Extended Dividend, Cash Flow and Residual Income Valuation Models - Accounting for Deviations from Ideal Conditions

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Abstract

Standard equity valuation approaches (i.e., DDM, RIM, and DCF) are based on restrictive assumptions regarding the availability and quality of payoff data. Therefore, we provide extensions of the standard approaches being suitable under less than ideal conditions (e.g. dirty surplus accounting and inconsistent steady state growth rates). Empirically, our extended models yield considerably smaller valuation errors, suggesting that the models are worthwhile to implement. Moreover, obtaining identical value estimates across the extended models, our approach provides a benchmark implementation. This allows us to quantify the magnitude of errors resulting from individual violations of ideal conditions in the standard approaches.

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1 Introduction

The most widely used equity valuation approaches, i.e., the dividend discount model (DDM), the residual income model (RIM) and discounted cash flow model (DCF), rest on rather restrictive assumptions. In particular, they require clean surplus accounting and payoff projections for infinite horizons. Such ideal valuation conditions are almost never given, neither in practice nor in empirical research. Therefore, we extend the three standard models to account for typically encountered deviations from ideal valuation conditions. Basically, we derive correction terms, which capture differences between ideal and real data. The extended models yield two major advantages: First, the proposed models generate considerably smaller valuation errors, suggesting that market prices are explained much better if deviations from ideal conditions are taken into account. Second, the extended models provide a benchmark since they yield identical valuation results under ideal as well as non-ideal conditions. This benchmark allows us to analyze to what extent specific violations distort the valuation results of standard models. Therefore, it explains, for example, previous studies' findings that RIM yields remarkably robust results.

To circumvent the lack of infinite payoff forecasts, most frequently, so-called two-stage models are implemented assuming a certain "steady state" payoff growth rate for the second phase. As pointed out by Penman [1998], then a particularly important problem can arise from inconsistencies between the assumed growth rate and the payout ratio. Because being affected differently, valuation results of the standard models may then diverge. In contrast, Levin and Olsson [2000] and Lundholm and O'Keefe [2001a], for example, show that the three standard models yield identical value estimates if in steady state all items on the balance sheet and income statement grow at the same rate. Taking into account differences in the underlying steady state assumptions of the standard models, we analyze the impact of inconsistent terminal value calculations and derive an appropriate correction. Dirty surplus accounting, narrow dividend measures and differences between book and market values of debt pose additional challenges for the standard models (see e.g. Lo and Lys [2000], Fama and French [2001] and Sweeney, Warga, and Winters [1997]). To correct for dirty surplus accounting, we simply include differences between the stated (dirty) income and the income derived under clean surplus. To adjust for narrow dividend definitions, we include other capital transactions between owners and the firm. To correct for violations of the assumption that debt is marked to market (i.e., the net interest relation required for weighted average cost of capital (WACC) versions of the DCF model), we correct for differences between interest expenses according to the so called net interest relation and interest expenses as reported in the income statement. While the last three corrections are easily obtained one by one, they affect both the explicit forecast period and the terminal period, and thus, interact with the terminal value correction. Our analysis shows how to account for these interactions. Intuitively, the general principle to derive our adjustments is that we mimic an integrated financial planning approach. Therefore, our extended valuation equations are based on comprehensive (i.e., all-inclusive) payout measures and steady state growth rates that are consistent with given payout ratios.

Using a portfolio approach with realized data from 1987 to 2004, we adopt a perfect foresight setting with unbiased and consistent analysts' forecasts. This approach yields the following main empirical results: First, bias and inaccuracy decrease remarkably suggesting that the proposed models are worthwhile to implement. For example, the extended DCF model has a 62 percentage points smaller bias compared to its standard counterpart. Second, we obtain identical value estimates for the extended DDM, RIM and DCF model, even under non-ideal valuation conditions. Thus, the extended models provide a benchmark valuation. This allows us to measure to what extent the standard models are affected by individual violations of ideal conditions. By quantifying the magnitude of these violations in a unified framework, our findings add to the explanation of previous horse race literature results, where various model specifications haven analyzed separately (see e.g. Penman and Sougiannis [1998], Francis, Olsson, and Oswald [2000] and Courteau, Kao, and Richardson [2001]). In particular, we find that the ranking of the three models depend on the number of considered correction terms. For example while RIM is generally more robust against deviations from ideal conditions and thus ranked first without any corrections, DCF is ranked third, respectively. However, if one introduces only a correction term for inconsistent growth rates the bias is reduced by around 46% percentage points and furthermore the ranking of these models changes.

Moreover, our empirical results highlight the importance of reasonable steady state assumptions, corrections for dirty surplus accounting, and a wide dividend definition. Due to these findings, this study gives guidance for analysts and standard setters alike. On the one hand, we would recommend that analysts should forecast all the components necessary to derive all-inclusive payoff measures, in order to facilitate a better estimation of stocks' intrinsic values. On the other hand, our results have broad implications for the standard setters, since the derivation of fair value estimates are encountered in many circumstances under US-

GAAP.[1] Moreover, the results are important for researchers and practitioners in order to assess the relative impact of deviations from ideal conditions encountered in practice. While projecting (pro-forma) company accounts, i.e., balance sheets and income statements, deviations from ideal conditions should be considered. In particular, company valuation based on these projected company accounts should be carried out by incorporating the proposed corrections.

The remainder of this study is organized as follows. Section 2 discusses the related literature. Section 3 briefly reviews the standard models and introduces the extended DDM, RIM and DCF model. Section 4 describes the data and contains the empirical results. Especially, we report the valuation errors for the standard and the extended models and quantify the magnitude of each correction term separately. Section 5 summarizes the results and concludes.

2 Related Literature

Obviously, there are quite a few studies concerned with either company valuation or non-ideal valuation conditions such as dirty surplus accounting. However, this is the first study we are aware of that directly incorporates corrections of deviations from ideal conditions into valuation models. Thereby these two branches of literature are combined in an innovative way.

Various studies deal with measuring the magnitude and the value relevance of dirty surplus accounting flows. Although, comprehensive income as defined in SFAS 130 is not an "all-inclusive" income measure that completely satisfies the clean surplus relation, other comprehensive income (OCI) is a rather good proxy for dirty surplus flows (e.g. Chambers et al. [2007]). The results on the importance of dirty surplus flows are mixed. For example, O'Hanlon and Pope [1999], Dhaliwal, Subramanyam, and Trezevant [1999] document a median of dirty surplus flows deflated by market value of shareholders' equity of 0.4% in the United Kingdom and 0% in the US, respectively. In contrast, Lo and Lys [2000] find that firms are comparatively strongly affected by dirty surplus flows under US-GAAP. In particular, 14% of their observations report dirty surplus flows that are larger than 10% of the clean surplus income. Similar results are found for several other countries.[2] For our sample

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1 An important case, where calculations of intrinsic company values might be necessary in order to derive fair value estimates, is e.g. the impairment test. Moreover, SFAS 157 par. 18 states that "The income approach uses valuation techniques to convert future amounts (for example, cash flows or earnings) to a single present amount (discounted). The measurement is based on the value indicated by current market expectations about those future amounts. Those valuation techniques include present value techniques."

2 Cahan et al. [2000] analyze the importance of dirty surplus flows for New Zealand, Isidro, O'Hanlon, and Young [2006] for France, Germany, the U.K. and the US, Wang, Buijink, and Eken [2006] for the

using our dirty surplus measure even 45% of observations report dirty surplus flows that are larger than 10% of clean surplus income. For further details, see Appendix 1.

In addition, also the results on the value relevance of dirty surplus accounting flows are mixed. Dhaliwal, Subramanyam, and Trezevant [1999] find no evidence for the US that comprehensive income is more strongly associated with returns/market values or better predicts future cash flows/income than net income. They find some evidence between returns and unrealized gains on marketable securities. Overall, their results do not support the claim that comprehensive income is a better measure of firm performance than net income. In contrast, Kanagaretnam, Mathieu, and Shehata [2005] using more recent data find a stronger association between dirty surplus and share returns. Biddle and Choi [2006] report that comprehensive income as defined in SFAS 130 dominates net income in explaining equity returns. Chambers et al. [2007] find that OCI is value relevant. Investors price especially two components of OCI, foreign currency translation adjustment and unrealized gains/losses on available-for-sale securities. Interestingly, they find that marketable securities adjustments are valued at a rate greater than dollar-for-dollar, although theory predicts, that these components should be purely transitory (see Ohlson [1999]). Summing up, Chambers et al. [2007] attribute the lack of consistent results in research amongst others to the different employed research designs. Concerning dirty surplus flows our study is most related to Isidro, O'Hanlon, and Young [2006]. Their study explores the association between valuation errors from the standard RIM and violations of the clean surplus relation. For the US, they find weak evidence of the relationship between valuation errors and dirty surplus flows by using a two-step approach. First, a clean surplus RIM based on IBES forecasts is employed and second the impact of dirty surplus on valuation errors using realized data is analyzed. In contrast, we follow a one-step approach by integrating a dirty surplus correction directly into the RIM and find that this significantly increases the fit of the model. In addition, we introduce further correction terms and analyze the impact on several models (i.e., DDM and DCF) as well.

Besides dirty surplus, previous studies have pointed out other violations of ideal conditions. Transactions with the equity owners via capital increases and share repurchases have dramatically increased in the recent past (see e.g. Fama and French [2001], Grullon and Michaely [2002]). Therefore, market participants have to be aware of these cash distributions.

Netherlands, Kanagaretnam, Mathieu, and Shehata [2005] for Canadian and US firms or Biddle and Choi [2006] and Chambers et al. [2007] for U.S. data.

Also our empirical results confirm that an inclusion of these cash transfers enhance the precision of the intrinsic value estimates obtained from the DDM.

In addition, our research contributes indirectly to the analysis whether market or book values of debt should be used in empirical research. Although theory is normally derived in terms of market values of debt,[3] empirical research typically relies on book values rather than on market values (see e.g. Bowman [1979]).[4] This holds true for the DCF model as well, since it is assumed that debt is marked to market under ideal conditions and thus the net interest relation holds. According to the net interest relation, the interest expense can be calculated by multiplying the interest bearing debt with the cost of debt. Therefore, we extend the DCF model by incorporating deviations of accounting cost of debt, i.e., the observed interest expense on the income statement from the estimated cost of debt according to the net interest relation. Sweeney, Warga, and Winters [1997] provide strong empirical evidence that book values are a good proxy for the market values of debt if long-term bond yields remain rather stable over time but can diverge largely during times of relatively fast interest rate changes. Since interest rates are rather stable over our sample period, we expect that the deviations of both measures (accounting vs. economic cost of debt) will be rather small.

Finally but most importantly, our study is related to research on company valuation, especially to intermodel evaluations of the DDM, RIM and DCF model. The theoretical equivalence of valuation techniques has been established by different studies (e.g. Ohlson [1995], Feltham and Ohlson [1995], Penman [1998], Levin and Olsson [2000]), however, primarily by (implicitly) assuming ideal conditions. Feltham and Ohlson [1995] show that the DDM, RIM and DCF are equivalent if payoff data for an infinite horizon are available. Penman [1998] shows that the RIM and DCF model can be reformulated in a finite valuation context as the DDM, given appropriate terminal value calculations. Levin and Olsson [2000] and Lundholm and O'Keefe [2001a] analyze different steady state conditions and their impact on the valuation equivalence.

Given the theoretical equivalence under restrictive assumptions, other studies have investigated the ability of valuation techniques to obtain reasonable estimates of market values (e.g. Bernard [1995], Kaplan and Ruback [1995], Frankel and Lee [1998], Sougiannis and Yaekura [2001]). Kaplan and Ruback [1995] explore the ability of DCF value estimates to explain transaction values of firms engaged in highly leveraged transactions. They find that

3 E.g. most of the literature on capital structure research starting with Modigliani and Miller [1958, 1963].

4 In addition, Courteau, Kao, and Richardson [2001] mention that the financial assets are marked to market is a crucial assumption in DCF valuations.

DCF estimates significantly outperform estimates based on comparable approaches. Penman and Sougiannis [1998] are concerned with the important practical question how the three intrinsic value methods perform if they are applied to a truncated forecast horizon arising naturally in practice. Based on an ex-post-portfolio approach with realized payoff data, they find evidence that RIM yields the lowest valuation errors followed by the DDM and DCF model. Employing an ex-ante approach based on analysts' forecasts Francis, Olsson, and Oswald [2000] provide supporting evidence for the RIM outperformance. In addition, Courteau, Kao, and Richardson [2001] compare the DCF model to the RIM approach. Using Value Line (VL) data, they find that DCF and RIM do not differ significantly neither for price nor for non-price based terminal values. Finally, Lundholm and O'Keefe [2001a] point out that the empirical findings in the afore mentioned studies are driven by the particular implementation.[5] They attribute these mixed findings particularly to three reasons: First, different steady state assumptions in the three models lead to different value estimates. Second, circularity difficulties occur when the cost of equity and the weighted average cost of capital (WACC) are independently determined in the valuation process. Third, dirty surplus accounting impairs valuation equivalence.

In our study we provide amongst other things a solution for the problems mentioned by Lundholm and O`Keefe [2001a]. Analyzing individual deviations from ideal conditions, we derive appropriate adjustment terms for the three models, and thus, restore their empirical equivalence. Beside this, the appealing characteristic of our extended models is that they lead to significantly smaller valuation errors compared to their standard counterparts.

3 Valuation Methods

3.1 Valuation Methods under Ideal Conditions

We consider the three most commonly used equity valuation techniques, which all are based on the idea that the value of a share is given by its discounted expected future payoffs. According to the first model, the *Dividend Discount Model (DDM)*[6], the market value of equity V at time t is obtained by discounting expected future net dividends d to shareholders at the cost of equity r_E:[7]

[5] See also the discussion between Penman [2001] and Lundholm and O'Keefe [2001b] in the "Contemporary Accounting Research".

[6] This is the standard model for firm valuation which is commonly attributed to Williams [1938], Gordon [1959], Gordon and Shapiro [1956].

[7] For ease of notation, the following valuation formulas contain only a time invariant discount rate and we suppress the (conditional) expectation operator E_t in the numerator. However, in our empirical implementation, we employ time variant discount rates.

(DDM) $$V_t = \sum_{\tau=1}^{\infty} \frac{d_{t+\tau}}{(1+r_E)^{\tau}} . \qquad (1)$$

Net dividends include all positive cash transfers to shareholders, such as cash dividends or share repurchases, as well as negative cash transfers, e.g. due to capital increases.

Assuming compliance with clean surplus accounting the DDM can be transferred to a second approach, the *Residual Income Model (RIM)*[8]. Both DDM and RIM yield identical value estimates, if the clean surplus relation holds. The clean surplus relation (CSR) postulates that changes in book value of equity bv between two periods result exclusively from differences between earnings x and net dividends d:

(CSR) $$bv_t = bv_{t-1} + x_t - d_t . \qquad (2)$$

In other words, equity changes can arise exclusively from retentions of earnings or transactions with equity holders. Solving for d in equation (2) and substituting into the DDM leads under the transversality condition[9] to the RIM:

(RIM) $$V_t = bv_t + \sum_{\tau=1}^{\infty} \frac{x^a_{t+\tau}}{(1+r_E)^{\tau}} , \qquad (3)$$

where residual income, also referred to as abnormal earnings, x^a, is given by $x^a_t = x_t - r_E bv_{t-1}$, i.e., regular earnings minus a charge for equity employed.

The third theoretically equivalent valuation approach is the *Discounted Cash Flow (DCF)*[10] model. In order to determine the market value, forecasts of free cash flows are discounted at an appropriate risk-adjusted cost of capital.

The DCF approach can be derived from the DDM by combining the CSR and the free cash flow definition $fcf_t = oi_t - (oa_t - oa_{t-1})$. Free Cash Flow fcf is the after-tax cash flow available to all investors, i.e., debt and equity holders. oa denotes net operating assets (total assets minus all non-interest-bearing liabilities), oi is the operating income, defined as all income except interest expense x on the interest-bearing liabilities int, net of tax s, i.e. $oi_t = x_t + int_t (1-s)$.[11]

8 See e.g. Preinreich [1938], Edwards and Bell [1961], Peasnell [1982].

9 I.e., the assumption $\lim_{\tau\to\infty} (1+r_E)^{-\tau} bv_{t+\tau} \to 0$.

10 See e.g. Rappaport [1986], Copeland, Koller, and Murrin [1990] and the latest edition of Koller, Goedhart, and Wessels [2005].

11 See Lundholm and O'Keefe [2001a], pp. 324-325 and p. 333 endnote 8.

From the CSR and the free cash flow definition, the financial asset relation (FAR) is obtained:[12]

(FAR) $$\text{debt}_t = \text{debt}_{t-1} + \text{int}_t\left(1-s\right) + d_t - \text{fcf}_t\,, \tag{4}$$

where debt is the sum of interest-bearing liabilities and preferred stock.[13] By further assuming the validity of the net interest relation (NIR):

(NIR) $$\text{int}_t = r_D \text{debt}_{t-1}\,, \tag{5}$$

where r_D denotes the cost of debt, a DCF model variant, i.e., the well-known text book WACC approach can be obtained (see Appendix 2):

$$V_t = \sum_{\tau=1}^{\infty} \frac{\text{fcf}_{t+\tau}}{\left(1+r_{WACC}\right)^{\tau}} - \text{debt}_t\,. \tag{6}$$

Although intuitively appealing, the WACC model in equation (6) is difficult to apply because it requires the estimation of the weighted average cost of capital r_{WACC}. Since capital weights have to be derived from market values, this approach encounters circularity problems. These difficulties are avoided by the feasible (implicit) WACC model, which is used, for example, by Courteau, Kao, and Richardson [2001] (see Appendix 2):

(DCF) $$V_t = \sum_{\tau=1}^{\infty} \frac{\text{fcf}_{t+\tau} - r_D\left(1-s\right)\text{debt}_{t+\tau-1} + r_E \text{debt}_{t+\tau-1}}{\left(1+r_E\right)^{\tau}} - \text{debt}_t\,. \tag{7}$$

While Equation (7) still assumes that debt is marked to market, i.e., the net interest relation equation (5) must hold, it is advantageous since it employs only the equity cost of capital r_E, which is also used in the DDM and RIM. Thus, all three models are directly comparable.

3.2 Extended Valuation Methods under Non-Ideal Conditions

The models presented above are based on rather restrictive assumptions. In practice however, we are confronted with less than ideal conditions, in particular dirty surplus accounting or deviations from the net interest relation. In addition, different steady state assumptions lead to inconsistencies and can have a remarkable impact on valuations. Therefore, it is necessary to introduce several corrections in order to guarantee that the three valuation methods remain applicable under less than ideal conditions. Specifically, we derive adjustments for dirty

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[12] The FAR can be derived by substituting $bv_t = oa_t - \text{debt}_t$ in the clean surplus relation, subtracting this restated clean surplus relation $oa_t - \text{debt}_t = oa_{t-1} - \text{debt}_{t-1} + x_t - d_t$ from the free cash flow definition $oa_t = oa_{t-1} + oi_t - \text{fcf}_t$ and assuming $oi_t - x_t = \text{int}_t\left(1-s\right)$.

[13] In our analysis, we abstract from a distinction between operating and financial assets (i.e., trade securities). See for instance Feltham and Ohlson [1995], where financial assets are defined as cash and marketable securities minus debt. For the treatment of preferred stock as debt, see e.g. Penman [2006].

surplus accounting, narrow dividend definitions and net interest relation violations. In addition, the extended models allow us to analyze different steady state assumptions simultaneously.

3.2.1 Steady State Assumptions and the Calculation of a Terminal Value

The DDM, RIM and DCF model equations in the preceding section require projecting all future payoffs to infinity, which is impossible in practice. To circumvent this problem, the future is typically divided into two periods: an explicit forecast period where payoffs are projected explicitly for a limited number of years and a terminal period. The terminal period captures the value beyond the explicit forecast period by a terminal value, which is often calculated based on (growing) perpetuities.[14] It is well known that an inadequate short explicit forecast horizon, and thus an early terminal value calculation, leads to inaccurate value estimates.[15] Our study does not focus on this question, when steady state is achieved, although by applying different forecast horizons, we provide some indicative results.

According to Levin and Olsson [2000] the notion of steady state can be separated into necessary and sufficient conditions. While the former postulates that the qualitative behavior of the company remains constant in the terminal period, i.e., valuation attributes can be expected to grow at a constant rate g, the latter condition focuses on the interactions of the balance sheet and income statement items, which both have to be modeled in a consistent manner. Regarding this issue, Levin and Olsson [2000] and Lundholm and O'Keefe [2001a] focus on different steady state conditions in their derivations. The following steady state conditions are defined by Levin and Olsson [2000]:[16]

(BSS)	Balance sheet steady state:	$BS^{item,i}_{t+T+1} = (1+g)BS^{item,i}_{t+T} \ \forall\, i, t$,
(DSS)	Dividend steady state:	$d^{DSS}_{t+T+1} = \left(1+g\right) d_{t+T} \ \forall\, t$,
(RSS)	Residual income steady state:	$x^{a,RSS}_{t+T+1} = (1+g)x^{a}_{t+T} \ \forall\, t$,
(CSS)	Cash flow steady state:[17]	$cf^{CSS}_{t+T+1} = (1+g)cf_{t+T} \ \forall\, t$.

14 The term continuing value or horizon value is sometimes used instead of terminal value in the literature.

15 See e.g. Sougiannis and Yaekura [2001].

16 Starting in period t+T the corresponding payoff, i.e., dividend, residual income, cash flow or all items on the balance sheet and income statement are assumed to grow beyond the explicit forecast horizon at the rate g up to infinity.

17 In contrast to Levin and Olsson [2000] we extrapolate the total numerator of the DCF model in equation (7) denoted by cf beyond the explicit forecast horizon at (1+g).

The balance sheet steady state (BSS) definition corresponds to the implementation in Lundholm and O'Keefe [2001a]. It is shown that this assumption assures that the forecasted balance sheets and income statements are internally consistent to each other. This assumption implies, that the return on equity $RoE_{t+T+\tau} \equiv (1+g)^{\tau} x_{t+T} / \left((1+g)^{\tau} bv_{t+T}\right)$ (i.e., for $\tau \geq 0$) and all other relevant parameters remain constant in the terminal period. In contrast, the use of the other three steady state concepts (DSS, RSS and CSS) leads to inconsistencies and consequently to different value estimates. We expand the work of Lundholm and O´Keefe [2001a] and Levin and Olsson [2000], by combining either DSS, RSS or CSS with the BSS assumption in each valuation formula. This allows us to analyze the impact of different steady state assumptions simultaneously and to derive appropriate correction terms.

First, splitting the infinite forecast horizon into two stages leads to the following DDM:

$$V_t^{DDM} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}}{\left(1+r_E\right)^{\tau}} + \frac{d_{t+T+1}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} . \qquad (8)$$

The first T years represent the explicit forecast period and consist of explicit and exogenous dividend forecasts. In the following terminal period, the dividend is assumed to grow at a constant growth rate g. The estimation of d_{t+T+1} is crucial, since at least two different steady state assumptions can be employed. According to the balance sheet steady state (BSS) assumption, d_{t+T+1}^{BSS} is obtained by letting each line item on the balance sheet (operating assets, debt, shareholders' equity etc.) and the income statement (net income, operating income, interest expense etc.) grow at the rate *g*. This steady state growth has to be applied first for period T to T+1 as well as all subsequent periods. Hence, under ideal conditions (e.g. clean surplus accounting), the DDM starting value of the perpetuity, which guarantees consistency across the three approaches, is given by:[18]

$$d_{t+T+1}^{BSS} = \left(1+g\right) x_{t+T} - \left(1+g\right) bv_{t+T} + bv_{t+T} = \left(1+g\right) x_{t+T} - g \cdot bv_{t+T} . \qquad (9)$$

Alternatively, according to the dividend steady state assumption (DSS) the payoff in period t+T+1 is determined by:

$$d_{t+T+1}^{DSS} = \left(1+g\right) d_{t+T} . \qquad (10)$$

Combining expressions (9) and (10) as

$$d_{t+T+1} = d_{t+T+1}^{DSS} + \left(d_{t+T+1}^{BSS} - d_{t+T+1}^{DSS}\right)$$

and inserting into equation (8) leads to:

18 See Lundholm and O'Keefe [2001a].

$$V_t^{DDM} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)d_{t+T} + tv_{t+T+1}^{BSS,DDM}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \quad (11)$$

$$\text{with} \quad tv_{t+T+1}^{BSS,DDM} = \left(1+g\right)x_{t+T} - g\cdot bv_{t+T} - \left(1+g\right)d_{t+T},$$

where $tv_{t+T+1}^{BSS,DDM}$ captures the difference between these two steady state calculations. Note, that this approach means that all models are implicitly based on the balance sheet steady assumption. Still, our approach is advantageous since it allows analyzing both steady state assumptions simultaneously. This procedure is applied to the other two models in a similar manner.

Turning to the RIM, the infinite forecast horizon model (equation (3)) is divided into the two periods as:

$$V_t^{RIM} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a}}{\left(1+r_E\right)^{\tau}} + \frac{x_{t+T+1}^{a}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \quad (12)$$

Under the balance sheet steady state (BSS) assumption, the final payoff in the RIM is calculated as:

$$x_{t+T+1}^{a,BSS} = \left(1+g\right)x_{t+T} - r_E bv_{t+T}. \quad (13)$$

Alternatively, assuming residual income steady state (RSS), the numerator of the terminal value is given by:

$$x_{t+T+1}^{a,RSS} = (1+g)x_{t+T}^{a} = (1+g)\left(x_{t+T} - r_E bv_{t+T-1}\right). \quad (14)$$

Inserting these two expressions ((13) and (14)) in the same way as above into equation (12) results in:

$$V_t^{RIM} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)x_{t+T}^{a} + tv_{t+T+1}^{BSS,RIM}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \quad (15)$$

$$\text{with} \quad tv_{t+T+1}^{BSS,RIM} = -r_E\left(bv_{t+T} - \left(1+g\right)bv_{t+T-1}\right).$$

The terminal value adaptation term represents again the difference between the two steady state assumptions.

Finally, the two-stage version for the DCF model is given by:

$$V_t^{DCF} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}}{\left(1+r_E\right)^{\tau}} + \frac{cf_{t+T+1}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} - debt_t \quad (16)$$

$$\text{with} \quad cf_{t+\tau} = fcf_{t+\tau} - r_D\left(1-s\right)debt_{t+\tau-1} + r_E debt_{t+\tau-1}, \text{ and}$$

$$fcf_{t+\tau} = oi_{t+\tau} - (oa_{t+\tau} - oa_{t+\tau-1}).$$

Again referring to BSS, assuming clean surplus accounting and compliance with the net interest relation, the numerator of the perpetuity in the DCF model is calculated as:

$$cf_{t+T+1}^{BSS} = (1+g)\,oi_{t+T} - (1+g)\,oa_{t+T} + oa_{t+T} - (1+g)\,r_D\,(1-s)\,debt_{t+T-1} + r_E debt_{t+T}\ . \tag{17}$$

In contrast, the extrapolation of the last payoff according to the cash flow steady state (CSS) assumption results in:

$$cf_{t+T+1}^{CSS} = (1+g)\,cf_{t+T} = (1+g)\left[fcf_{t+T} - r_D\,(1-s)\,debt_{t+T-1} + r_E debt_{t+T-1}\right] \tag{18}$$

Using the same substitutions as in the other two models yields:

$$V_t^{DCF} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}}{(1+r_E)^{\tau}} + \frac{(1+g)\,cf_{t+T} + tv_{t+T+1}^{BSS,DCF}}{(1+r_E)^{T}\,(r_E - g)} - debt_t \tag{19}$$

with $cf_{t+\tau} = fcf_{t+\tau} - r_D\,(1-s)\,debt_{t+\tau-1} + r_E debt_{t+\tau-1}$,

$fcf_{t+\tau} = oi_{t+\tau} - (oa_{t+\tau} - oa_{t+\tau-1})$, and

$tv_{t+T+1}^{BSS,DCF} = oa_{t+T} - (1+g)\,oa_{t+T-1} + r_E debt_{t+T} - (1+g)\,r_E debt_{t+T-1}$.

Summarizing, this extended approach yields two stage valuation formulas for the DDM, RIM and DCF model. Most importantly, it is advantageous to other model specifications since each model nests both steady state assumptions (i.e., the respective model specific steady state formula (DSS, RSS or CSS) and in addition the BSS). In conclusion, implementing the BSS assumption assures identical value estimates and allows us to analyze the impact of other steady state assumptions on the accuracy of the value estimates.

Note that these derivations are obtained under ideal conditions, i.e., clean surplus accounting, compliance with the net interest relation and full payoff information like share repurchases and capital contributions. In order to relax these restrictive constraints, all three models are next enhanced to deal with deviations from ideal conditions. Specifically, we derive adjustments for dirty surplus accounting, narrow dividend definitions and net interest relation violations.

3.2.2 Additional Model Specific Corrections

Dividend Discount Model

Notice that the dividend d in equation (11) must include all cash transfers between owners and the firm. If, for simplicity, only cash dividends are used (as, for example, in Francis, Olsson and Oswald [2000]) a substantial part of cash transfers is neglected.[19] To account for this, we

[19] Note again that this is not a criticism, since first unfortunately Value Line does not provide easily accessable forecasts of share repurchase volumes and prices and second the purpose of Francis, Olsson, and Oswald (2001) was to provide evidence how the models perform under common practice.

substitute $d_t = d_t^{cash} + d_t^{cor}$ where d_t^{cor} contains all neglected cash components, namely capital increases and share repurchases.

Moreover, the valuation equation (11) requires clean surplus accounting as assumed in equation (9). Since this relation is usually violated under US-GAAP accounting, it is necessary to incorporate a dirty surplus correction in the terminal period of the DDM.[20] To account for dirty surplus elements, we substitute $x_{t+T} = x_{t+T}^{dirt} + dirt_{t+T}^{cor}$, where x^{dirt} denotes the net income, which is affected by dirty surplus accounting.[21]

The dirty surplus correction term $dirt^{cor}$ captures any differences between the earnings number x, which is calculated from the clean surplus relation and the income measure x^{dirt}, observed from the income statement. The clean surplus income x contains all changes in book value of equity not resulting from transactions with the owners.[22] Thus, the dirty surplus amount is calculated as:[23]

$$dirt_{t+T}^{cor} = x_{t+T} - x_{t+T}^{dirt} = bv_{t+T} - bv_{t+T-1} + \left(d_{t+T}^{cash} + d_{t+T}^{cor}\right) - x_{t+T}^{dirt}. \qquad (20)$$

Hence, substituting $d_t = d_t^{cash} + d_t^{cor}$ for all t and $x_{t+T} = x_{t+T}^{dirt} + dirt_{t+T}^{cor}$ leads to the final extended DDM valuation equation,

$$(\text{DDM}^{\text{extended}}) \quad V_t^{DDM} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}^{cash} + d_{t+\tau}^{cor}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)\left(d_{t+T}^{cash} + d_{t+T}^{cor} + dirt_{t+T}^{cor}\right) + tv_{dirt,t+T+1}^{BSS,DDM}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \qquad (21)$$

$$\begin{aligned} \text{with} \quad & tv_{dirt,t+T+1}^{BSS,DDM} = \left(1+g\right)x_{t+T}^{dirt} - g \cdot bv_{t+T} - \left(1+g\right)\left(d_{t+T}^{cash} + d_{t+T}^{cor}\right), \\ & dirt_{t+T}^{cor} = x_{t+T} - x_{t+T}^{dirt}, \text{ and} \\ & d_{t+\tau}^{cor} = \text{share repurchases in } t+\tau - \text{capital increases in } t+\tau . \end{aligned}$$

20 Clean surplus violations are e.g. unrealized gains and losses on securities available for sale, on foreign currency translations or on derivative instruments.

21 Alternative specifications of dirty surplus income can be earnings measures such as comprehensive income according to SFAS No. 130, net income before extraordinary items or net income before extraordinary items and special items. In our study, we employ net income as the x^{dirt} measure, because SFAS 130 “Reporting of Comprehensive Income” became effective in 1997 and thus is not completely available for our sample period. For empirical evidence on dirty surplus accounting see Appendix 1.

22 Note that our approach only implicitly deals with stock options, since they are contained in our clean surplus calculation of x. Since there is no further data breakdown in Compustat, we are not capable of disentangling the effects of stock option accounting further.

23 Alternatively, according to Lo and Lys [2000] the clean surplus earnings can be estimated as the change of retained earnings after cash dividends. Although, this definition has to be treated with care, since stock dividends, that are distributions to shareholders in additional shares, lead to an increase of paid-in capital and a decrease of retained earnings and hence to a biased disclosure of clean surplus income. Moreover, this approach causes biases by neglecting capital increases.

Note that the $dirt^{cor}_{t+T}$ term is necessary only because we need a (dirty) income measure to calculate the starting dividend in the terminal period if BSS is assumed. Therefore, the dirty surplus correction affects only the terminal value expression and we get a slightly different terminal correction as opposed to equation (11). Both corrections $dirt^{cor}_{t+T}$ and $tv^{BSS,DDM}_{dirt}$ are required simultaneously in the terminal period.

So far, we have employed a simple perpetuity with growth in the terminal value expression. Alternatively, according to Penman [1998] a discounted T-year ahead stock price forecast[24] could be employed to substitute the terminal value calculation. Using this “price-based terminal value” instead of the growth rate based perpetuity (i.e., the so called “non-price-based terminal value”) the extended DDM is equal to:

$$(DDM^{extended\text{-}price}) \quad V^{DDM,Price}_t = \sum_{\tau=1}^{T} \frac{d^{cash}_{t+\tau} + d^{cor}_{t+\tau}}{(1+r_E)^{\tau}} + \frac{P_{t+T}}{(1+r_E)^{T}}. \tag{22}$$

In contrast to the $DDM^{extended}$ implementation, the correction terms $dirt^{cor}$ and $tv^{BSS,DDM}_{dirt}$ are obviously unnecessary, if such a price-based valuation is employed.

Residual Income Model

If the clean surplus relation is violated under US-GAAP accounting it can be seen from equation (23) that a dirty surplus correction should also be incorporated in the RIM approach.

$$\begin{aligned} x^a_t &= x_t - r_E bv_{t-1} = \left(x^{dirt}_t + dirt^{cor}_t\right) - r_E bv_{t-1} \\ &= \left(x^{dirt}_t - r_E bv_{t-1}\right) + dirt^{cor}_t = x^{a,dirt}_t + dirt^{cor}_t \end{aligned} \tag{23}$$

Note that x^a_t is calculated on the supposition that the clean surplus relation holds. Hence, x^a_t consists of a residual income resulting from the usage of an actually observed income measure x^{dirt} and a dirty surplus correction $dirt^{cor}$. In contrast to the DDM, clean surplus violations have to be incorporated during the explicit forecast period as well as the terminal period.

The extended RIM implementation, which captures the difference between the steady state assumptions and the dirty surplus correction, consequently results in:

$$(RIM^{extended}) \quad V^{RIM}_t = bv_t + \sum_{\tau=1}^{T} \frac{x^{a,dirt}_{t+\tau} + dirt^{cor}_{t+\tau}}{(1+r_E)^{\tau}} + \frac{(1+g)\left(x^{a,dirt}_{t+T} + dirt^{cor}_{t+T}\right) + tv^{BSS,RIM}_{t+T+1}}{(1+r_E)^{T}(r_E - g)} \tag{24}$$

$$\text{with} \quad \begin{aligned} tv^{BSS,RIM}_{t+T+1} &= -r_E\left(bv_{t+T} - (1+g)\,bv_{t+T-1}\right), \text{ and} \\ dirt^{cor}_{t+\tau} &= x_{t+\tau} - x^{dirt}_{t+\tau}. \end{aligned}$$

[24] Providers of long-term price forecasts are e.g. ValueLine.

If a terminal stock price forecast is available, the extended RIM employing a price-based-terminal value is given by:

$$(\text{RIM}^{\text{extended-price}}) \qquad V_t^{\text{RIM,Price}} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a,dirt} + dirt_{t+\tau}^{cor}}{(1+r_E)^{\tau}} + \frac{P_{t+T} - bv_{t+T}}{(1+r_E)^{T}} . \qquad (25)$$

The ideal price-based terminal value is the difference between the forecasted market price of the stock and the book value of equity at the horizon t+T. A positive premium $\left[P_{t+T} - bv_{t+T}\right]$ indicates accounting conservatism or positive net present value projects in the future.

Discounted Cash Flow Model

In line with the DDM and RIM, dirty surplus accounting necessitates the inclusion of an appropriate correction term in the DCF approach:

$$fcf_t = fcf_t^{dirt} + dirt_t^{cor} = oi_t^{dirt} - (oa_t - oa_{t-1}) + dirt_t^{cor} . \qquad (26)$$

Equation (26) states that the free cash flow calculated on the assumption of clean surplus accounting consists of the dirty surplus free cash flow fcf^{dirt}, which is calculated indirectly starting from the net income x^{dirt}, and the $dirt^{cor}$ term. By incorporating equation (26) into equation (19), the modified DCF model, which explicitly regards dirty surplus accounting, is given by:

$$V_t^{DCF} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{dirt} + dirt_{t+\tau}^{cor}}{(1+r_E)^{\tau}} + \frac{(1+g)\left(cf_{t+T}^{dirt} + dirt_{t+\tau}^{cor}\right) + tv_{t+T+1}^{BSS,DCF}}{(1+r_E)^{T}(r_E - g)} - debt_t \qquad (27)$$

with $cf_{t+\tau}^{dirt} = fcf_{t+\tau}^{dirt} - r_D(1-s)debt_{t+\tau-1} + r_E debt_{t+\tau-1}$,
$fcf_{t+\tau}^{dirt} = oi_{t+\tau}^{dirt} - (oa_{t+\tau} - oa_{t+\tau-1})$,
$tv_{t+T+1}^{BSS,DCF} = oa_{t+T} - (1+g)oa_{t+T-1} + r_E debt_{t+T} - (1+g)r_E debt_{t+T-1}$, and
$dirt_{t+T}^{cor} = x_{t+T} - x_{t+T}^{dirt}$.

Next, if debt is not marked to market the interest expense of a particular period cannot be determined according to the net interest relation (NIR) $int_t^{NIR} = r_D debt_{t-1}$ and thus one assumption of the WACC model is violated. To account for the possible deviation between interest expense from the income statement int_t^{IS} and interest expense according to the NIR int_t^{NIR}, a last new correction term, namely nir^{cor}, is incorporated into the DCF model:

$$nir_t^{cor} = \left(int_t^{NIR} - int_t^{IS}\right)(1-s) = \left(r_D debt_{t-1} - int_t^{IS}\right)(1-s) . \qquad (28)$$

Accounting for the net interest relation adjustment nir^{cor} in equation (27) leads to the following final extended DCF model:

(DCF$^{\text{extended}}$) $$V_t^{DCF} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{dirt} + dirt_{t+\tau}^{cor} + nir_{t+\tau}^{cor}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)\left(cf_{t+T}^{dirt} + dirt_{t+T}^{cor} + nir_{t+T}^{cor}\right) + tv_{t+T+1}^{BSS,DCF}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} - debt_t \quad (29)$$

with $$cf_{t+\tau}^{dirt} = fcf_{t+\tau}^{dirt} - r_D\left(1-s\right)debt_{t+\tau-1} + r_E debt_{t+\tau-1},$$
$$fcf_{t+\tau}^{dirt} = oi_{t+\tau}^{dirt} - (oa_{t+\tau} - oa_{t+\tau-1}),$$
$$tv_{t+T+1}^{BSS,DCF} = oa_{t+T} - \left(1+g\right)oa_{t+T-1} + r_E debt_{t+T} - \left(1+g\right)r_E debt_{t+T-1},$$
$$dirt_{t+\tau}^{cor} = x_{t+\tau} - x_{t+\tau}^{dirt}, \text{ and}$$
$$nir_{t+\tau}^{cor} = \left(int_{t+\tau}^{NIR} - int_{t+\tau}^{IS}\right)\left(1-s\right) = \left(r_D debt_{t+\tau-1} - int_{t+\tau}^{IS}\right)\left(1-s\right).$$

Again, if a terminal stock price forecast for time t+T is available, the ideal price-based terminal value is the discounted sum of $\left[P_{t+T} + debt_{t+T}\right]$. The DCF model using a price-based continuing value is then given by:

(DCF$^{\text{extended-price}}$) $$V_t^{DCF} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{dirt} + dirt_{t+\tau}^{cor} + nir_{t+\tau}^{cor}}{\left(1+r_E\right)^{\tau}} + \frac{P_{t+T} + debt_{t+T}}{\left(1+r_E\right)^{T}} - debt_t\,. \quad (30)$$

3.3 Special Cases of the Extended Valuation Methods: The Standard Models

As already mentioned in the introduction each extended valuation model nests its standard model counterpart. Therefore as a starting point for model evaluation purposes, we introduce the standard models, where all the above given corrections are neglected.

The standard DDM considers only cash dividends, i.e., a narrow dividend definition, by leaving out the d^{cor}, $dirt^{cor}$ and $tv^{BSS,DDM}$ terms.

(DDM$^{\text{standard}}$) $$V_t^{DDM} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}^{cash}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)d_{t+T}^{cash}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \quad (31)$$

(DDM$^{\text{standard-price}}$) $$V_t^{DDM,Price} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}^{cash}}{\left(1+r_E\right)^{\tau}} + \frac{P_{t+T}}{\left(1+r_E\right)^{T}} \quad (32)$$

The standard RIM implementation abstracts from the dirty surplus and terminal value adjustment.

(RIM$^{\text{standard}}$) $$V_t^{RIM} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a,dirt}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right)x_{t+T}^{a,dirt}}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \quad (33)$$

$$(\text{RIM}^{\text{standard-price}}) \quad V_t^{\text{RIM,Price}} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a,dirt}}{(1+r_E)^{\tau}} + \frac{P_{t+T} - bv_{t+T}}{(1+r_E)^{T}} \tag{34}$$

Finally, the standard DCF model disregards the corrections for dirty surplus, violations of the net interest relation and the terminal value calculation.

$$(\text{DCF}^{\text{standard}}) \qquad V_t^{\text{DCF}} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{dirt}}{(1+r_E)^{\tau}} + \frac{(1+g)\,cf_{t+T}^{dirt}}{(1+r_E)^{T}(r_E - g)} - debt_t \tag{35}$$

$$(\text{DCF}^{\text{standard-price}}) \quad V_t^{\text{DCF,Price}} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{dirt}}{(1+r_E)^{\tau}} + \frac{P_{t+T} + debt_{t+T}}{(1+r_E)^{T}} - debt_t \tag{36}$$

For convenience, Table 1 summarizes the different correction terms used in the DDM, RIM and DCF model.

[Insert Table 1 about here]

Furthermore, Appendix 3 provides an illustrative example where the correction terms are calculated for a specific firm, namely the 3M Corporation.

4 Empirical Analysis

4.1 Research Design and Data Description

We use data from COMPUSTAT Annual and Research Files containing companies listed at the New York Stock Exchange (NYSE), the American Exchange (AMEX) and the National Association of Securities Dealers Quotations (NASDAQ) market. Our study comprises the time period from 1987 to 2004, mainly because credit ratings needed to calculate cost of debt are not available before 1987.[25] In line with other studies, financial companies (SIC codes 6000 to 6999) are excluded from the sample due to their different characteristics. Furthermore, we exclude companies with negative equity book values, share values smaller than $1.00 and fewer than 1 million shares outstanding. This selection procedure avoids largely distortions due to outliers and thus yields more robust model estimates.[26] In total, we obtain 36,112 company years consisting of 4,285 different companies. The number of companies ranges

[25] Credit ratings are only sparsely available for firms in COMPUSTAT beginning in 1985/1986 and more reliably available starting in 1987.

[26] Overall, our data selection procedure is comparable to most other studies (e.g. Frankel and Lee [1998]). However, Bhojraj and Lee [2002] or Liu, Nissim, and Thomas [2002] impose more severe restrictions with regard to COMPUSTAT data.

from 1,530 companies in 2004[27] to 2,335 companies in 1996 (see Table 2 for additional details).[28] The payoff definitions and their implementation with COMPUSTAT data are given in Appendix 4.

Following Penman and Sougiannis [1998] we use realized payoff data (i.e., a perfect foresight setting) in connection with a portfolio approach. Using realized data instead of forecasts is advantageous for several reasons. First, it leads to a larger database. For example, we can analyze four times more companies per year in contrast to the studies of Francis, Olsson and Oswald [2000] and Courteau, Kao, and Richardson [2001] who use analyst forecasts from Value Line.[29] Second, it is well known that forecasts for several items (e.g. dividends, book values of equity and earnings, etc.) are not necessarily consistent to each other (see e.g. Courteau, Kao, and Richardson [2001]). Moreover, analysts' forecasts can be biased (see e.g. Chan, Karceski, and Lakonishok [2003]). Biases and inconsistencies in analysts' forecasts, however, are problems we do not want to address here since they add unnecessary complexity to the comparison of the three models. Third, using realized data allows exact measurement of dirty surplus amounts, growth rates of payoffs and other important input variables such as capital expenditures, free cash flows, dividends, capital increases, share repurchases and earnings. Nevertheless, realized data do not perfectly match expectations. However, the use of realized data is justifiable as long as the ex post observed payoffs match expected values. Presuming that deviations of realized from expected values cancel out on average, the companies are grouped into 20 portfolios. This results in an average number of firms of 69 per portfolio (over all years).

Companies are assigned randomly to individual portfolios in order to calculate the present value for a particular year. The portfolio composition is maintained throughout all periods associated with a single valuation. To compute present values for subsequent years, the evaluation window is moved ahead and companies are assigned randomly to portfolios, again. For each portfolio the average relevant figure (cash flows, earnings, dividends, etc.) is computed for each horizon up to 10 subsequent years (t + T, T = 2,...,10) and discounted at the average costs of equity capital in order to obtain an average present value per portfolio.

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[27] Even if no data requirements are made, the number of observable firms from the COMPUSTAT Annual and Research Files has decreased in the last years of our sample period.

[28] Compared to Penman and Sougiannis [1998] our sample contains fewer companies. This is attributable to the fact, that more COMPUSTAT items are used than in their study.

[29] Value Line forecasts about 1,600 US companies. Francis, Olsson, and Oswald [2000] examine about 600, Courteau, Kao, and Richardson [2001] examine 422 companies per year for a five year evaluation period.

We estimate cost of equity r_E using the annualized one-year Treasury bill rate as the risk-free rate and then adding Fama and French's [1997] industry specific risk premiums (48 industry code). This results in a time invariant risk premium of 6.60% on average, ranging from 1.5% for Drugs to 12.2% for Fabricated Products. The average median cost of equity is 11.36%.[30]

For the cost of debt r_D we use Reuters industrial corporate spread data. Unfortunately, the firm specific rating information can be obtained from COMPUSTAT only for a sub-sample of 14,675 firm years. We replace missing rating information by the median rating of firms in corresponding industries using the Fama/French 48 industry classification. We then calculate cost of debt by adding Reuters 5 year spreads to the risk free rate.[31] As shown in Table 2 average median cost of debt over all years is approximately 6.5% and the median company rating is BBB.

In line with Kaplan and Ruback [1995], Penman and Sougiannis [1998], Francis, Olsson, and Oswald [2000] and others, we evaluate the valuation techniques by comparing actual traded prices with intrinsic values calculated from payoffs prescribed by the techniques. Assuming market efficiency the market capitalization is an appropriate criterion to evaluate the model performance. The signed prediction error (bias) denotes the deviation of intrinsic value estimate at t from share price at t. This error is defined as $\text{bias} = (\text{price}_t - \text{intrinsic value estimate}_t) / \text{price}_t$. The absolute prediction error is calculated as $\text{accuracy} = \left|\text{price}_t - \text{intrinsic value estimate}_t\right| / \text{price}_t$. Note that a positive bias indicates that the intrinsic value is smaller than the market price.

[Insert Table 2 about here]

Furthermore, summary statistics on the most important input variables are given in Table 2. For example, the companies' equity book value is $6.66 per share compared to an average median debt level of $2.90 per share. Thus firms are mainly equity financed (median leverage ratio based on book values amounts to 0.44 = 2.90/6.66). The median market value of equity varies between $96.85 million in 1987 and $622.83 million in 2004.

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30 Several sensitivity tests of our results are performed. The costs of equity were also computed based on a 10-year T-bond rate as risk-free interest rate and an alternative risk premium in terms of a market premium of 6% (see Ibbotson and Sinquefield [1993]) in conjunction with a CAPM firm specific risk component (rolling beta-estimation). Moreover, an analysis was performed with a uniform cost of equity rate for all companies and years of 10%, 11%, 12% and 13%. The empirical results (not reported) for our sample do not react sensitively to the choice of the costs of capital, although some minor level effects concerning the bias and inaccuracy are obviously observed.

31 5 years is a reasonable assumption according to the findings of Stohs and Mauer [1996].

We observe an average median book to market ratio of 57% suggesting that the sample firms follow conservative financial reporting. Median cash dividend payments per share of dividend paying firms range from $0.30 in 1987 to $0.46 in 2004 with a dividend payout ratio varying between 42% (in 1991) to 30% (in 2000 and 2004). Average median net dividends per share ($0.41) turn out to be higher than cash dividends per share ($0.37) because share repurchases exceed capital increases. Median free cash flow is equal to $0.12 per share and median residual income is $0.04 on average. As expected, in the years of the technology bubble (especially 2001 and 2002) the residual income per share is negative and the return on assets (ROA) is comparatively small. Overall, our sample has similar characteristics as in other studies (see e.g. Frankel and Lee [1998]).

4.2 Empirical Results

4.2.1 Valuation Errors

Table 3 reports average valuation errors – bias (Panel A) and inaccuracy (Panel B) – for the three extended valuation approaches in comparison to the standard model implementation for a t+6 forecast horizon.

[Insert Table 3 about here]

Most importantly, all three extended models perform substantially better than their standard counterparts in terms of bias and inaccuracy. In particular, the huge average bias associated with the standard DCF model can be reduced remarkably by implementing our extended model version (from 78% to 17% for a steady state growth rate of 2%). Similarly, large gains with respect to bias are observed for the DDM (from 54% to 17%) and even for RIM bias is reduced by half (35% to 17%). Clearly, gains in bias are less pronounced for the price-based models, which is consistent with Courteau, Kao, and Richardson [2001]. A similar picture is observed regarding absolute valuation errors (Panel B), although inaccuracy is of greater magnitude as compared to bias and differences between the models are less pronounced.

Overall, implementing our extended valuation models yields identical valuation results (e.g. a bias of 17% for 2% growth) being associated with substantial reductions in mean valuation errors even when compared to the best standard model.

To evaluate the robustness that the extended models perform better than their standard counterparts, we repeat the above analysis on year by year basis (see Figure 1). In general, as in Table 3 the extended models provide considerably smaller valuation errors than their standard counterparts even on a year-by-year comparison. The only exception is observed for the DCF model in 1996 when the standard DCF model slightly outperforms the extended model version in terms of bias. Interestingly, standard DDM produces the most stable errors, underestimating market values by an almost constant 60%. This result is in line with expectations since cash dividends are generally smoothed over time. In contrast, standard DCF produces more volatile average valuation errors, exceeding the other models' errors in every single year, whereas standard RIM comes closest to the extended model.

[Insert Figure 1 about here]

As a further robustness check, we analyze whether the observed improvement in valuation errors depends on forecast horizons. Table 4 provides bias (Panel A) and inaccuracy (Panel B) for different forecast horizons (t+2, t+4, t+8, t+10). In line with the monotonicity-property developed by Ohlson and Zhang [1999], we observe that valuation errors for the standard as well as the extended models decline steadily with a longer finite forecast horizon. For example, employing a non-price-based terminal value with a 2% growth rate the bias of the extended models declines steadily from 29% to 7% with an increasing forecast horizon (t+2 to t+10, respectively). A similar steady decline, although on a higher level, is observed for the three standard models.

[Insert Table 4 about here]

Again, a similar picture is obtained regarding mean inaccuracy (Panel B). Concerning the extended models, inaccuracy for the non-price-based approaches again declines from 52% to 39% (g=2%). In contrast, while also declining, the inaccuracy of standard DCF is about twice as high, of standard DDM about 10 percentage points higher, whereas almost no difference is observed for RIM.

Overall, the above results suggest that the extended models provide considerable advantages. They lead to more precise valuation estimates and thus smaller valuation errors. This result is robust for different sampling periods and different forecast horizons. Moreover, relative and absolute valuation errors are for our extended models (especially DDM and DCF) considerably smaller than previously reported.[32]

4.2.2 Robustness of Standard Models against Violations of Ideal Conditions

Besides yielding lower valuation errors, a second major advantage of the extended models is the restored valuation equivalence. This provides a benchmark for analyzing to which extent the standard models are affected by specific violations of the underlying assumptions. The results of such an analysis are given in Table 5, which provides an assessment of the relative importance of each valuation component. First, we analyze the absolute Dollar amount and their respective percentage share of intrinsic value estimate for each component in Table 5 (Panel A). Second, their corresponding impact on the valuation bias is evaluated in Panel B. As before, calculations are based on a 6-year explicit forecast horizon with subsequent terminal value.

[Insert Table 5 about here]

In the DDM the three corrections d^{cor}, $dirt^{cor}$ and tv^{BSS} (capturing the difference between the steady state assumptions BSS and DSS) are nearly equally important. The dividend correction alone accounts for 16% of the intrinsic value (for g = 2%). In contrast, in the RIM the book value of equity and the present value of residual income account with 76% for a very large fraction of the intrinsic value. In the RIM and the DCF model the dirty surplus correction $dirt^{cor}$ is identical and represents nearly a quarter of the intrinsic value. In comparison, the respective dirty surplus correction in the DDM is smaller since this correction occurs only in the terminal period. Therefore, it is particularly important to correct for dirty surplus in the RIM and DCF model. In the DCF model the present value of the correction components together (i.e., the sum of $dirt^{cor}$, nir^{cor}, and tv^{BSS}) accounts for 75% of the mean intrinsic value estimate. By far the largest correction term is tv^{BSS} with 55% of the intrinsic value estimate. This result highlights the importance of a reasonable steady state assumption within the terminal value calculation of the DCF model and demonstrates that the CSS condition leads to heavy distortions of the intrinsic value estimate. Whereas the correction for violations of the net interest relation nir^{cor} in the DCF model is with -5% rather small (the negative sign

[32] For instance, Penman and Sougiannis [1998] report a bias for the DDM of 31.4%, for the RIM of 8.3% and the DCF model of 111.2% assuming a t+4 forecast horizon and no growth in the terminal period. Francis, Olsson, and Oswald [2000] report a bias (inaccuracy) based on analyst forecasts of 75.5% (75.8%), 20.0% (33.1%), 31.5% (48.5%) for the DDM, RIM and DCF model, respectively.

indicates that $int^{IS}_{t+T} > int^{NIR}_{t+T}$). Given these findings for the 2% growth case, the results remain qualitative similar if no growth is assumed.

The results are rather different if a price-based terminal value is employed. The DDM requires only the dividend correction, which accounts for 5% of equity value. In the RIM the remaining $dirt^{cor}$ term amounts to 6%. In the DCF model $dirt^{cor}$ and nir^{cor} sum up to 5%. Nevertheless, even with a price-based terminal value these corrections are worthwhile to consider.
Panel B translates individual corrections into relative valuation errors. For convenience, these results are illustrated in Figure 2. Starting with the standard model (left bar) and then introducing our correction terms step-by-step leads to the extended model implementation (right bar).

[Insert Figure 2 about here]

Figure 2 (respectively Table 5, Panel B) clearly points out the importance of consistent terminal value calculations, showing that differences in the performance of the three standard models can be largely explained by this correction term. While the DCF model is most heavily affected by inappropriate terminal value calculations (explaining about 2/3 (=46.47%/78.48%) of the model's bias), its impact on the DDM is much more modest (about 1/5 (=10.25%/54.02%)) and virtually zero for the RIM. The second most important violation is dirty surplus, showing an almost identical impact on the valuation results of RIM and DCF and a somewhat more moderate impact on DDM. Among specific corrections, in particular the correction for hidden dividends is noteworthy. It reduces the bias of the DDM by about 1/4 (=13.24%/54.02%), while the violation of the net-interest relation has almost no impact on the DCF model's performance.

Overall, this error decomposition adds to the explanation of previous results of the horse race literature (see e.g. Penman and Sougiannis [1998], Francis, Olsson, and Oswald [2000] and Courteau, Kao, and Richardson [2001]). In particular, we find that the ranking of the three models depend on the number of considered correction terms. For example while RIM is generally more robust and ranked first without any correction terms, DCF is ranked third respectively. However, if one introduces only a correction for different steady state assumptions, the ranking of these models changes.

5 Summary and Conclusion

While standard DDM, RIM and DCF model are formulated for ideal valuation conditions, such conditions are almost never encountered in practice. Therefore, we extend the three models to account for less than ideal valuation conditions. In particular, we correct for dirty surplus accounting, narrow dividend definitions, net interest relation violations and inconsistent growth projections in terminal value calculations.

Based on a broad sample of realized payoffs we provide the following main three findings: First, the proposed models generate considerably smaller valuation errors. Second, the adjusted models provide a benchmark valuation that enables us to analyze to what extent the standard models are affected by specific violations of ideal conditions. Third, in contrast to the standard models, the extended models naturally yield identical valuation results under less than ideal conditions. These results are robust with respect to the sample period as well as to the choice of the forecast horizon. Overall, we provide the first large sample evidence of the consequences of specific violations of the restrictive assumptions underlying standard valuation models, in particular, how specific violations affect the valuation precision of standard models. While we focus on realized data – mainly to circumvent well-known problems associated with analysts' forecasts – our results provide some implications for valuation studies based on forecasted payoffs. In particular, differences of the models with respect to the required data items on a forecasts basis impose challenges to their applicability. For example, forecasts of share repurchases might be particularly difficult to obtain. This impairs the applicability of the DDM. In general, applying the extended models requires payoff forecasts obtained from a fully integrated financial planning approach. Our extended models provide correction terms derived by mimicking such a planning approach.

Appendices

Appendix 1

Descriptive Statistics on Dirty Surplus

		Net Income	Income Before Extraordinary Items	Income Before Extraordinary Items and Special Items
Absolute dirty surplus as % of the absolute clean surplus income	Mean	22.78%	26.60%	38.25%
	Median	7.68%	10.29%	20.77%
	% of obs > 10 %	45.13%	50.55%	62.87%
Absolute dirty surplus as % of equity book value	Mean	5.28%	6.26%	12.82%
	Median	0.95%	1.23%	2.49%
	% of obs > 1 %	36.02%	53.96%	65.95%
Absolute dirty surplus as % of total assets	Mean	2.44%	2.82%	8.16%
	Median	0.43%	0.57%	1.14%
	% of obs > 2 %	33.96%	26.24%	39.44%
Number of firm years		36,112	36,112	36,112

Notes:
Dirty surplus is the absolute value of the difference between the clean surplus income and a particular measure of income. Used income measures (COMPUSTAT item numbers in parentheses) are GAAP net income (#172), income before extraordinary items (#18), income before extraordinary and special items (#18+#17). Dirty surplus of more than 100% is included with a maximum of 100% in order to mitigate the effect of random outliers.

Appendix 2

Derivation of the DCF model for a Company with an Infinite Life-Span

Propostion:

$$V_t = \sum_{\tau=1}^{\infty} \frac{E_t[fcf_{t+\tau}]}{(1+r_E)^\tau} - \sum_{\tau=1}^{\infty} \frac{E_t[int_{t+\tau}(1-s) - \Delta debt_{t+\tau}]}{(1+r_E)^\tau} \Leftrightarrow V_t = \sum_{\tau=1}^{\infty} \frac{E_t[fcf_{t+\tau} - int_{t+\tau}(1-s) + r_E debt_{t+\tau-1}]}{(1+r_E)^\tau} - debt_t$$

Proof:

It is sufficient to show that

$$\sum_{\tau=1}^{\infty} \frac{\Delta debt_{t+\tau}}{(1+r_E)^\tau} = \sum_{\tau=1}^{\infty} \frac{r_E debt_{t+\tau-1}}{(1+r_E)^\tau} - debt_t$$

$$\text{Let } D^T = \sum_{\tau=1}^{T} \frac{\Delta debt_{t+\tau}}{(1+r_E)^\tau}$$

Hence it follows:

$$D^T = \sum_{\tau=1}^{T} \frac{debt_{t+\tau}}{(1+r_E)^\tau} - \sum_{\tau=1}^{T} \frac{debt_{t+\tau-1}}{(1+r_E)^\tau} = \sum_{\tau=0}^{T} \frac{debt_{t+\tau}}{(1+r_E)^\tau} - \sum_{\tau=1}^{T} \frac{debt_{t+\tau-1}}{(1+r_E)^\tau} - debt_t$$

$$= \sum_{\tau=0}^{T} \frac{r_E debt_{t+\tau}}{(1+r_E)^{\tau+1}} + \sum_{\tau=1}^{T+1} \frac{debt_{t+\tau-1}}{(1+r_E)^\tau} - \sum_{\tau=1}^{T} \frac{debt_{t+\tau-1}}{(1+r_E)^\tau} - debt_t = \sum_{\tau=1}^{T+1} \frac{r_E debt_{t+\tau-1}}{(1+r_E)^\tau} + \frac{debt_{t+T}}{(1+r_E)^T} - debt_t$$

and consequently by assuming the standard transversality condition:

$$\sum_{\tau=1}^{\infty} \frac{\Delta debt_{t+\tau}}{(1+r_E)^\tau} = \lim_{T\to\infty} \sum_{\tau=1}^{T} \frac{\Delta debt_{t+\tau}}{(1+r_E)^\tau} = \lim_{T\to\infty} \sum_{\tau=1}^{T+1} \frac{r_E debt_{t+\tau-1}}{(1+r_E)^\tau} + \lim_{T\to\infty} \frac{debt_{t+T}}{(1+r_E)^T} - debt_t = \sum_{\tau=1}^{\infty} \frac{r_E debt_{t+\tau-1}}{(1+r_E)^\tau} - debt_t$$

Derivation of the WACC Model for a Company with an Infinite Life Span

Proposition:

$$V_t = \sum_{\tau=1}^{\infty} \frac{E_t[fcf_{t+\tau} - int_{t+\tau}(1-s) + r_E \cdot debt_{t+\tau-1}]}{(1+r_E)^\tau} - debt_t = \sum_{\tau=1}^{\infty} \frac{E_t[fcf_{t+\tau}]}{(1+wacc)^\tau} - debt_t$$

Proof:

Knowing that $int_{t+1} = r_D debt_t$ and using the recursive relation (valid for all t)

$$V_t = \frac{E_t[fcf_{t+1} - r_D debt_t(1-s) + r_E debt_t] + E_t[V_{t+1}]}{(1+r_E)} - debt_t$$

$$\Leftrightarrow (V_t + debt_t)(1+r_E) = E_t[fcf_{t+1}] - r_D debt_t(1-s) + r_E debt_t + E_t[V_{t+1}]$$

$$\Leftrightarrow E_t[fcf_{t+1}] = (V_t + debt_t)(1+r_E) + r_D debt_t(1-s) - r_E debt_t - E_t[V_{t+1}]$$

$$\Leftrightarrow \frac{E_t[fcf_{t+1}]}{(V_t + debt_t)} = 1 + \frac{r_E V_t}{(V_t + debt_t)} + \frac{r_D debt_t(1-s)}{(V_t + debt_t)} - \frac{E_t[V_{t+1}]}{(V_t + debt_t)} = 1 + wacc - \frac{E_t[V_{t+1}]}{(V_t + debt_t)}$$

$$V_t = \frac{E_t[fcf_{t+1}] + E_t[V_{t+1}]}{1+wacc} - debt_t$$

and hence via induction on k:

$$V_t = \sum_{\tau=1}^{k} \frac{E_t[fcf_{t+\tau}]}{(1+wacc)^\tau} + \frac{E_t[V_{t+1}]}{(1+wacc)^k} - debt_t$$

Since this relation holds for all $k \in \mathbb{N}$ and assuming transversality again yields:

$$V_t = \sum_{\tau=1}^{\infty} \frac{E_t[fcf_{t+\tau}]}{(1+wacc)^\tau} - debt_t$$

Appendix 3

Excerpt of the financial statements for the 3M Corporation between 1998 and 2003 from COMPUSTAT in millions of US-Dollars

	1998	1999	2000	2001	2002	2003
net operating assets (oa)	9,042	8,899	9,368	8,979	9,370	10,892
debt	3,106	2,610	2,837	2,893	3,377	3,007
debt in current liabilities	1,492	1,130	1,866	1,373	1,237	1,202
long term debt	1,614	1,480	971	1,520	2,140	1,805
preferred stock	0	0	0	0	0	0
stockholders' equity (bv)	5,936	6,289	6,531	6,086	5,993	7,885
net income (x^{dirt})	1,175	1,763	1,782	1,430	1,974	2,403
interest expense (int^{IS})	139	109	111	124	80	84
cash dividends (d^{cash})	887	901	918	948	968	1,034

Calculated input parameters

	1998	1999	2000	2001	2002	2003
r_E	0.1176	0.1160	0.1279	0.1077	0.0854	0.0793
r_D	0.0679	0.0663	0.0784	0.0585	0.0365	0.0309
net dividends ($d^{cash} + d^{cor}$)	1,213	1,336	1,307	1,808	1,388	1,164
x		1,689	1,549	1,363	1,295	3,056
$x^{a,dirt}$		1,074.42	977.64	726.61	1,454.26	1,927.76
fcf^{dirt}		1,972.49	1,380.71	1,894.64	1,631.80	932.24
cf^{dirt}		2,207.13	1,589.79	2,098.95	1,814.40	1,136.42
int^{NIR}		205.99	204.50	165.96	105.67	104.29
d^{cor}	326.00	435.00	389.00	860.00	420.00	130.00
$dirt^{cor}$		-74.00	-233.00	-67.00	-679.00	653.00
nir^{cor}		59.17	57.03	25.59	15.66	12.38

Intrinsic Values estimated by the DDM, the RIM and the DCF model

Dividend Discount Model

	Present Value	1999	2000	2001	2002	2003	2004
d^{cash}	11,472.09	901.00	918.00	948.00	968.00	1,034.00	1,034.00
d^{cor}	2,676.38	435.00	389.00	860.00	420.00	130.00	130.00
$dirt^{cor}$	5,041.40						653.00
$tv_{dirt}^{BSS,DDM}$	9,565.53						1,239.00
Sum of Present Value components	28,755.40						
Intrinsic Value per share	**35.77**						

Residual Income Model

	Present Value	1999	2000	2001	2002	2003	2004
bv in 1998	5,936.00						
$x^{a,dirt}$	19,284.68	1,074.42	977.64	726.61	1,454.26	1,927.76	1,927.76
$dirt^{cor}$	4,693.05	-74.00	-233.00	-67.00	-679.00	653.00	653.00
$tv^{BSS,RIM}$	-1,158.33						-150.04
Sum of Present Value components	28,755.40						
Intrinsic Value per share	**35.77**						

Discounted Cash Flow Model

	Present Value	1999	2000	2001	2002	2003	2004
cf^{dirt}	15,414.30	2,207.13	1,589.79	2,098.95	1,814.40	1,136.42	1,136.42
$dirt^{cor}$	4,693.05	-74.00	-233.00	-67.00	-679.00	653.00	653.00
nir^{cor}	230.18	59.17	57.03	25.59	15.66	12.38	12.38
$tv^{BSS,DCF}$	11,523.87						1,492.66
debt in 1998	3,106.00						
Sum of Present Value components	28,755.40						
Intrinsic Value per share	**35.77**						

Notes:
Calculations are based on a five year forecast horizon (t+5), no growth (g=0%) and a tax rate of 39%. Reported figures are in millions of US-Dollars. Implemented models are given in equation (21), (24) and (29).

Appendix 4

Variable Definitions

Label		Description	Measurement
bv_t	=	common equity total at date t	= #60
d_t^{cash}	=	common cash dividends at date t	= #21
d_t^{cor}	=	difference between stock repurchases and capital contributions at date t	= #115 - #108
$debt_t$	=	debt at date t	= (#9 + #34 + #130)
$dirt_t^{cor}$	=	dirty surplus at date t	$= x_t^{clean} - x_t$
fcf_t^{dirt}	=	free cash flow at date t	$= oi_t^{dirt} - (oa_t - oa_{t-1})$
g	=	growth rate	
int_t^{IS}	=	interest expense from the income statement at date t	= #15
int_t^{NIR}	=	interest expense derived from the net interest relation at date t	$= debt_{t-1} \cdot r_D$
oa_t	=	net operating assets at date t	= #6 - (#181 - #9 - #34)
oi_t^{dirt}	=	operating income at date t	= #172 + (1-s) · #15
P_t	=	price for a company's stock at date t	= #199
r_D	=	cost of debt	= 1 year T-Bill rate + industry specific premium depending on the credit rating by Reuters
r_E	=	cost of equity capital	= 1 year T-Bill rate + industry specific risk premium by Fama/French
r_F	=	risk free rate	= 1 year T-Bill rate
s	=	constant corporate tax rate	= 0.39[33]
V_t	=	estimate of the market value of equity at date t	
x_t	=	clean surplus income at date t	$= \#60_t - \#60_{t-1} + d_t^{cash} + d_t^{cor}$
x_t^{dirt}	=	net income at date t	= #172

We obtain the following items from COMPUSTAT [data item number (if available), (mnemonic), description]:

#6	(AT):	Assets Total
#9	(DLTT):	Long Term Debt Total
#15	(XINT):	Interest Expense
#17	(SPI):	Special Items
#18	(IB):	Income Before Extraordinary Items
#21	(DVC):	Common Cash Dividends
#25	(CSHO):	Common Shares Outstanding
#34	(DLC):	Debt in Current Liabilities
#60	(CEQ):	Common Equity Total
#108	(SSTK):	Sale of Common and Preferred Stock
#115	(PRSTKC):	Purchase of Common and Preferred Stock
#130	(PSTK):	Preferred Stock
#172	(NI):	Net Income (Loss)
#181	(LT):	Liabilities Total
#199	(PRCCF):	Price - Fiscal Year – Close
n.a.	(MKVAL):	Market Value - Total

[33] See e.g. Berk and DeMarzo [2006].

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Table 1

The Different Correction Terms – an Overview

		***d** ^{cor}*	***dirt** ^{cor}*	***nir** ^{cor}*	***tv** ^{BBS}*
explicit forecast period	**DDM^{extended}**	$\sum_{\tau=1}^{T}\frac{d^{cor}_{t+\tau}}{(1+r_E)^{\tau}}$			
	RIM^{extended}		$\sum_{\tau=1}^{T}\frac{x_{t+\tau}-x^{dirt}_{t+\tau}}{(1+r_E)^{\tau}}$		
	DCF^{extended}		$\sum_{\tau=1}^{T}\frac{x_{t+\tau}-x^{dirt}_{t+\tau}}{(1+r_E)^{\tau}}$	$\sum_{\tau=1}^{T}\frac{\left(r_D debt_{t+\tau-1}-int^{IS}_{t+\tau}\right)(1-s)}{(1+r_E)^{\tau}}$	
terminal period	**DDM^{extended}**	$\frac{d^{cor}_{t+T}(1+g)}{(1+r_E)^{T}(r_E-g)}$	$\frac{(1+g)\left(x_{t+T}-x^{dirt}_{t+T}\right)}{(1+r_E)^{T}(r_E-g)}$		$\frac{(1+g)x^{dirt}_{t+T}-g\cdot bv_{t+T}-(1+g)\left(d^{cash}_{t+T}+d^{cor}_{t+T}\right)}{(1+r_E)^{T}(r_E-g)}$
	RIM^{extended}		$\frac{(1+g)\left(x_{t+T}-x^{dirt}_{t+T}\right)}{(1+r_E)^{T}(r_E-g)}$		$\frac{-r_E\left(bv_{t+T}-(1+g)bv_{t+T-1}\right)}{(1+r_E)^{T}(r_E-g)}$
	DCF^{extended}		$\frac{(1+g)\left(x_{t+T}-x^{dirt}_{t+T}\right)}{(1+r_E)^{T}(r_E-g)}$	$\frac{\left(r_D debt_{t+T-1}-int^{IS}_{t+T}\right)(1-s)}{(1+r_E)^{T}(r_E-g)}$	$\frac{oa_{t+T}-(1+g)oa_{t+T-1}+r_E debt_{t+T}-(1+g)r_E debt_{t+T-1}}{(1+r_E)^{T}(r_E-g)}$

Notes:
DDM^{extended} denotes the extended dividend discount model according to equation (21). RIM^{extended} represents the residual income model from equation (25). DCF^{extended} is the discounted cash flow model in equation (29). The different correction terms in the terminal period are not required if a price-based terminal value is employed (see equations (22), (25), (30)). d^{cash} denotes cash dividends. d^{cor} indicates the dividend correction that comprises the difference between share repurchases and capital increases. $dirt^{cor}$ is the dirty surplus correction, nir^{cor} symbolizes the correction of the net interest relation violation and tv^{BSS} represents the difference between the steady state assumption BSS and DSS, RSS and CSS, respectively. debt denotes the interest bearing debt. x is the calculated income derived from the clean surplus relation, x^{dirt} is an actually observed income measure, bv indicates book value of equity, oa is operating assets, int^{IS} is interest expense from the income statement and s is the tax rate. r_E refers to the cost of equity, r_D denotes the cost of debt and g is the constant growth rate beyond the horizon.

Table 2

Summary Statistics by Year

Year	No. firms	Median Cost of Equity	Median Cost of Debt	Median Book Value per Share	Median Debt per Share	Median Market Value of Equity	Median Book to Market Ratio	Median Cash Dividends per Share	Median ROA	Median Payout Ratio	Median Net Dividend per Share	Median FCF per Share	Median Residual Income per Share
1987	2,166	0.1221	0.0644	5.1971	2.5279	96.8530	0.6494	0.2993	0.0495	0.3402	0.3314	0.1281	0.0640
1988	2,033	0.1310	0.0731	5.3366	2.7065	118.0930	0.6292	0.3242	0.0531	0.3215	0.3558	0.1373	0.0590
1989	1,934	0.1512	0.0933	5.5727	2.7721	138.9940	0.5987	0.3489	0.0487	0.3472	0.3413	0.1213	-0.0958
1990	1,933	0.1458	0.0879	5.6891	2.6885	119.7720	0.7157	0.3471	0.0452	0.3961	0.4186	0.1917	-0.0877
1991	1,980	0.1234	0.0655	5.7104	2.5685	155.6280	0.6051	0.3426	0.0390	0.4247	0.3000	0.2221	-0.0689
1992	2,085	0.1024	0.0447	5.6757	2.3524	165.2140	0.5609	0.3317	0.0405	0.4118	0.2910	0.1645	0.0219
1993	2,173	0.0964	0.0387	5.8544	2.2908	184.5750	0.5065	0.3054	0.0404	0.4023	0.2572	0.0965	0.0755
1994	2,210	0.1065	0.0488	5.9772	2.5282	182.6860	0.5599	0.3289	0.0474	0.3709	0.3492	0.0654	0.1762
1995	2,254	0.1234	0.0657	6.1869	2.5868	213.9805	0.5069	0.3406	0.0462	0.3277	0.3809	0.0072	0.0746
1996	2,335	0.1194	0.0617	6.4791	2.4918	246.1060	0.4833	0.3646	0.0483	0.3287	0.4136	0.0000	0.1110
1997	2,272	0.1199	0.0622	6.6493	2.6067	306.8580	0.4446	0.3741	0.0472	0.3024	0.4231	0.0042	0.0831
1998	2,129	0.1159	0.0582	6.8913	3.1743	259.5480	0.5608	0.3993	0.0427	0.3099	0.5887	0.0069	0.0590
1999	2,006	0.1143	0.0566	7.1936	3.4853	299.8670	0.6035	0.4065	0.0418	0.3149	0.6757	0.0727	0.0659
2000	1,873	0.1262	0.0693	7.6241	3.5802	297.8430	0.6289	0.4008	0.0381	0.3013	0.6669	0.0750	-0.0699
2001	1,761	0.1060	0.0498	7.7746	3.5097	362.3495	0.5818	0.4166	0.0250	0.3446	0.4373	0.1659	-0.2680
2002	1,737	0.0837	0.0275	7.8917	3.3661	291.4180	0.6857	0.4057	0.0260	0.3414	0.3819	0.3340	-0.1169
2003	1,701	0.0776	0.0214	8.7365	3.3215	472.8300	0.5216	0.4032	0.0318	0.3246	0.4066	0.2264	0.2195
2004	1,530	0.0793	0.0231	9.5025	3.6423	622.8300	0.4789	0.4553	0.0413	0.3035	0.3798	0.1860	0.4668
Mean	2,006	0.1136	0.0562	6.6635	2.9000	251.9692	0.5734	0.3664	0.0418	0.3452	0.4110	0.1225	0.0427
Std. Dev.	222	0.0205	0.0200	1.2290	0.4668	134.4656	0.0740	0.0432	0.0078	0.0395	0.1186	0.0916	0.1577

Notes:
Table values represent annual, median statistics for the sample firms. Median market value of equity is measured in millions of dollars. All other values are in US$ except for percentages. Averages and standard deviations reported in the bottom row represent time series means of the annual statistics. COMPUSTAT item numbers are given in parenthesis. We calculate cost of equity by using the one-year Treasury bill rate as the risk free rate and then adding Fama and French [1997] industry specific risk premiums (48 industry code). We calculate industry specific cost of debt by adding Reuters 5 year spreads to the risk free rate. Book value per share denotes book value of equity (#70) divided by common shares outstanding (#25). We calculate debt per share as the sum of long-term debt (#9), debt in current liabilities (#34) and preferred stock (#130) divided by common shares outstanding. We compute median cash dividends per share for dividend paying firms as common stock dividends (#21) divided by common shares outstanding. We estimate median dividend payout ratio for dividend paying firms as common stock dividends (#21) divided by net income (#172). For firms with negative earnings, we compute the payout ratio as common stock dividends divided by total assets x average median ROA (0.042). ROA is the return on total assets and is estimated as net income divided by total assets (#6). In addition to cash dividends, net dividends include the purchase (#115) and sale (#108) of stocks. We estimate free cash flow per share as operating income minus the change in net operating assets divided by common shares outstanding. Operating income denotes net income (#172) plus net interest, net of tax (#15 x (1-s)). Net operating assets are defined as assets total (#6) minus liabilities total (#181) plus long term debt total (#9) plus debt in current liabilities (#34). We calculate residual income as net income (#172) minus a charge for cost of equity employed (r_E x (#60)).

Table 3

Valuation Errors for the three Standard Models and the Extended Models

Panel A: Bias for the three Standard Models and the Extended Models

	Horizon (t+6)			
	standard models			**extended models**
	DDM	**RIM**	**DCF**	
g = 0%	60.15% (3.46%)	36.95% (18.08%)	88.24% (23.45%)	22.45% (19.63%)
g = 2%	54.02% (4.19%)	34.80% (20.26%)	78.48% (29.14%)	16.74% (24.62%)
price-based	2.57% (11.98%)	3.65% (12.76%)	2.45% (12.93%)	-1.75% (11.94%)

Panel B: Inaccuracy for the three Standard Models and the Extended Models

	Horizon (t+6)			
	standard models			**extended models**
	DDM	**RIM**	**DCF**	
g = 0%	60.15% (3.46%)	41.91% (10.18%)	94.59% (22.61%)	38.75% (11.94%)
g = 2%	54.10% (4.20%)	45.09% (12.11%)	91.57% (25.69%)	42.05% (13.66%)
price-based	14.38% (3.50%)	14.83% (3.86%)	14.72% (4.03%)	14.13% (3.68%)

Notes:
Calculations are based on a t+6 year forecast horizon. Standard models represent the model implementations according to equation (31) - (36). The extended models are given in equations (21) and (22) for the DDM, (24) and (25) for the DCF and (29) and (30) for the RIM. Signed prediction errors (bias) are calculated as (price – intrinsic value estimate)/price. Absolute prediction errors (inaccuracy) are calculated as |price – intrinsic value estimate|/price. Bias is calculated as the average of annual mean signed valuation errors across the 20 portfolios to which firms are randomly assigned in each year. Accordingly, inaccuracy is calculated as the average of annual mean absolute valuation errors across portfolios. Standard deviations (in parentheses) are calculated over annual portfolio valuation errors.

Table 4

Valuation Errors for Different Forecast Horizons

Panel A: Bias for the three Standard Models and the Extended Models for Different Forecast Horizons

	standard models			extended models
	DDM	**RIM**	**DCF**	
g = 0%				
t + 2	66.11%	44.70%	95.84%	33.18%
t + 4	62.66%	42.54%	91.68%	29.31%
t + 8	57.29%	33.33%	82.74%	17.97%
t + 10	53.81%	30.74%	79.91%	13.36%
g = 2%				
t + 2	58.72%	44.05%	83.11%	28.63%
t + 4	55.76%	41.55%	79.96%	24.57%
t + 8	51.51%	30.93%	73.22%	12.14%
t + 10	48.08%	28.13%	71.14%	7.09%
price-based				
t + 2	2.81%	3.56%	3.05%	1.68%
t + 4	3.09%	4.40%	3.50%	0.53%
t + 8	1.26%	1.27%	-0.14%	-4.77%
t + 10	2.26%	1.50%	-0.29%	-5.30%

Panel B: Inaccuracy for the three Standard Models and the Extended Models for Different Forecast Horizons

	standard models			extended models
	DDM	**RIM**	**DCF**	
g = 0%				
t + 2	66.11%	51.15%	104.94%	48.27%
t + 4	62.66%	50.07%	101.67%	44.72%
t + 8	57.29%	41.25%	94.35%	36.83%
t + 10	53.81%	37.98%	90.28%	34.58%
g = 2%				
t + 2	58.72%	52.62%	100.92%	52.18%
t + 4	55.83%	51.03%	97.78%	48.34%
t + 8	51.66%	41.61%	94.54%	40.85%
t + 10	48.08%	39.31%	91.10%	39.16%
price-based				
t + 2	11.14%	11.36%	11.44%	10.95%
t + 4	12.08%	12.95%	12.83%	11.89%
t + 8	12.40%	13.21%	13.21%	13.43%
t + 10	13.64%	13.84%	13.93%	14.11%

Notes:
The standard DDM, RIM and DCF are implemented according to equations (31) **-** (36). Signed prediction errors (bias) are calculated as $(\text{price - intrinsic value estimate})/\text{price}$. The extended models are given in equations (21) and (22) for the DDM, (24) and (25) for the DCF and (29) and (30) for the RIM. Absolute prediction errors (inaccuracy) are calculated as $|(\text{price - intrinsic value estimate})|/\text{price}$. Bias is calculated as the average of annual mean signed valuation errors across the 20 portfolios to which firms are randomly assigned in each year. Accordingly, inaccuracy is calculated as the average of annual mean absolute valuation errors across portfolios.

Table 5

Importance of the Proposed Correction Terms

Panel A: Relative Importance of the Correction Terms

Horizon (t+6)

	d^{cash}	$bv+x^{a,dirt}$	cf-debt	d^{cor}	$dirt^{cor}$	nir^{cor}	tv^{BSS}	Intrinsic Value (IV)
$DDM^{consistent}$ (g = 0%)	5.81			1.74	1.73		2.28	11.55
(% of IV)	50.32%			15.03%	14.95%		19.69%	100.00%
$RIM^{consistent}$ (g = 0%)		9.18			2.60		-0.23	11.55
(% of IV)		79.47%			22.50%		-1.97%	100.00%
$DCF^{consistent}$ (g = 0%)			1.59		2.60	-0.50	7.86	11.55
(% of IV)			13.80%		22.50%	-4.36%	68.06%	100.00%
$DDM^{consistent}$ (g = 2%)	6.75			2.00	2.21		1.50	12.46
(% of IV)	54.13%			16.08%	17.73%		12.06%	100.00%
$RIM^{consistent}$ (g = 2%)		9.51			3.08		-0.13	12.46
(% of IV)		76.32%			24.72%		-1.04%	100.00%
$DCF^{consistent}$ (g = 2%)			3.09		3.08	-0.62	6.91	12.46
(% of IV)			24.77%		24.72%	-4.94%	55.45%	100.00%
$DDM^{consistent-price}$	14.20			0.69				14.88
(% of IV)	95.38%			4.62%				100.00%
$RIM^{consistent-price}$		14.01			0.87			14.88
(% of IV)		94.14%			5.86%			100.00%
$DCF^{consistent-price}$			14.18		0.87	-0.17		14.88
(% of IV)			95.25%		5.86%	-1.11%		100.00%

Panel B: Mean Change in Bias by Introducing the Proposed Correction Terms

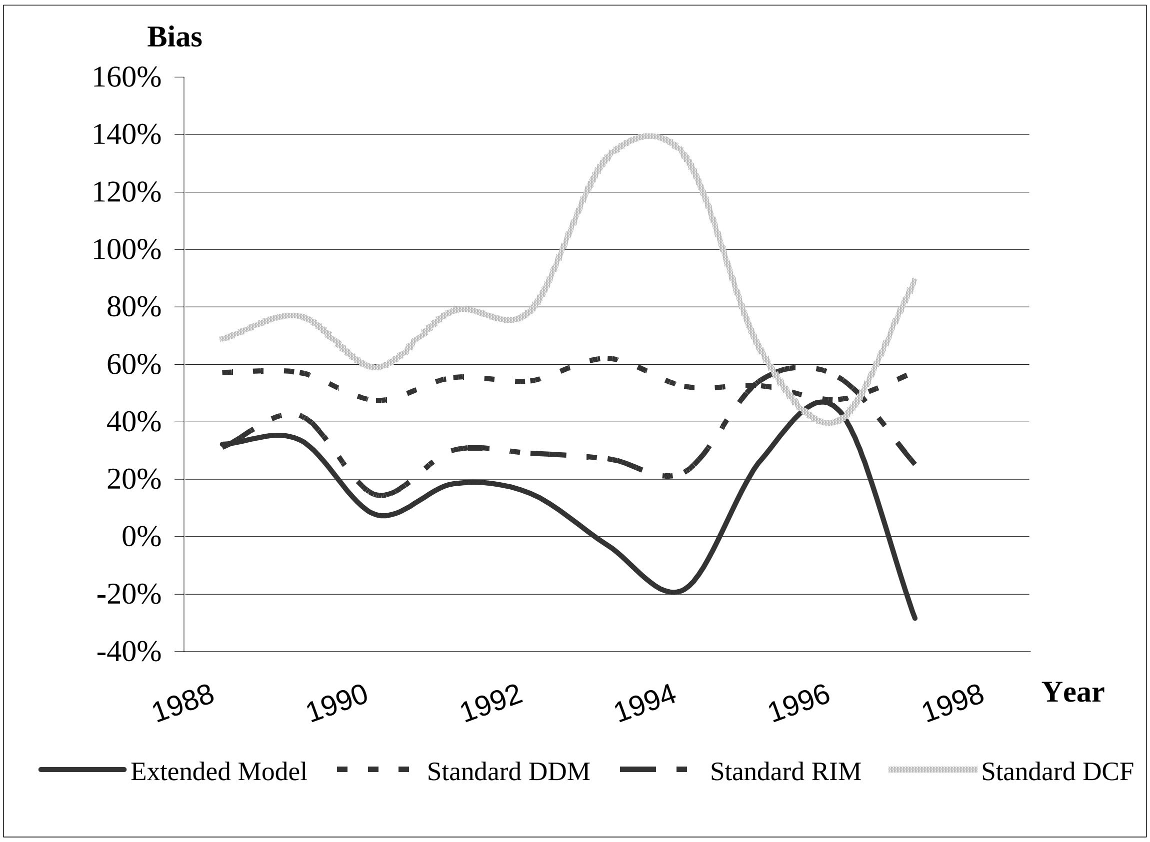
	Bias Standard Model	Change in bias				Bias Extended Model
		d^{cor}	$dirt^{cor}$	nir^{cor}	tv^{BSS}	
$DDM^{extended}$ (g = 0%)	60.15%	-11.46%	-10.85%		-15.39%	22.45%
$RIM^{extended}$ (g = 0%)	36.95%		-16.24%		1.74%	22.45%
$DCF^{extended}$ (g = 0%)	88.24%		-16.24%	3.25%	-52.79%	22.45%
$DDM^{extended}$ (g = 2%)	54.02%	-13.24%	-13.79%		-10.25%	16.74%
$RIM^{extended}$ (g = 2%)	34.80%		-19.18%		1.12%	16.74%
$DCF^{extended}$ (g = 2%)	78.48%		-19.18%	3.91%	-46.47%	16.74%
$DDM^{extended-price}$	2.57%	-4.32%				-1.75%
$RIM^{extended-price}$	3.65%		-5.39%			-1.75%
$DCF^{extended-price}$	2.45%		-5.39%	1.20%		-1.75%

Notes:
Calculations are based on a t+6 year forecast horizon. All reported components represent present values on a per share basis and are in US$. $DDM^{extended}$ denotes the extended dividend discount model according to equation (21), $DDM^{extended-price}$ is the extended model in equation (22). $RIM^{extended}$ represents the residual income model from equation (24). $RIM^{extended-price}$ is the extended RIM in equation (25). $DCF^{extended}$ is the discounted cash flow model in equation (29). $DCF^{extended-price}$ is the DCF employing a price-based terminal value according to equation (30).

bv denotes the book value of equity. debt denotes interest bearing debt, PV represents the present value of valuation components during the explicit forecast horizon. DTV are the discounted terminal value components and IV denotes the intrinsic value estimate. Signed prediction errors (bias) are calculated as (price – intrinsic value estimate)/price. Bias is calculated as the average of annual mean signed valuation errors across the 20 portfolios to which firms are randomly assigned in each year.

Figure 1

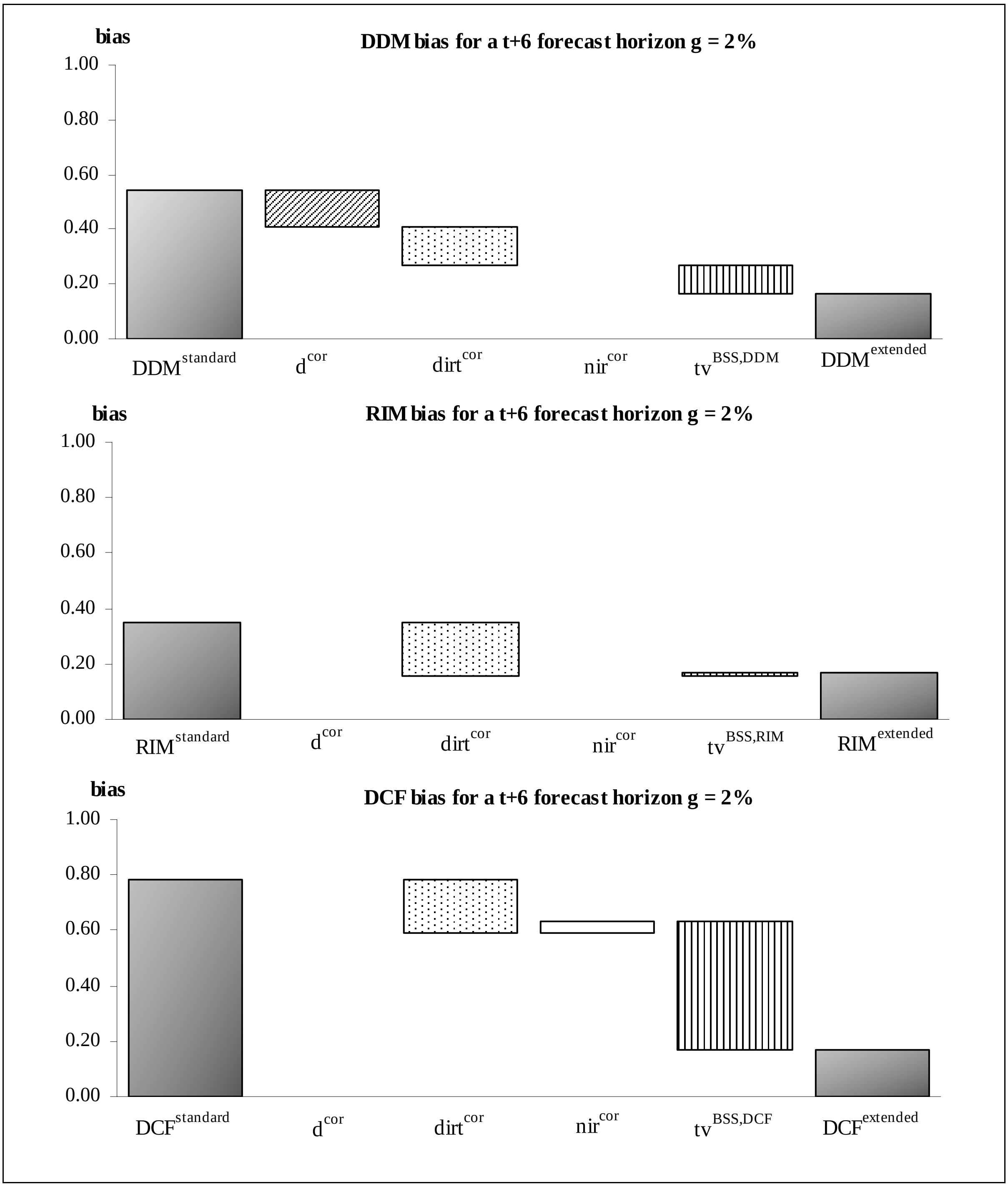
Mean Bias by Year for a t+6 Forecast Horizon and 2% Growth in the Terminal Period



Notes:
Calculations are based on a t+6 year forecast horizon. Standard models represent the model implementations according to equation (31) - (36). The extended models are given in equations (21) and (22) for the DDM, (24) and (25) for the DCF and (29) and (30) for the RIM. Signed prediction errors (bias) are calculated as (price – intrinsic value estimate)/price. Bias is calculated as the average of annual mean signed valuation errors across the 20 portfolios to which firms are randomly assigned in each year.

Figure 2

Magnitude of the different Correction Terms – an Illustration



Notes:

Calculations are based on a t+6 year forecast horizon. The mean bias of the extended and standard valuation models is calculated as $(\text{price - intrinsic value estimate})/\text{price}$. The mean bias of the correction terms is determined as the difference between the mean price and the mean present value of the correction terms divided by the mean price. DDMextended is the model according to equation (21), DDMextended-price is the model in equation (22). RIMextended represents the model in (24). RIMextended-price is the RIM in equation (25). DCFextended is the discounted cash flow model in equation (29). DCFextended-price is the DCF model employing a price-based terminal value according to equation (30). The standard versions of the DDM, RIM and DCF are given by neglecting all different correction terms in the model implementation (see equations (31) - (36)). d^{cor} is the difference between stock repurchases and capital contributions, $dirt^{cor}$ is the correction for dirty surplus accounting, nir^{cor} is the correction for violations of the net interest relation and tv^{BSS} denotes the difference between the steady state assumptions.