SSE Working Paper Series in Business Administration
No. 2015:3

The Accuracy of Parsimonious Equity Valuation Models – Empirical tests of the Dividend discount, Residual income and Abnormal earnings growth models

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(December 2015)

Abstract

In many contexts there is a need for parsimonious valuation models, i.e. technically less complex models that are based on few and readily available input variables. Previous research indicates that the accuracy of such models can be weak, and that the choice of a model specification involves striking a balance between the need for valuation accuracy and modelling simplicity. In this paper we investigate the accuracy of four well-known valuation models - the dividend discount (PVED) model, the residual income valuation (RIV) model and two versions of the abnormal earnings growth (AEG) model – using financial data from a Scandinavian (Denmark, Finland, Iceland, Norway and Sweden) capital market setting. Measuring the valuation accuracy in terms of both precision and spread, we find that the RIV model in general allows for the best parsimonious model specifications. Incorporating complexity adjustments (longer explicit forecast periods, bankruptcy risk adjustment of discount rates, and elimination of transitory income items) in our most parsimonious models, we find that the valuation accuracy of all models improve. RIV modelling still comes out as the best valuation approach, but the gap to PVED modelling decreases. Despite our complexity adjustments, the AEG models generate poor valuation results and basically cannot be used as valuation benchmarks for our sample of Scandinavian firms.

Keywords: Abnormal earnings growth (AEG) model, Accuracy score, Dividend discount (PVED) model, Equity valuation, Fundamental valuation, Parsimonious modelling, Residual income valuation (RIV) model.

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1. Introduction

Complex valuation models have in previous literature been argued to be potentially more useful than parsimonious models, in the sense that such models should be more accurate in relation to observed market prices (Kaplan & Ruback, 1995; Bradshaw, 2004; Gleason, Johnson & Li, 2012). However, even though it is important that a valuation model is accurate, a valuation model must also be simple as investors seek ways to simplify their investment decisions (Peng & Xiong, 2006; Beunza & Garud, 2007). Penman & Sougiannis (1998) stress the virtue of simplicity in equity valuation and argue for example that the discounted cash flow model is cumbersome owing to its "untangling" of accruals to arrive at "free cash flows". It has also been observed that parsimonious valuation modeling has taken a prominent place in fundamental valuation (cf. Berkman, Bradbury & Ferguson, 2000; Asquith, Mikhail & Au, 2005; Demirakos, Strong & Walker, 2010; Cavezzali & Rigoni, 2013). Thus, although more simplistic models are not as technically sophisticated, they can nevertheless be quite useful. For an equity investor this implies that the modeling choice boils down to striking a balance between technical sophistication and application simplicity. Models that put emphasis on the latter characteristic are typically parsimonious in terms of the model specification and input parameters. Parsimony can hence be expressed in terms of fewer and more readily available input variables in the valuation model.

To test the accuracy of parsimonious valuation models, we investigate four well-known models and their performance relative to observed stock prices in a Scandinavian market setting. The models being examined are the *dividend discount* (PVED) model, the *residual income valuation* (RIV) model, and two versions of the *abnormal earnings growth* (AEG) model. We will then also consider the effect of adding *some* modelling complexity. This is investigated through incorporating three adjustments in the model specifications. First, we examine the effect of extending the *explicit forecast period.* Second, the importance of incorporating *bankruptcy risk* in the models is evaluated, and third the importance of excluding *transitory items* in forecasted earnings is evaluated.

Besides McCrae & Nilsson (2001), research on the accuracy of valuation models in a Scandinavian capital market setting is limited. The paper thus adds to the literature by looking at stock markets with other characteristics than commonly have been studied. Also, the trade off in altering the degree of complexity in these models has not been explicitly evaluated previously.

Our empirical results show that the valuation accuracy differs considerably between our valuation models, with the RIV model typically being superior to the other models, and that the relative ranking of the models in the main persists regardless of complexity adjustment. Our results support the view that there is a positive association between modelling complexity and valuation accuracy, even though the improvements in several cases are surprisingly marginal.

The outline of the paper is as follows. Section 2 includes an overview of previous empirical research on accounting based valuation models. Our methodology and selected sample are presented in sections 3 and 4. In section 5, we present empirical valuation results, along with a discussion of the implications of our observations. Section 6 sums up our main results and provides some guidance on the choice of model specifications that appear to be relevant for a Scandinavian market setting.

2. Previous research

2.1. Dividend discount model

Williams' seminal contribution in modelling the linkage between dividends and stock prices (Gordon, 1959; Damodaran, 2006) stipulates that "a stock is worth the present value of all the dividends *ever* to be paid upon it, no more, no less [...]" (1938; p. 80), implying that

$$V_0 = \sum_{t=1}^{\infty} \frac{E_0[Div_t]}{(1+\rho_e)^t} \tag{1}$$

where V_0 is the value of owners' equity at time $t = 0$, Div_t the dividend payment at time *t*, $\mathrm{E_t}[\dots]$ the expectation operator reflecting available information at time *t*, and ρ_e the cost of equity capital. The rationale behind this *dividend discount* (PVED) model is intuitive in the sense that dividends are the cash payments that equity investors in aggregate can expect to receive from investing in a firm's stock. However, the model specification in (1) requires cumbersome dividend forecasting into perpetuity. Gordon & Shapiro (1956) and Gordon (1959) addressed this problem, making dividend growth (*g*) an explicit parameter of the model[2]. They derived a parsimonious valuation formula including a parameter reflecting the future eternal dividend growth rate (g):

[2] They assumed that a firm retained a fraction of its net income every year, and earned a rate of return on that retention, in addition to a return on the original book equity.

$$V_0 = \frac{E_0[Div_1]}{\rho_e - g} \tag{2}$$

The dividend discount model in (2) requires that $\rho_e > g$ to hold. As a response to the potentially problematic eternal growth rate assumption, more dynamic models have emerged that incorporate period specific growth rates over explicit forecast periods and truncate the forecasting at some distant future steady state (cf. Molodovsky, May & Chottiner, 1965; Bauman, 1969; Fuller & Hsia, 1984; Damodaran, 2006).

Much of the early empirical literature concerned the PVED model's ability to explain stock prices. In a research setting of this kind, advocates of efficient capital markets attribute stock price movements to "new information" about future dividends. However, LeRoy & Porter (1981) and Shiller (1981) challenged this view. By using variance bound statistical tests, they claimed that stock price indices seemed to be too volatile to be justified only by new information about future dividends. Jacobs & Levy (1989) concluded that PVED explained only a small part of the change in ex-post returns[3], but Sorensen & Williamson (1985) nevertheless provided evidence that a PVED model could be useful in identifying mispricing by evaluating return performance for portfolios based on different valuation techniques. The latter authors actually found a positive association between annual returns and model complexity, with a three-period PVED model performing best.

2.2. Residual income valuation model

Preinreich (1938) showed that economic values can be expressed as a function of accounting book values and accounting earnings less a required return on the book values (residual income or abnormal earnings). This constitutes the foundation of the *residual income valuation* (RIV) model. Besides Preinreich (1938), RIV has been applied in Edwards & Bell (1961) and advocated in Peasnell (1981; 1982). However, the currently most well-known RIV elaborations are arguably due to Ohlson (1995) and Feltham & Ohlson (1995). The modelling in Ohlson (1995) rests on three main assumptions. First, the price of a security is equal to the present value of future dividends. Second, the clean surplus relation holds, meaning that changes in the book value of owners' equity are due to reported net income, dividends and capital contributions. These assumptions are sufficient to express the capital value of owners' equity as the sum of the book value of owners' equity and the present value of future residual income:

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[3] $R^2 = 0{,}037$.

$$V_0 = BV_0 + \sum_{t=1}^{\infty} \frac{E_0[\tilde{x}_t^a]}{(1+\rho_e)^t} \quad (3)$$

where V_0 is the value of owners' equity at $t = 0$, ρ_e the cost of equity capital, BV_0 the book value of owners' equity at $t = 0$, and $\tilde{x}_t^a$ depicts residual income for period t. Residual income is defined as the difference between net income (x_t) and a cost of capital charge on the book value of equity at the beginning of the period, i.e.:

$$x_t^a = x_t - \rho_e \cdot BV_{t-1} \quad (4)$$

The third and novel assumption in Ohlson (1995) is the "linear information dynamics" idea, where *other information* than accounting based numbers is assumed to impact the value of owners' equity. An assumption of this kind is in principle clearly reasonable, as there typically should exist additional non-accounting information affecting stock prices. Unfortunately, the assumption makes parsimonious modelling markedly more difficult.

Future growth is also relevant in RIV modelling. Penman (2005) explains that one arguably likely scenario is where high growth is expected in the short term, turning "in a geometric fashion" to a lower growth rate in the long-term. The original model is however unable to integrate this without adding non-trivial complexity to the RIV model specification.

2.3. Abnormal earnings growth model

Ohlson & Juettner-Nauroth (2005) - henceforth OJ - derived the *abnormal earnings growth* (AEG) model, commonly also referred to as the "OJ model". The model focuses on the *growth* of abnormal earnings as the important value driver. A characteristic feature of AEG is its non-dependence of the clean surplus relation, allowing for more robust model specifications.

The measure of abnormal earnings growth (z_t) is defined as the difference between earnings plus dividends reinvested and the previous period's earnings growing at the required rate of return:

$$z_t \equiv [x_{t+1} + \rho_e \cdot Div_t] - (1 + \rho_e) \cdot x_t \quad (5)$$

When the clean surplus relation holds, OJ shows that abnormal earnings growth is equal to the growth in residual income between two adjacent periods and that the *non-*

parsimonious AEG model can be expressed as (cf. Jennergren & Skogsvik, 2011; Penman, 2012):

$$V_0 = \frac{x_1}{\rho_e} + \frac{1}{\rho_e}\sum_{t=1}^{\infty}\frac{1}{(1+\rho_e)^t}\cdot z_t \tag{6}$$

The AEG model is anchored on earnings in the first period ("year 1"), capitalized at the cost of equity capital. The second term captures abnormal earnings growth in the following years. One can imagine a scenario where $z_t = 0$ for all future years, implying that the capital value of equity coincides with capitalized earnings of year one. However, when there is positive abnormal earnings growth, equity will be priced at a premium over capitalized earnings of year one. OJ set up their base AEG model for one explicit forecast period, assuming that:

$$z_{t+1} = \gamma z_t \tag{7}$$

with $1 \leq \gamma < (1+\rho_e)$ and $z_t > 0$. The parameter γ captures the time series behaviour of the abnormal earnings growth variable over time. This assumption leads to the well-known parsimonious OJ model:

$$V_0 = \frac{x_1}{\rho_e} + \frac{z_1}{R_E - \gamma_{AEG}} \tag{8}$$

where $R_E = (1 + \rho_e)$ and $\gamma_{AEG} = (1 + g_{AEG})$.

Many factors can have an impact on the abnormal earnings growth parameter. In a competitive business environment, one can reasonably assume that the expected value of abnormal earnings growth should gravitate towards zero. However, with a conservative accounting regime abnormal earnings growth can be positive also towards infinity, as residual income will persist due to conservative accounting. Accommodating these two opposing factors, a reasonable conclusion is that the effects can be offsetting such that $\gamma = 1$ (cf. Skogsvik & Juettner-Nauroth, 2013). This assumption applied to the parsimonious AEG model gives rise to a version of the model commonly referred to as the PEG model (cf. Easton, 2004).

Penman (2005) and Jorgensen, Lee & Yoo (2011) argue that the accuracy of the AEG model potentially should increase when the number of periods increases, as short-term earnings are likely to be distorted by non-sustainable "noise". This "noise" can erroneously be magnified through the constant growth property in the model. Therefore, non-permanent parts of historical earnings can skew assessed equity values. Extending the AEG model with one additional time period, we get:

$$V_0 = \frac{x_1}{\rho_e} + \frac{z_1/\rho_e}{(1+\rho_e)} + \frac{z_2/\rho_e}{(R_E - \gamma_{AEG})(1+\rho_e)} \quad (9)$$

Empirical applications of the AEG model have chiefly been concerned with estimating the implied cost of capital inherent in observed stock prices. For example, to infer the risk premium implied by current stock prices Gode & Mohanram (2003) used a two-period version of AEG, setting γ equal to $(1 + r_f - 0{,}03)$. The authors found that the inferred risk premiums were correlated with common risk factors, although the overall explanatory power was higher for RIV model based assessments of the implied cost of capital. Botosan & Plumlee (2005) examined the reliability of cost of capital estimates from five types of valuation models, of which two were AEG model specifications. They found systematic understatements in the cost of capital estimates, although the AEG model based estimates appeared to provide a close match. Easton & Monahan (2005) examined seven accounting based cost of capital estimates imputed from observed stock prices and analysts' forecasts. The investigation included two two-year PEG models with different dividend schemes, one AEG model with γ based on the risk-free rate, and one AEG model allowing for variations in γ.[4] The reported results indicated that none of the model specifications provided reliable estimates of the cost of equity capital.

2.4. Issues related to model comparability

Penman & Sougiannis (1998) investigated the *truncation* issue in fundamental valuation modelling with finite time horizons. For this purpose, the authors investigated the bias in model performance by including and excluding terminal values[5]. When excluding the terminal values, the authors found that the accounting based models (RIV and a "capitalized earnings" model) performed better than cash flow models (PVED and a Discounted Cash Flow ("DCF") model). However, the relative ranks persisted also when including terminal values. The authors ascribed RIV's domination to the fact that a significant part of its calculated value comes from the present book value of equity.

[4] The AEG application allowing variations in γ was derived from Easton (2004), where it was argued for a more complex estimation of long run growth rates.

[5] The performance of the models were evaluated by comparing observed prices with value estimates derived from *realized* payoffs averaged in portfolios. For each model, portfolio valuation biases were calculated using signed pricing errors.

Including terminal values, their results suggested that this component was relatively more important for the cash flow models.

Extending the investigation of Penman & Sougiannis (1998), Francis, Olsson & Oswald (2000) investigated the accuracy of the PVED, RIV and DCF models using pricing errors[6]. The authors argued that biases based on portfolio value estimates are lacking validity as fundamental investors ultimately look at pricing accuracy for individual firms. The results showed that the RIV model performed better than both the PVED and the DCF model. The median pricing error (defined as the absolute deviation between the calculated value and the observed stock price, divided by the stock price) was 30% for the RIV model and 69% for the PVED model. Substituting forecasted value attributes with realized values, the authors found that the relative rankings remained.

Penman (2005) specifically examined two period RIV and AEG model specifications and their relation to stock prices, using so called consensus forecasts[7]. The author found a median value to price ratio of about 1,0 (2,0) for the RIV (AEG) model, and that the variance of the value to price ratio was larger for the AEG model. Brief (2007) used the interquartile range to estimate the standard deviation of the RIV and AEG value to price distributions. He found that the standard deviation of the AEG model was about four times larger than that of the RIV model, highlighting the volatile outcomes of the former. Brief proposed that one presumably should use longer forecast horizons to avoid biased abnormal earnings growth assessments in the AEG model.

As noted in Penman (2005), the impact of adjustments for horizon and transitory items is potentially important in fundamental valuation. One study that explicitly has tested such adjustments is Jorgensen et al. (2011), examining RIV and AEG over longer time horizons. In this study, the AEG and the PEG model and three RIV model applications were evaluated, all with two and five year forecast horizons. Interestingly, the PEG model generated lower valuation errors than the AEG model, with a value to price ratio of 1,407 (1,298) for the two-year (five-year) PEG as compared to 1,994 (1,749) for the two-year (five year) AEG. Increasing the forecast horizon lowered the value to price ratio for the AEG model, while increasing the forecast horizon for the RIV models yielded mixed results. In sum, the PEG and the AEG models exhibited higher pricing errors than the RIV model applications.

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[6] The authors provided evidence based on *individual* firm value estimates using *analyst forecast* data, and not on portfolio estimates derived from realized payoffs.

[7] Valuations were made every year over the time period 1975-2002, using a sample of U.S. trading equities and employing a constant cost of equity capital for all firms.

2.5. Summing up previous empirical research

Previous literature - summarized in Table 1 - provides some robust findings. First, RIV modelling seems to allow for more accurate valuation model specifications, whereas AEG appears to generate overvaluations and PVED ends up somewhere in between. Extending the horizon and making the terminal value calculations more sophisticated are two potentially useful improvements. Although previous research provides valuable insights, methodological differences between the studies make it difficult to draw any more general conclusions. Also, previous research has not explicitly considered modelling complexity. A more systematic approach to assess the possible benefits from modelling complexity can shed additional light on this important valuation model characteristic.

(*TABLE 1 IN HERE*)

3. Methodological roadmap

We set out to perform a more uniform examination of parsimonious PVED, RIV, AEG and OJ valuation modelling. For this purpose we evaluate two separate three-year periods (2009 - 2011 and 2014 - 2016), implying two different valuation points in time where we investigate two payoff prediction schemes; analysts' forecasts (forward-looking estimates) versus estimates based on historical accounting numbers. Furthermore, we consider the performance impact of methodological improvements on the above models. We investigate three such improvements, i.e. the extension of the explicit forecast period, the inclusion of bankruptcy risk, and the exclusion of transitory items. Our investigation hence generates three different modelling settings: 1) non-adjusted valuation models, 2) single-adjusted valuation models, and 3) multi-adjusted valuation models.

3.1. Model specifications

We calculate equity values based on the PVED, RIV and AEG model specifications. Owing to the potential sensitivity of AEG, we have included two alternative specifications for this model, a one-year model (AEG(OJ)) and three-year model (AEG(3)). More precisely, our models are as follows:

PVED:

$$VPS_0 = \sum_{t=1}^{T} \frac{DPS_t}{(1+\rho_e)^t} + \frac{\frac{DPS_{T+1}}{\rho_e - g_{ss}}}{(1+\rho_e)^T} \qquad (10)$$

where T = 3 in the initial specification.

RIV:

$$VPS_0 = BVPS_0 + \sum_{t=1}^{T} \frac{(ROE_t - \rho_e) \cdot BVPS_{t-1}}{(1+\rho_e)^t} + \frac{q_T \cdot BVPS_T}{(1+\rho_e)^T} \qquad (11)$$

where T = 3 in the initial specification.

AEG(T):

$$VPS_0 = \frac{EPS_1}{\rho_e} + \sum_{t=1}^{T} \frac{z_t/\rho_e}{(1+\rho_e)^t} + \frac{z_{T+1}/\rho_e}{(R-\gamma)(1+\rho_e)^T} \qquad (12.a)$$

and

$$z_t = \left[EPS_{t+1} + \rho_e \cdot DPS_t\right] - \left(1+\rho_e\right) \cdot EPS_t \qquad (12.b)$$

where T = 3 in the initial specification.

AEG(OJ):

$$VPS_0 = \frac{EPS_1}{\rho_e} + \frac{z_1/\rho_e}{R-\gamma} \qquad (13)$$

Our notation in the above specifications are as follows:

VPS_0 = equity book value (ex dividend) per share at the valuation date $t = 0$.
DPS_t = dividend per share at time *t*.
ROE_t = book return on owners' equity for period *t*.
$BVPS_t$ = equity book value per share at time *t*.
EPS_t = earnings (net income) per share for period *t*.
z_t = abnormal earnings growth between period *t* and $t + 1$.
q_T = relative measurement bias of owners' equity.
ρ_e = cost of equity capital.
g_{ss} = growth rate of future dividends.
γ = $(1 + g_{AEG})$ = growth relative of abnormal earnings growth.
g_{AEG} = growth rate of future abnormal earnings growth.
R_E = $(1 + \rho_e)$.

Equity values are calculated for each company three days after the annual reporting dates in 2009 and 2014, henceforth referred to as the *valuation dates*. In order to calculate these values, we perform two adjustments. First, our valuation models (expressions (10), (11), (12.a) and (13)) yield equity values at the *dividend dates* in 2009 and 2014, respectively. As we want to compare our model values with the stock prices at the valuation dates, we need to consider the time period between the valuation date and the dividend date. Adjusting for this timing difference, we have discounted our equity values (using the equity cost of capital) to the valuation date. Secondly, at the valuation dates observed stock prices are *cum-dividend*, i.e. including the upcoming dividend (denoted DPS_{0+f}). Hence, a second adjustment has been made where we have added the discounted value of this upcoming dividend to our model (ex-dividend) equity values.[8]

As regard the choice of a valuation date, we use a three-day delay to allow for some information friction in the stock market. In robustness tests we have also evaluated our calculated equity values at the *reporting dates* and *five days after* the reporting dates.

3.2. Implementation issues

Our forecasts of the value drivers in the valuation models either constitute *analysts' forecasts* or *historical averages*. Analysts' forecasts are median financial numbers provided by analysts that cover the firms in our sample. However, due to the difficulty of finding analysts' forecasts for the first sub-period 2009-2013, we have followed Penman & Sougiannis (1998) and Francis et al. (2000) and used *realized* future numbers to proxy for such forecasted values.

Historical averages are based on financial statement numbers being available at the valuation date. We have calculated average values over the past five years and assumed these averages to be representative for the firm's future performance. For example, historical ROE_t averages constitute five-year historical ROE_t averages, expected to be remain constant over the forecast periods. Our forecasted EPS_t estimates are calculated from assessed values of ROE_t and $BVPS_{t-1}$. Historical averages of DPS_t are based on five-year historical average payout-ratios (*pr*), and the values of EPS_t. Presuming that the clean surplus relation holds in expectation, values of $BVPS_t$ have been calculated from the assessed values of EPS_t and DPS_t. Finally, we have limited the historical ROE_t averages to

[8] We have hence performed the following adjustment to our calculated equity values:

$$VPS_0^{CUM} = \frac{VPS_0}{(1+\rho_e)^f} + \frac{DPS_f}{(1+\rho_e)^f}, \tag{14}$$

where VPS_0^{CUM} is the cum-dividend equity value at the valuation date, VPS_0 is the ex-dividend value at the dividend date, and DPS_f is the upcoming dividend.

the range [0% - 100%], as values outside of this range typically are at odds with firms' performance.

(#) Cost of equity capital

We have applied the *capital asset pricing model* (CAPM; Sharpe, 1964; Lintner, 1965; Mossin, 1966)[9] to arrive at firm-specific costs of equity capital, i.e.

$$\rho_e = r_f + \beta_j \cdot \left[E(r_m) - r_f\right] \quad (15)$$

where r_f is the treasury bond yield (based on the 10-year government bond yield for the reporting currency; cf. Koller, Goedhart & Wessels, 2010), and β_j is a firm-specific beta-value obtained from standard type regressions of 60 months of stock and market index returns. The market risk-premium ($\left[E(r_m) - r_f\right]$) has been set to 5% (cf. Francis et al., 2000; Fernandez, Linares & Fernández Acìn, 2014). As customary in this type of analysis, we have assumed that ρ_e is a constant over the all forecasted years.

(#) Truncation values

Truncation values are calculated from conventional terminal value formulas (cf. Penman, 1997; Courteau, Kao & Richardson, 2001). For the PVED model, DPS_{T+1} has been estimated from the forecasted dividend DPS_T using a steady state growth rate. In line with Francis et al. (2000), we have set this growth rate to 4%. The truncation value for the RIV model is obtained by multiplying the book value at the end of the last forecast year with the accounting "measurement bias", labelled q_T. Firm-specific values of q_T have been obtained from Runsten (1998), in which values of this measurement bias (denoted "PMB" in Runsten's report) were carefully estimated for a number of Swedish industries. We have assigned a value of q_T to each firm in our sample by using available SIC-coding. As regards the abnormal earnings growth parameter γ in AEG(3) and AEG(OJ), we assume that the counter-balancing forces of business competition and conservative accounting are offsetting in the sense that $\gamma = 1$ (in line with Skogsvik & Juettner-Nauroth, 2013).

3.3. The complexity adjustments

We test three *complexity adjustments* to our valuation models, concerning the explicit forecast period, bankruptcy risk, and transitory items. We examine their impact in four steps:

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[9] Jorgensen et al. (2011) embrace several cost of capital models, but conclude that the relative performance of the valuation models was not affected by this choice.

- Adjustments for explicit forecast period (b) and bankruptcy risk (c).
- Adjustments for explicit forecast period (b) and transitory items (d).
- Adjustments for bankruptcy risk (b) and transitory items (d).
- Adjustments for explicit forecast period (b), bankruptcy risk (c), and transitory items (d).

3.3.1. *Explicit forecast period*

As regards the complexity adjustments of the forecasting period, we have extended this somewhat in all our valuation models. The PVED, RIV and AEG(T = 3) models are extended to five-year explicit forecast periods, whereas the AEG(OJ) model has been extended to a two-year horizon. Hence, the value drivers of PVED, RIV and AEG(3) are explicitly forecasted for the years 2009-2013 and 2014-2018, respectively, whereas AEG(OJ) incorporates explicit forecasts for 2009-2010 and 2014-2015, respectively.

3.3.2. Bankruptcy risk

Previous studies have ignored the potential importance of bankruptcy risk (for example, Penman & Sougiannis, 1998; Frankel & Lee, 1998; Penman, 2005; Jorgensen et al., 2011). However, as realized value attributes and analysts' forecasts are conditioned on firm survival, valuation model applications should in line with Skogsvik (2006) be adjusted for this risk.

In order to estimate bankruptcy probabilities, we have applied the bankruptcy prediction models that were estimated in Skogsvik (1990). These prediction models are representative for medium to large Swedish manufacturing companies, and the models allow for predictions up to six years ahead. The bankruptcy probabilities have been incorporated in the equity cost of capital for each company, as specified in Skogsvik (2006):

$$\rho_e^* = \frac{\rho_e + p(fail)}{1 - p(fail)} \tag{16}$$

where ρ_e is the (CAPM-based) unconditioned cost of capital and p(fail) the firm-specific bankruptcy probability. In the bankruptcy adjusted models, the bankruptcy probabilities constitute averages of estimated values of p(fail), such that e.g. the average of p(fail) for the forecast years 1, 2, and 3 is used in a three year valuation model specification. Also, we have adjusted the bankruptcy probabilities for the choice based bias associated with the sampling proportions in Skogsvik (1990).[10] This will render more unbiased estimates of bankruptcy risks, and presumably contribute to more valid assessments of the equity cost of capital.

3.3.3. Transitory items

To assess the potential distortive effects that transitory items can have in a valuation modelling context (cf. Penman, 2005; Jorgensen et al., 2011; Gao et al., 2013), we have chosen earnings measures that either include or exclude transitory items[11]. This implies that we alternatively use EPS_t *including* transitory items or *excluding* transitory items (EPS_t^{xt}). This explicitly affects (12.a) to (13). Also, it impacts our historical values of ROE_t, and hence our calculated equity values according to (10) and (11).

3.4. Valuation performance

To assess the performance of our valuation models, we use six evaluation metrics that capture valuation accuracy in terms of *precision* and *spread*. Our metrics are as follows:

- *Pricing error*: PE

  PE stands for pricing error calculated as the difference between model based equity values and the stock prices, deflated by the stock price, i.e.:

$$PE_{0,j} = \frac{V_{0,j} - P_{0,j}}{P_{0,j}} \tag{17}$$

- *Absolute pricing error*: APE

  APE is the *unsigned* pricing error (Beatty et al, 1999; Jorgensen et al, 2011), calculated as:

$$APE_{0,i} = \left| \frac{V_{0,j} - P_{0,j}}{P_{0,j}} \right| \tag{18}$$

In terms of *spread*, we focus on the standard deviation of PE, 15%APE and IQRPE. The metric 15%APE (Kim & Ritter, 1999) represents the fraction of the sample that has

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[10] Calculated in accordance with Skogsvik & Skogsvik (2013); i.e.

$$p(fail)_{POP} = p(fail)_{ES} \cdot \left[\frac{\pi \cdot (1-prop)}{prop \cdot (1-\pi) + p(fail)_{ES} \cdot (\pi - prop)}\right],$$

where $p(fail)_{ES}$ is the probability of bankruptcy predicted in the model by Skogsvik (1990), π is the (a priori) probability of bankruptcy in the population of companies (depending on the choice of forecast horizon, equal to 0.3%, 0,9%, 1.5% or 2.8% in our study), and $prop$ is the proportion of failure companies in the total estimation sample in Skogsvik (1990).

[11] The chosen data for this procedure is EPS *excluding transitory items* in the FACTSET database.

an unsigned pricing error *exceeding* 15%. IQRPE is the *inter-quartile range* of signed pricing errors (Liu, Nissim & Thomas, 2002), i.e. it measures the range between the third and first quartiles of PE.[12]

Assessing the valuation performance along precision and spread *simultaneously* is typically not a clear-cut task. Therefore we have also used a comprehensive metric that makes such comparisons feasible, the "A-score" This score considers both precision and spread by combining the mean value of APE (precision) and IQRPE (spread):[13]

$$A_{0,i} = \frac{\left[{}^{1}/_{IQRPE_{0,i}}\right]}{Mean(APE_{0,i})} \tag{19}$$

The A-score provides a summary measure of the performance of each valuation model, showing high values for low values of *mean APE* (i.e. high precision) and/or low values of IQRPE (i.e. low spread).

4. Sample selection

Our sample is collected from FACTSET, a database with historical and forecasted financial statement numbers used by investment banks, private equity funds and the financial press. The database includes large- and mid-cap companies from the five Nordic stock exchanges,[14] with a total of 303 firms. Financial firms[15] have been excluded from our sample. We have also excluded firms that lacked some of the data being required in our valuation model specifications. After these exclusions we have obtained a sample of 233 companies, mainly consisting of Swedish firms (49%). The companies are evenly distributed across business sectors, with a slight overweight of manufacturing, process, and medical technology firms. Sample statistics by business sector and country is summarized in Table 2.

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[12] For instance, if the third quartile and first quartile have PE values of 0,60 and 0,30, respectively, the IQRPE is (0,60 – 0,30) = 0,30.

[13] The relevance of the A-score hinges on the trade-off between *precision* and *spread* (Faber, 1999; Newbold, Carlson & Thorne, 2012). The rationale is that as model complexity increases, the precision typically improves but at the cost of an increased spread. The A-score captures both precision and spread, being defined as:

$$A_i = \frac{\left[{}^{1}/_{(Q_3[PE_i] - Q_1[PE_i])}\right]}{\frac{1}{n}\sum_{j=1}^{n}\left|\frac{V_j - P_j}{P_j}\right|} = \frac{\left[{}^{1}/_{IQRPE_i}\right]}{Mean(APE_i)}$$

for model i, valuation observations $j = \{1, \dots, n\}$.

[14] Nasdaq-owned stock exchanges in Denmark, Finland, Iceland, Norway, and Sweden.

[15] I.e. financial institutions, investment companies and real-estate firms.

(*TABLE 2 IN HERE*)

We have collected seven income statement numbers (i.e. *total revenue*, *earnings before interest cost and taxes* (EBIT), *interest expense*, *earnings before taxes* (EBT), *tax expense*, *net income* (NI), and *net income excluding transitory items*), and seven balance sheet numbers (i.e. *shareholders' equity*, *total assets*, *total liabilities*, *inventory*, *cash assets*, *current assets* and *current liabilities*) for all firms. We have also collected data being necessary for estimating the cost of equity capital and other model parameters[16]. FACTSET provides information about reporting and dividend payout dates. Forecasted items in the data base are analysts' median forecasts and there is information about the number of analysts covering each firm[17]. The availability of data has differed between firms and financial statement items, resulting in 590, 345, 485, and 311 firm-year observations for the RIV, PVED, AEG(3) and AEG(OJ) model specifications, respectively.

4.1. Descriptive statistics

We report median values of key variables included in our investigation in table 3. The median market cap ranges between 3 156 to 3 832 MEUR over the years 2009 - 2013, reflecting the large size of our sample firms. Historically the firms have experienced modest growth, and analysts expect the firms to grow by 4 - 6% annually towards 2018. In terms of profitability, the firms have shown a stable profitability over the historic period 2009-2013, with EBIT margins in the interval 7 - 9%. Going forward, analysts anticipate the profitability to improve towards 2018.[18] Our CAPM based costs of equity capital are in the interval 6,1% - 8,0% over the period 2009-2013. The equity capital costs for the second period 2014-2018 are the same as for 2014. One-, two-, three- and five-year annual bankruptcy risks are in general small, ranging from 0,1% (one-year) to 0,7% (five-year). Again, the bankruptcy risk for 2014 is assumed to be representative for the period 2014-2018 in all model applications.

(*TABLE 3 IN HERE*)

[16] We have thus collected 10-year treasury bond yields for Denmark, Finland, Iceland, Norway and Sweden, and dividends per share, (common) shares outstanding and stock prices.

[17] On average, each firm is covered by six brokers.

[18] The firms which have analysts' estimates until 2018 are the largest in our sample.

With regard to the value attributes of our valuation models, these clearly differ between analysts' forecasts the historically based averages. Median analysts' forecasts of ROE range between 10 - 16% over the period 2009-2013, whereas the historical median average value of ROE is 21% for this period. For the period 2014-2018, analysts' forecasts of ROE increase somewhat as compared to the historical average median value. Analysts' forecasted payout ratios are stable around 50 - 60% for both time periods. As regards the historical averages, there is a clear difference in median payout ratios over the two periods. Table 3 also includes earnings excluding transitory items, EPS_t^{xt}, and apparently median average transitory gains are positive in the analysts' forecasts all years.

5. Results

5.1. Parsimonious models

Table 4 includes results for our base (the most parsimonious) models. As indicated above, we use three measures to evaluate precision (mean PE, median PE, and mean APE) and three measures to evaluate spread (std. dev. PE, 15%APE, and IQRPE) for each model.

Table 4 shows that both the PVED and AEG(OJ) models on average overstate equity values, since the metric Mean(PE) is positive for both time periods and forecasting approaches. On the other hand, the RIV model typically appears to understate equity values as there are negative median values of Mean(PE) in all RIV specifications, whereas the accuracy of AEG(3) varies with the chosen forecast approach (overstatements of equity values with forecasts based on historical averages, but understatements with analysts' forecasts).

As regards our indicators of valuation uncertainty, we note that the spread metrics are large for all valuation models – even for the RIV model we have standard deviations of PE as large as 0,54 - 0,92, and the assessed values of 15%APE imply that between 77% and 92% of the calculated equity values deviate more than +/-15 % from stock market prices. The PVED model comes out about the same as RIV in this regard, but obviously both AEG(3) and AEG(OJ) are associated with somewhat extreme values of our spread metrics.

(***TABLE 4*** *IN HERE*)

Looking at our composite accuracy measure - the *A-score* - we can rank the models in a more clear-cut fashion. This metric indicates that the RIV model is better than all other models in both time periods and for both value driver forecasting approaches (with A-scores between 2,17 - 4,09). The PVED model performs better than both AEG models, with a highest A-score of 2,41. Comparing the two AEG models, our results are non-conclusive and we observe very low A-scores. Testing the robustness of these observations by altering the valuation date[19] and the value driver assumptions with regard to ROE,[20] we find that the valuation performance of the models in the main remains the same.

The superior valuation performance of the RIV model and its somewhat negative value bias is in line with previous research (Bernard, 1995; Penman, 1995; Penman & Sougiannis, 1998; Francis et al, 2000; Courteau et al, 2001). The strength of the model has often been attributed to its anchoring on the book value of equity. Looking specifically at the terminal values in our model applications, we find that on average 31% of the RIV model's equity value is captured by this term, whereas the terminal values of the other models capture between 90 - 95% of the equity values.[21] However, RIV's anchoring on the equity book value can also be a reason for the model's tendency to understate stock prices.

In line with Jorgensen et al (2011), we observe substantial overvaluations and spreads[22] for the AEG(3) and AEG(OJ) models. As these models include the growth of abnormal earnings, a constant growth rate creates an exponential development of the abnormal earnings growth of the last explicit forecast period. This might cause the abnormal earnings growth at the truncation date to become inflated. Given this reliance on terminal growth capitalization in the AEG models, variations in the expected future abnormal earnings growth clearly will affect our value assessments strongly.

Regarding our value driver forecasts, analysts' forecasts appear to work better than historical based estimates for the PVED and RIV models. Francis et al (2000) found that analysts' forecasts also provide more accurate valuation results than realized value attributes for the PVED and the RIV models, but we cannot really observe any robust differences of this kind when comparing our valuation results between the two periods.

5.2. Single step adjustments

In a first step, we adjust the parsimonious models as follows; i) extension of explicit forecast period *[b]*, ii) inclusion of bankruptcy risk *[c]*, and iii) exclusion of transitory

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[19] We alter the valuation date to be either the *reporting date* or *five days after* the reporting date.

[20] We test for robustness if the ROE cap is set to [$\rho_{e,j}$, 100%]; cf. Appendix 1.

[21] The PVED model 90%, the AEG model 92%, and the OJ model 95%.

[22] With, for instance std. dev. PE ranging from 12,69 - 33,90 and 9,53 - 20,81 for AEG(3) and AEG(OJ), respectively.

items *[d]*. Focusing on the A-score metric, Table 5 shows our observed scores for these single step adjusted valuation models.[23]

(*TABLE 5 IN HERE*)

Looking first at the extension of the explicit forecast period, we can see that for all model specifications but the PVED model, this adjustment generates higher A-scores when using analysts' forecasts for our value drivers. Especially the RIV model shows an improvement. The AEG(3) and AEG(OJ) models appear to follow the same pattern, however the results are less clear cut due to their low initial scores. On the other hand, when historical averages are used in these models, the A-scores actually decrease. The PVED model with historical based forecasts improves its valuation performance with extended forecast periods. Overall we note that the rankings of the models basically persists, with the exception that the PVED model with historical averages in the first evaluation period actually supersedes RIV as the best model.

Previous studies have claimed that extended model forecast periods yield better valuation accuracy (cf. Jorgensen et al., 2011). However, we find that the advantage of this model adjustment appears to depend on the combination of value driver prediction methodology and the choice of valuation model. The drawback of historical based averages is apparent in the RIV model. In the PVED model on the other hand, the martingale approach to forecast future dividends appears to suffice. This can be due to payout ratios being quite stable over time and that our historical averages capture this stability well.

Almost 80% of the tested model specifications benefit from the inclusion of bankruptcy risk[24]. More specifically, all models but the RIV model benefit from this adjustment, while RIV on average appears to be more or less unchanged.

We can also see that about half of our model specifications benefit from the exclusion of transitory items from EPS.[25] Overall, this adjustment primarily impacts the AEG(3) and AEG(OJ) models positively.

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[23] Assessed values of all evaluation metrics are provided in tables A.2.1, A.2.2 and A.2.3 in Appendix 2.

[24] This is also observed in our robustness tests with alternative valuation dates and ROE truncation limits (cf. Appendix 3).

[25] The PVED model is excluded in this comparison, as it by construction relies on EPS for the calculation of payout ratios.

5.2.1. Implications of the single step adjustments

In our assessment of the most parsimonious valuation models, we found that RIV dominates the other models. Adding the complexity adjustments of the extended forecast period, bankruptcy risk and the exclusion of transitory items, the RIV modelling advantage appears to remain. However, there are basically positive effects in valuation performance of all model specifications, suggesting gains from adding "some" complexity to the parsimonious models. Out of the 16 possible (model, value driver and time period) combinations, the adjustments for forecast period, bankruptcy risk or transitory items render improvements in 15 instances, leaving only one best performing application in its most parsimonious setup (the RIV model based on historical averages, the first time period).

The best performing single adjusted model specifications are displayed in Table 6. The RIV model displays the largest A-score improvement when extending the explicit forecast period. Furthermore, adjusting for company bankruptcy risk appears to be the most performance enhancing adjustment for the other three valuation models.

(*TABLE 6 IN HERE*)

5.3. Multiple step adjustments

Table 7 displays multiple step adjustments including 2 or 3 adjustments and their A-scores.

We observe that the model rankings in general remains the same, with the RIV model being the best model in 11 out of 16 possible test combinations and the PVED model being competitive when the value attributes are based on historical averages. Our results suggest that a distinctive majority of the valuation models are improved through multiple complexity adjustments, as compared to their most parsimonious counterparts. For example, RIV with its value attributes being predicted through analysts' forecasts is markedly improved, with A-scores of 4,09 in the parsimonious setup and 5,55 and 5,00 after full adjustments in the first and the second valuation period, respectively. Using historical based forecasts, RIV appears to be a good model in its parsimonious specification as enhancements are either nonexistent or small. The PVED model seems to improve with multiple adjustments and is most positively affected by the combination of extending the explicit forecast period [b] and the inclusion of bankruptcy risk [c]. For the AEG(3) and AEG(OJ) models, we observe marginal improvements at best.

(*TABLE 7 IN HERE*)

The [*[a] + [b] + [c]*] combination (i.e. models with extended forecast periods and bankruptcy risk adjustments) illustrates two interesting results; its positive effect on the PVED model and its positive effect for valuation models employing analysts' forecasts in general. We saw previously that the single step adjustment of extending the explicit forecast period (*[b]*) made the A-scores more uniform across the PVED model specifications. When adding bankruptcy risk (*[c]*) this effect is amplified. Presumably the extended forecast period's positive effect is due to a comparative advantage of analysts' forecasts over a longer forecast period. The improvement from the inclusion of bankruptcy risk is likely due to analysts' forecasts being conditioned on survival (cf. Skogsvik, 2006).

In Appendix 3 we include multiple step adjusted model A-scores for truncated values of ROE_t ([$\rho_{e,j}$, 100%]) and alternative valuation dates (the reporting date, or the reporting date + 5 days) as robustness tests. Our results are more or less unaffected by these alternative operationalisations.[26]

5.3.1. Implications of multiple adjustments

As summarized in Table 8, we observe clear benefits from the multiple adjustments for the best performing model combinations, where the PVED, RIV and AEG models all gain from such adjustments. The table also shows that the rankings of the models remain, with the RIV model in combination with analysts' forecasts providing the highest A-score (5,33). Having access to analysts' forecasts, extending the explicit forecast period (5 years instead of 3) and incorporating bankruptcy risk in the discounting rate, implies an improvement of +30% as compared to the parsimonious RIV model specification.

In a setting without analysts' forecasts, multiple adjusted variants of the RIV and PVED models appear to perform similarly (A-scores of 2,98 and 2,88 respectively). It is striking that the PVED model gains substantially (+82%) from extending the forecast period and incorporating bankruptcy risk in the discounting rate, while the gain for the RIV model is rather trivial (+ 2%). The AEG(3) and AEG(OJ) models perform poorly both in their parsimonious and multiple step adjusted versions. Adjustments for bankruptcy risk and transitory items generate modest relative improvements to the average A-scores when using forecasts based on historical averages. When analysts'

[26] Cf. tables A.3.1, A.3.2 and A.3.3 in Appendix 3.

forecasts are available, extending the explicit forecast period contributes to improvements for both AEG models, but without attaining any commendable A-scores.

(*TABLE 8 IN HERE*)

6. Summary and concluding remarks

Previous literature has indicated that complexity adjustments to accounting based fundamental valuation models can increase the valuation performance of such models. Because of this expected increase in performance of complexity adjustments, equity investors should benefit from an empirical investigation focused on how different types of such adjustments can affect the valuation accuracy of commonly used equity valuation models.

We have investigated the performance of PVED, RIV and AEG modelling under uniform assumptions and two recent time periods to assess the accuracy of parsimonious and complexity adjusted models. Using an accuracy measure that considers both precision and spread when comparing the most parsimonious models, we find that RIV dominates the other valuation approaches, that PVED comes second and that the AEG models perform weakly. In line with Penman (2005; 2012) we believe that the superiority of the RIV model depends on its anchoring on a stable equity book value, whereas the weak results of the AEG models appear to be due to their comparatively large and sensitive truncation values (contributing with 90-95% of the calculated equity values). For both AEG models the truncation values are strongly affected by the long run book return (ROE) forecasts, which have a strong impact on the development of the abnormal earnings growth measure.

Investigating the effect of complexity adjustments to the parsimonious models has been carried out in two steps, where first adjustments of the explicit forecast period, bankruptcy risk, and transitory income items have been done one at the time. In a second step, we have investigated the effect from combining all complexity adjustments. As regards the single-adjusted valuation models, our adjustments typically contribute to increased valuation performance. For example, extending the explicit forecast period clearly benefits the RIV model when analysts' forecasts of the value drivers are available. The inclusion of bankruptcy risk increased the valuation performance of nearly all model specifications. Notably, all top performing model specifications incorporated one or several complexity adjustment.

Regarding the multi-adjusted valuation models, the performance rankings are in line with those for the single-adjusted models. The adjustments that contributed the most to the valuation accuracy were the extension of the explicit forecast period and the inclusion of bankruptcy risk. Given that analysts' forecasts are unavailable, in particular the PVED model benefits strongly from these two adjustments. Given access to analysts' forecasts, the RIV model also appear to benefit substantially from these adjustments.

Depending on whether analysts' forecasts are available, our results allow for the following guidelines:

- If analysts' forecasts are *unavailable*, the parsimonious RIV model together with the PVED model adjusted for a *longer explicit forecast period* and *bankruptcy risk*, perform about equally well. The RIV model might be marginally improved in a setting of this kind with adjustments for bankruptcy risk and transitory items in earnings.
- If analysts' forecasts are *available*, the *RIV* model adjusted for a *longer explicit forecast period* and *bankruptcy risk* generates the highest valuation accuracy.

Being able to make all complexity adjustments, our empirical findings indicate that the RIV model is superior if analysts' forecasts are available, but that RIV and PVED perform about equally well if only historical financial data is available. Our general conclusion is hence that the RIV model appears to provide for the most versatile and accurate parsimonious equity valuation approach for the Scandinavian capital market.

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Tables to insert

[Table 1]

Table 1. Previous Empirical Research.

The table includes a summary of model specifications, estimation of value drivers and assessment of valuation performance in previous research. *RIV* refers to the Residual Income Valuation model, *PVED* to the Dividend Discount model, *DCF* to the Discounted Cash Flow model, *CapEarn* to the Capitalized Earnings Model, *AEG* to the Abnormal Earnings Growth Model, and *PEG* to a variant of the Abnormal Earnings Growth model. (...*Y*) refers to the number of years that are explicitly forecasted, and *V/P-ratio* is the Value-to-Price ratio.

Author/-s	*Sample*	*Models specification*	*Estimation of value driver/-s*	*Performance assessment*	*Findings*
Penman & Sougiannis (1995)	U.S 1973-1992	-RIV (1,2,3,6,8,10Y) excl./incl. term values -PVED (1,2,3,6,8,10Y) excl./incl. term values -DCF (1,2,3,6,8,10Y) excl./incl. term values -CapEarn (1,2,3,6,8,10Y) excl./incl. term values	-Ex-post realized values	-Portfolio valuation bias	-RIV and CapEarn dominate in general. -RIV dominates all but two horizons (6 and 10Y). -Inclusion of terminal values did not change performance ranking.
Francis, Oswald & Olsson (2000)	U.S 1989-1993	-RIV (5Y) incl. term value -PVED (5Y) incl. term value -DCF (5Y) incl. term value	-Analysts' forecasts -Ex-post realized values	-Unsigned pricing errors -Univariate and multivariate regressions	-RIV dominates DCF and PVED. -Smaller pricing errors with analysts' forecasts.
Penman (2005)	U.S 1975-2002	-RIV (2Y) incl. term value -AEG (2Y) incl. term value	-Analysts' forecasts	-V/P-ratio	-RIV dominates AEG. -V/P spread smaller for RIV.
Jorgensen, Lee & Yoo (2011)	U.S 1984-2005	-RIV(IT) (2,5Y) incl. term values -RIV(CT) (2,5Y) incl. term values -RIV(GT) (2,5Y) incl. term values -AEG (2,5Y) incl. term values -PEG (2,5Y) incl. term values	-Analysts' forecasts	-V/P-ratio -Unsigned pricing error	-RIV and PEG dominate AEG. -Longer explicit forecast period benefit AEG and PEG, but not RIV. -AEG and PEG overvaluations.
Chang, Landsman & Monahan (2012)	U.S 1980-2010	-RIV (1Y) -RIV (5Y) incl. term value -RIV(15Y) incl. term value -AEG (1Y) -AEG (5Y) incl. term value -AEG (15Y) incl. term value	-Analysts' forecasts	-Unsigned pricing errors -Signed pricing error -Accuracy ranks	-RIV best on average. -AEG best for median firm. -Non-stable results for AEG (15Y), RIV(1Y) and AEG (15Y).

[Table 2]

Table 2. Sample of Scandinavian firms.

Industry sector	*No. of firms*	*% of total sample*
Producer Manufacturing	37	16%
Health Technology	27	12%
Process Industries	21	9%
Energy (excl. Energy Minerals)	20	9%
Consumer Non-Durables	14	6%
Industrial Services	13	6%
Electronic Technology	12	5%
Retail Trade	12	5%
Transportation	12	5%
Consumer Services	11	5%
Commercial Services	10	4%
Consumer Durables	10	4%
Energy Minerals	9	4%
Technology Services	9	4%
Communications	7	3%
Distribution Services	7	3%
Utilities	2	1%
Total:	**233**	**100%**

Country	*No. of firms*	*% of total sample*
Sweden	114	49%
Denmark	52	22%
Finland	35	15%
Norway	21	9%
Iceland	11	5%
Total:	**233**	**100%**

[Table 3]

Table 3. Sample statistics.

The table shows yearly *median* values for the variables of the study. Model based equity values are estimated in 2009 and 2014. Analysts' forecasts for 2009-2013 have been operationalized as ex post realized values, whereas analysts' median forecasts have been used 2014-2018. *BVPS* is book value per share, *EPS* earnings per share, EPS^{xt} earnings per share excluding transitory items, *DPS* dividend per share, *ROE* book return on owners equity, and *pr* the payout ratio.

Year t	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
Market cap (MEUR)	3 213	3 823	3 156	3 431	3 832	n.a	n.a	n.a	n.a	n.a
Sales (MEUR)	3 998	4 033	4 353	4 587	4 562	4 892	5 379	5 865	5 599	16 048
$EBIT_t$ (MEUR)	208	341	369	289	388	435	524	584	929	2122
$Margin_t$	7%	9%	9%	8%	8%	9%	10%	12%	14%	20%
Beta (βe)	0,86	0,85	0,81	0,79	0,80	0,83	0,83	0,83	0,83	0,83
CAPM cost of capital	8,0%	7,3%	6,7%	6,1%	6,7%	5,7%	5,7%	5,7%	5,7%	5,7%
Risk-free rate	3,2%	2,7%	2,1%	1,5%	2,3%	1,2%	1,2%	1,2%	1,2%	1,2%
One-year bankruptcy risk	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Two-year bankruptcy risk	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%
Three-year bankruptcy risk	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%
Five-year bankruptcy risk	0,6%	0,7%	0,6%	0,7%	0,6%	0,6%	0,6%	0,6%	0,6%	0,6%
Value driver forecasting:										
Analysts' forececasts:										
$BVPS_t$ (EUR)	23	25	26	26	26	27	30	33	35	45
EPS_t (EUR)	2,9	4,0	3,6	3,6	3,7	4,0	4,8	5,7	5,6	6,0
EPS^{xt}_t (EUR)	2,4	3,8	3,5	3,4	3,4	3,9	4,7	5,4	5,7	5,9
DPS_t (EUR)	1,5	2,0	2,5	2,3	2,6	2,5	3,0	3,1	4,2	4,8
ROE_t	10%	16%	14%	13%	13%	15%	17%	18%	17%	18%
pr_t	50%	54%	53%	57%	60%	57%	51%	50%	53%	51%
Historical averages:										
$BVPS_t$ (EUR)	25	29	31	37	42	27	29	30	29	37
EPS_t (EUR)	4,7	5,4	6,2	7,1	8,0	6,8	4,4	4,7	4,8	3,9
EPS^{xt}_t (EUR)	5,4	5,4	6,1	6,7	7,9	5,7	4,1	4,4	4,5	4,5
DPS_t (EUR)	1,4	1,9	1,9	1,9	1,6	2,9	3,3	3,8	2,7	3,5
ROE_t	21%	21%	21%	21%	21%	15%	15%	15%	15%	15%

[Table 4]

Table 4. Valuation Results: Parsimonious models.

The table shows valuation accuracy measures for the PVED, RIV, AEG(3) and AEG(OJ) models. *PE* is the signed pricing error, *APE* the absolute pricing error, *15%APE* the proportion of observations whose absolute pricing errors is more than 15%, *IQRPE* the inter-quartile range of pricing errors, and *A-score* the inverse of IQRPE divided by MAPE.

Model	*Year*	*Value driver prediction*	*Mean PE*	*Median PE*	*Std. dev. PE*	*Mean APE*	*15% APE*	*IQRPE*	*A-score*	*Firm-year obs.*
PVED	2009	Analysts' forecast	0,19	0,03	0,86	0,54	0,78	0,78	2,36	351
PVED	2009	Historical average	0,17	-0,08	0,91	0,63	0,85	0,88	1,80	339
PVED	2014	Analysts' forecast	0,23	0,08	0,72	0,53	0,79	0,78	2,41	477
PVED	2014	Historical average	0,39	0,29	0,89	0,69	0,85	1,06	1,37	432
RIV	2009	Analysts' forecast	-0,11	-0,25	0,54	0,42	0,79	0,59	4,09	546
RIV	2009	Historical average	0,17	-0,04	0,92	0,58	0,77	0,80	2,17	567
RIV	2014	Analysts' forecast	-0,29	-0,40	0,71	0,53	0,90	0,46	4,09	651
RIV	2014	Historical average	-0,31	-0,47	0,61	0,56	0,92	0,49	3,68	651
AEG(3)	2009	Analysts' forecast	-0,14	-0,10	12,69	5,58	0,88	4,93	0,04	621
AEG(3)	2009	Historical average	10,32	2,68	33,90	10,40	0,93	5,79	0,02	405
AEG(3)	2014	Analysts' forecast	-6,70	-0,53	17,31	11,93	0,97	17,65	0,00	657
AEG(3)	2014	Historical average	5,59	1,16	19,85	5,74	0,91	3,26	0,05	378
AEG(OJ)	2009	Analysts' forecast	3,57	1,41	20,81	8,13	0,92	5,70	0,02	211
AEG(OJ)	2009	Historical average	3,43	1,21	9,53	3,68	0,91	3,51	0,08	176
AEG(OJ)	2014	Analysts' forecast	6,99	3,19	19,58	9,36	0,98	5,76	0,02	220
AEG(OJ)	2014	Historical average	3,20	0,57	12,56	3,48	0,89	2,25	0,13	185

[Table 5]

Table 5. Results: A-scores after single-adjustment.

The table shows *A-scores* for the PVED, RIV, AEG(3) and OJ models. A-scores are calculated for each adjustment, where the adjustments are added one at the time to the parsimounious models. Underlined A-scores highlight the best outcome for each forecast method and valuation year. [a] denotes parsimonious model specifications, [b] model specifications where the forecast period is extended to 5 years for PVED, RIV and AEG(3) and to 2 years for AEG(OJ), [c] model specifications adjusted for bankruptcy risk in the cost of capital, and [d] model specifications where tranistory items have been excluded from EPS.

			Adjustment			
Model	*Year*	*Value driver prediction*	*Parsimonious [a]*	*Extend period [b]*	*Bankruptcy [c]*	*Transitory items [d]*
PVED	2009	Analysts' forecast	2,36	2,20	**2,58**	2,36
PVED	2009	Historical average	1,80	**2,03**	1,83	1,80
PVED	2014	Analysts' forecast	2,41	2,38	**2,57**	2,41
PVED	2014	Historical average	1,37	**2,49**	1,64	1,37
RIV	2009	Analysts' forecast	4,09	**5,16**	4,07	4,31
RIV	2009	Historical average	2,17	1,23	2,18	**2,35**
RIV	2014	Analysts' forecast	4,09	**5,12**	4,12	4,07
RIV	2014	Historical average	**3,68**	3,53	3,49	3,67
AEG(3)	2009	Analysts' forecast	0,04	0,05	0,04	**0,06**
AEG(3)	2009	Historical average	0,02	0,00	0,02	**0,03**
AEG(3)	2014	Analysts' forecast	0,00	0,00	**0,01**	0,00
AEG(3)	2014	Historical average	0,05	0,01	**0,06**	0,05
AEG(OJ)	2009	Analysts' forecast	0,02	0,03	0,01	**0,03**
AEG(OJ)	2009	Historical average	0,08	0,05	0,09	**0,10**
AEG(OJ)	2014	Analysts' forecast	0,02	**0,05**	0,02	0,02
AEG(OJ)	2014	Historical average	0,13	0,09	**0,14**	0,10

[Table 6]

Table 6. Best performing single adjusted valuation models.

The table shows the best performing model specifications as measured by the A-score after single adjustments.

			A-score	
Model	*Value driver prediction*	*Adjustment*	*Before adj.*	*After adj.*
PVED	Analysts' forecast	Bankruptcy [c]	2,41	2,58
RIV	Analysts' forecast	Extended period [b]	4,09	5,16
AEG(3)	Historical average	Bankruptcy [c]	0,05	0,06
AEG(OJ)	Historical average	Bankruptcy [c]	0,13	0,14

[Table 7]

Table 7. Valuation Results - A-scores after multiple adjustments.
The table shows A-scores for the parsimonious and multiple adjusted PVED, RIV, AEG(3) and AEG(OJ) models, where underlined A-scores highlight the best outcome for each forecast method and valuation year. [a] denotes parsimonious model specifications, [b] model specifications where the forecast period is extended to 5 years for PVED, RIV and AEG(3) and to 2 years for AEG(OJ), [c] model specifications adjusted for bankruptcy risk in the cost of capital, and [d] model specifications where tranistory items have been excluded from EPS.

			Parsimonious	**Multiple adjustments**			
Model	*Year*	*Value driver prediction*	*[a]*	*[b] + [c]*	*[b] + [d]*	*[c] + [d]*	*[b] + [c] + [d]*
PVED	2009	Analysts' forecast	2,36	2,58	2,20	2,58	2,58
PVED	2009	Historical average	1,80	**2,52**	2,03	1,83	2,52
PVED	2014	Analysts' forecast	2,41	**3,07**	2,38	2,57	3,07
PVED	2014	Historical average	1,37	**3,24**	2,49	1,64	3,24
RIV	2009	Analysts' forecast	4,09	5,38	5,34	4,26	**5,55**
RIV	2009	Historical average	2,17	1,34	1,37	**2,35**	1,46
RIV	2014	Analysts' forecast	4,09	**5,28**	4,72	4,08	5,00
RIV	2014	Historical average	**3,68**	3,02	3,67	3,60	3,16
AEG(3)	2009	Analysts' forecast	0,04	0,07	0,06	0,06	**0,09**
AEG(3)	2009	Historical average	0,02	0,01	0,01	**0,03**	0,01
AEG(3)	2014	Analysts' forecast	0,00	**0,01**	0,00	0,00	0,01
AEG(3)	2014	Historical average	0,05	0,04	0,01	0,05	0,02
AEG(OJ)	2009	Analysts' forecast	0,02	0,01	**0,06**	0,02	0,04
AEG(OJ)	2009	Historical average	0,08	0,06	0,07	**0,11**	0,07
AEG(OJ)	2014	Analysts' forecast	0,02	**0,06**	0,04	0,02	0,06
AEG(OJ)	2014	Historical average	0,13	0,11	0,07	0,12	0,08

[Table 8]

Table 8. Best performing model specifications.
The table shows the best performing model specifications as measured by the A-score, after (single or multiple) adjustments.

Model	*Value driver prediction*	*Adjustments*	*Average A-score for -09 and -14 samples*	*A-score improvement vs. parsimonious model*
PVED	Historical average	*[b] + [c]*	2,88	82%
	Analysts' forecast	*[b] + [c]*	2,83	18%
RIV	Historical average	*[c] + [d]*	2,98	2%
	Analysts' forecast	*[b] + [c]*	5,33	30%
AEG(3)	Historical average	*[c] + [d]*	0,04	14%
	Analysts' forecast	*[b] + [c] + [d]*	0,05	150%
AEG(OJ)	Historical average	*[c] + [d]*	0,12	10%
	Analysts' forecast	*[b] + [d]*	0,05	150%

8. Appendix

Appendix 1: Non-adjusted parsimonious model specifications

[Table A.1]

Table A.1. Valuation Results - Parsimonious models with ROE truncation in the interval [ρ(e), 100%].
The table shows valuation accuracy measures for the PVED, RIV, AEG(3) and AEG(OJ) models. *PE* is the signed pricing error, *APE* is the absolute pricing error, *15%APE* is the proportion of observations whose absolute pricing errors is more than 15%, *IQRPE* is the inter-quartile range of pricing errors, and *A-score* is the inverse of IQRPE divided by MAPE.

Model	*Period*	*Value driver predicition*	*Mean PE*	*Median PE*	*Std. dev. PE*	*Mean APE*	*15% APE*	*IQRPE*	*A-score*	*Firm-year obs.*
PVED	2009-2011	Analysts' forcast	0,19	0,03	0,86	0,54	0,78	0,78	2,36	351
PVED	2009-2011	Historical average	0,17	-0,08	0,91	0,63	0,85	0,88	1,80	339
PVED	2014-2016	Analysts' forcast	0,23	0,08	0,72	0,53	0,79	0,78	2,41	477
PVED	2014-2016	Historical average	0,39	0,29	0,89	0,69	0,85	1,06	1,37	432
RIV	2009-2011	Analysts' forcast	-0,11	-0,25	0,54	0,42	0,79	0,59	4,09	546
RIV	2009-2011	Historical average	0,21	-0,02	0,97	0,61	0,79	0,83	1,98	567
RIV	2014-2016	Analysts' forcast	-0,29	-0,40	0,71	0,53	0,90	0,46	4,09	651
RIV	2014-2016	Historical average	-0,27	-0,45	0,71	0,58	0,92	0,50	3,43	651
AEG(3)	2009-2011	Analysts' forcast	-0,14	-0,10	12,69	5,58	0,88	4,93	0,04	621
AEG(3)	2009-2011	Historical average	9,64	2,28	32,69	9,73	0,92	5,28	0,02	438
AEG(3)	2014-2016	Analysts' forcast	-6,70	-0,53	17,31	11,93	0,97	17,65	0,00	657
AEG(3)	2014-2016	Historical average	4,67	0,95	17,62	4,89	0,89	3,41	0,06	486
AEG(OJ)	2009-2010	Analysts' forcast	3,57	1,41	20,81	8,13	0,92	5,70	0,02	211
AEG(OJ)	2009-2010	Historical average	3,22	1,19	9,15	3,46	0,90	3,40	0,08	193
AEG(OJ)	2014-2015	Analysts' forcast	6,99	3,19	19,58	9,36	0,98	5,76	0,02	220
AEG(OJ)	2014-2015	Historical average	3,07	0,50	11,65	3,35	0,88	2,82	0,11	218

Appendix 2: Single-adjusted parsimonious model specifications

[Table A.2.1]

Table A.2.1. Valuation Results - Models with extended forecast periods [b].
The table shows valuation accuracy measures for the PVED, RIV, AEG(3) and AEG(OJ) models adjusted for extended forecast periods [b]. *PE* is the signed pricing error, *Mean APE* is the mean absolute pricing error, *15%APE* is the proportion of observations whose absolute pricing errors is more than 15%, *IQRPE* is the inter-quartile range of pricing errors, and *A-score* is the inverse of IQRPE divided by MAPE.

Model	*Period*	*Value driver prediction*	*Mean PE*	*Median PE*	*Std. Dev PE*	*Mean APE*	*15% APE*	*IQRPE*	*A-score*	*Firm-year obs.*
PVED	2009-2013	Analysts' forecast	0,16	0,03	0,69	0,53	0,80	0,86	2,20	555
PVED	2009-2013	Historical average	0,03	-0,10	0,76	0,56	0,84	0,88	2,03	535
PVED	2014-2018	Analysts' forecast	0,12	0,03	0,73	0,50	0,86	0,84	2,38	175
PVED	2014-2018	Historical Average	0,21	0,14	0,66	0,51	0,73	0,78	2,49	185
RIV	2009-2013	Analysts' forecast	-0,12	-0,21	0,51	0,39	0,76	0,50	5,16	890
RIV	2009-2013	Historical average	0,55	0,19	1,98	0,89	0,85	0,92	1,23	930
RIV	2014-2018	Analysts' forecast	-0,37	-0,39	0,57	0,45	0,83	0,44	5,12	415
RIV	2014-2018	Historical Average	-0,28	-0,42	0,57	0,52	0,88	0,55	3,53	645
AEG(3)	2009-2013	Analysts' forecast	1,90	0,64	13,03	5,19	0,91	4,19	0,05	1020
AEG(3)	2009-2013	Historical average	27,46	3,59	108,30	27,52	0,94	8,67	0,00	635
AEG(3)	2014-2018	Analysts' forecast	-9,50	-10,84	12,13	11,21	0,97	17,98	0,00	175
AEG(3)	2014-2018	Historical Average	12,61	1,98	54,76	12,65	0,92	5,27	0,01	180
AEG(OJ)	2009-2011	Analysts' forecast	0,92	0,12	15,09	6,64	0,92	5,55	0,03	424
AEG(OJ)	2009-2011	Historical average	4,89	1,34	16,23	5,13	0,90	3,78	0,05	352
AEG(OJ)	2014-2016	Analysts' forecast	4,77	2,40	7,91	5,05	0,97	4,29	0,05	440
AEG(OJ)	2014-2016	Historical Average	4,10	0,53	17,69	4,38	0,91	2,43	0,09	370

[Table A.2.2]

Table A.2.2. Valuation Results - Models with bankruptcy risk adjusted cost of capital [c].
The table shows valuation accuracy measures for the PVED, RIV, AEG(3) and AEG(OJ) models adjusted for bankruptcy risk [c]. *PE* is the signed pricing error, *Mean APE* is the mean absolute pricing error, *15%APE* is the proportion of observations whose absolute pricing errors is more than 15%, *IQRPE* is the inter-quartile range of pricing errors, and *A-score* is the inverse of IQRPE divided by MAPE.

Model	*Period*	*Value driver prediction*	*Mean PE*	*Median PE*	*Std. Dev PE*	*Mean APE*	*15% APE*	*IQRPE*	*A-score*	*Firm-year obs.*
PVED	2009-2011	Analysts' forecast	0,15	-0,04	0,85	0,53	0,75	0,72	2,58	351
PVED	2009-2011	Historical average	0,13	-0,14	0,89	0,62	0,88	0,88	1,83	339
PVED	2014-2016	Analysts' forecast	0,17	0,02	0,70	0,51	0,79	0,77	2,57	477
PVED	2014-2016	Historical average	0,33	0,18	0,86	0,65	0,81	0,94	1,64	432
RIV	2009-2011	Analysts' forecast	-0,11	-0,25	0,54	0,42	0,80	0,59	4,07	546
RIV	2009-2011	Historical average	0,16	-0,04	0,92	0,58	0,76	0,80	2,18	567
RIV	2014-2016	Analysts' forecast	-0,28	-0,39	0,71	0,53	0,88	0,46	4,12	651
RIV	2014-2016	Historical average	-0,27	-0,43	0,65	0,55	0,91	0,52	3,49	651
AEG(3)	2009-2011	Analysts' forecast	-0,15	-0,13	12,52	5,36	0,87	4,61	0,04	621
AEG(3)	2009-2011	Historical average	9,73	2,41	32,43	9,81	0,93	5,45	0,02	405
AEG(3)	2014-2016	Analysts' forecast	-6,20	-0,52	15,93	11,03	0,97	17,20	0,01	657
AEG(3)	2014-2016	Historical average	5,20	1,05	18,40	5,36	0,90	3,30	0,06	378
AEG(OJ)	2009-2010	Analysts' forecast	3,15	1,31	17,77	17,77	0,91	5,54	0,01	211
AEG(OJ)	2009-2010	Historical average	3,23	1,18	9,18	3,48	0,90	3,38	0,09	176
AEG(OJ)	2014-2015	Analysts' forecast	5,90	2,90	17,10	8,10	0,98	5,34	0,02	220
AEG(OJ)	2014-2015	Historical average	2,96	0,52	11,94	3,25	0,95	2,16	0,14	185

[Table A.2.3]

Table A.2.3. Valuation Results - Models with adjustments for transitory items [d].

The table shows valuation accuracy measures for the PVED, RIV, AEG(3) and AEG(OJ) models adjusted for transitory items. *PE* is the signed pricing error, *Mean APE* is the mean absolute pricing error, *15%APE* is the proportion of observations whose absolute pricing errors is more than 15%, *IQRPE* is the inter-quartile range of pricing errors, and *A-score* is the inverse of IQRPE divided by MAPE.

Model	*Period*	*Value driver prediction*	*Mean PE*	*Median PE*	*Std. Dev PE*	*Mean APE*	*15% APE*	*IQRPE*	*A-score*	*Firm-year obs.*
PVED	2009-2011	Analysts' forecast	0,19	0,03	0,86	0,54	0,78	0,78	2,36	351
PVED	2009-2011	Historical average	0,17	-0,08	0,91	0,63	0,85	0,88	1,80	339
PVED	2014-2016	Analysts' forecast	0,23	0,08	0,72	0,53	0,79	0,78	2,41	477
PVED	2014-2016	Historical average	0,39	0,29	0,89	0,69	0,85	1,06	1,37	432
RIV	2009-2011	Analysts' forecast	-0,10	-0,23	0,54	0,41	0,79	0,57	4,31	546
RIV	2009-2011	Historical average	0,12	-0,06	0,86	0,55	0,77	0,77	2,35	546
RIV	2014-2016	Analysts' forecast	-0,29	-0,40	0,71	0,53	0,91	0,46	4,07	651
RIV	2014-2016	Historical average	-0,30	-0,46	0,67	0,57	0,92	0,48	3,67	630
AEG(3)	2009-2011	Analysts' forecast	-0,05	-0,01	7,14	4,19	0,89	4,29	0,06	591
AEG(3)	2009-2011	Historical average	7,69	2,26	22,38	7,76	0,93	4,85	0,03	405
AEG(3)	2014-2016	Analysts' forecast	-9,16	-7,74	16,85	13,39	0,96	18,89	0,00	642
AEG(3)	2014-2016	Historical average	6,73	1,16	35,10	6,89	0,89	2,91	0,05	408
AEG(OJ)	2009-2010	Analysts' forecast	3,01	1,67	10,24	5,67	0,91	5,19	0,03	200
AEG(OJ)	2009-2010	Historical average	2,92	1,10	7,19	3,16	0,92	3,30	0,10	175
AEG(OJ)	2014-2015	Analysts' forecast	7,01	3,17	20,03	9,45	0,99	5,95	0,02	215
AEG(OJ)	2014-2015	Historical average	3,53	0,72	14,99	3,77	0,88	2,63	0,10	186

Appendix 3: Multi-adjusted parsimonious model specifications (100% & ρ_e) and valuation dates (0 and +5 days)

[Table A.3.1]

Table A.3.1. Valuation Results - A-scores after multiple adjustments and ROE truncation.
The table shows A-scores for the parsimonious and multiple adjusted PVED, RIV, AEG(3) and AEG(OJ) models when ROE is truncated in the interval [ρ (e), 100%], where underlined A-scores highlight the best outcome for each forecast method and valuation year. [a] denotes parsimonious model specifications, [b] model specifications where the forecast period is extended to 5 years for PVED, RIV and AEG(3) and to 2 years for AEG(OJ), [c] model specifications adjusted for bankruptcy risk in the cost of capital, and [d] model specifications where tranistory items have been excluded from EPS.

			Parsimonious		**Multiple adjustments**		
Model	*Year*	*Value driver prediction*	*[a]*	*[b] + [c]*	*[b] + [d]*	*[c] + [d]*	*[b] + [c] + [d]*
PVED	2009	Analysts' forecast	2,36	2,58	2,20	**2,58**	2,58
PVED	2009	Historical average	1,80	**2,52**	2,03	1,83	2,52
PVED	2014	Analysts' forecast	2,41	**3,07**	2,38	2,57	3,07
PVED	2014	Historical average	1,37	**3,24**	2,49	1,64	3,24
RIV	2009	Analysts' forecast	4,09	5,38	5,34	4,26	**5,55**
RIV	2009	Historical average	1,98	1,24	1,28	**2,19**	1,35
RIV	2014	Analysts' forecast	4,09	**5,28**	4,72	4,08	5,00
RIV	2014	Historical average	3,43	2,91	**3,50**	3,33	3,10
AEG(3)	2009	Analysts' forecast	0,04	0,07	0,06	0,06	**0,09**
AEG(3)	2009	Historical average	0,02	0,01	0,01	**0,03**	0,01
AEG(3)	2014	Analysts' forecast	0,00	**0,01**	0,00	0,00	0,01
AEG(3)	2014	Historical average	0,06	0,04	0,01	0,06	0,02
AEG(OJ)	2009	Analysts' forecast	0,02	0,01	**0,06**	0,02	0,04
AEG(OJ)	2009	Historical average	0,08	0,06	0,08	**0,12**	0,09
AEG(OJ)	2014	Analysts' forecast	0,02	**0,06**	0,04	0,02	0,06
AEG(OJ)	2014	Historical average	0,11	0,10	0,07	0,11	0,08

[Table A.3.2]

Table A.3.2. Valuation Results - A-scores after multiple adjustments and valuation date = reporting date.

The table shows A-scores for the parsimonious and multiple adjusted PVED, RIV, AEG(3) and AEG(OJ) models when the valuation date coincedes with the reporting date, where underlined A-scores highlight the best outcome for each forecast method and valuation year. [a] denotes parsimonious model specifications, [b] model specifications where the forecast period is extended to 5 years for PVED, RIV and AEG(3) and to 2 years for AEG(OJ), [c] model specifications adjusted for bankruptcy risk in the cost of capital, and [d] model specifications where tranistory items have been excluded from EPS.

			Parsimonious	**Multiple adjustments**			
Model	*Year*	*Value driver prediction*	*[a]*	*[b] + [c]*	*[b] + [d]*	*[c] + [d]*	*[b] + [c] + [d]*
PVED	2009	Analysts' forecast	2,50	2,59	2,24	**2,66**	2,59
PVED	2009	Historical average	1,76	**2,57**	1,86	2,20	2,35
PVED	2014	Analysts' forecast	2,41	**3,08**	2,38	2,57	**3,08**
PVED	2014	Historical average	1,37	**3,24**	2,10	1,83	2,61
RIV	2009	Analysts' forecast	4,12	5,02	5,24	4,16	**5,45**
RIV	2009	Historical average	2,11	1,37	1,38	2,27	1,46
RIV	2014	Analysts' forecast	4,09	**5,28**	4,72	4,08	5,00
RIV	2014	Historical average	**3,68**	3,02	3,66	3,60	3,16
AEG(3)	2009	Analysts' forecast	0,04	0,07	0,06	0,06	**0,09**
AEG(3)	2009	Historical average	0,02	0,01	0,01	**0,03**	0,01
AEG(3)	2014	Analysts' forecast	0,00	**0,01**	0,00	0,00	0,01
AEG(3)	2014	Historical average	0,05	0,04	0,01	0,05	0,02
AEG(OJ)	2009	Analysts' forecast	0,02	0,01	**0,03**	0,02	0,03
AEG(OJ)	2009	Historical average	0,08	0,06	0,05	**0,11**	0,07
AEG(OJ)	2014	Analysts' forecast	0,02	**0,07**	0,05	0,02	0,06
AEG(OJ)	2014	Historical average	0,13	0,11	0,09	0,12	0,08

[Table A.3.3]

Table A.3.3. Valuation Results - A-scores after multiple adjustments and valuation = reporting date + 5.

The table shows A-scores for the parsimonious and multiple adjusted PVED, RIV, AEG(3) and AEG(OJ) models when the valuation date is five days after the reporting date, where underlined A-scores highlight the best outcome for each forecast method and valuation year. [a] denotes parsimonious model specifications, [b] model specifications where the forecast period is extended to 5 years for PVED, RIV and AEG(3) and to 2 years for AEG(OJ), [c] model specifications adjusted for bankruptcy risk in the cost of capital, and [d] model specifications where tranistory items have been excluded from EPS.

			Parsimonious		**Multiple adjustments**		
Model	*Year*	*Value driver prediction*	*[a]*	*[b] + [c]*	*[b] + [d]*	*[c] + [d]*	*[b] + [c] + [d]*
PVED	2009	Analysts' forecast	2,34	2,56	2,21	**2,69**	2,56
PVED	2009	Historical average	1,82	**2,54**	1,87	2,15	2,31
PVED	2014	Analysts' forecast	2,41	**3,07**	2,37	2,57	3,07
PVED	2014	Historical average	1,37	**3,24**	2,09	1,83	2,60
RIV	2009	Analysts' forecast	4,08	5,46	5,38	4,18	**5,66**
RIV	2009	Historical average	2,17	1,37	1,36	**2,33**	1,44
RIV	2014	Analysts' forecast	4,09	**5,28**	4,72	4,07	5,00
RIV	2014	Historical average	**3,68**	3,02	3,67	3,60	3,16
AEG(3)	2009	Analysts' forecast	0,04	0,07	0,06	0,06	**0,09**
AEG(3)	2009	Historical average	0,02	0,01	0,01	**0,03**	0,01
AEG(3)	2014	Analysts' forecast	0,00	**0,01**	0,00	0,00	0,01
AEG(3)	2014	Historical average	0,05	0,04	0,01	0,05	0,02
AEG(OJ)	2009	Analysts' forecast	0,02	0,01	**0,05**	0,02	0,04
AEG(OJ)	2009	Historical average	0,08	0,06	0,07	**0,11**	0,07
AEG(OJ)	2014	Analysts' forecast	0,02	**0,06**	0,04	0,02	0,06
AEG(OJ)	2014	Historical average	0,13	0,11	0,07	0,12	0,08