these varying levels between the two time periods. Looking further into the development of the yearly mean and median ROE over time in our sample, one can see that the ROE level fell in the years before the valuation in 2004 (see Appendix C). This results in relatively low forecasts of $\overline{ROE}$ in 2004.[31] The sample mean and median ROE are, on the other hand, on higher levels before the valuation in 2015, resulting in higher forecasts of $\overline{ROE}$ in the second period. Furthermore, r_E^* is rather low in 2015. As already mentioned, this is to a large extent attributable to the low risk-free rates and decreasing average beta values during that period.

5.2.2. INPUT VARIABLES - METHOD II

In Method II, valuations have only been carried out for firms with combinations of r_E^{RE} and δ^{RE} that pass the criteria testing.[32] Out of the 158 firms included in our sample in 2004, only 80 firms (50.6%) pass the criteria testing. For 2015, 128 out of 234 firms (54.7%) pass the criteria testing. Table 4 presents descriptive statistics for the input variables estimated for Method II. The results relate solely to the firms passing the criteria testing.

In Method II the q(CMB) value was allowed to range between 0 and 4. The median q(CMB) value for 2004 is 0.4, implying that half of the valued firms have a q(CMB) between 0 and 0.4. In 2015, the median value is even lower, 0.0. If strictly interpreting this result, at least 50% of the firms in our sample in 2015 do not have any conservative measurement bias, which would suggest that their reporting is in line with fair value accounting. Overall, the q(CMB) values that survive the criteria testing seem to be rather low on average. At the same time, 4.0 estimates of q(CMB) are present in both time periods. For a full distribution of the q(CMB) values that pass the criteria testing, see Appendix D.

The mean and median $\overline{ROE}^{UB}$ are slightly lower than the reported mean and median $\overline{ROE}$ in Method I. This is consistent with theory as return ratios are likely to be positively biased when conservative accounting is present (Zhang, 2000; Penman, 2013). However, it is not a certainty as the magnitude of the conservative measurement bias and the growth have an impact on the outcome (Skogsvik, 1998). Comparisons between Method I and Method II should be done with caution as the results for Method II pertain to a different set of companies. Additionally, the mean and median r_E^{RE} are larger than the mean and median r_E^* estimated based on CAPM. The estimate of δ^{RE}, which can be interpreted as growth adjusted for the fade away factor in residual income^{UB}, has a mean of 91.6% and 96.1% in respective period. The mean residual income^{UB} is negative in both time periods, while the median is positive in 2004 and negative in 2015.

[31] In 2004, the mean and median $\overline{ROE}$ are lower compared to the ROE levels reported in the descriptive statistics table for period 1997-2003. The reason for this is that $\overline{ROE}$ is only based on ROE values from 2001-2003 when ROE was, on average, lower.

[32] For further specifications regarding the criteria testing, see section 3.3.2.

Table 4

Input Variables - Method II

2004

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.84	1.16	0.00	0.40	4.00
$\overline{ROE}^{UB}$	3.2%	14.8%	-42.2%	5.4%	27.3%
r_E^{RE}	16.0%	12.2%	0.6%	13.9%	40.0%
δ^{RE}	91.6%	26.7%	2.9%	97.3%	137.0%
Residual Income_1^{UB}	-0.19	0.46	-3.46	-0.03	0.14

2015

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.63	1.14	0.00	0.00	4.00
$\overline{ROE}^{UB}$	12.8%	11.2%	-12.9%	12.3%	57.5%
r_E^{RE}	10.9%	8.9%	0.5%	9.2%	38.9%
δ^{RE}	96.1%	22.3%	2.2%	101.3%	137.5%
Residual Income_1^{UB}	-0.02	0.20	-1.17	0.01	0.97

Table 4 shows descriptive statistics for key variables estimated for Method II. The data refers only to firms surviving the criteria testing. 80 out of 158 firms pass the criteria testing in 2004, while 128 out of 234 firms pass it in 2015. $\overline{ROE}^{UB}$ is the forecasted unbiased return on equity and is estimated as an average of past realizations from the previous three consecutive years. Both r_E^{RE} and δ^{RE} are estimated by reverse engineering. The unbiased residual income is scaled by market value.

5.3. ANALYSIS OF VALUATION ACCURACY

Previous research has found that the RIV model understates the market value of equity (Dechow, Hutton and Sloan, 1999; Myers, 1999; Choi, O'Hanlon and Pope, 2006). Method I and Method II intend to account for this bias. Nevertheless, both methods still generate a majority of undervaluations, see Appendix E.

Table 5 presents the different measures used to evaluate the valuation performance of Method I, Method II and the base model. The results indicate that Method I exhibits the highest valuation accuracy, while Method II exhibits the poorest valuation accuracy. Similar patterns in our measures of valuation performance are found in both time periods. This indicates that the relative performance between the models is not dependent on the valuation point in time.

Starting with valuation accuracy, MAPE, Method I exhibits the lowest MAPE. A low MAPE is desirable as it implies better valuation accuracy. The base model has the second lowest MAPE, while Method II exhibits the highest MAPE.

Table 5

Valuation Performance

2004

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15%APE	IQRPE
Method I	0.380	-0.125	-0.211	0.484	0.766	0.489
Method II	3.511	-3.243	-0.530	13.968	0.838	1.315
Base Model	0.553	0.048	-0.137	0.824	0.804	0.795

2015

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15%APE	IQRPE
Method I	0.303	-0.146	-0.214	0.382	0.739	0.318
Method II	2.681	0.319	-0.277	10.301	0.891	0.809
Base Model	0.663	0.029	-0.288	1.045	0.846	0.746

Table 5 presents our six measures of valuation performance. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibit an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles of SPE.

Moving forward to the mean and median SPE, the measures of bias, one can observe negative median SPE for all models in both time periods. This supports our finding that the majority of the firms in our sample are undervalued. The negative median SPEs are in line with the results reported by both Jorgensen, Lee and Yoo (2011) and Anesten, Möller and Skogsvik (2015). The valuation bias is largest for Method II, whereas the base model seems to in most cases exhibit the lowest bias.

The spread measures, SPE standard deviation, 15%APE and IQRPE, provide consistent results regarding all three models. Method I has the smallest spread, followed by the base model and lastly by Method II. For example, Method I has a 15%APE of 0.739 in 2015, meaning that 26.1% of the valuations in 2015 have an absolute prediction error less than 15%. In Method II, on the other hand, 10.9% of the valuations have an absolute prediction error less than 15% in the same period. Furthermore, the relatively large SPE standard deviation and IQRPE for Method II show the large spread in valuation accuracy obtained from that specific method.

In summary, the results presented in Table 5 indicate that Method I exhibits the best valuation accuracy, the base model the second best, followed by Method II. The statistical tests further support these results. For Method I, we are able to reject the null hypothesis both with the Z-test and the signed test for paired samples at a 5% significance level in both time periods. We therefore conclude that Method I exhibits better valuation accuracy than the base model.[33] For Method II,

[33] When testing APE differences between the base model and Method I the following p-values are obtained. In 2004, the reported p-values are 0.001 (Z-test) and 0.005 (signed test for paired samples). In 2015, the reported p-values are 0.000 (Z-test) and 0.000 (signed test for paired samples).

however, we are not able to reject the null hypothesis at a 5% level with any of the statistical tests or time periods.[34]

To benchmark our results, a comparison to other RIV studies with a sample from similar markets and time periods is desirable. One such study is Anesten, Möller and Skogsvik's (2015) paper. Comparing our results, Method I appears to exhibit better valuation accuracy than the RIV model examined in their study.[35] Almost all valuation performance measures are better or similar, and this holds for both time periods. Anesten, Möller and Skogsvik (2015) added different complexity adjustments to their RIV model.[36] Interestingly, our simplified RIV model with one year explicit forecast horizon and a reverse engineered value of q(TOT) appears to exhibit better valuation accuracy. However, other RIV studies from the US market for example have found similar, or even lower, MAPE levels compared to what is reported in this thesis (e.g. Courteau, Kao and Richardson, 2001; Jorgensen, Lee and Yoo, 2011).

5.3.1. VALUATION ACCURACY ANALYSIS - METHOD I

In Method I we aim to improve the valuation accuracy of the RIV model by incorporating the market's historical expectation of the firm's goodwill at the horizon point in time. Even though we have solved for firm specific q(TOT) values that would generate correct valuations in historical years, the forecasted $\overline{q(TOT)}$ does not seem to manage to properly adjust for the RIV model's tendency to understate the value of equity. For both time periods studied, the majority of the firms are still being undervalued.

q(TOT) is supposed to help explain the difference between the expected market value and book value of owners' equity at the end of the forecast horizon. If the market changes its expectations about the firm's future goodwill/badwill it will instantly be reflected in the market price, but not in the accounting numbers. This could cause fluctuations in the market-to-book ratio. If the market-to-book ratio changes substantially in the valuation year compared to historical years, our forecasted $\overline{q(TOT)}$, which is based on an average of historical values, may no longer be representable for the valuation year. Hence, the development of the market-to-book ratio over time is further investigated to gain more knowledge about the valuation results.[37]

To study the development of the market-to-book ratios, the sample is divided into two groups: undervalued firms and overvalued firms. In each of these two groups the 10 firms with the highest

[34] When testing APE differences between the base model and Method II the following p-values are obtained. In 2004, the reported p-values are 0.997 (Z-test) and 1.000 (signed test for paired samples). In 2015, the reported p-values are 0.968 (Z-test) and 0.893 (signed test for paired samples).

[35] There are some methodological differences between this thesis and Anesten, Möller and Skogsvik's (2015) study. For example, Anesten, Möller and Skogsvik (2015) used an explicit forecast horizon of three and five years, whereas in this thesis we use a forecast horizon of one year. Also, Anesten, Möller and Skogsvik (2015) based their forecasts on historical realizations on five year averages. The results in this thesis have been compared to the RIV model estimated based on historical realizations.

[36] Anesten, Möller and Skogsvik (2015) investigated how valuation performance was affected when extending the forecast horizon, accounting for transitory items and, similar to this thesis, including bankruptcy risk.

[37] Worth noting is that q(TOT) is not identical to the market-to-book ratio. q(TOT) is defined as $(V_T/BV_T\text{-}1)$. However, in our simplified setting with a short explicit forecast horizon of one year, the yearly market-to-book ratio is considered a reasonable approximation and should provide insights to the development of the estimate of q(TOT) over time.

and lowest valuation accuracy have been identified, resulting in two subgroups for each category. Figure 2 illustrates the development of the average yearly market-to-book ratio for the two subcategories of undervalued firms in respective period. The same development for the overvalued firms is illustrated in Figure 3. In each figure, the forecasted market-to-book value is also presented. This forecast is, similar to the $\overline{q(TOT)}$ forecast, based on an average of historical values from the three consecutive years.[38]

Figure 2

Market-to-Book Development - Undervaluations

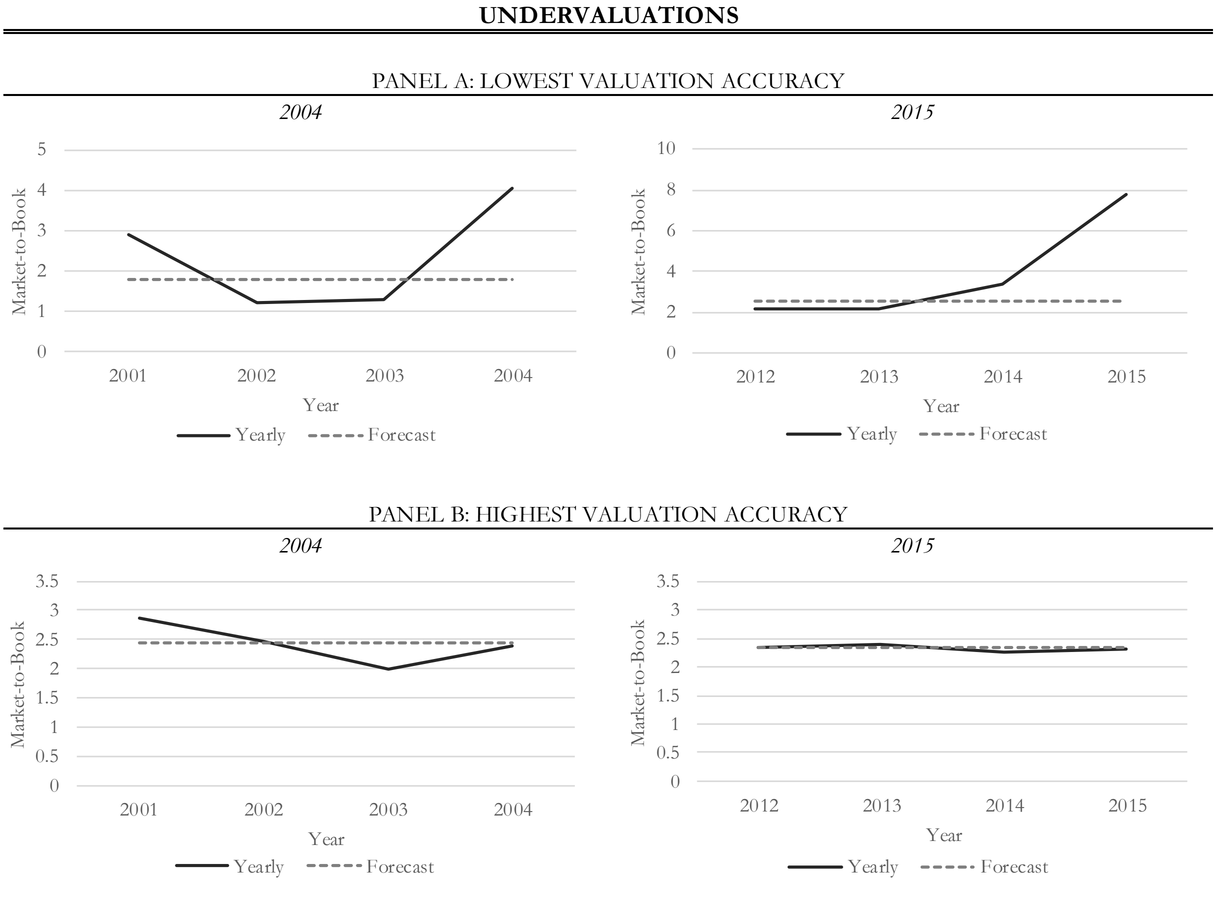

Figure 2 shows the development of the market-to-book ratio for the 10 firms with the highest and poorest valuation accuracy that are undervalued. Panel A shows data for the 10 firms with the poorest valuation accuracy while Panel B shows data for the 10 firms with the best valuation accuracy. In each graph, 'Yearly' represents the yearly average market-to-book ratio for the 10 firms. The 'Forecast' is calculated as an average of the yearly average market-to-book ratio. E.g. the 'Forecast' in 2004 is conducted as an average of the 10 firms' average market-to-book ratio between 2001-2003.

[38] The market-to-book forecast for 2004 is based on an average of the subcategory's market-to-book ratio for 2001-2003. Likewise, the market-to-book forecast for 2015 is based on an average for that subcategory's market-to-book value in 2012-2014.

Figure 3

Market-to-Book Development - Overvaluations

OVERVALUATIONS

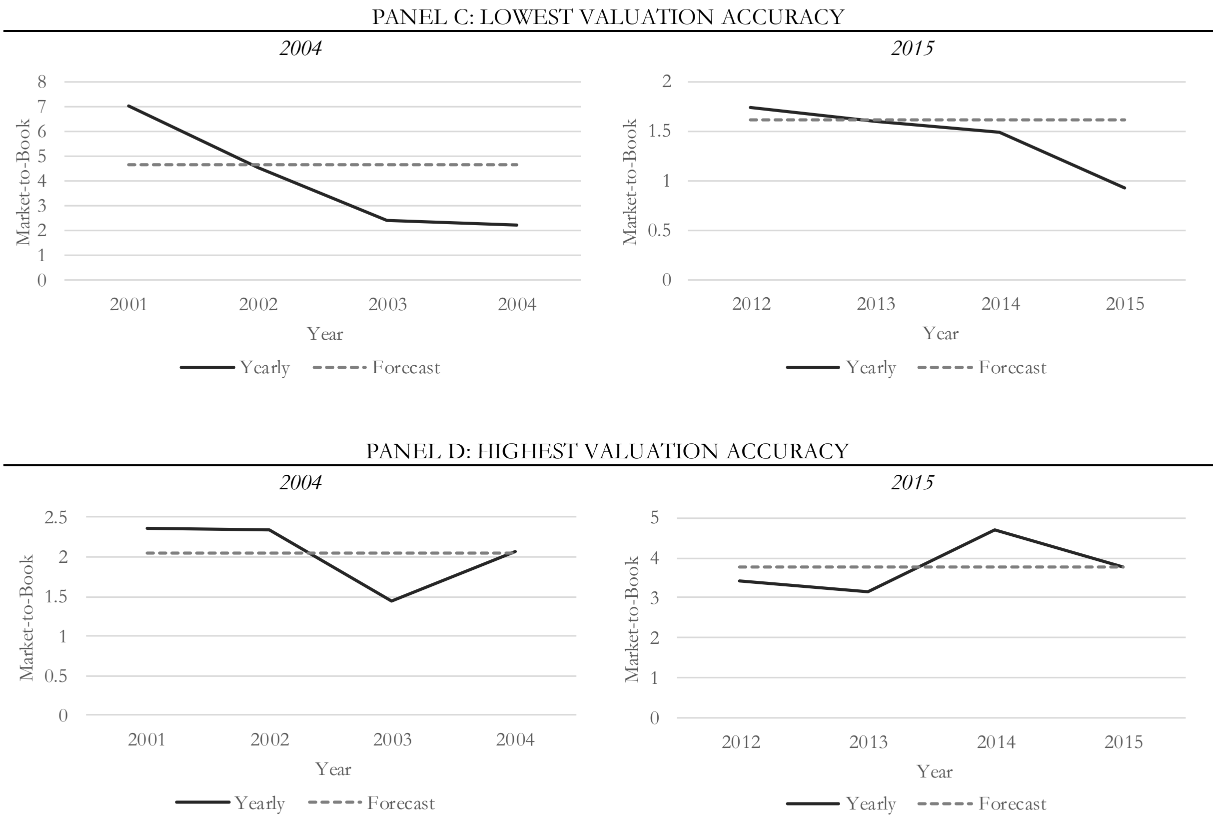

Figure 3 shows the development of the market-to-book ratio for the 10 firms with the highest and poorest valuation accuracy that are overvalued. Panel C shows data for the 10 firms with the poorest valuation accuracy while Panel D shows data for the 10 firms with the best valuation accuracy. In each graph, 'Yearly' represents the yearly average market-to-book ratio for the 10 firms. The 'Forecast' is calculated as an average of the yearly average market-to-book ratio. E.g. the 'Forecast' in 2004 is conducted as an average of the 10 firms' average market-to-book ratio between 2001-2003.

Panel A shows the market-to-book ratio development for the 10 undervalued firms with the poorest valuation accuracy in each period. These firms seem to experience an increase in the market-to-book ratio in the valuation year, 2004 and 2015. Panel A reveals that there is a large discrepancy between the forecasted market-to-book ratio and the actual market-to-book ratio in 2004 and 2015. The figure indicates that our forecast of the firms' future goodwill, which is based on historical market beliefs, is more pessimistic for these firms than what the market actual projects the valuation year. The increase in market-to-book ratio in the valuation year could be a reason why we undervalue these firms in Method I.

Panel C presents the market-to-book ratio development for the 10 overvalued firms with the poorest valuation accuracy in respective time period. For these firms the opposite trend can be observed. The average yearly market-to-book ratio for these firms decreased over time. Our forecasted q(TOT) is computed as an average of the three consecutive years and does not seem to manage to capture the downward trend in the market-to-book ratio very well. For these 10 overvalued firms, we seem to forecast higher goodwill than what the market is anticipating at the valuation point in time. This could be a potential explanation for overvaluing these firms.

For the firms with the best valuation accuracy in each group, see Panel B and Panel D, the forecasted market-to-book ratio coincide with the actual market-to-book ratio in 2004 and 2015. This supports the theory that the development of the firm's market-to-book ratio has an influence on the ability to conduct accurate valuations with Method I.

In this thesis we use a short explicit forecast horizon of one year, thus q(TOT) is likely to capture both conservative measurement bias and business goodwill/badwill. The relative conservative measurement bias is expected to be stable over time, hence the fluctuations in q(TOT) are likely to be mostly attributable to the market's speculations of the firm's future business goodwill/badwill. If q(TOT) is not stable over time, historical values of q(TOT) may not serve as good estimates of the firm's goodwill in future years. However, since the valuation accuracy in general appears to improve in Method I, the goodwill parameter seems to capture value relevant information.

Inaccurate valuations do not only have to be attributable to forecasting errors in q(TOT). Inaccuracies can also arise because of forecasting errors in other variables such as r_E^* or $\overline{ROE}$. However, these variables are not expected to have as large influence on the valuation as q(TOT) has. For example, since we are using a short explicit forecast horizon of one year in this thesis, the discounted residual income only accounts for -2% of the intrinsic equity value in 2004 and 4% of the intrinsic equity value in 2015.[39] This is to be compared with the terminal value, representing 35% of the intrinsic equity estimate in 2004 and 47% in 2015.

5.3.2. VALUATION ACCURACY ANALYSIS - METHOD II

In Method II, we aim to improve the valuation accuracy of the RIV model by estimating a q(CMB) parameter to correct for conservative measurement biases in the accounting numbers. In order to get a better understanding of why Method II generates poor valuation accuracy, a large spread and a majority of undervaluations, the unbiased book value of owners' equity and the capitalized residual income^{UB} are investigated in this section.

The estimated firm specific q(CMB) parameter is used to solve for the unbiased book value of owners' equity. If the q(CMB) parameter is correctly estimated, we expect to obtain a more accurate estimate of the 'real' book value. In our sample we find that the majority of the estimated q(CMB) values in 2015 are equal to zero. This implies that at least half of the valued firms in 2015 do not exhibit any conservative measurement bias in their financial reporting. This does not seem to be in line with previous research. Up until 2010, prudence was part of the Conceptual Frame for Financial Reporting (IFRS, 2015). Although the concept of prudence has been removed from the Conceptual Framework, there are still arguments that there is inherent conservatism in the IFRS accounting practices. Barker (2015) for example argues that the IFRS definition of net assets as such generates conservatism in the accounting. Moreover, when Runsten (1998) studied the

[39] The reported values refer to median values in each time period.

conservative measurement bias for Swedish firms, he found conservatism to be present across all industries.

In order to get a better understanding of the q(CMB) values estimated, the q(CMB) value that is assigned to a firm in 2004 is compared to the q(CMB) value given to the same firm in 2015.[40] Changes in accounting principles, inflation rates, and investment patterns are factors that could change a firm's q(CMB) value (Runsten, 1998; Zhang, 2000). It could therefore be worth to have in mind that it became mandatory for firms listed in European security markets to adopt IFRS in 2005 (Regulation (EC), NO 1606/2002). If the IFRS accounting practices differ from the firm's previous accounting practices, the firm's conservative accounting bias could be affected. Looking further into our sample, the q(CMB) is stable for some firms. For other firms, however, the estimated q(CMB) changes substantially between the two periods, e.g. going from 0.0 in 2004 to 4.0 in 2015. Even though there may be changes in the firm's surrounding that could affect the firm's conservative measurement bias, a substantial change in q(CMB) is still hard to motivate. One of the RIV model's claimed advantages is its anchoring on the current book value of owners' equity, something that is not speculative (Penman, 2013). However, if a firm gets assigned an incorrect q(CMB) value, the estimate of the unbiased book value of owners' equity may no longer represent something 'real'.

In Method II, the forecasted residual income^{UB} is capitalized and added to the estimated unbiased book value of owners' equity. If the estimated q(CMB) parameter manages to appropriately adjust for conservatism in the accounting, the forecasted residual income^{UB} should merely capture future business goodwill/badwill. It can be observed from the data that a lot of the intrinsic equity value can be attributable to the capitalized residual income^{UB}. For some firms, the forecasted residual income^{UB} should contribute with a lot of value in order to capture the value of the firm's future business goodwill/badwill. For other firms, however, the residual income^{UB} is given an unreasonable amount of weight. For example, for the firms with the poorest valuation accuracy the reverse engineered values of $(1+r_E^{RE})$ and δ^{RE} are almost identical. This results in a discount factor close to zero, which heavily inflates the forecasted residual income^{UB}. For the most extreme valuation inaccuracy, we observe an absolute prediction error of as much as 11 492%. For this valuation the capitalized residual income^{UB} accounts for 99% of the intrinsic equity value. In addition to a large spread in valuation accuracy, Method II exhibits a bias towards undervaluing firms. Under the assumption that the conservative measurement bias is correctly estimated, the reason for undervaluing firms should be attributable to estimation errors in the discounted future business goodwill/badwill.

The valuation inaccuracies observed suggests that the specific procedure used in Method II does not manage to accurately estimate conservative measurement bias and business goodwill/badwill.

5.4. MODEL ADJUSTMENTS

To test if the valuation accuracy of Method I and Method II can be further improved, additional adjustments are carried out to test the models' sensitivity to methodological choices.

[40] Only 16 firms in our sample are valued with Method II in both periods.

Adjustments for Method I:

- Forecasting q(TOT) based on last year's q(TOT) value, rather than on a three year average.
- Extending the explicit forecast horizon from one year to three years.

Adjustments for Method II:

- Inserting CAPM r_E^* into the model instead of solving for r_E^{RE} by reverse engineering.
- Forecasting ROE^{UB} based on the previous year's ROE^{UB} rather than using a historical three year average.

5.4.1. METHOD I - LAST YEAR'S q(TOT)

q(TOT) is supposed to capture the market's perception about a firm's expected goodwill at the horizon point in time. In Method I, forecasts of q(TOT) are estimated by taking an average of the market's implied q(TOT) value for the three previous years. However, this procedure may not necessarily be the most suitable. q(TOT) values estimated two and three years back in time are based on information that was available to the market at those points in time. If the market has received new information about the firm, expectations about the firm's future goodwill may have changed. The most recent q(TOT) value should contain the newest information and expectations that the market has regarding the firm's future and may thus serve as a better estimate. Therefore, last year's q(TOT) value will in this adjustment be used to forecast q(TOT), $q(TOT)_t = q(TOT)_{t-1}$.

Table 6

Valuation Performance

Method I – Last Year's q(TOT)

2004

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15% APE	IQRPE
Method I - Last Year's q(TOT)	0.371	-0.316	-0.329	0.291	0.835	0.299
Method I - Original	0.380	-0.125	-0.211	0.484	0.766	0.489

2015

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15% APE	IQRPE
Method I - Last Year's q(TOT)	0.244	-0.056	-0.108	0.357	0.581	0.320
Method I - Original	0.303	-0.146	-0.214	0.382	0.739	0.318

Method I – Last Year's q(TOT) is an adjusted version of Method I, where the forecast of q(TOT) is estimated by last year's estimated value of q(TOT). Descriptive statistics for the input variables for Method I – Last Year's q(TOT) is found in Appendix F. Method I – Original refers to the original version of Method I. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibit an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles SPE.

The results presented in Table 6 show that the accuracy measure, MAPE, remains almost the same in 2004, but improves in 2015. The SPE measures indicate a stronger negative bias in 2004 while the bias decrease in 2015. Most of the spread measures improve as well, except for 15%APE in 2004 and IQRPE in 2015. The results indicate that the valuation accuracy can be improved when using last year's q(TOT) value as a forecast instead of an average of the three previous consecutive years. The improvement in valuation accuracy is supported statistically in 2015, but no support for improvement is found in 2004.[41] Overall, the results indicate that a more simplistic forecast procedure of q(TOT) can be used without hurting the valuation performance of the model considerably.

5.4.2. METHOD I - EXTENDED FORECAST HORIZON

In Method I, we use a short explicit forecast horizon of one year. In this setting, the terminal value accounts for 35% of the intrinsic equity value in 2004 and for 47% of the value in 2015.[42] The discounted residual income, on the other hand, represents only -2% in 2004 and 4% in 2015.[43] If the explicit forecast horizon is extended, more weight will be given to the forecasted residual income and less to the terminal value calculation. Previous research has found varying results when extending the forecast horizon of the RIV model. For example, Jorgensen, Lee and Yoo (2011) found that a longer explicit forecast horizon did not always improve the valuation accuracy of the RIV model. The results presented by Penman and Sougiannis (1998), on the other hand, suggest that the valuation errors can decrease with an extended explicit forecast horizon. With these studies in mind, we investigate if the valuation accuracy of Method I improves if the explicit forecast horizon is extended from one year to three years. The forecast of ROE is held constant over the three year forecast horizon, a potential drift in ROE is hence not considered.

When extending the explicit forecast horizon, the residual income accounts for -3% of the intrinsic equity value in 2004 and 12% of the intrinsic value in 2015.[44] Table 7 shows that MAPE for both periods increase. Overall, there seem to be a slight increase in most of the spread measures. Mean and median SPE, on the other hand, are hardly affected. Since the added complexity did not improve the valuation accuracy measure, nor any of the other valuation performance measures substantially, we conclude that an extension of the explicit forecast horizon is not supported. The conclusion is further supported by the statistical tests.[45]

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[41] When testing APE differences between the original Method I and Method I using last year's q(TOT) value, the following p-values are obtained. In 2004, the reported p-values are 0.376 (Z-test) and 0.996 (signed test for paired samples). In 2015, the reported p-values are 0.000 (Z-test) and 0.000 (signed test for paired samples).
[42] The values refer to the median value for the specific period.
[43] The values refer to the median value for the specific period.
[44] The values refer to the median value for the specific period.
[45] When testing APE differences between the original Method I and Method I when extending the explicit forecast horizon to three years the following p-values are obtained. In 2004, the reported p-values are 0.997 (Z-test) and 1.000 (signed test for paired samples). In 2015, the reported p-values are 0.968 (Z-test) and 0.893 (signed test for paired samples).

Table 7

Valuation Performance

Method I - Extended Forecast Horizon

2004

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15% APE	IQRPE
Method I - Extended Forecast Horizon	0.506	-0.114	-0.299	0.892	0.823	0.481
Method I - Original	0.380	-0.125	-0.211	0.484	0.766	0.489

2015

	MAPE	Mean SPE	Median SPE	Standard Deviation SPE	15% APE	IQRPE
Method I - Extended Forecast Horizon	0.324	-0.131	-0.197	0.439	0.709	0.349
Method I - Original	0.303	-0.146	-0.214	0.382	0.739	0.318

Method I – Extended forecast horizon is an adjusted version of Method I. The explicit forecast horizon is extended from one year to three years. Descriptive statistics for the input variables used for Method I - Extended Forecast Horizon is found in Appendix F. Method I – Original refers to the original version of Method I. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibit an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles of SPE.

5.4.3. METHOD II - CAPM r_E^*

In Method II we apply reverse engineering to solve for r_E^{RE} and δ^{RE}. In an attempt to improve the valuation accuracy of Method II, we insert the firm specific r_E^* rates estimated based on CAPM instead. In section 3.3.1. we argued that it could be appealing to use reverse engineering to obtain an estimate of the required rate of return on owners' equity since uncertainty can be attributable to the CAPM estimate. However, it is not certain that our r_E^{RE} estimates result in better estimations of the 'true' required rate of return. Therefore, the firm specific CAMP r_E^* is inserted into the RIV model in Method II and reverse engineering is only used to solve for δ^{RE}. This choice is further supported by the sample reduction that the criteria testing causes. In 2004, 12.7% of the firms do not have a single combination with r_E^{RE} that fulfills criteria 1, $0.05 \leq r_E^{RE} < 0.40$. In 2015, 12.4% of the firms do not have any combination that meets the same criteria. Inserting the firms' CAPM r_E^*, on the other hand, ensures that all firms pass the required rate of return criteria.

When inserting CAPM r_E^* into Method II, 138 firms (87.3%) survive the criteria testing in 2004.[46] In the original Method II the corresponding number is 80 firms (50.6%). In 2015, 221 firms (94.4%) pass the criteria testing when using CAPM r_E^* instead of r_E^{RE}, while in the original method only 128 firms (54.7%) pass it in 2015.

[46] $0.05 \leq r_E^* \leq 0.40$ and $0 \leq \delta^{RE} < (1+ r_E^*)$

Table 8

Valuation Performance

Method II - CAPM r_E^*

2004

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - CAPM r_E^*	1.077	-0.302	-0.252	2.989	0.781	0.702
Method II - Original	3.511	-3.243	-0.530	13.968	0.838	1.315

2015

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - CAPM r_E^*	81.110	79.264	-0.293	1180.084	0.833	0.468
Method II - Original	2.681	0.319	-0.277	10.301	0.891	0.809

Method II – CAPM r_E^* is an adjusted version of Method II. The required rate of return on owners' equity is estimated by CAPM in this version of Method II. Descriptive statistics for the input variables used in Method II - CAPM r_E^* is found in Appendix F. Method II – Original refers to the original version of Method II. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibit an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles of SPE.

Looking at the results in Table 8, all measures of valuation performance improve in 2004. However, this is not the case for 2015. The main reason for this is that one extreme valuation skews the result significantly. If this extreme observation is eliminated from the sample, almost all valuation performance measures improve in 2015 as well (see Appendix G). Looking closer into the extreme observation, one can observe that the denominator in the terminal value $\left[(1+r_E^*) - \delta^{RE}\right]$ is close to zero. Substantial weight is hence given to the forecasted residual income^{UB}. The valuation results suggest that the valuation accuracy can potentially be improved when using firm specific CAPM r_E^* in Method II. This is, however, not supported by both of the statistical tests.[47] Moreover, the extreme observation further illustrates that Method II can easily result in substantial estimation errors.

5.4.4. METHOD II - LAST YEAR'S ROE^{UB}

In the original Method II, ROE^{UB} is forecasted based on an average of the three previous years' ROE^{UB} ratios. It is, however, possible that the development of ROE^{UB} is better represented by a martingale process.[48] If this is the case, the best estimate of next period's value is the current value of that variable (Ball and Watts, 1972). Thus, in this adjusted version of Method II we forecast ROE^{UB} by the realized ROE^{UB}, $ROE_t^{UB} = ROE_{t-1}^{UB}$.

[47] When testing APE differences between the original Method II and Method II CAPM r_E^* the following p-values are obtained. In 2004, the reported p-values are 0.407 (Z-test) and 0.000 (signed test for paired samples). In 2015, the reported p-values are 0.517 (Z-test) and 0.000 (signed test for paired samples). Also, since we look at matched pairs, the same observation needs to be included in both the extended version of Method II and well as the original Method II. The criteria testing, however, can generate samples with different combination of firms and hence all observations may not be part of the statistical test.

[48] Martingale $E(Y_{t+1}|Y_0, \ldots, Y_t) = Y_t$ for all t (Ball and Watts, 1972).

Table 9

Valuation Performance

Method II - Last Year's ROE^{UB}

2004

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - Last Year's ROE^{UB}	1.509	-1.225	-0.488	2.487	0.833	1.068
Method II - Original	3.511	-3.243	-0.530	13.968	0.838	1.315

2015

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - Last Year's ROE^{UB}	1.929	-0.326	-0.353	7.769	0.860	0.544
Method II - Original	2.681	0.319	-0.277	10.301	0.891	0.809

Method II – Last Year's ROE^{UB} is an adjusted version of Method II. The forecasted ROE^{UB} in Method II – Last Year's ROE^{UB} is estimated by the previous year's realized ROE^{UB}. Descriptive statistics for the input variables used for the adjusted Method II is found in Appendix F. Method II – Original refers to the original version of Method II. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibits an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles for the SPEs.

When ROE^{UB} is forecasted based on last year's ROE^{UB}, rather than as an average of the three consecutive years, both MAPE and all three spread measures improve in both time periods, see Table 9. The mean and median SPE, become less negative in 2004, but more negative in 2015. The decrease in MAPE suggests that the valuation accuracy of Method II can be improved when estimating ROE^{UB} based on the latest realized ROE^{UB}. Hence, a valuation model based on even more simplistic forecasting procedures could generate better valuation accuracy. This observation, however, is not supported by both statistical tests.[49] Nevertheless, when ROE^{UB} is forecasted by a martingale process, fewer firms pass the criteria testing compared to the original Method II.[50]

6. CONCLUDING REMARKS

This thesis aims to investigate if it is possible to improve the valuation accuracy of the RIV model when taking both firm specific conservative measurement bias and business goodwill/badwill into account. We find that Method I exhibits better valuation accuracy compared to our base model, while Method II does not exhibit better valuation accuracy compared to our base model.

[49] When testing APE differences between the original Method II and Method II when last year's ROE^{UB} is used as a forecast the following p-values are obtained. In 2004, the reported p-values are 0.118 (Z-test) and 0.000 (signed test for paired samples). In 2015, the reported p-values are 0.585 (Z-test) and 0.000 (signed test for paired samples). Also, since we look at matched pairs, the same observation needs to be included in both the extended version of Method II and well as the original Method II. The criteria testing, however, can generate samples with different combination of firms and hence all observations may not be part of the statistical test.

[50] 66 firms (41.8%) pass the criteria testing in 2004 and 107 firms (45.7%) pass it in 2015.

In Method I, we introduce a parameter intended to capture the value of both conservative measurement bias and business goodwill/badwill at the truncation point in time. The result suggests that firm specific goodwill parameters estimated by reverse engineering, provide better estimates of the firms' future goodwill at the horizon point in time, compared to industry specific PMB coefficients only incorporating conservative measurement bias. We also observe that this simplistic version of the RIV model can provide similar, or even better, valuation accuracy compared to other adaptations of the RIV model where additional complexity adjustments have been added (Anesten, Möller and Skogsvik, 2015). Even though the valuation accuracy of Method I is found to be better than our base model, the estimation procedure does still not seem to manage to capture all value relevant information as the valuation inaccuracies are still considerable.

In Method II, we estimate a firm specific conservative measurement bias parameter which should, if correctly estimated, enable us to use unbiased accounting in the RIV model. However, the specific procedure used in Method II results in that only part of our sample obtains realistic estimates of r_E^{RE} and δ^{RE}. As a result, only 50.6% of the firms in our sample are valued in 2004 and 54.7% of the firms in 2015. Furthermore, we obtain a large spread in valuation accuracy for the firms being valued. The valuation results from Method II, indicate that the method does not manage to appropriately account for conservative accounting and business goodwill/badwill as intended to. The large sample reduction together with the spread in valuation accuracy raise questions about the usefulness of Method II when estimating the market value of owners' equity.

Moreover, two methodological adjustments are carried out for Method I and Method II. The results from these adjustments suggest that there is room for further improvements in valuation accuracy for both methods.

In line with previous research, we find that Method I and Method II result in a majority of undervaluations. We confirm the difficulty in improving the valuation accuracy of the RIV model when accounting for conservative accounting. Additionally, previous research has argued that one advantage of the RIV model is its ability to anchor the valuation on the book value of owners' equity (Penman, 2013). We conclude from the results for Method II that if the conservative measurement bias parameter is incorrectly estimated, there is a risk that the RIV model loses one of its major strengths: its anchoring on something 'real'.

6.1. LIMITATIONS

To conclude, this section will present some limitations of our thesis by highlighting assumptions and conditions on which the thesis is based upon.

Reverse engineering has been used to estimate certain input variables in both Method I and Method II. In Method I, for example, we use reverse engineering to estimate a firm's goodwill at the end of the forecast horizon. To be able to estimate the goodwill parameter correctly, market values have to properly reflect all available information about the firm. The market efficiency hypothesis is thus a central assumption in this thesis. Even if market values do not reflect all available information, we believe that market values still contain value relevant and useful information about the firms' future goodwill.

Furthermore, several assumptions have been made when empirically implementing Method I and Method II. For example, forecasts are based on past realizations, assuming that historical values give a good indication of future performance. An alternative approach could have been to use analysts' forecasts. Although other assumptions could have been made, our assumptions are clearly stated throughout this thesis and it should therefore be possible for the reader to draw conclusions about the result under the conditions the models are operationalized under.

In order to determine if it is possible to improve the valuation accuracy of the RIV model, the valuation performance of Method I and Method II has been compared to our base model. The focus in this thesis is on Method I and Method II and limited attention has been given to the base model. It is, however, important to be aware of the characteristics of the base model when interpreting the results. For example, the structure of the base model implies that the firm has reached a steady state at the end of the explicit forecast horizon. In our simplified setting with a short explicit forecast horizon, it can be questioned if this assumption holds for all firms in our sample. Furthermore, the PMB coefficients used in the base model were estimated in 1998 (Runsten, 1998). Changes in, for example, accounting principles and industry characteristics can result in changes in the magnitude of the industry specific PMB coefficients. As a result, Runsten's PMB coefficients may no longer serve as good approximations of the relative conservative measurement bias.

The data used in this thesis has been collected from Compustat. To ensure the reliability of the data, randomly selected data points have been compared with the financial reports. Few errors were found. Although we experienced a shortfall in data due to missing data, we consider the reliability of the data available to be satisfying.

Lastly, we have looked at a sample from the Swedish, Finnish, Norwegian and Danish market for two specific time periods. It is thus not certain that the results can be generalized for other markets and time periods.

7. REFERENCES

Accounting Principles Board (APB). 1970. APB Statement No. 4, Basic Concepts and Accounting Principles Underlying Financial Statements of Business Enterprises, Paragraph 171. New York: AICPA.

Ahmed, A.S., Morton, R.M. and Schaefer, T.F., 2000. Accounting Conservatism and the Valuation of Accounting Numbers: Evidence on the Feltham-Ohlson (1996) Model. *Journal of Accounting, Auditing & Finance*, 15(3), pp.271-292.

Altman, E.I., 1968. Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *Journal of Finance*, 23(4), pp.589-609.

Anesten, S., Möller, N., and Skogsvik, K., 2015. The Accuracy of Parsimonious Equity Valuation Models – Empirical Tests of the Dividend Discount, Residual Income and Abnormal Earnings Growth Models. *SSE Working Paper Series in Business Administration*, 2015(3), pp.1-39.

Ashton, D., Wang, P., 2015. Conservatism in Residual Income Models: Theory and Supporting Evidence. *Accounting and Business Research*, 45(3), pp.387-410.

Ball R. and Watts R., 1972. Some Time Series Properties of Accounting Income. *The Journal of Finance*, 27(3), pp. 663-681.

Bar-Yosef, S., Callen, J.L. and Livnat, J., 1996. Modeling Dividends, Earnings, and Book Value Equity: An Empirical Investigation of the Ohlson Valuation Dynamics. *Review of Accounting Studies*, 1, pp. 207-224.

Barker, R., 2015. Conservatism, prudence and the IASB's Conceptual Framework. *Accounting and Business Research*, 45(4), pp.514-538.

Bartov, E., Lindahl, F.W. and Ricks, W.E., 1998. Stock Price Behavior Around Announcements of Write-Offs. *Review of Accounting Studies*, 3(4), pp.327-346.

Beaver, W.H., 1966. Financial Ratios as Predictors of Failure. *Journal of Accounting Research*, 4(3), pp.71-111.

Beaver, W.H. and Ryan, S.G., 2000. Biases and Lags in Book Value and Their Effects on the Ability of the Book-to-Market Ratio to Predict Book Return on Equity. *Journal of Accounting Research*, 38(1), pp.127-148.

Begley, J. and Feltham, G.A., 2002. The Relation between Market Values, Earnings Forecasts, and Reported Earnings. *Contemporary Accounting Research*, 19(1), pp.1-48.

Berk, J. and DeMarzo, P., 2014. Corporate Finance. 3rd ed. Harlow: Pearson Education.

Bernard, V.L., 1995. The Feltham-Ohlson Framework: Implications for Empiricists. *Contemporary Accounting Research*, 11(2), pp.733-747.

Bernard, V.L. and Thomas, J.K., 1989. Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium? *Journal of Accounting Research*, 27(3), supplement, pp.1-36.

Botosan, C.A. and Plumlee, M.A., 2005. Assessing Alternative Proxies for the Expected Risk Premium. *Accounting Review*, 80(1), pp.21-53.

Brief, R.P. and Lawson, R.A., 1992. The Role of the Accounting Rate of Return in Financial Statement Analysis.Accounting Review, 67(2), pp.411-426.

Choi, Y.S., O'Hanlon, J.F. and Pope, P.F., 2006. Conservative Accounting and Linear Information Valuation Models. *Contemporary Accounting Research*, 23(1), pp.73-101.

Compustat - Capital IQ, 2016. Compustat Monthly Updates. [Global > Fundamentals Annual] ISurv [online] Available through: Wharton Research Data Services <http:// wrds-web.wharton.upenn.edu/wrds> [Accessed 17 February 2016].

Compustat - Capital IQ, 2016. Compustat Monthly Updates. [Global > Index Prices] ISurv [online] Available through: Wharton Research Data Services <http:// wrds-web.wharton.upenn.edu/wrds> [Accessed 26 February 2016].

Compustat - Capital IQ, 2016. Compustat Monthly Updates. [Global > Security Daily] ISurv [online] Available through: Wharton Research Data Services <http:// wrds-web.wharton.upenn.edu/wrds> [Accessed 24 February 2016].

Courteau, L., Kao, J.L. and Richardson, G.D., 2000. Equity Valuation Employing and Ideal versus Ad Hoc Terminal Value Expressions. *Contemporary Accounting Research*, 18(4), pp.625-661.

Damodaran, A., 2007. Return on Capital (ROC), Return on Invested Capital (ROIC) and Return on Equity (ROE): Measurement and Implications. Social Science Research Network, [online] Available at: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1105499> [Accessed 15 March 2016].

Damodaran, A., 2012. Investment Valuation: Tools and Techniques for Determining the Value of Any Asset. 3rd ed. Hoboken, New Jersey: John Wiley & Sons.

Damodaran, A., 2016. Data. [Current Data > Discount Rate Estimation > Costs of Capital by Industry Sector > Europe] ISurv [online] Available through: Damodaran online < http://people.stern.nyu.edu/adamodar/New_Home_Page/datacurrent.html#discrate> [Accessed 11 March 2016].

Dechow, P.M., Hutton, A.P. and Sloan, R.G., 1999. An Empirical Assessment of the Residual Income Valuation Model. *Journal of Accounting and Economics*, 26, pp.1-34.

Edwards, E.O. and Bell, P.W., 1961. The Theory and Measurement of Business Income. London: Cambridge University Press.

EY, 2015. Estimating risk-free rates for valuations. [pdf] EY. Available at: < http://www.ey.com/Publication/vwLUAssets/EY-estimating-risk-free-rates-for-valuations/$FILE/EY-estimating-risk-free-rates-for-valuations.pdf > [Accessed 2 March 2016].

Fama, E.F. and French, K.R., 1992. The Cross-Section of Expected Stock Returns. *Journal of Finance*, 47(2), pp.427-465.

Fama, E.F. and French, K.R., 1997. Industry Costs of Equity. *Journal of Financial Economics*, 43(2), pp.153-193.

Fama, E.F. and French, K.R., 2000. Forecasting Profitability and Earnings. *Journal of Business*, 73(2), pp.161-176.

Feltham G.A. and Ohlson J.A., 1995. Valuation and Clean Surplus Accounting for Operating and Financial Activities. *Contemporary Accounting Research*, 11(2), pp.689-731.

Fernandez, P., Pizzaro, A.O. and Acín, I.F., 2015. Discount Rate (Risk-Free Rate and Market Risk Premium) Used for 41 Countries in 2015: A Survey. Social Science Research Network, [online] Available at: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2598104> [Accessed 17 March 2016].

Financial Accounting Standards Board (FASB). 1980. Qualitative Characteristics of Accounting Information. Statement of Financial Accounting Concepts No. 2. Norwalk, CT: FASB.

Francis, J., LaFond, R., Olsson, P.M. and Schipper, K., 2004. Costs of Equity and Earnings Attributes. *Accounting Review*, 79(4), pp.967-1010.

Francis, J., Olsson, P. and Oswald, D.R., 2000. Comparing the Accuracy and Explainability of Dividend, Free Cash Flow, and Abnormal Earnings Equity Value Estimates. *Journal of Accounting Research*, 38(1), pp.45-70.

Frankel, R., and Lee, C., 1998. Accounting Valuation, Market Expectation, and Cross-Sectional Stock Returns. *Journal of Accounting and Economics,* 25, pp.283-319.

Gordon, M.J. and Shapiro, E., 1956. Capital Equipment Analysis: the Required Rate of Profit. *Management Science*, 3(1), pp.102-110.

IFRS, 2015. Investor Perspectives – A Tale of 'Prudence'. [pdf] IFRS. Available at: <http://www.ifrs.org/Investor-resources/Investor-perspectives-2/Documents/Prudence_Investor-Perspective_Conceptual-FW.PDF> [Accessed 20 February 2016].

Jiang, X. and Lee, B-S., 2005. An Empirical Test of the Accounting-Based Residual Income Model and the Traditional Dividend Discount Model. *Journal of Business*, 78(4), pp.1465-1504.

Johansson, S-E. and Runsten, M., 2014. Profitability, Financing Growth of the Firm - Goals, Relationships and Measurement Methods. Lund: Studentlitteratur.

Jorgensen, B.N., Lee, Y.G. and Yoo, Y.K., 2011. The Valuation Accuracy of Equity Value Estimates Inferred from Conventional Empirical Implementations of the Abnormal Earnings Growth Model: US Evidence. *Journal of Business Finance & Accounting*, 38(3-4), pp.446-471.

M., Kim and Ritter, J.R., 1999. Valuing IPOs. *Journal of Financial Economics*, 53(3), pp.409-437.

Koller, T., Goedhart, M., and Wessels, D., 2014. Profitability, Financing Growth of the Firm - Goals, Relationships and Measurement Methods. 5th ed. Hoboken, New Jersey: John Wiley & Sons.

Lawrence, A., Sloan, R. and Sun, Y., 2012. Mandatorily Conservative Accounting: Evidence and Implications. s.n., [online] Available at: <http://www.simon.rochester.edu/search-results/index.aspx?start=0&num=20&q=Mandatorily+Conservative+Accounting%3A+Evidence+and+Implications&Submit=Go> [Accessed ? March 2016].

Lee, C., 1999. Accounting-Based Valuation: Impact on Business Practices and Research. *Accounting Horizons*. 13(4), pp.413-425.

Liu, J., Nissim, D. and Thomas, J., 2002. Equity Valuation Using Multiples. *Journal of Accounting Research*, 40(1), pp.135-172.

K. Lo. and Lys, T., 2000. The Ohlson Model: Contribution to Valuation Theory, Limitations, and Empirical Applications. *Journal of Accounting, Auditing & Finance*, 15(3), pp.337-367.

Lundholm, R. and O'Keefe, T., 2001. Reconciling Value Estimates from the Discounted Cash Flow Model and the Residual Income Model. *Contemporary Accounting Research*, 18(2), pp.311-335.

Lundholm, R.J., 1995. A Tutorial on the Ohison and Feltham/Ohlson Models: Answers to Some Frequently Asked Questions. *Contemporary Accounting Research*, 11(2), pp.749-761.

Miller, M.H. and Modigliani, F., 1961. Dividend Policy, Growth, and the Valuation of Shares. *The Journal of Business*, 34(4), pp.411-433.

Mora, A. and Walker, M., 2015. The Implication of Research on Accounting Conservatism for Accounting Standard Setting. *Accounting and Business Research*, 45(5), pp.620-650.

Myers, J.N., 1999. Implementing Residual Income Valuation with Linear Information Dynamics. *Accounting Review*. 74(1), pp.1-28.

Nasdaq, Inc., 2016. OMXC20, OMX Copenhagen 20, (DK0016268840). [online] Available at: <http:// http://www.nasdaqomxnordic.com/index> [Accessed 14 March 2016].

Nasdaq, Inc., 2016. OMXH25, OMX Helsinki 25, (FI0008900212). [online] Available at: <http:// http://www.nasdaqomxnordic.com/index> [Accessed 14 March 2016].

Nasdaq, Inc., 2016. OMXS30, OMX Stockholm 30 Index, (SE0000337842). [online] Available at: <http:// http://www.nasdaqomxnordic.com/index> [Accessed 10 October 2009].

Newbold, P., Carlson, W.L. and Thorne, B., 2010. Statistics for Business and Economics. 7th ed. Upper Saddle River, New Jersey: Pearson Education.

Ohlson, .A., 1980. Financial Ratios and the Probabilistic Prediction of Bankruptcy. *Journal of Accounting Research*, 18(1), pp.109-131.

Ohlson, J.A., 1995. Earnings, Book Values, and Dividends in Equity Valuation. *Contemporary Accounting Research*, 11(2), pp.661-687.

Ohlson, J.A., 2001. Earnings, Book Values, and Dividends in Equity Valuation: An Empirical Perspective. *Contemporary Accounting Research,* 18(1), pp.107-120.

Ohlson, JA. and X-J., Zhang., 1999. On the Theory of Forecast Horizon in Equity Valuation. *Journal of Accounting Research*, 37(2), pp.437-449.

Penman, S.H., 1998. A Synthesis of Equity Valuation Techniques and the Terminal Value Calculation for the Dividend Discount Model. *Review of Accounting Studies*, 2, pp.303-323.

Penman, S.H., 2013. Financial Statement Analysis and Security Valuation. 5th ed. New York, New York: McGraw-Hill.

Penman, S.H. and Sougiannis, T., 1998. A Comparison of Dividend, Cash Flow, and Earning Approaches to Equity Valuation. *Contemporary Accounting Research*, 15(3), pp.343-383.

Penman, S.H. and X-Jun. Zhang., 2002. Accounting Conservatism, the Quality of Earnings, and Stock Returns. *Accounting Review*, 77(2), pp.237-264.

Porter, M., 1980. Industry Structure and Competitive Strategy: Keys to Profitability. *Financial Analysts Journal*, 36(4), pp.30-41.

Preinreich, G.A.D., 1938. Annual Survey of Economic Theory: The Theory of Depreciation. *Econometrica*, 6(3), pp.219-241.

Regulation (EC) No 1606/2002 of the European Parliment and of the Council of 19 July 2002 on the application of international accounting standards. 2002 SI 1606/2002. Brussels: The European Parliment and the Council of the European Uunion.

Runsten, M., 1998. The Association between Accounting Information and Stock Prices. *Ph. D. Stockholm School of Economics.*

Schilit, H.M. and Perler, J., 2010. Financial Shenanigans. 3rd ed. New York, New York: McGraw-Hill.

Shiller, R.J., 1981. Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?. *American Economic Review*, 71(3), pp.421-437.

Skogsvik, K., 1990. Current Cost Accounting Ratios as Predictors of Business Failure: the Swedish Case. *Journal of Business Fiance & Accounting*, 17(1), pp.137-160.

Skogsvik, K., 1998. Conservative Accounting Principles, Equity Valuation and the Importance of Voluntary Disclosures. *British Accounting Review*, 1998. 30, pp.361-381.

Skogsvik, K., 2002. A Tutorial on Residual Income Valuation and Value Added Valuation. *SSE Working Paper Series in Business Administration*, 1999:10.

Skogsvik, K., 2006. Probabilistic Business Failure Prediction in Discounted Cash Flow Bond and Equity Valuation. *SSE/EFI Working Paper Series in Business Administration*, 2006:5.

Skogsvik, K. and Juettner-Nauroth, B., 2013. A Note on Accounting Conservatism in Residual Income and Abnormal Earnings Growth Equity Valuation. *The British Accounting Review*, 45(1), pp.70-80.

Skogsvik, K. and Skogsvik, S., 2013. On the Choice Based Sample Bias in Probabilistic Bankruptcy Prediction. *Investment Management and Financial Innovations*, 10(1), pp.29-37.

Skogsvik, S., 2008. Financial Statement Information, the Prediction of Book Return on Owners' Equity and Market Efficiency: The Swedish Case. *Journal of Business Finance & Accounting*, 35(7-8), pp.795–817.

Stowe, J.D., Robinson, T.R., Pinto, J.E. and McLeavey D.W., 2007. Equity Asset Valuation. 3rd ed. Hoboken, New Jersey: John & Sons John Wiley & Sons.

The International Accounting Standard Board (IASB), 2014. A Guide through IFRS – Part A. London: IFRS Foundation Publication Department.

Trading Economics, 2016. Denmark Government Bond 10Y. [online] Available at: <http:// http:// http://www.tradingeconomics.com/denmark/government-bond-yield> [Accessed 17 March 2016].

Trading Economics, 2016. Finland Government Bond 10Y. [online] Available at: <http:// http:// http://www.tradingeconomics.com/finland/government-bond-yield> [Accessed 17 March 2016].

Trading Economics, 2016. Norway Government Bond 10Y. [online] Available at: <http:// http:// http://www.tradingeconomics.com/norway/government-bond-yield> [Accessed 17 March 2016].

Trading Economics, 2016. Sweden Government Bond 10Y. [online] Available at: <http:// http:// http://www.tradingeconomics.com/sweden/government-bond-yield> [Accessed 17 March 2016].

X.-J., Zhang, 2000. Conservative Accounting and Equity Valuation. *Journal of Accounting & Economics*, 29(1), pp.125-149.

8. APPENDIX

Appendix A: Deriving the Gordon Growth Formula

The DDM states that firm value is equal to the present value of all future dividends, Eq. (A).

$$V_0 = \frac{Div}{1+r_E} + \frac{Div(1+g)}{(1+r_E)^2} + \frac{Div(1+g)^2}{(1+r_E)^3} + \cdots + \frac{Div(1+g)^{t-1}}{(1+r_E)^t} \quad \text{(A)}$$

Each term in Eq. (A) is equal to the previous term multiplied with the constant $(1 + g)/(1 + r_E)$. As a first step, that constant is multiplied with each term, Eq. (B).

$$V_0 \frac{(1+g)}{(1+r_E)} = \frac{Div(1+g)}{(1+r_E)^2} + \frac{Div(1+g)^2}{(1+r_E)^3} + \frac{Div(1+g)^3}{(1+r_E)^4} \ldots + \frac{Div(1+g)^{t-1}}{(1+r_E)^t} \quad \text{(B)}$$

Eq. (B) is then subtracted from Eq. (A) and we get the following simplified expression:

$$V_0 - V_0 \frac{(1+g)}{(1+r_E)} = \frac{Div}{1+r_E} \quad \text{(C)}$$

By rearranging the expression, we can solve for V_0:

$$V_0 \left(1 - \frac{(1+g)}{(1+r_E)}\right) = \frac{Div}{1+r_E} \quad \text{(D)}$$

$$V_0 = \frac{Div}{1+r_E} \times \frac{1}{1 - \frac{(1+g)}{(1+r_E)}} \quad \text{(E)}$$

Eq. (E) can be further simplified by multiplying the right side with $(1 + r_E)$ in both the denominator and numerator, resulting in:

$$V_0 = \frac{Div}{1+r_E} \times \frac{1+r_E}{(1+r_E)-(1+g)} \quad \text{(F)}$$

$$V_0 = \frac{Div}{(1+r_E)-(1+g)} \quad \text{(G)}$$

Furthermore, simplifying the denominator we obtain the following equation:

$$V_0 = \frac{Div}{r_E - g} \quad \text{(H)}$$

The same mathematics is applied to Eq. (30). If dividends are substituted with residual income (RI) and our fade away factor, ω, is added to (1 + g), Eq. (G) can be rewritten as:

$$V_0 = \frac{RI}{(1 + r_E) - \omega(1 + g)} \tag{I}$$

Because of the fade away factor, Eq. (I) cannot be simplified to Eq. (H). With $\omega(1 + g) = \delta$, Eq. (I) can finally be rewritten as:

$$V_0 = \frac{RI}{(1 + r_E) - \delta} \tag{J}$$

Appendix B: Industry Distribution

Table 10

Industry Distribution

Industry	**SIC-code**	**Number of Firms**
Agriculture, Forestry, Fishing	01-09	1
Mining	10-14	12
Construction	15-17	12
Manufacturing	20-39	169
Transportation & Public Utilities	40-49	34
Wholesale Trade	50-51	7
Retail Trade	52-59	9
Services	70-89	71
Public Administration	91-99	3
Total		318

Table 10 shows which industry the firms in our entire sample belong to. The industry classification is based on the assigned SIC-code in Compustat.

Appendix C: ROE Development

Figure 4

ROE Development

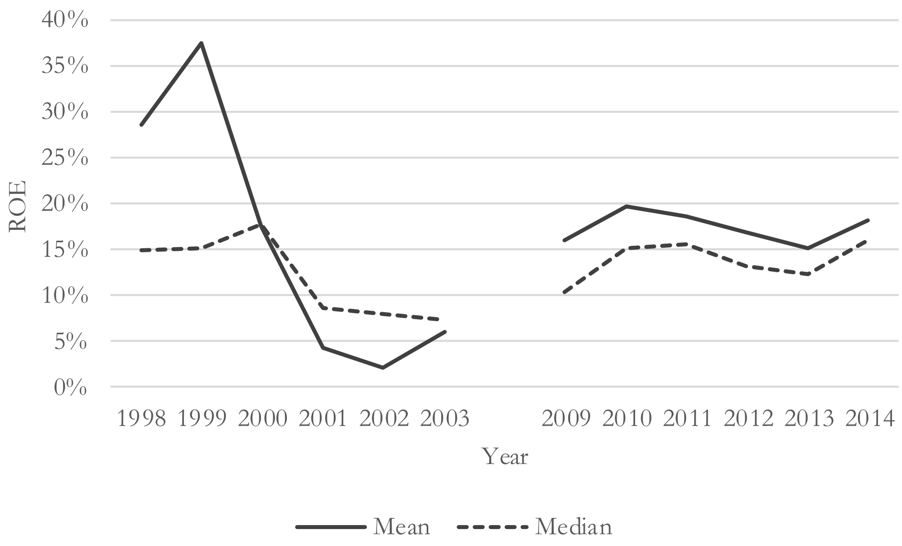

Figure 4 illustrates the development of the yearly mean and median ROE for the total sample in both time periods.

Appendix D: Distribution of q(CMB) Values for Method II

Table 11
Distribution of q(CMB) Values - Method II

	2004		*2015*	
q(CMB)	Number	Percentage	Number	Percentage
0	28	35.0%	67	52.3%
0.2	9	11.3%	11	8.6%
0.4	9	11.3%	14	10.9%
0.6	6	7.5%	9	7.0%
0.8	4	5.0%	2	1.6%
1	4	5.0%	3	2.3%
1.2	2	2.5%	2	1.6%
1.4	2	2.5%	0	0.0%
1.6	2	2.5%	2	1.6%
1.8	1	1.3%	4	3.1%
2	3	3.8%	1	0.8%
2.2	0	0.0%	1	0.8%
2.4	0	0.0%	0	0.0%
2.6	1	1.3%	1	0.8%
2.8	2	2.5%	1	0.8%
3	0	0.0%	0	0.0%
3.2	1	1.3%	0	0.0%
3.4	1	1.3%	0	0.0%
3.6	0	0.0%	0	0.0%
3.8	0	0.0%	0	0.0%
4	5	6.3%	10	7.8%
Total	80	100.0%	128	100.0%

Table 11 shows the distribution of q(CMB) values that pass the criteria testing in Method II.

Appendix E: Number of Over- and Undervaluations

Table 12

Number of Over- and Undervaluation

Method I	*2004*		*2015*	
	Number	Percentage	Number	Percentage
Undervaluation	116	73.4%	182	77.8%
Overvaluation	42	26.6%	52	22.2%
Total	158	100.0%	234	100.0%

Method II	*2004*		*2015*	
	Number	Percentage	Number	Percentage
Undervaluation	63	78.8%	88	68.8%
Overvaluation	17	21.3%	40	31.3%
Total	80	100.0%	128	100.0%

Base Model	*2004*		*2015*	
	Number	Percentage	Number	Percentage
Undervaluation	96	60.8%	157	67.1%
Overvaluation	62	39.2%	77	32.9%
Total	158	100.0%	234	100.0%

Table 12 shows the number of over- and undervaluations for Method I, Method II and the base model in respective period. The absolute number of firms are less in Method II since we only perform valuations for firms passing the criteria testing.

Appendix F: Estimated Input Variables for Model Adjustments.

Table 13

Input Variables

Method I – Last Year's q(TOT)

2004

	Mean	Standard Deviation	Min	Median	Max
q(TOT)	0.71	1.42	-0.88	0.35	9.64
$\overline{ROE}$	4.1%	18.3%	-54.7%	6.9%	48.7%
r_E^*	9.9%	3.7%	1.9%	9.1%	24.2%
Residual Income_1	-0.04	0.13	-0.91	-0.01	0.48

2015

	Mean	Standard Deviation	Min	Median	Max
q(TOT)	2.00	3.26	-0.67	1.31	35.76
$\overline{ROE}$	16.7%	16.8%	-23.2%	13.7%	105.1%
r_E^*	4.9%	2.7%	0.5%	4.7%	12.9%
Residual Income_1	0.03	0.07	-0.30	0.03	0.45

This table reports descriptive statistics of variables estimated for Method I – Last Year's q(TOT). q(TOT) is forecasted by the estimated value of q(TOT) the year before the valuation. $\overline{\text{ROE}}$ is estimated based on an average of past realizations from three consecutive years. r_E^* is estimated by CAPM and the residual income is scaled by the market value.

Appendix F Continued

Table 14

Input Variables

Method I – Extended Forecast Horizon

2004

	Mean	Standard Deviation	Min	Median	Max
$\overline{q(TOT)}$	2.33	7.88	-0.88	0.42	78.83
$\overline{ROE}$	4.1%	18.3%	-54.7%	6.9%	48.7%
r_E^*	9.9%	3.7%	1.9%	9.1%	24.2%
Residual Income_1	-0.04	0.13	-0.91	-0.01	0.48

2015

	Mean	Standard Deviation	Min	Median	Max
$\overline{q(TOT)}$	1.30	1.96	-0.72	0.85	12.88
$\overline{ROE}$	16.7%	16.8%	-23.2%	13.7%	105.1%
r_E^*	4.9%	2.7%	0.5%	4.7%	12.9%
Residual Income_1	0.03	0.07	-0.30	0.03	0.45

This table reports descriptive statistics of variable estimated for Method I – Extended Forecast Horizon. In this version of Method I, we extend the explicit forecast horizon from one year to three years. Similar to Method I original, $\overline{q(TOT)}$ and $\overline{ROE}$ are both estimated based on averages of past realizations from the three consecutive years for each respective variable. r_E^* is estimated by CAPM and the residual income is scaled by the market value.

Appendix F Continued

Table 15

Input Variables

Method II - CAPM r_E^*

2004

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.84	1.18	0.00	0.20	4.00
$\overline{ROE}^{UB}$	5.1%	16.4%	-47.1%	6.5%	62.5%
r_E^*	9.8%	3.6%	1.9%	9.0%	24.2%
δ^{RE}	72.6%	31.5%	1.5%	83.8%	111.8%
Residual Income_1^{UB}	-0.07	0.44	-3.35	-0.03	3.27

2015

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.41	0.99	0.00	0.00	4.00
$\overline{ROE}^{UB}$	16.8%	17.4%	-12.9%	13.8%	105.1%
r_E^*	5.0%	2.7%	0.5%	4.8%	12.9%
δ^{RE}	86.7%	21.0%	0.8%	94.7%	107.7%
Residual Income_1^{UB}	0.02	0.15	-0.80	0.03	1.02

This table shows descriptive statistics of variables estimated for Method II – CAPM r_E^*. In contrast to the original Method II, the required rate of return is estimated based on CAPM. The data refers only to firms passing the criteria testing. 138 out of 158 firms pass the criteria testing in 2004, while 221 out of 234 firms pass it in 2015. $\overline{ROE}^{UB}$ is the forecasted unbiased return on equity and is estimated as an average of past realizations from the previous three consecutive years. δ^{RE} is estimated by reverse engineering and the unbiased residual income is scaled by the market value.

Appendix F Continued

Table 16

Input Variables

Method II – Last Year's ROE^{UB}

2004

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.79	1.15	0.00	0.20	4.00
ROE^{UB}	3.0%	18.8%	-55.5%	7.4%	48.6%
r_E^{RE}	16.2%	10.5%	0.7%	13.9%	38.3%
δ^{RE}	84.3%	28.5%	10.2%	92.5%	127.9%
Residual Income_1^{UB}	-0.35	1.01	-7.20	-0.04	0.12

2015

	Mean	Standard Deviation	Min	Median	Max
$q(CMB)$	0.99	1.22	0.00	0.40	4.00
ROE^{UB}	8.1%	12.0%	-35.5%	7.9%	52.9%
r_E^{RE}	12.3%	9.8%	0.5%	9.7%	38.5%
δ^{RE}	82.3%	30.5%	4.8%	93.5%	136.1%
Residual Income_1^{UB}	-0.15	0.70	-5.74	0.00	1.42

This table shows descriptive statistics of variables estimated for Method II – Last Year's ROE^{UB}. Here the forecast of ROE^{UB} is estimated based on the realized ROE^{UB} the year before the valuation. The data refers only to firms surviving the criteria testing. 66 out of 158 firms pass the criteria testing in 2004, while 107 out of 234 firms pass it in 2015. Both r_E^{RE} and δ^{RE} are estimated by reverse engineering. The unbiased residual income is scaled by the market value.

Appendix G: Valuation Performance Method II – CAPM r_E^* Extreme Observation Removed

Table 17

Valuation Performance

Method II - CAPM r_E^* Extreme Observation Removed

2004

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - CAPM r_E^*	1.077	-0.302	-0.252	2.989	0.781	0.702
Method II - Original	3.511	-3.243	-0.530	13.968	0.838	1.315

2015

	MAPE	Mean SPE	Median SPE	SPE Standard Deviation	15% APE	IQRPE
Method II - CAPM r_E^*	1.739	-0.115	-0.293	7.575	0.832	0.467
Method II - Original	2.681	0.319	-0.277	10.301	0.891	0.809

Method II – CAPM r_E^* is an adjusted version of Method II. The required rate of return on owners' equity is estimated by CAPM in this version of Method II. Method II – Original refers to the original version of Method II. This table presents the valuation results when the most extreme valuation in terms of accuracy is removed from the sample in 2015. The mean absolute prediction error (MAPE) is the measure of accuracy. The mean and median signed prediction error (SPE) are the measures of bias. The standard deviation SPE, 15%APE and IQRPE are the measures of spread. 15%APE shows the percentage of valuations that exhibit an absolute prediction error of more than 15%. IQRPE reports the difference between the third and the first quartiles of SPE.