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, DCF, and RIM) are based on restrictive assumptions regarding the availability and quality of payoff data. Therefore, we demonstrate how to extend the standard approaches to be applicable 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 markets are aware of the standard models' deficiencies. 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.

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1 Introduction

The question of how to value corporations given future payoffs has a long tradition in both corporate finance and accounting. The standard approaches are the dividend discount model (DDM), the discounted cash flow models (DCF), and the residual income model (RIM). These models are formulated for ideal valuation conditions that require in particular clean surplus accounting and the availability of payoffs up to infinity. However, such ideal conditions are almost never encountered in practice. Therefore, in this paper we extend the three models to account for less than ideal valuation conditions. In particular, we correct for dirty surplus accounting, inconsistent growth projections in terminal value calculations, and other problems. Our extended models provide three main advantages: First, the proposed models generate considerably smaller valuation errors. This suggests that financial markets are well aware of the deficiencies of the standard models. Second, in contrast to the standard models, the extended models yield identical valuation results under less than ideal conditions. Third, 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. This sheds light on the results of previous studies, which find that the standard RIM tends to outperform the standard DDM and DCF.

Ideal valuation conditions for DDM, DCF, or RIM require in particular projections of clean surplus payoffs until infinity. Such an ideal situation is almost never given. However, a noteworthy exception may be the data gathering in a late stage of a takeover deal coming close to ideal conditions. Here, an integrated forecasting approach is implemented to project the set of (pro-forma) financial statements of a company while the forecast horizon is split into two stages, i.e. into an explicit (or detailed) planning period and a terminal (or steady state growth) period. This procedure yields, for example, (free) cash flow projections complying with clean surplus accounting and being undistorted by dividend policy considerations. However, such ideal data are rarely available for the broad public. Instead, researchers as well as most practitioners have to work with actually disclosed financial data and analysts' forecasts. Disclosed financial statements, however, are subject to dirty surplus accounting and analysts' forecasts are just targeting this distorted data. Moreover, analysts' forecasts are available only for a small number of periods and long-term growth estimates do not necessarily reflect steady state growth rates and may not be consistent with projected payout ratios.

Since the available data frequently do not match the assumptions underlying the standard DDM, DCF and RIM approaches, we extend the models to be applicable to the data researchers and practitioners have to work with. As pointed out previously by Penman (1998) and others, an important problem arises from inconsistencies between the assumed growth rate and the payout ratio. Providing conditions for steady state growth assumptions, Lundholm/O'Keefe (2001a) and Levin/Olsson (2000), for example, find that the three 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 steady state assumptions, we analyze the impact of inconsistent terminal value calculations and derive appropriate correction terms for the three standard models.

Moreover, we account for violations of other rather restrictive assumptions like the availability of clean surplus accounting data, comprehensive dividend measures, or marked to market debt values. Our extended models relax these assumptions by introducing appropriate correction terms. To correct for the prevalent dirty surplus accounting under US-GAAP, 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. In addition, the net interest relation, required for the WACC version of the DCF model, assumes that debt is marked to market. Since this assumption is frequently violated, we include a correction that accounts for differences between the interest expense according to the net interest relation and the interest expense found in the income statement. While these three corrections are easily obtained one by one, they affect both the explicit forecast period and the steady state growth period, and thus, interact with the terminal value correction. Our analysis shows how to account for these interactions. In principal, we mimic an integrated financial planning approach since our extended valuation equations are based on comprehensive (i.e. all-inclusive) payout measures and steady state growth rates that are consistent with the resulting payout ratios.

Employing our extended versions of the DDM, RIM and DCF model to a broad US dataset of realized payoffs from 1987 to 2004, we obtain the following main results: First, the proposed models are worthwhile to implement, since the valuation errors drop remarkably. Assuming 2% growth beyond a ten year explicit forecast horizon leads to very accurate value estimates and the bias even declines to 7%. Using a price-based terminal value, where price information are employed in the terminal value calculation, valuation errors are close to zero. Since each extended model nests its standard counterpart, valuation errors of the standard models are directly comparable to the extended models. In the DCF model, for example, the bias is reduced from 71% to 7%. Second, identical value estimates for the DDM, RIM and DCF model are even obtained under non-ideal valuation conditions. Besides this, we confirm the results of previous studies that forecasts at each horizon convey new value relevant information and lead to more accurate and precise value estimates. Thus, valuation errors are smaller for a longer explicit forecast horizon. The bias of the extended models decreases from 28% with a two-year explicit forecast horizon to 7% with a ten-year explicit forecast horizon. Third, the extended models allow us also to measure the magnitude of each correction separately. This is important for researchers and practitioners alike in order to assess the relative importance of deviations from ideal conditions encountered in practice. We find that disregarding the dirty surplus correction alone amounts already to an underestimation of 25% when a 2% growth is assumed in the terminal value calculation. In addition, the valuation models imply a broad classification of dividends including share sales and repurchases (see e.g. Jiang/Lee (2005)). In the DDM, the present value of the difference between share repurchases and capital increases sums to 16% of the intrinsic value estimate. This confirms findings in previous studies (see e.g. Fama/French (2001), Grullon/Michaely (2002)) that this component is of major importance since there is ample evidence that the significance of these transactions with equity owners has increased over time. In the DCF model, the precision of the valuation estimation depends by far on the selected steady state assumption. The correction that accounts for the difference between the steady state assumptions is considerably large (68% of the equity value estimate). In contrast, the adjustment for violations of the net interest relation is negligible small (4% of equity value).

Finally, our analysis sheds light on the findings of previous studies. Especially, we are able to approximate exemplarily the results of Penman/Sougiannis (1998) and Francis/Olsson/Oswald (2000). Thus, we disclose reasons *why* previous studies get different equity value estimates by disentangling ceteris paribus the effect of different steady state assumptions and non-ideal conditions.[1] Our findings are consistent with previous studies concerning the robustness of the RIM to deviations from ideal conditions but we argue that it is worthwhile to enhance even the RIM with the proposed dirty surplus correction to yield more accurate value estimates.

The remainder of this study is organized as follows. Section 2 contains the related literature. Section 3 briefly reviews the standard models and introduces the extended model versions of the DDM, RIM and DCF model. In addition, we derive model specific growth rates within the

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[1] We particularly stress that this is not a criticism. Especially Penman/Sougiannis (1998) and Francis/Olsson/Oswald (2000) performed a path breaking analyses by investigating the standard approaches and by focusing on the issue of how the models perform under common practice. However, we address another (but related) research question, namely how to extend models to account for non-ideal valuation conditions.

terminal value calculation, which correspond to the selected steady state assumption and are consistent with the payout ratio. Section 4 describes the data and contains the empirical results. We report the valuation errors for the standard and the extended models and quantify the magnitude of each correction term separately. Finally, our approach allows us to approximate and analyze the findings of previous studies. Section 5 summarizes the results and concludes.

2 Related Literature

The current study bridges the gap between the literature on company valuation and deviations from ideal conditions. Specifically, we derive adjustments for dirty surplus accounting, narrow dividend definitions and net interest relation violations.

Concerning dirty surplus, a branch of literature deals with measuring the magnitude and the value relevance of these accounting flows. Although, comprehensive income as defined in SFAS 130 is not an “all-inclusive“ income measure that completely satisfies the clean surplus relation, the other comprehensive income (OCI) is a rather good proxy for dirty surplus flows (e.g. Chambers et al. (2007)). Thus, the studies which are concerned with “other comprehensive income” are also related to our study. O'Hanlon/Pope (1999) and Dhaliwal/Subramanyam/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/Lys (2000) report that firms are comparatively strong 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 can be found in Cahan et al. (2000) with New Zealand data, Isidro/O’Hanlon/Young (2006) for France, Germany, the U.K. and the US, Wang/Buijink/Eken (2006) for the Netherlands, Kanagaretnam/Mathieu/Shehata (2005) for Canadian and US firms or Biddle/Choi (2006) and Chambers et al. (2007) all with U.S. data.[2]

However, the results on the value relevance of dirty surplus accounting flows are mixed. Dhaliwal/Subramanyam/Trezevant (1999) find no evidence for a US dataset that comprehensive income is more strongly associated with returns/market value or better predicts future cash flows/income than net income. They find some evidence between returns and unrealized gains on marketable securities. But 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/Shehata (2005) using a later dataset find a stronger

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[2] See Appendix 5 in order to assess the magnitude of dirty surplus using our dirty surplus measuring methods.

association between dirty surplus and share returns. Biddle/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. Especially, two components of OCI, foreign currency translation adjustment and unrealized gains/losses on available-for-sale securities, are priced by investors. Chambers et al. (2007) attribute the lack of consistent results in research amongst others to the different employed research designs. They claim that the results of other studies are driven by the use of data from periods before the effective date of comprehensive income reporting. The closest companion regarding the analysis of dirty surplus is Isidro/O'Hanlon/Young (2006). This study explores for four different countries the association between valuation errors from the standard RIM and violations of the clean surplus relation. For the US the study finds weak evidence of the relationship between valuation errors and dirty surplus flows. The design and results are different to our study in some aspects: In contrast to this study Isidro/O'Hanlon/Young (2006) use IBES forecasts and they implement a clean surplus RIM that is not affected by dirty surplus. Afterwards, they analyze the relationship between the resulting valuation errors of the RIM and the dirty surplus flows derived from COMPUSTAT items using linear regressions. In contrast, we integrate a dirty surplus correction directly in the RIM and find that it is worthwhile and necessary to incorporate such a correction in order to obtain more precise value estimates.

Beside the importance of consistently addressing the issue of dirty surplus accounting, our research confirms the prominent finding that transactions with the equity owners via capital increases and share repurchases have dramatically increased in the recent past (see e.g. Fama/French (2001), Grullon/Michaely (2002)). Therefore, market participants will be aware of the importance of these cash distributions and an inclusion of these cash transfers should enhance the precision of the intrinsic value estimates with the DDM.

In addition, our research design is indirectly related to the strand of literature that examines 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. However, 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. Sweeney/Warga/Winters (1997) provide strong empirical evidence that book values are a good

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

[4] Also Courteau/Kao/Richardson (2001) mention that the financial assets are marked to market is a crucial assumption in DCF valuations.

proxy for the market values of debt if long-term bond yields remain fairly stable over time but can diverge heavily during times of relatively fast interest rate adjustments. Although we rely on the book value of debt as stock variable and only use market related cost of debt via rating information and credit spreads, we provide some additional insights to this issue from the valuation perspective.

Finally, our study is related to the 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/Ohlson (1995), Penman (1998) and Levin/Olsson (2000)), but in different settings. Feltham/Ohlson (1995) show that the DDM, RIM and DCF are equivalent in infinite valuations. 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/Olsson (2000) analyze different steady state conditions and their effect on the valuation equivalence.

Given the theoretical equivalence, other studies have investigated the ability of valuation techniques to obtain reasonable estimates of market values.[5] Kaplan/Ruback (1995) analyze the ability of DCF value estimates to explain transaction values of firms engaged in high leverage transactions. They find that DCF estimates significantly outperform estimates based on comparables or multiple approaches. Penman/Sougiannis (1998) is 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 are the first to provide evidence that RIM yields the lowest valuation errors followed by the DDM and DCF model. For example, RIM shows the smallest valuation errors for a 10 year explicit forecast horizon followed by an ad-hoc perpetuity payoff (RIM: -16% vs. DCF: 82%). Francis/Olsson/Oswald (2000) employ an ex-ante approach based on analysts' forecasts and support the findings of Penman/Sougiannis (1998) that RIM is superior to DDM- and DCF approaches. In addition, Courteau/Kao/Richardson (2001) compare the DCF model to the RIM approach. Using Value Line (VL) price forecasts instead of perpetuity terminal values the authors find that DCF and RIM do not differ significantly, thus valuation equivalence cannot be rejected. Furthermore, it is shown that valuation errors of RIM and DCF are close to each other in the case of non-price terminal values.[6] However, valuation equivalence is again not fully established using real world data and the ranking performance of the three valuation models is mixed (mostly RIM tends to outperform but there are cases where DCF is preferable). Finally, Lundholm/O'Keefe (2001a) point out that the empirical findings in Penman/Sougiannis (1998), Francis/Olsson/Oswald (2000) and Courteau/Kao/Richardson (2001) are driven by the selected

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[5] See e.g. Bernard (1995), Kaplan/Ruback (1995), Frankel/Lee (1998), Sougiannis/Yaekura (2001).

[6] See Courteau/Kao/Richardson (2001).

implementation procedure.[7] The authors attribute the mixed findings in these empirical studies to three reasons: First, different steady 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 causes a breach of valuation equivalence. In addition, although the above mentioned studies demonstrate that RIM outperforms the other models, it is questionable whether the RIM is actually applied in practice. Other studies (e.g. Block (1999), Bradshaw (2002, 2004), Demirakos/Strong/Walker (2004)) show that the RIM – although theoretically desirable – is not the most often applied valuation method.

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)*[8], the market value of equity V_t at time t is obtained by discounting expected future net dividends d to shareholders at the cost of equity r_E:[9]

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

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)*.[10] Both DDM and RIM yield identical value estimates, if the clean surplus relation holds (CSR). The CSR postulates that changes in book value of equity bv between two periods result exclusively from differences between earnings x and net dividends d:

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

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[7] See also the discussion between Penman (2001) and Lundholm/O’Keefe (2001b) in the “Contemporary Accounting Research”.

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

[9] For ease of notation the (conditional on time t information) expectation operator E_t in the numerator is suppressed in the following analysis.

[10] See e.g. Preinreich (1938), Edwards/Bell (1961), Peasnell (1982).

The CSR is related to a comprehensive dividend definition since it assumes that 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[11] to the RIM:

$$\text{(RIM)} \qquad V_t = bv_t + \sum_{\tau=1}^{\infty} \frac{x_{t+\tau}^a}{\left(1+r_E\right)^{\tau}} . \qquad (3)$$

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

The third theoretically equivalent valuation approach is the *Discounted Cash Flow (DCF) Model*.[12] 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 $fcf_t = oi_t - \left(oa_t - oa_{t-1}\right)$. 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 net operating profit after adjusted taxes.[13]

From the CSR and the free cash flow definition, the financial asset relation (FAR) is obtained:[14]

$$\text{(FAR)} \qquad debt_t = debt_{t-1} + int_t\left(1-s\right) + d_t - fcf_t , \qquad (4)$$

where $debt$ is the sum of interest-bearing liabilities and preferred stock,[15] int denotes the interest expense and s represents the tax rate. By further assuming the validity of the net interest relation (NIR):

$$\text{(NIR)} \qquad int_t = r_D debt_{t-1} , \qquad (5)$$

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):

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[11] I.e. the assumption $\lim_{\tau\to\infty} \left(1+r_E\right)^{-\tau} bv_{t+\tau} \to 0$

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

[13] See also Appendix 1and Lundholm/O'Keefe (2001a), pp. 324-325 and p. 333 endnote 8.

[14] The FAR can be derived by substituting $bv_t = \left(oa_t - debt_t\right)$ in the clean surplus relation and subtracting this restated clean surplus relation $oa_t - debt_t = oa_{t-1} - debt_{t-1} + x_t - d_t$ from the free cash flow definition $oa_t = oa_{t-1} + oi_t - fcf_t$.

[15] In our analysis, we abstract from a distinction between operating and financial assets (i.e. trade securities). See for instance Feltham/Ohlson (1995), where financial assets are defined as cash and marketable securities minus debt.

$$V_t = \sum_{\tau=1}^{\infty} \frac{fcf_{t+\tau}}{\left(1+r_{WACC}\right)^{\tau}} - debt_t . \tag{6}$$

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/Richardson (2001):

$$\text{(DCF)} \qquad V_t = \sum_{\tau=1}^{\infty} \frac{\left(fcf_{t+\tau} - r_D\left(1-s\right)debt_{t+\tau-1} + r_E debt_{t+\tau-1}\right)}{\left(1+r_E\right)^{\tau}} - debt_t . \tag{7}$$

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 requires only the knowledge of the cost of equity r_E just as DDM and RIM do. Then, 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 as well as academic research, we are confronted with less than ideal conditions, in particular dirty surplus accounting. In addition, different steady state assumptions lead to inconsistencies and can have a substantial impact on the valuation. 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 surplus accounting, narrow dividend definitions and net interest relation violations.

3.2.1 Steady State Assumptions and the Calculation of a Terminal Value

The DDM, DCF and RIM equations in the preceding section require projecting all future payoffs to infinity, which is impossible in practice. Thus, the future is divided into two periods: the explicit forecast period where payoffs are projected explicitly for a limited number of years and the 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.[16]

According to Levin/Olsson (2000) the notion of steady state can be separated into necessary and sufficient conditions. While the former postulates that the qualitative behavior of a company remains constant in the terminal period i.e. valuation attributes can be expected to

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[16] It is well known that an early terminal value calculation leads to inaccurate value estimates (see e.g. Sougiannis/Yaekura (2001)).

grow at a constant rate, 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.

While it is very interesting to determine the point in time, when steady state is achieved,[17] Levin/Olsson (2000) and Lundholm/O’Keefe (2001a) focus on different steady state conditions in their derivations. Especially interesting is their finding that when all line items on the balance sheet grow with rate g (BSS), inconsistencies in calculating the model specific payoffs are avoided.

(BSS) Balance Sheet steady state: $BS_{t+T+1}^{item,i} = (1+g)BS_{t+T}^{item,i} \; \forall \, i$.

In principle, this is found in the integrated financial planning approach implemented typically by investment bankers.

In contrast, the standard models assume less sophisticated steady state conditions. For example, DDM assumes:

(DSS) Dividend steady state: $d_{t+T+1} = \left(1+g\right) d_{t+T}$,

This simple extrapolation of the last dividend by (1+g) does not take into account whether the projected dividends can be achieved given the current payout ratio. In other words, there is no feedback between growth and the necessary investment expenditures to ensure the assumed dividend increase.

Similarly, the underlying steady state assumption of the standard RIM and DCF can be formulated as:

(RSS) Residual income steady state: $x_{t+T+1}^{a} = (1+g)x_{t+T}^{a}$,

(CSS) Cash flow steady state: $cf_{t+T+1} = (1+g)cf_{t+T}$,

There the same problem arises since these conditions establish no interrealtion between payoff to investors and investment needs by the company. In contrast, BSS assures that the forecasted balance sheets and income statements are internally consistent to each other.

We expand the work of Lundholm/O´Keefe (2001a) and Levin/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 the different steady state assumptions simultaneously and to derive appropriate correction terms. In principle, our adjustment terms can be interpreted as the difference between a model derived by assuming BSS and models based on one of the other three (problematic) steady state assumptions. This results in extended valaution models which are consistent with eacher. This assumption also implies, that the return on equity

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[17] See. e.g Sougiannis/Yaekura (2001).

$\mathrm{RoE}_{t+T+\tau} \equiv (1+g)^{\tau} x_{t+T} / \left((1+g)^{\tau} bv_{t+T}\right)$ (i.e. for $\tau \geq 0$) and all other relevant parameters remain constant in the terminal period.

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

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

The first T years represent the explicit forecast period and consist of specific and exogenous dividend forecasts. In the following terminal period, the dividend is assumed to grow at the constant growth rate g. The calculation 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} 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 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]

$$d_{t+T+1} \;=\; \left(1+g\right) x_{t+T} - \left(1+g\right) bv_{t+T} + bv_{t+T} = \left(1+g\right) x_{t+T} - g \cdot bv_{t+T}\,. \tag{9}$$

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

$$d_{t+T+1} \;=\; \left(1+g\right) d_{t+T}\,. \tag{10}$$

Inserting expressions (9) and (10) into equation (8) leads to:

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

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

where $tv_{t+T+1}^{BSS,DDM}$ captures the difference between these two steady state calculations. This procedure has to be 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:

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

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[18] See Lundholm/O'Keefe (2001a).

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

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

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

$$x^{a}_{t+T+1} = (1+g)x^{a}_{t+T} = (1+g)\left(x_{t+T} - r_E bv_{t+T-1}\right). \tag{14}$$

Inserting these two expressions ((13) and (14)) into equation (12) results in:

$$V_t^{RIM} = bv_t + \sum_{\tau=1}^{T} \frac{x^{a}_{t+\tau}}{\left(1+r_E\right)^{\tau}} + \frac{\left(\left(1+g\right) x^{a}_{t+T} + tv^{BSS,RIM}_{t+T+1}\right)}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \tag{15}$$

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

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:

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

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

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

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:

$$\begin{aligned} cf_{t+T+1} = {} & \left(1+g\right) oi_{t+T} - \left(1+g\right) oa_{t+T} + oa_{t+T} \\ & -\left(1+g\right) r_D\left(1-s\right) debt_{t+T-1} + r_E debt_{t+T} \end{aligned}\,. \tag{17}$$

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

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

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

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

$$\begin{aligned} \text{with} \quad & cf_{t+\tau} = fcf_{t+\tau} - r_D\left(1-s\right) debt_{t+\tau-1} + r_E debt_{t+\tau-1}, \\ & fcf_{t+\tau} = oi_{t+\tau} - (oa_{t+\tau} - oa_{t+\tau-1}), \text{ and} \\ & tv^{BSS,DCF}_{t+T+1} = oa_{t+T} - \left(1+g\right) oa_{t+T-1} + r_E debt_{t+T} - \left(1+g\right) r_E debt_{t+T-1}. \end{aligned}$$

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).

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/Oswald (2000)) a substantial part of cash transfers is neglected. To account for this, we 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.[19] 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.[20]

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

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

[20] 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 **4**.

equity not resulting from transactions with the owners. Thus, the dirty surplus amount is then calculated as:[21]

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

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

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

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

Note that the $\mathrm{dirt}_{t+T}^{cor}$ 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 $\mathrm{dirt}_{t+T}^{cor}$ and $tv_{dirt}^{BSS,DDM}$ 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[22] 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:

$$(\mathrm{DDM}^{extended\text{-}price}) \quad V_t^{DDM,Price} = \sum_{\tau=1}^{T} \frac{\left(d_{t+\tau}^{cash} + d_{t+\tau}^{cor}\right)}{\left(1+r_E\right)^{\tau}} + \frac{P_{t+T}}{\left(1+r_E\right)^{T}}. \tag{22}$$

In contrast to the $\mathrm{DDM}^{extended}$ implementation, the correction terms dirt^{cor} and $tv_{dirt}^{BSS,DDM}$ 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.

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[21] Alternatively according to Lo/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.

[22] Providers of price forecasts are e.g. ValueLine.

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

Note that x_t^a is calculated on the supposition that the clean surplus relation holds. Hence, x_t^a 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:

$$\text{(RIM}^{\text{extended}}\text{)} \qquad V_t^{RIM} = bv_t + \sum_{\tau=1}^{T} \frac{\left(x_{t+\tau}^{a,dirt} + dirt_{t+\tau}^{cor}\right)}{\left(1+r_E\right)^{\tau}} + \frac{\left(\left(1+g\right)\left(x_{t+T}^{a,dirt} + dirt_{t+T}^{cor}\right) + tv_{t+T+1}^{cor,RIM}\right)}{\left(1+r_E\right)^{T}\left(r_E - g\right)} \tag{24}$$

$$\begin{aligned} \text{with} \qquad tv_{t+T+1}^{BSS,RIM} &= -r_E\left(bv_{t+T} - \left(1+g\right)bv_{t+T-1}\right), \text{ and} \\ dirt_t^{cor} &= x_t - x_t^{dirt}. \end{aligned}$$

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

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

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 addition, dirty surplus accounting necessitates the inclusion of an appropriate correction term in the DCF approach as can be seen from the following equation:

$$fcf_{t+\tau} = fcf_{t+\tau}^{dirt} + dirt_{t+\tau}^{cor} = \left(oi_{t+\tau}^{dirt} - (oa_{t+\tau} - oa_{t+\tau-1})\right) + dirt_{t+\tau}^{cor}. \tag{26}$$

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:

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

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

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 (equation (6)) 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:

$$nir_{t+\tau}^{cor} = \left(int_{t+\tau}^{NIR} - int_{t+\tau}^{IS}\right)(1-s) = \left(r_D debt_{t+\tau-1} - int_{t+\tau}^{IS}\right)(1-s). \tag{28}$$

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

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

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

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:

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

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

The standard models are easily obtained by setting all adjustment terms to zero. For further reference, these model versions including an explicit terminal value caculation are given by:

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

$$(\mathrm{RIM}^{\text{standard}}) \qquad V_t^{\mathrm{RIM}} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a,\mathrm{dirt}}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right) x_{t+T}^{a,\mathrm{dirt}}}{\left(1+r_E\right)^{T}\left(r_E-g\right)} \tag{32}$$

$$(\mathrm{DCF}^{\text{standard}}) \qquad V_t^{\mathrm{DCF}} = \sum_{\tau=1}^{T} \frac{cf_{t+\tau}^{\mathrm{dirt}}}{\left(1+r_E\right)^{\tau}} + \frac{\left(1+g\right) cf_{t+T}^{\mathrm{dirt}}}{\left(1+r_E\right)^{T}\left(r_E-g\right)} - debt_t \tag{33}$$

Price-based counterparts are given by

$$(\mathrm{DDM}^{\text{standard-price}}) \quad V_t^{\mathrm{DDM,Price}} = \sum_{\tau=1}^{T} \frac{d_{t+\tau}^{\mathrm{cash}}}{\left(1+r_E\right)^{\tau}} + \frac{P_{t+T}}{\left(1+r_E\right)^{T}} \tag{34}$$

$$(\mathrm{RIM}^{\text{standard-price}}) \quad V_t^{\mathrm{RIM,Price}} = bv_t + \sum_{\tau=1}^{T} \frac{x_{t+\tau}^{a,\mathrm{dirt}}}{\left(1+r_E\right)^{\tau}} + \frac{\left(P_{t+T} - bv_{t+T}\right)}{\left(1+r_E\right)^{T}} \tag{35}$$

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

4 Empirical Analysis

Based on a broad US data set of realized payoffs from 1987-2004 we report absolute intrinsic value estimates and corresponding valuation errors for our extended models. Interestingly, these extended models yield considerably smaller valuation errors as compared to the standard models. This suggests that financial markets are well aware of the standard models' deficiencies. Moreover, due to our adjustments we obtain identical valuation errors across the three models, and thus valuation equivalence is restored. This allows us then to quantify the magnitude of errors resulting from individual violations of ideal conditions. Thus, our approach provides a sort of benchmark model, which nests their standard counterpart where all corrections are neglected in the implementation. Finally, we derive conclusions about the models' robustness against violations of the underlying assumptions and resolve the puzzling and seemingly robust findings of previous studies that RIM tends to outperform the DDM and DCF model. Especially, we confirm the findings of Penman/Sougiannis (1998) and

Francis/Olsson/Oswald (2000), but disclose reasons why the DDM and DCF model yield less accurate estimates.

4.1 Data Description and Research Design

The data used in this study are taken from COMPUSTAT Annual and Research Files, which contain companies that are listed on the New York Stock Exchange (NYSE), the American Exchange (AMEX) and at the National Association of Securities Dealers Quotations (NASDAQ) market. For the cost of debt calculation credit ratings are necessary, but these are only sparsely available for firms in COMPUSTAT beginning in 1985/1986 and more reliably available starting in 1987. Therefore, our study comprises the time period from 1987 to 2004. In line with previous studies financial companies (SIC codes 6000 to 6999) are excluded from the sample due to their different characteristics. Furthermore, companies with negative equity book values, share values smaller than $1.00 and fewer than 1 million shares outstanding are excluded from the analysis. This selection procedure avoids largely distortions due to outliers and thus yields robust model estimates.[23] In total, we obtain 36,112 company years consisting of 4,285 different companies. The number of companies ranges from 1,530 companies in 2004[24] to 2,335 companies in 1996 (see Table 2 for additional details).[25] The payoff definitions and their implementation with COMPUSTAT data are given in Appendix 1.

Cost of equity r_E is estimated using the annualized one-year Treasury bill rate as the risk-free rate and then adding Fama/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%.[26]

For the cost of debt r_D Reuters industrial corporate spread data is used. Unfortunately, firm specific rating information can be obtained from COMPUSTAT only for a sub-sample of 14,675 firm years. Missing rating information is replaced by the median rating of firms in corresponding industries using the Fama/French 48 industry classification. Cost of debt are

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

[24] 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.

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

[26] 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/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 accuracy are obviously observed.

then calculated by adding Reuters 5 year spreads to the risk free rate.[27] As shown in Table 2 average median cost of debt over all years is approximately 6.5% and the median company rating is BBB.

[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. Regarding the median book to market ratio of 57% (averaged over all sample years) it becomes clear that equity book values are smaller compared to the market capitalization indicating a conservative financial reporting. The median cash dividend payments per share of dividend paying firms range from \$0.30 in 1987 to \$0.46 in 2004. The median dividend payout ratio varies from a maximum of 42% in 1991 to a minimum of 30% in the years 2000 and 2004. Average median net dividends per share (\$0.41) turn out to be higher than the 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 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/Lee (1998)).

Turning to the research design, we use realized payoff data (perfect foresight setting) in connection with a portfolio approach in line with Penman/Sougiannis (1998). Using realized data instead of forecasts is advantageous for several reasons. First, it leads to a larger database.[28] 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/Richardson (2001)). Moreover, analysts' forecasts can be biased (see e.g. Chan/Karceski/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, realized data allows exact measurement of dirty

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[27] 5 years is a reasonable assumption according to the findings of Stohs/Mauer (1996).

[28] For example, we can analyze four times more companies per year in contrast to the studies of Francis/Olsson/Oswald (2000) and Courteau/Kao/Richardson (2001) who use analyst forecasts from Value Line.

surplus amounts, growth rates of payoffs and other important input variables such as capital expenditure, 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. Most likely deviations of realized from expected values cancel out on average, if the companies are grouped into larger portfolios. Therefore, we assign companies randomly to 20 individual portfolios in order to calculate the present value for a particular year.The portfolio composition is maintained for all periods needed. 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. The randomization produces portfolios with similar characteristics, including risk and cost of capital estimates.

Based on these calculations DDM, RIM and DCF model are evaluated 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.

4.2 Empirical Results

4.2.1 Valuation Errors using the Extended Valuation Models

Table 3 depicts average valuation errors – bias (Panel A) and accuracy (Panel B) – for the three extended valuation approaches depending on the forecast horizon (t+2 to t+10) and the chosen terminal value calculation (non-price-based vs. price-based). The mean valuation errors are calculated over years of means for 20 portfolios to which firms are randomly assigned in each year.[29] Standard deviations of portfolio errors (given in parentheses below

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[29] Consequently, by forming 20 portfolios per year and assuming for example a two year forecast horizon the valuation models are for our sample period computable from 1987 to 2002. Thus, the mean valuation error is calculated over 320 portfolio values.

valuation errors) are calculated over all portfolio values. The mean number of firms in portfolios (over all years) was 69.

[Insert Table 3 about here]

The extended models yield identical valuation errors even under less than ideal conditions. By accounting for deviations from ideal conditions, the three models are now applicable to the data researchers and practitioners have to work with. Furthermore, the valuation errors decline steadily with a longer finite forecasting horizon. This steady decline of valuation errors supports the monotonicity-property developed by Ohlson/Zhang (1999). In addition, the results indicate that forecasts at each horizon convey new value relevant information and lead to more accurate and precise value estimates.

In Panel A the relative valuation errors (bias) employing a non-price-based terminal value decline from 33% to 13% with an increasing forecast horizon. Assuming a 2% growth rate in the terminal period the bias declines from 29% to 7%, thus smaller than the no growth case. The standard deviation declines with an increasing forecast horizon for the non-price-based model (with growth) from 17% to 4% (from 37% to 25%). The variation is smaller (as expected) for the price-based-model with growth. In addition, the model employing a price-based terminal value possesses by far the smallest valuation errors and standard deviations. The bias is very close to zero and varies with increasing forecast horizon between 2% and -5%. The standard deviation decreases from 11% to 8%.

The absolute valuation errors (accuracy) in Panel B are of greater magnitude. Accuracy for the non-price-based approaches again declines from 48% to 35% and with a 2% growth rate from 52% to 39%. Accuracy for the price-based terminal value decreases from 11% to 14%. The results concerning both signed and absolute valuation errors are similar to the RIM valuation errors in previous studies. However, bias and accuracy for the DDM and DCF model are considerably smaller than previously reported.[30]

The relative importance of the explicit forecast period and the terminal period of the DDM, RIM and DCF model based on a 6-year forecast horizon are analyzed in Table 4.

[Insert Table 4 about here]

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[30] For instance, Penman/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/Oswald (2000) report a bias (accuracy) 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.

For the DDM the equity value generated in the terminal period (DTV) amounts to approximately three quarters (73% for g=0%). A similar result is obtained for the DCF model, however in terms of the entity value: slightly more than three quarters of the combined value of equity and debt is determined by the terminal value (i.e. 124% of 164%). In relation to the intrinsic value (IV), the terminal value of the DCF model accounts for an extremely high fraction of intrinsic value. Consistent with prior literature, Copeland/Koller/Murrin (1995) or Courteau/Kao/Richardson (2001), for instance, report DTV amounts to 125% and 93%, respectively. While in the DDM and DCF model a similarly large fraction of value is allocated in the terminal period, a completely different picture is obtained under the RIM. Here, around two thirds (63% for g=0%) of the market value of equity is determined by its book value bv, while the terminal period accounts only for slightly less than a quarter (24%), while the rest is due to the present value of residual income in the explicit forecast horizon. These findings confirm prior literature that more wealth is captured in valuation attributes to the explicit forecast horizon under RIM than under DDM and DCF. For the DDM and the DCF model, these results seem to be quite robust for alternative assumptions regarding the terminal value calculations (i.e. a growth of 2% or a price-based calculation). For the RIM, however, the percentage of value determined by the book value of equity is sensitive to terminal assumptions. Thus, DTV becomes more important and bv is least important. For example, bv (DTV) accounts for 49% (41%) of intrinsic value estimate under $\mathrm{RIM}^{\text{extended-price}}$ and 58% (29%) under $\mathrm{RIM}^{\text{extended}}$ (g=2%) compared to $\mathrm{RIM}^{\text{extended}}$ (g=0%).

4.2.2 Relative Importance of the Correction Terms

Absolute Valuation

In this section, the importance of each valuation component including the correction terms is analyzed. It is of high interest to regard the present value of each component separately in order to evaluate their relevance. First, we analyze the absolute Dollar amounts of each component. Second, we translate these Dollar values into valuation errors.

The importance of the valuation models' particular components are analyzed on a disaggregated level in Table 5. Again, the calculations are based on a 6-year explicit forecast horizon with subsequent terminal value. As in Table 4 the extended versions of the DDM, RIM and DCF model yield identical estimates of the market value of equity ($11.55 for g=0%, $12.46 for g=2% and $14.88 for a price based terminal value).

[Insert Table 5 about here]

The DDM comprises the present value of cash dividends $\mathrm{d}^{\mathrm{cash}}$ as well as the difference between stock repurchases and capital contributions $\mathrm{d}^{\mathrm{cor}}$. $\mathrm{d}^{\mathrm{cash}}$ and $\mathrm{d}^{\mathrm{cor}}$ together account for approximately 65% of the estimated market value of equity, presuming a non-price-based terminal value without growth. Compared to $\mathrm{d}^{\mathrm{cor}}$ with 15% the cash dividends account with 50% for a higher share of the market value of equity. In addition, the DDM consists of the dirty surplus correction $\mathrm{dirt}^{\mathrm{cor}}$ and the terminal value adjustment $\mathrm{tv}^{\mathrm{BSS}}$ and they are nearly equally important. The correction $\mathrm{tv}^{\mathrm{BSS}}$ which captures the difference between the steady state assumptions BSS and DSS accounts for nearly 20% of the intrinsic value while the dirty surplus correction represents 15% of the value estimate. By introducing growth in the terminal period the share of $\mathrm{tv}^{\mathrm{BSS}}$ reduces to 12% while the other three DTV-components' percentages increase accordingly.

In the RIM the sum of book value of equity bv and the present value of residual income $\mathrm{x}^{\mathrm{a,dirt}}$ accounts with 79% for an important fraction of the estimated market value of equity in the explicit forecast horizon. While it is of highest importance to correct for dirty surplus accounting in the RIM since it accounts for 23% of the share price, the discounted difference between the steady state assumptions (BSS and RSS) represented by $\mathrm{tv}^{\mathrm{BSS}}$ amounts to a relatively small fraction of -2% compared to the other valuation approaches. Neglecting this correction would lead to a slight overestimation of the intrinsic value, but since all three models underestimate the market value for our data, this mistake turns out to be favorable, i.e. the valuation errors decrease. In contrast, omitting the dirty surplus correction would result in an underestimation of the market value of equity amounting up to \$2.60. Assuming 2% growth beyond the explicit forecast period leads to slightly larger absolute values for the sum of book value of equity and present value of abnormal earnings as well as the $\mathrm{dirt}^{\mathrm{cor}}$ term, while the $\mathrm{tv}^{\mathrm{BSS}}$ increases to -1% of the share price. If a price-based terminal value is employed in the RIM, only the dirty surplus correction is necessary. The $\mathrm{dirt}^{\mathrm{cor}}$ term amounts to 6%, so even with a price-based terminal value it is worthwhile to consider.

Turning to the extended DCF model, beside the difference of the present value of cash flows and interest bearing debt $(\mathrm{cf}-\mathrm{debt})$ three additional correction terms, i.e. corrections for violations of the net interest relation $\mathrm{nir}^{\mathrm{cor}}$, for dirty surplus $\mathrm{dirt}^{\mathrm{cor}}$ and for different steady state assumptions $\mathrm{tv}^{\mathrm{BSS}}$ are considered. The present value of the correction components together accounts for approximately 86% of the mean intrinsic value estimate. The by far largest correction term is $\mathrm{tv}^{\mathrm{BSS}}$ with 68% or \$7.86 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. Thus, the CSS condition leads to heavy distortions of the intrinsic value estimate.

The dirty surplus correction is of same importance as in the RIM (23%), whereas $\mathrm{nir}^{\mathrm{cor}}$ is with -4.36% rather small (the negative sign indicates that $\mathrm{int}_{t+T}^{\mathrm{IS}} > \mathrm{int}_{t+T}^{\mathrm{NIR}}$). While these findings are similar for the 2% growth case, they are different for the price-based terminal value. In this setting, no terminal value adjustment is necessary and the present value of free cash flows and the discounted price-based terminal value minus debt account for 95% of the share price. Obviously, the remaining correction terms ($\mathrm{dirt}^{\mathrm{cor}}$ and $\mathrm{nir}^{\mathrm{cor}}$) sum up to 5%.

Valuation Errors

In a next step, we translate the absolute Dollar amounts into valuation errors, in order to analyze the importance of each correction by benchmarking the estimates against their market values.

As starting point we employ the standard models as outlined in section 3.3, since these models allow us to analyze the effect on the valuation errors (bias and accuracy) by leaving out the different correction terms.

[Insert Table 6 about here]

Table 6 depicts the bias (Panel A) and the accuracy (Panel B) of the standard valuation models DDM, RIM and DCF for different terminal value calculations and explicit forecast horizons. As in the extended models, valuation errors decrease with an increasing explicit forecast horizon. In addition, the employment of a terminal value with growth leads to smaller valuation errors as compared to the non-growth case.

By leaving out all correction terms, the standard RIM turns out to be the least affected valuation method in terms of bias and accuracy, followed by DDM and DCF model.[31] Especially, we find that the RIM is more robust concerning the selected steady state assumption. Nevertheless, this is consistent since the terminal value plays only a minor role in determining the market value of equity. The bias of the RIM decreases from 45% with a two-year explicit forecast horizon to 31% with a ten-year finite forecast horizon (see Panel A). For

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[31] Moreover, we calculate logarithmic valuation errors (not reported) as proposed by Dittmann/Maug (2007). In contrast to Dittmann/Maug (2007) our ranking of the three valuation models does not depend on the error measure.

the standard DDM (standard DCF model) the bias decreases from 66.11% (95.84%) to 53.81% (79.91%) with an increasing forecast horizon assuming no growth. Especially the DCF model is heavily affected by neglecting the proposed corrections. The bias resulting from the application of a price-based terminal value is close to zero and differs only insignificantly employing the Wilcoxon signed rank test (not reported) among the approaches. The volatility of the valuation errors is the lowest for DDM (5% for t+2), supposedly caused by commonly practiced dividend smoothing. In contrast, the DCF model possesses a considerably high variation up to 34%. The results in Panel B are qualitative similar, however the absolute valuation errors have a slightly higher level. Note that the valuation errors in terms of accuracy and bias are nearly the same for the standard DDM since we underestimate usually the actual traded price independently of the selected growth in the terminal period.

Compared to the extended model implementation (Table 3), the valuation errors for the standard valuation models are significantly higher for all three approaches. The RIM shows thereof the lowest increment with regard to bias. The DCF model and the DDM show heavily biased market value estimates due to the simplified implementation where all corrections are neglected. Thus, the RIM seems to be more robust since there is less room for mistakes due to the inclusion of the book value of equity. The difference between the accuracy of the benchmark model (Panel B in Table 3) and the accuracy of the standard model (Panel B in Table 6) is smaller for all three models. The change in accuracy is the lowest for RIM and the highest for the DCF model.

Finally, in Figure 1 we illustrate exemplarily the importance of the different correction terms for a t+6 forecast horizon in terms of the bias. 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 1 about here]

As can be seen from this figure, the extended DDM requires three corrections and all of them are nearly equally important. Furthermore, the RIM is most heavily affected by dirty surplus accounting and the terminal value calculation is only of minor importance. The DCF model requires three adjustment terms, from which the difference between the steady state assumptions is by far the most important correction. This result points out the importance of an adequate steady state assumption within the terminal value calculation. Moreover, it demonstrates that the CSS condition is not a reasonable assumption as long as the same growth rate is used in all three models. The dirty surplus correction should also be considered in the DCF model in order to yield meaningful and less biased results. Since the dirty surplus correction occurs only in the terminal period of the DDM, this correction is smaller than in the DCF model and the RIM.

In the end, all three equity valuation techniques yield identical intrinsic value estimates, if one accounts for deviations from ideal conditions. Overall, the RIM is more robust against less than ideal conditions, but also heavily affected by dirty surplus accounting.

4.2.3 Approximating Pricing Errors from Prior Studies

The findings outlined in the preceding section allow us to resolve the puzzling findings of different equity value estimates obtained in previous studies. Exemplarily, we approximate the results of Penman/Sougiannis (1998) and Francis/Olsson/Oswald (2000).[32] Most importantly, by employing the above outlined standard model implementations we expect to confirm their results, i.e. RIM outperforms DDM and DCF. We are well aware that these studies have another purpose by trying to replicate the situation of a typical investor facing an investment decision. Although these studies demonstrate that RIM outperforms the other models, it is questionable whether the RIM is actually applied in practice. Other studies (e.g. Block (1999), Bradshaw (2002, 2004), Demirakos/Strong/Walker (2004)) show that the RIM – although theoretically desirable – is not the most often applied valuation method and thus we suppose that observed market prices cannot reflect RIM estimates. From this point of view, one might argue that investment professionals are sophisticated users of our proposed extended DCF model.

[Insert Table 7 about here]

As shown in Table 7 the ranking of our standard model implementation corresponds entirely with the findings in Penman/Sougiannis (1998) since RIM performs best, second DDM and third DCF in terms of the bias. Francis/Olsson/Oswald (2000) employ forecasts instead of realized values, but again, the RIM performs best independent of the chosen evaluation criteria. Only minor differences are observed with regard to the second and third placement depending on the chosen performance measure. While the implementation of Francis/Olsson/Oswald (2000) result in a second place for the DCF model with regard to bias,

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[32] Courteau/Kao/Richardson (2001) implement the terminal value of the RIM and DCF model according to the BSS assumption. We suppose that the differences in bias and accuracy in their study are amongst others mainly caused by the missing dirty surplus correction.

it is ranked third in our study. However, regarding accuracy, Francis/Olsson/Oswald (2000) place the DCF always second and the DDM third, which might be due their specific DCF model implementation and necessary approximations.[33]

Overall, our hypothesis is confirmed that the ranking of the three intrinsic value methods depends on the violations of ideal conditions and the different steady state assumptions. Finally, we have shown that controlled deviations from our extended model implementations allow us to reconcile the empirical rankings of the above mentioned studies. Thus, the proposed extended models could be used as a benchmark to measure deviations from ideal conditions and to analyze their impact in a systematic manner.

5 Conclusion

This study is motivated by the fact that the standard DDM, RIM and DCF model are formulated for ideal valuation conditions but such ideal conditions are almost never encountered in practice. Therefore, in this paper we extend the three models to account for less than ideal valuation conditions. Our main three findings are: First, the proposed models generate considerably smaller valuation errors. This result suggests that financial markets are well aware of the deficiencies of the standard models. Second, in contrast to the standard models, the extended models naturally yield identical valuation results under less than ideal conditions. Third, 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. This sheds light on the results of previous studies, which find that the standard RIM tends to outperform the standard DDM and DCF. In addition, it provides guidance to future studies by shifting the focus to dirty surplus accounting effects.

Within our extended models, we derive appropriate correction terms for the models in order to account for deviations from ideal conditions. In particular, we correct for dirty surplus accounting, narrow dividend definitions, net interest relation violations and inconsistent growth projections in terminal value calculations.

We demonstrate that it is worthwhile to apply this approach with all corrections since the obtained value estimates are more accurate in terms of bias and accuracy. Assuming a 2% growth rate in the terminal period, valuation errors are smaller than in the no growth case and close to zero if a price-based terminal value is employed.

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[33] Exemplarily, the authors approximate the WACC with target weights inferred from Value Line. In contrast to our study, they add excess cash and marketable securities to the firm value and they set the free cash flow equal to zero in the terminal period if the free cash flow is smaller than zero, which is not an issue in our portfolio approach.

Compared to the DDM and DCF model, the RIM is more robust against deviations from ideal conditions. Under RIM, more wealth is captured in valuation attributes during the explicit forecast horizon and thus, the terminal value in conjunction with the selected steady state assumption is less important. However, in the DDM and DCF model different steady state assumptions result in completely different estimates and thus are more severe. In the DCF model the difference between the steady state assumptions (BSS and CSS) is by far the largest correction term with around 68% of the equity value estimate. This different importance of the steady state assumption is also pointed out by the higher growth rate adjustments. Neglecting the dirty surplus correction term leads to considerably higher valuation errors for all models. The bias resulting from dirty surplus accounting is smallest for the DDM since the corresponding correction is only necessary in the terminal period. Regarding the RIM and DCF model the correction for dirty surplus accounting amounts up to 25% of the share price. Moreover, we point out the importance of a broad dividend definition in the DDM since the significance of this component has increased remarkably over time. This dividend correction (share sales minus share repurchases) leads to significantly smaller valuation errors. However, the adjustment for violations of the net interest relation is negligible small.

By leaving out the different corrections we are able to approximate the findings of previous studies. The ranking of our standard model implementation corresponds entirely with the findings in Penman/Sougiannis (1998) - RIM performs best, second DDM and third DCF regarding bias as performance criterion. Moreover, we confirm the studies employing analyst forecasts that RIM outperforms DDM and DCF model.

For practitioners and researchers dealing with financial statement analysis, our paper contains several important messages. We propose extended model versions of the DDM, RIM and DCF model which are now applicable even under less than ideal valuation conditions, i.e. “real world data”. Moreover, we demonstrate that it is worthwhile to implement these corrections even in the RIM in order to obtain smaller valuation errors. In addition, we agree with other studies that RIM is more robust against different steady state assumptions and if less than ideal conditions are given. Based on our theoretical and empirical findings, we suggest in line with other researchers, that subsequent efforts should be directed to the important issue how future payoff forecasts can be improved. Finally, the here proposed models provides a guideline and starting point for this issue since it shifts the research question from “what is the best model” to “how could valuation be improved”.

References

Berk, J.; and P. DeMarzo. *Corporate Finance.* Boston, MA: Addison-Wesley, 2006.

Bernard, V. “The Feltham-Ohlson Framework: Implications for Empiricists.” *Contemporary Accounting Research* 11 (1995): 733 - 47.

Bhojraj, S.; and C. Lee. “Who Is My Peer? A Valuation-Based Approach to the Selection of Comparable Firms.” *Journal of Accounting Research* 40 (2002): 407 - 39.

Biddle, G. C.; and J.-H. Choi. “Is Comprehensive Income Useful?“ *Journal of Contemporary Accounting and Economics* 2 (2006): 387 - 405

Block, S. “A study of Financial Analysts: Practice and theory.” *Financial Analysts Journal* 55 (1999): 86 - 95.

Bowman, R. G. “The Theoretical Relationship Between Systematic Risk and Financial (Accounting) Variables” *Journal of Finance* 34 (1979): 617 - 630.

Bradshaw, M. “The Use of Target Prices to Justify Sell-Side Analysts' Stock Recommendations.“ *Accounting Horizons* 16 (2002): 27 - 41.

Bradshaw, M. "How Do Analysts Use Their Earnings Forecasts in Generating Stock Recommendations?" *The Accounting Review* 79 (2004): 25 - 50.

Cahan, S. F.; and S. M. Courtenay; P. L. Gronewoller; and D. R. Upton. “Value Relevance of Mandated Comprehensive Income Disclosures.” *Journal of Business Finance & Accounting* 27 (2000): 1273 – 301.

Chan, L.; J. Karceski; and J. Lakonishok. “The Level and Persistence of Growth Rates.” *Journal of Finance* 58 (2003): 643 - 84.

Chambers, D.; T.J. Linsmeier; C. Shakespeare; T. Sougiannis. “An evaluation of SFAS No. 130 comprehensive income disclosures” *Review of Accounting Studies* 12 (2007): 557 - 593.

Copeland, T.; T. Koller; and J. Murrin. *Valuation: Measuring and Managing the Value of Companies*, 2nd ed. New York: Wiley, 1994.

Courteau, L.; J. Kao; and G. Richardson. “Equity Valuation employing the Ideal versus Ad Hoc Terminal Value Expressions.” *Contemporary Accounting Research* 18 (2001): 625 - 61.

Dhaliwal, D., and K. Subramanyam, R.H. Trezevant. “Is Comprehensive Income Superior to Net Income as a Summary Measure of Firm Performance?” *Journal of Accounting and Economics* 26 (1999), 43 - 67.

Demirakos, E.; C. Strong; and M. Walker. “What Valuation Models Do Analysts Use?” *Accounting Horizons* 18 (2004): 221-40.

Dittmann, I.; and E. Maug. “Biases and Error Measures: How to Compare Valuation Method.” Working Paper, University of Mannheim, 2007.

Edwards, E.; and P. Bell. *The Theory and Measurement of Business Income*, Berkeley: University of California Press, 1961.

Fama, E.; and K. French. “Industry costs of equity.” *Journal of Financial Economics* 43 (1997): 153 - 93.

Fama, E.; and K. French. “Disappearing dividends: changing firm characteristics or lower propensity to pay?” *Journal of Financial Economics* 60 (2001): 3 - 43.

Feltham, G.; and J. Ohlson. “Valuation and Clean Surplus Accounting for Operating and Financial Activities.” *Contemporary Accounting Research* 11 (1995): 689 - 731.

Fernández, P. *Valuation Methods and Shareholder Value Creation*, New York: Academic Press, 2002.

Francis, J.; P. Olsson; and D. Oswald. “Comparing the accuracy and explainability of dividend, free cash flow, and abnormal earnings equity value estimates.” *Journal of Accounting Research* 38 (2000): 45 - 70.

Frankel, Richard; and C. Lee. “Accounting valuation, market expectation, and cross-sectional stock returns.” *Journal of Accounting and Economics* 25 (1998): 283 - 319.

Gordon, M. “Dividends, Earnings, and Stock-Prices.” *Review of Economics and Statistics* 41 (1959): 99 - 105.

Gordon, M.; and E. Shapiro. “Capital Equipment Analysis: The Required Rate of Profit.” *Management Science* 3 (1956): 102 - 10.

Grullon, G.; and R. Michaely. “Dividends, Share Repurchases, and the Substitution Hypothesis.” *Journal of Finance* 57 (2002): 1649 - 84.

Ibbotson, R.; and R. Sinquefield. *Stocks, Bonds, Bills and Inflation, 1962 – 1992.* Charlottesville, Va.: Financial Analysts Research Foundation, 1993.

Isidro, H. D.; J. F. O’Hanlon; and S. E. Young. “Dirty surplus accounting flows and valuation errors.” *Abacus* 42 (2006), 302 - 344.

Jiang, X.; and B. Lee. “An empirical test of the accounting-based residual income model and the traditional dividend discount model.” (2005), *Journal of Business* 78 (2005): 1465 - 1504.

Kanagaretnam, K., R. Mathieu and M. Shehata. “Usefulness of Comprehensive Income Reporting in Canada”, Working Paper, 2005.

Kaplan, S.; and R. Ruback. “The Valuation of Cash Flow Forecasts: An Empirical Analysis.” *Journal of Finance* 50 (1995): 1059-93.

Koller, T.; M. Goedhart; and D. Wessels. *Valuation: Measuring and Managing the Value of Companies*. 4th ed. New York: Wiley, 2005.

Levin, J., and P. Olsson. “Terminal Value Techniques in Equity Valuation – Implications of the Steady State Assumption”, Working Paper, Stockholm School of Economics, 2000.

Levin J. “On the General Equivalence of Company Valuation Models”, Working Paper, Stockholm School of Economics, 1998.

Liu, J.; D. Nissim; and J. Thomas. “Equity Valuation Using Multiples.” *Journal of Accounting Research* 40 (2002): 135 - 72.

Lo, K.; and T. Lys. “The Ohlson Model: Contribution to Valuation Theory, Limitations and Empirical Applications.” *Journal of Accounting, Auditing & Finance* 15 (2000): 337 - 66.

Lundholm, R.; and T. O'Keefe. “Reconciling Value Estimates from the Discounted Cash Flow Model and the Residual Income Model.” *Contemporary Accounting Research* 18 (2001a): 311 - 35.

Lundholm, R.; and T. O’Keefe. “On Comparing Cash Flow and Accrual Accounting Models for Use in Equity Valuation: A Response to Penman 2001.” *Contemporary Accounting Research* 18 (2001b), 693 - 6.

Modigliani, F.; and M. Miller. “Corporate Income Taxes and the Cost of Capital - A Correction.”, *American Economic Review* 53 (1963): 433 - 43.

Modigliani, F.; and M. Miller. “The Cost of Capital, Corporation Finance and the Theory of Investment.” *American Economic Review* 48 (1958): 261 - 97.

Ohlson, J.; and X. Zhang. “On the theory of forecast horizon in equity valuation.” *Journal of Accounting Research* 37 (1999): 437 - 49.

Ohlson, J. “Earnings, Book Values, and Dividends in Equity Valuation.” *Contemporary Accounting Research* 11 (1995): 661 - 87.

O’Hanlon, J.F.; and P.F. Pope. “The value-relevance of UK dirty surplus accounting flows”, *British Accounting Review* 31 (1999), 459-82.

Peasnell, K. “Some formal connections between economic values and yields and accounting numbers.” *Journal of Business, Finance & Accounting* 9 (1982): 361 – 81.

Penman, S. “A Synthesis of Equity Valuation Techniques and the Terminal Value Calculation for the Dividend Discount Model.” *Review of Accounting Studies* 2 (1998): 303 - 23.

Penman, S.; and T. Sougiannis. “A Comparison of Dividend, Cash Flow, and Earnings Approaches to Equity Valuation.” *Contemporary Accounting Research* 15 (1998): 343 - 83.

Penman, S. “On Comparing Cash Flow and Accrual Accounting Models for Use in Equity Valuation: A Response to Lundholm and O’Keefe” *Contemporary Accounting Research* 18 (2001): 681 - 92.

Preinreich, G. “Annual Survey of Economic Theory: The Theory of Depreciation.”, *Econometrica* 6 (1938): 219 - 41.

Rappaport, A. *Creating Shareholder Value: The New Standard for Business Performance*. New York: Free Press, 1986.

Stohs, M.; and D. Mauer. “The determinants of corporate debt maturity structure.” *Journal of Business* 69 (1996): 279 - 312.

Sougiannis T.; and T. Yaekura. “The Accuracy and Bias of Equity Values Inferred from Analysts‘ Earnings Forecasts“ *Journal of Accounting, Auditing & Finance* 16 (2001): 311-62.

Sweeney, R. J.; A. D. Warga and D. Winters. “The Market Value of Debt, Market Versus Book Value of Debt, and Returns to Assets” *Financial Management* 26 (1997): 5 - 21.

Wang, Y.; W. Buijink; and R. Eken. “The value relevance of dirty surplus accounting flows in The Netherlands.“ *International Journal in Accounting* 41 (2006): 387 - 405.

Williams, J. *The Theory of Investment Value.* Cambridge, MA: Harvard University Press, 1938.

Table 1

The Different Correction Terms – an Overview

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

Notes:
DDM$^{\text{extended}}$ denotes the extended dividend discount model according to equation (21). RIM$^{\text{extended}}$ represents the residual income model from equation (25). DCF$^{\text{extended}}$ 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 which 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	0.0723	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	0.0806	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	0.1005	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	0.0951	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	0.0729	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	0.0524	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	0.0468	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	0.0573	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	0.0743	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	0.0703	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	0.0702	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	0.0663	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	0.0649	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	0.0772	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	0.0573	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	0.0364	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	0.0309	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	0.0320	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	0.0643	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	0.0195	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. The cost of equity are calculated by using the one-year Treasury bill rate as the risk free rate and then adding Fama/French (1997) industry specific risk premiums (48 industry code). Industry specific cost of debt are calculated 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). Debt per share is calculated as the sum of long-term debt (#9), debt in current liabilities (#34) and preferred stock (#130) divided by common shares outstanding. Median cash dividends per share are computed for dividend paying firms as common stock dividends (#21) divided by common shares outstanding. Median dividend payout ratio is estimated for dividend paying firms as common stock dividends (#21) divided by net income (#172). For firms with negative earnings, payout ratio is computed 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. Free cash flow per share is estimated 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). Residual income is calculated as net income (#172) minus a charge for cost of equity employed (r_E x (#60)).

Table 3

Panel A: Mean Signed Prediction Errors (Bias) using an Extended Application

	Horizon (t+T)				
	t+2	t+4	t+6	t+8	t+10
DDM^{extended} ; RIM^{extended} ; DCF^{extended} (g = 0%)	0.3318 (0.1684)	0.2931 (0.1712)	0.2245 (0.1044)	0.1797 (0.1261)	0.1336 (0.0428)
DDM^{extended} ; RIM^{extended} ; DCF^{extended} (g = 2%)	0.2863 (0.3667)	0.2457 (0.3430)	0.1674 (0.2462)	0.1214 (0.2744)	0.0709 (0.2545)
DDM$^{extended\text{-}price}$; RIM$^{extended\text{-}price}$; DCF$^{extended\text{-}price}$	0.0168 (0.1077)	0.0053 (0.1009)	-0.0175 (0.1194)	-0.0477 (0.0937)	-0.0530 (0.0801)

Panel B: Mean Absolute Prediction Errors (Accuracy) using an Extended Application

	Horizon (t+T)				
	t+2	t+4	t+6	t+8	t+10
DDM^{extended} ; RIM^{extended} ; DCF^{extended} (g = 0%)	0.4827 (0.1077)	0.4472 (0.1009)	0.3875 (0.1194)	0.3683 (0.0937)	0.3458 (0.0801)
DDM^{extended} ; RIM^{extended} ; DCF^{extended} (g = 2%)	0.5218 (0.2165)	0.4834 (0.2084)	0.4205 (0.1366)	0.4085 (0.1817)	0.3916 (0.0778)
DDM$^{extended\text{-}price}$; RIM$^{extended\text{-}price}$; DCF$^{extended\text{-}price}$	0.1095 (0.0503)	0.1189 (0.0366)	0.1413 (0.0368)	0.1343 (0.0515)	0.1411 (0.0415)

Notes:
DDM^{extended} denotes the extended dividend discount model according to equation (21), DDM$^{extended\text{-}price}$ is the extended model in equation (22). RIM^{extended} represents the residual income model from equation (24). RIM$^{extended\text{-}price}$ is the extended RIM in equation (25). DCF^{extended} is the discounted cash flow model in equation (29). DCF$^{extended\text{-}price}$ is the DCF employing a price-based terminal value according to equation (30). Signed prediction errors (bias) are calculated as $(\text{price - intrinsic value estimate})/\text{price}$. Absolute prediction errors (accuracy) are calculated as $\left|(\text{price - intrinsic value estimate})\right|/\text{price}$. Means are means over years of means for 20 portfolios to which firms are randomly assigned in each year. Standard deviation in parentheses represent the standard deviation over all portfolio valuation errors for a given horizon.

Table 4

Relative Importance of the Explicit Forecast Period and the Terminal Period

	Horizon (t+6)				
	Mean bv (% of mean IV)	Mean debt (% of mean IV)	Mean PV (% of mean IV)	Mean DTV (% of mean IV)	Mean Intrinsic Value (IV) (% of mean IV)
DDM$^{\text{extended}}$ (g = 0%)			3.14	8.41	11.55
(% of IV)			27.21%	72.79%	100.00%
RIM$^{\text{extended}}$ (g = 0%)	7.29		1.51	2.76	11.55
(% of IV)	63.08%		13.03%	23.89%	100.00%
DCF$^{\text{extended}}$ (g = 0%)		-7.40	4.57	14.38	11.55
(% of IV)		-64.05%	39.59%	124.46%	100.00%
DDM$^{\text{extended}}$ (g = 2%)			3.14	9.32	12.46
(% of IV)			25.23%	74.77%	100.00%
RIM$^{\text{extended}}$ (g = 2%)	7.29		1.51	3.67	12.46
(% of IV)	58.48%		12.08%	29.45%	100.00%
DCF$^{\text{extended}}$ (g = 2%)		-7.40	4.57	15.29	12.46
(% of IV)		-59.38%	36.70%	122.68%	100.00%
DDM$^{\text{extended-price}}$			3.14	11.74	14.88
(% of IV)			21.13%	78.87%	100.00%
RIM$^{\text{extended-price}}$	7.29		1.51	6.09	14.88
(% of IV)	48.97%		10.11%	40.92%	100.00%
DCF$^{\text{extended-price}}$		-7.40	4.57	17.71	14.88
(% of IV)		-49.72%	30.73%	118.99%	100.00%

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$. DDM$^{\text{extended}}$ denotes the extended dividend discount model according to equation (21), DDM$^{\text{extended-price}}$ is the extended model in equation (22). RIM$^{\text{extended}}$ represents the residual income model from equation (24). RIM$^{\text{extended-price}}$ is the extended RIM in equation (25). DCF$^{\text{extended}}$ is the discounted cash flow model in equation (29). DCF$^{\text{extended-price}}$ 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.

Table 5

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)
$DDM^{extended}$ (g = 0%)	5.81			1.74	1.73		2.28	11.55
(% of IV)	50.32%			15.03%	14.95%		19.69%	100.00%
$RIM^{extended}$ (g = 0%)		9.18			2.60		-0.23	11.55
(% of IV)		79.47%			22.50%		-1.97%	100.00%
$DCF^{extended}$ (g = 0%)			1.59		2.60	-0.50	7.86	11.55
(% of IV)			13.80%		22.50%	-4.36%	68.06%	100.00%
$DDM^{extended}$ (g = 2%)	6.75			2.00	2.21		1.50	12.46
(% of IV)	54.13%			16.08%	17.73%		12.06%	100.00%
$RIM^{extended}$ (g = 2%)		9.51			3.08		-0.13	12.46
(% of IV)		76.32%			24.72%		-1.04%	100.00%
$DCF^{extended}$ (g = 2%)			3.09		3.08	-0.62	6.91	12.46
(% of IV)			24.77%		24.72%	-4.94%	55.45%	100.00%
$DDM^{extended\text{-}price}$	14.20			0.69				14.88
(% of IV)	95.38%			4.62%				100.00%
$RIM^{extended\text{-}price}$		14.01			0.87			14.88
(% of IV)		94.14%			5.86%			100.00%
$DCF^{extended\text{-}price}$			14.18		0.87	-0.17		14.88
(% of IV)			95.25%		5.86%	-1.11%		100.00%

Notes:
Calculations are based on a t+6 year forecast horizon. All reported components represent mean present values on a per share basis and are in US$. $DDM^{extended}$ denotes the extended dividend discount model according to equation (21), $DDM^{extended\text{-}price}$ is the model in equation (22). $RIM^{extended}$ represents the residual income model from equation (24). $RIM^{extended\text{-}price}$ is the extended RIM in equation (25). $DCF^{extended}$ is the discounted cash flow model in equation (29). $DCF^{extended\text{-}price}$ is the DCF employing a price-based terminal value according to equation (30). d^{cash} are cash dividends, bv denotes book value of equity, $x^{a,dirt}$ is residual income, cf indicates the cash flow, 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 corresponding steady state assumptions. IV denotes the intrinsic value estimate.

Table 6

Panel A: Mean Signed Prediction Errors (Bias) using the Standard Model Implementation

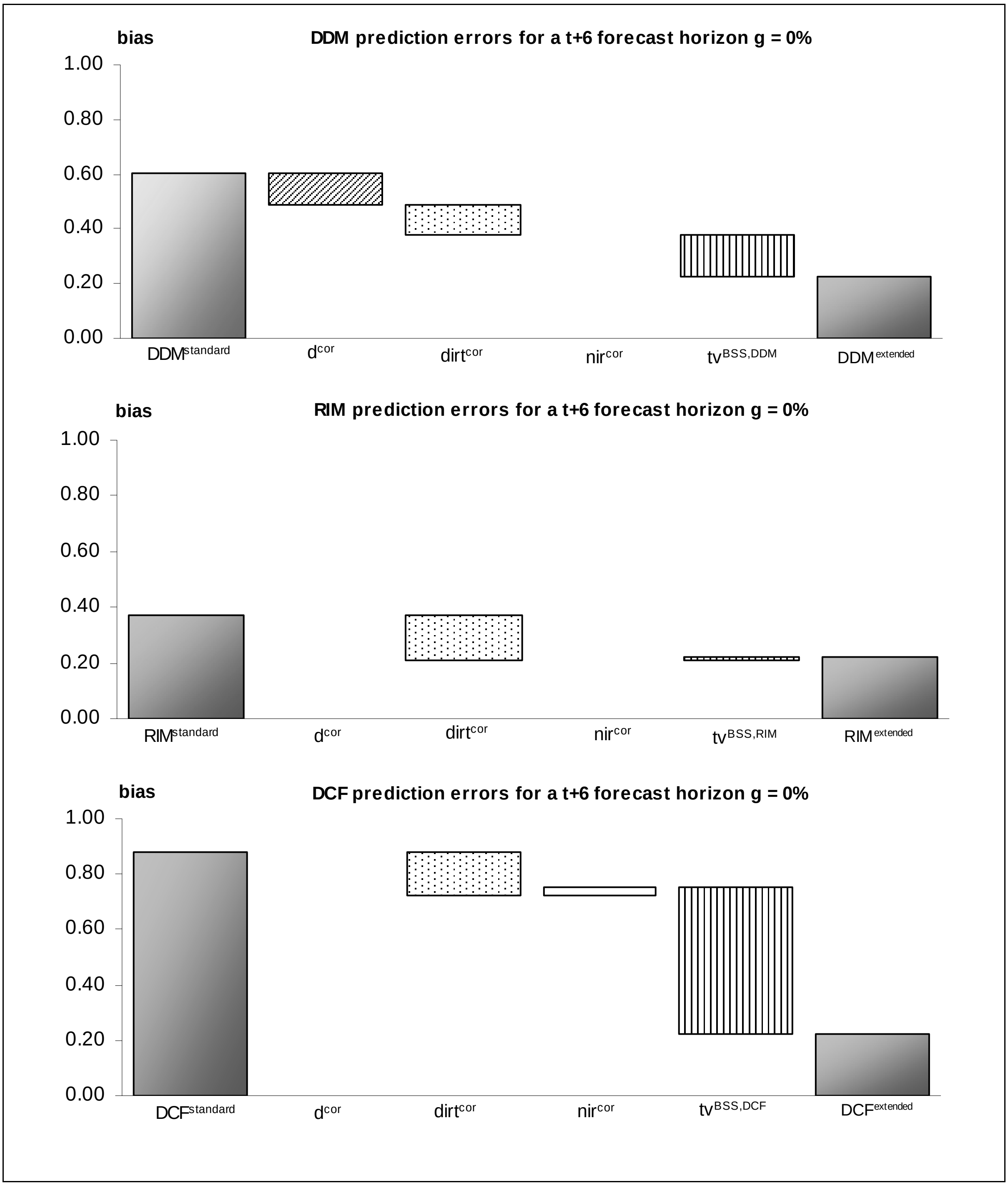
	Horizon (t+T)				
	t+2	t+4	t+6	t+8	t+10
DDM^{standard} (g = 0%)	0.6611	0.6266	0.6015	0.5729	0.5381
	(0.0509)	(0.0405)	(0.0346)	(0.0344)	(0.0373)
RIM^{standard} (g = 0%)	0.4470	0.4254	0.3695	0.3333	0.3074
	(0.1653)	(0.1790)	(0.1108)	(0.1104)	(0.0843)
DCF^{standard} (g = 0%)	0.9584	0.9168	0.8824	0.8274	0.7991
	(0.3431)	(0.3128)	(0.2345)	(0.2018)	(0.2670)
DDM^{standard} (g = 2%)	0.5872	0.5576	0.5402	0.5151	0.4808
	(0.0707)	(0.0501)	(0.0419)	(0.0504)	(0.0509)
RIM^{standard} (g = 2%)	0.4405	0.4155	0.3480	0.3093	0.2813
	(0.2154)	(0.2239)	(0.1326)	(0.1413)	(0.1076)
DCF^{standard} (g = 2%)	0.8311	0.7996	0.7848	0.7322	0.7114
	(0.4415)	(0.3893)	(0.2914)	(0.2690)	(0.3460)
DDM$^{standard-price}$	0.0281	0.0309	0.0257	0.0126	0.0226
	(0.1078)	(0.1014)	(0.1198)	(0.0938)	(0.0844)
RIM$^{standard-price}$	0.0356	0.0440	0.0365	0.0127	0.0150
	(0.1071)	(0.1119)	(0.1276)	(0.0982)	(0.0825)
DCF$^{standard-price}$	0.0305	0.0350	0.0245	-0.0014	-0.0029
	(0.1083)	(0.1125)	(0.1293)	(0.1010)	(0.0850)

Panel B: Mean Absolute Prediction Errors (Accuracy) using the Standard Model Implementation

	Horizon (t+T)				
	t+2	t+4	t+6	t+8	t+10
DDM^{standard} (g = 0%)	0.6611	0.6266	0.6015	0.5729	0.5381
	(0.0509)	(0.0405)	(0.0346)	(0.0344)	(0.0373)
RIM^{standard} (g = 0%)	0.5115	0.5007	0.4291	0.4125	0.3798
	(0.1432)	(0.1515)	(0.1018)	(0.0827)	(0.0589)
DCF^{standard} (g = 0%)	1.0494	1.0167	0.9459	0.9435	0.9028
	(0.3036)	(0.3030)	(0.2261)	(0.1503)	(0.2034)
DDM^{standard} (g = 2%)	0.5872	0.5583	0.5410	0.5166	0.4808
	(0.0707)	(0.0499)	(0.0420)	(0.0483)	(0.0509)
RIM^{standard} (g = 2%)	0.5262	0.5103	0.4309	0.4161	0.3931
	(0.1713)	(0.1787)	(0.1211)	(0.0998)	(0.0667)
DCF^{standard} (g = 2%)	1.0092	0.9778	0.9157	0.9454	0.9110
	(0.3567)	(0.3511)	(0.2569)	(0.1833)	(0.2207)
DDM$^{standard-price}$	0.1114	0.1208	0.1438	0.1240	0.1364
	(0.0503)	(0.0398)	(0.0350)	(0.0341)	(0.0264)
RIM$^{standard-price}$	0.1136	0.1295	0.1483	0.1321	0.1384
	(0.0545)	(0.0554)	(0.0386)	(0.0436)	(0.0262)
DCF$^{standard-price}$	0.1144	0.1283	0.1472	0.1321	0.1393
	(0.0522)	(0.0532)	(0.0403)	(0.0485)	(0.0276)

Notes:
DDM^{standard}, DDM$^{standard-price}$, RIM^{standard}, RIM$^{standard-price}$, DCF^{standard} and DCF$^{standard-price}$ are implemented according to equations (31) - (36). Signed prediction errors (bias) are calculated as $(\text{price - intrinsic value estimate}) / \text{price}$. Absolute prediction errors (accuracy) are calculated as $\left|(\text{price - intrinsic value estimate})\right| / \text{price}$. Means are means over years of means for 20 portfolios to which firms are randomly assigned in each year. Standard deviation in parentheses is the standard deviation over all portfolio valuation errors.

Figure 1
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. $\text{DDM}^{\text{extended}}$ is the model according to equation (21), $\text{DDM}^{\text{extended-price}}$ is the model in equation (22). $\text{RIM}^{\text{extended}}$ represents the model in (24). $\text{RIM}^{\text{extended-price}}$ is the RIM in equation (25). $\text{DCF}^{\text{extended}}$ is the discounted cash flow model in equation (29). $\text{DCF}^{\text{extended-price}}$ 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 also Table 6 and its notes, respectively). 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.

Table 7

Comparison of Valuation Studies

		This Study Table 6, standard model t+6, (g=0%)	Penman/Sougiannis (1998), Table 1, p. 356 t+6, (g=0%)	Francis/Olsson/Oswald (2000), Table 1, p. 55 t+5, (g=0%)
DDM	Mean Bias	60.15%	42.60%	75.50%
	Mean Accuracy	60.15%	n/a	n/a
	Median Accuracy	61.64%	n/a	75.80%
RIM	Mean Bias	36.95%	33.10%	20.00%
	Mean Accuracy	38.91%	n/a	n/a
	Median Accuracy	37.32%	n/a	33.10%
DCF-Model	Mean Bias	88.24%	124.00%	31.50%
	Mean Accuracy	94.59%	n/a	n/a
	Median Accuracy	81.24%	n/a	41.00%

Notes:
The first column shows valuation errors for the three models as implemented in this study according to equations (31), (32) and (33) based on a t+6 year forecast horizon. Columns 2 and 3 reprint valuation errors as given by the respective studies. Note that we adjust the errors reported by Penman/Sougiannis (1998) (column 2) by adding their price model errors to their respective models' results. This is reasonable since they argue that valuation errors should be compared to their so named price model. This price model is equivalent to our extended DDM employing a price-based terminal value. Since the valuation errors of the price-based model are negligible in our study, no adjustment is necessary. Further, since the employed growth rates in the terminal period differ from study to study, the most common base line is chosen, namely a growth rate of 0%. Consistently in all studies bias is calculated as $(\text{price - intrinsic value estimate}) / \text{price}$ and accuracy is given by $\left|(\text{price - intrinsic value estimate})\right| / \text{price}$.

Appendix

Appendix 1

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[34]
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 – Company
#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

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[34] See e.g. Berk/DeMarzo (2006).

Appendix 2

Derivation of the DCF model for a company with an infinite life-span

Propostion:

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

Proof:

It is sufficient to show that

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

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

Hence it follows:

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

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

and consequently by assuming the standard transversality condition:

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

Derivation of the WACC model for a company with an infinite life-span

Proposition:

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

Proof:

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

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

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

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

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

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

and hence via induction on k:

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

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

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

Appendix 3

Excerpt of the financial statement 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
$tv^{BSS,DDM}_{dirt}$	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
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.