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Decision-usefulness of ideal cost- and ideal value accounting for valuation and stewardship



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Abstract: This paper contrasts the decision-usefulness of prototype accounting regimes based on perfect accounting for value, i.e. ideal value accounting (IVA), and perfect matching of cost, i.e. ideal cost accounting (ICA). The regimes are analyzed in the context of a firm with overlapping capacity investments where projects earn excess returns and residual income is utilized as performance indicator. Provided that IVA and ICA systematically differ based on the criterion of unconditional conservatism, we assess their respective decision-usefulness for different valuation- and stewardship-scenarios. Assuming that addressees solely observe current accounting data of the firm, ICA provides information which is useful for valuation and stewardship without reservation whereas IVA entails problems under specific assumptions.

Keywords: Cost accounting · Value accounting · (unconditional) Accounting conservatism · Stewardship · Valuation

JEL Classification: M41 · G31 · G32

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1 Introduction

General purpose financial reporting aims to provide decision-useful information. This objective is central to the Conceptual Framework of the IASB and FASB, where IFRS F.OB2 includes the objective of valuation when stating that "the objective of general purpose financial reporting is to provide financial information about the reporting entity that is useful to existing and potential investors, lenders and other creditors in making decisions about providing resources to the entity". In addition, IFRS F.OB4 refers to stewardship purposes and proposes that the "potential investors, lenders and other creditors need information about [. . .] how efficiently and effectively the entity's management and governing board have discharged their responsibilities to use the entity's resources". Provided this prominence in the Conceptual Framework, stewardship and valuation can be regarded as co-existing goals of standard setters and equally important, as stated in IFRS F.BC51.27.

When discussing the implementation of valuation and stewardship two basic paradigms are commonly referred to: The matching-principle and the asset/liability-principle.[1] Whereas the matching-principle postulates that cost is recognized along with the realized revenues and thereby focuses on the measurement of income (Nissim and Penman 2008, p. 14; Ronen 2008, p. 184), the asset/liability-principle proposes a measurement of value to equity holders by focusing on the difference between assets and liabilities measured in market values (Ronen 2008, p. 184). In general, both paradigms represent ideal specifications in the spirit of either (ideal) cost accounting (ICA), focusing on a perfect matching of cost and revenues, or (ideal) value-accounting (IVA), focusing on true disclosure of value.

We question whether these fundamentally different accounting measurement approaches both serve the tasks of valuation and stewardship when utilizing residual income as performance measure. We investigate whether the goals of standard setters can be achieved when assuming that the accounting regimes are fully implemented. As a central result we show that even under such ideal conditions there are shortcomings of the idealized approaches under specific circumstances. Based on these results, we challenge general assertions in the literature that ICA and IVA both serve valuation and stewardship. This question has to our knowledge not been evaluated in a rigorous model so far. It should be noted that the ideal regimes differ from fair value- and historic cost accounting under Generally Accepted Accounting Principles (GAAP), since in addition to ideal principles also measurement problems and data availability govern the formulation of standards (Hitz 2007; Laux and Leuz 2009; Nissim and Penman 2008). Analyzing idealized accounting regimes might however serve as starting point to reevaluate value- and cost- accounting in less idealized settings.

In this context we question whether observing current accounting data of the firm is sufficient to complete the tasks of valuation and stewardship without reference to past single transactions of the firm and their aggregation rules, in analogy to Nezlobin (2010), who defines the criterion of informational sufficiency based on these terms. Our interpretation of informational sufficiency in the context of stewardship requires firm data under ICA and IVA to provide a sufficient amount of information to create robust investment incentives, as defined by Dutta and Reichelstein (2005), when compensating the decision-maker based on a constant share of residual income. Our interpretation of informational sufficiency in the context of valuation requires firm data under ICA and IVA to provide a sufficient amount of information to outsiders of the firm, i.e. equity holders and potential investors, to determine the value of the firm based on current accounting data without additional information on past transactions. Informationally sufficient accounting data is then a sound basis to forecasts data required to value the firm.

The question whether ICA and IVA both serve the tasks of valuation and stewardship is of particular interest as both ideal paradigms are commonly understood to provide decision useful information for both valuation as well as stewardship in the literature: Penman (2007, p. 36) and Barth (2006, p. 275), for instance, argue that IVA fulfills a stewardship role by reporting values appropriately. In addition, IVA intuitively ties in with the objective of providing useful information for valuation and investment decisions, particularly by providing timely information (Barth 2007, p. 9). Further, under IVA the market-to-book ratio is equal to one, which corresponds to the neutral value and Ohlson's (1995) and Feltham and Ohlson's (1995) definition of unbiased accounting. Nezlobin (2010), on the other hand, argues that only ICA, applying a relative matching-rule, provides a decision useful accounting regime in the context of residual income valuation. This statement is in line with Nissim and Penman (2008, p. 14), who promote cost matching based on the argument that it reveals the success of current transactions in markets. Finally, Ronen (2008, p. 185) argues that, if perfectly implemented, the choice between fair value- and historic cost accounting would become a matter of indifference.

Overall, we find that based on the criterion of unconditional conservatism the recognition of excess returns differs systematically for ICA and IVA.[2] Given excess returns IVA implies a market-to-book ratio of one whereas ICA is unconditionally, i.e. on a regular, news-independent basis, more conservative, and implies a market-to-book ratio higher than one. As a consequence, on aggregate firm level with overlapping capacity investments there exist specific settings where IVA does not provide a sufficient amount of information to fulfill the purpose of valuation and stewardship. To derive these results we model a firm that undertakes joint overlapping capacity investments, similar to the model utilized by Rajan et al. (2007) or Rajan and Reichelstein (2009).[3] We refer to residual income as performance indicator since it has been shown to possess particular properties in the context of stewardship problems (Dutta and Reichelstein 2005; Ewert and Wagenhofer 2000; Mohnen and Bareket 2007; Reichelstein 1997; Rogerson, 1997), as well as in the context of accounting-based valuation (Feltham and Ohlson 1995; Lücke 1955; Ohlson 1995; Preinreich 1938). We implement IVA based on a simple discounted cash flow model, comparable to the concept of value-in-use or value-of-the-firm. For the purpose of matching costs and revenues under ICA we utilize the Relative Benefit Depreciation-rule (RBD-rule), well known from the works of Rogerson (1997) and Reichelstein (1997, 2000).

The paper proceeds as follows: Sections II and III detail the model and a description of the ideal accounting regimes for a single project and on aggregate firm level. Sections IV and V apply the findings to stewardship and valuation and assess whether ICA and IVA possess the properties required to fulfill the valuation and stewardship purpose in various settings with increasing complexity. Section VI concludes.

2 Model description

The model is based on the works of Rajan et al. (2007) and Rajan and Reichelstein (2009), who detail a stylized firm with periodic investments in a representative project p.[4] New projects require capital investments of v. The amount of investment is determined by $I_t \cdot v$ for each period t, where the investment in period zero (I_0) is by assumption normalized to one, i.e. $I_0 = 1$. Investments are delayed by one period until they are productive and generate a sequence of units of expected capacity $\vec{x} = (x_1, x_2, \ldots, x_T)$, where $x_T \leq x_{T-1} \leq \ldots \leq x_1 = 1$ with $1 \leq t \leq T$ and $T > 1$. The representative project p is characterized as $p = (-v, \theta \cdot x_1, \ldots, \theta \cdot x_T)$, where capacities scaled by a profitability factor θ denote expected cash flows ($cf_t = \theta \cdot x_t$). For $\theta - 1 > 0$ a positive net present value (*npv*) project is the result, where *npv* is defined through (1), with $\gamma = 1/(1+r)$ and r denoting the risk adjusted cost of capital.

$$npv = -v + \sum_{i=1}^{T} \theta \cdot x_i \cdot \gamma^i \tag{1}$$

For $\theta = 1$ the *npv* is zero and $v = \sum_{i=1}^{T} x_i \cdot \gamma^i$. For the purpose of this model we assume that expected values are utilized in the process of determining the proper periodic accrual charges. These are common knowledge when determining accounting data but unknown to outsiders of the firm who exclusively observe aggregate firm numbers. As a result, information asymmetries between the firm and addressees prevails with regards to single projects characteristics such as profitability. It is further assumed that investments are the only cash expense and that they are either generated through cash flows from existing projects or equity financed in the case of positive net investments. Cash flows that are not reinvested are distributed as dividends.

We refrain from defining a common accounting process based on historic cost accruals and instead describe an *economic accounting process* that refers to an approach based on invested capital. The sequence of invested capital (ic_t) has an initial expenditure $ic_0 = v$ and is subsequently updated for incurred cash in and out flows according to (2), where the only periodic adjustment is the incurred cost of capital r on the invested capital.

$$ic_t = ic_{t-1}(1+r) - cf_t \tag{2}$$

At the end of the project's active life T it follows that the capital invested is negative whenever $npv > 0$, i.e. $ic_T = -npv(1+r)^T$. We propose the invested capital to be the basis for our economic accounting process in which we additionally allocate residual income charges (ri-charges), defined for the representative project as $\vec{ri} = (ri_0, ri_1, \ldots, ri_T)$ to each period according to (3).

$$bv_t = bv_{t-1}(1+r) + ri_t - cf_t \tag{3}$$

The book value in T must always be zero and as a consequence ri-charges reconcile the sequences of invested capital and book values, with $ic_T = bv_T - npv\,(1+r)^T$, where $bv_T = 0$. The book values in (3) denote economic values in the sense that they evolve from the ic_0 and only depend on cash flows, cost of capital, and the ri-charges. On the other hand, the book values are accounting figures where ri-charges are "quasi"-accruals. Accruals as of a common accrual accounting process, are implicitly determined, where a reformulation of (3) according to $ri_t = cf_t - [bv_{t-1} - bv_t] - r \cdot bv_{t-1}$ contains the implied depreciation charges $bv_{t-1} - bv_t = d_t \cdot ic_0$, with d_t denoting the relative periodic depreciation. Implied depreciation in period zero is negative in case of write-ups and positive for direct expensing.[5]

We evaluate a firm with periodic investments in the representative project. Firm variables are denoted by capital letters. In period T the firm is composed of the projects invested in over the past T periods. Productive capacity K_T is equal to the sum of the individual investments scaled with growth rates according to (4). In this representation x_1 denotes the capacity from the investment undertaken at the beginning of the current period and x_T denotes the capacity of the oldest existing investment. Growth is accounted for by the history of growth rates of the investment $\vec{\lambda} = (\lambda_1, \ldots, \lambda_{T-1})$, with $\lambda_t \in (0, 1)$ for any $1 \leq t \leq T-1$, according to $I_t = I_0 \cdot \prod_{i=1}^{t} (1 + \lambda_i)$ with $I_0 = 1$. By specifying $\lambda_t \in (0, 1)$ we imply that the firm is weakly growing.

$$K_T(\vec{\lambda}) = x_T + x_{T-1}(1 + \lambda_1) + \ldots + x_2 \prod_{i=1}^{T-2} (1 + \lambda_i) + x_1 \prod_{i=1}^{T-1} (1 + \lambda_i) \quad (4)$$

Sales S_T are defined through the sum of cash flows from single projects according to (5).

$$S_T(\vec{\lambda}) = cf_T + cf_{T-1}(1 + \lambda_1) + \ldots + cf_2 \prod_{i=1}^{T-2} (1 + \lambda_i) + cf_1 \prod_{i=1}^{T-1} (1 + \lambda_i) \quad (5)$$

Firm book values (BV_{T-1}) at the beginning of period T capture remaining book values from projects invested in at the beginning of the last T years until the current period according to (6).

$$BV_{T-1}(\vec{\lambda}, \vec{ri}) = bv_{T-1} + bv_{T-2}(1 + \lambda_i) + \ldots + bv_0 \prod_{i=1}^{T-1} (1 + \lambda_i) \quad (6)$$

Further, firm accounting variables are aggregated cost (H_T), as expressed in (7), where cost charges z_t of individual projects capture depreciation charges as well as cost of capital charges according to $z_t = d_t \cdot ic_0 + r \cdot bv_{t-1}$. Last but not least, aggregate income (INC_T) is captured as detailed in (8). z_0 and inc_0 result from direct expensing and write-ups of assets that are purchased at the date of reporting.

$$H_T(\vec{\lambda}, \vec{ri}) = z_T + z_{T-1}(1 + \lambda_1) + \ldots + z_1 \prod_{i=1}^{T-1} (1 + \lambda_i) + z_0 \prod_{i=1}^{T} (1 + \lambda_i) \quad (7)$$

$$INC_T(\vec{\lambda}, \vec{ri}) = inc_T + inc_{T-1}(1 + \lambda_1) + \ldots + inc_1 \prod_{i=1}^{T-1} (1 + \lambda_i) + inc_0 \prod_{i=1}^{T} (1 + \lambda_i) \quad (8)$$

3 Ideal accounting for single projects and on an aggregate firm level

In this section we implement ICA and IVA and compare the regimes based on their provisions for the recognition of excess returns by the criterion of unconditional accounting conservatism. ICA requires that accounting cost equals marginal cost, where marginal cost is defined as the cost of producing one additional unit of output. Provided the idealized set-up we assume that the information required for the implementation is available. Consistent with the literature we acknowledge that it is not possible to determine marginal cost for single projects given that investment expenditure constitutes sunk cost and cannot be meaningfully distributed to individual periods. Following Rogerson (2008) we therefore refer to an aggregated firm formulation. Rogerson shows that under such conditions, if cost is additively separable, it can be charged to single units of output, given capacities are fully employed.[6] Rogerson (2008, p. 939) additionally shows that if historic cost is determined using the Relative Replacement Cost-rule (RRC-rule) the average historic cost (*ahc*) is equal to marginal cost (c). We apply the Relative Benefit Depreciation-rule (RBD-rule) (Reichelstein 1997, 2000; Rogerson 1997) to determine ri-charges under ICA. For prices tied to capacities through constant θ the RBD-rule is an allocation rule that results in cost allocations corresponding to the RRC-rule. The sequence of ri-charges ($\vec{ri}^C$) is detailed in (9), where Lemma 1 implies that such a rule for value recognition warrants that *ahc* equals marginal cost c.

$$ri_t^C = npv \cdot \frac{cf_t}{\sum_{i=1}^{T} cf_i \cdot \gamma^i} \tag{9}$$

Lemma 1: Any project with $npv > 0$ meets the requirement of ICA that $ahc_t = c$ for any t with $0 \le t \le T$, if under the economic accounting process the *npv* is allocated to the single periods of the project according to sequence $\vec{ri}^C$.

Given that residual income is the complement to average historic cost ($cf = ahc + ri$), the allocation rule in Lemma 1 is the natural complement to the RBD-rule, i.e. for constant $ahc_t = c$ a constant ri_t per unit of capacity follows.

IVA requires book values to equal market values (mv_t) for any $t = (0,1,\ldots,T)$, as determined by the present value of future cash flows, i.e. $mv_t = \sum_{i=t+1}^{T} cf_i \cdot \gamma^{i-t}$. In the case of $npv = 0$ this naturally coincides with economic depreciation as proposed by Hotelling (1925), who determines depreciation through changes in book values. In our analysis we extend the formulation to projects with $npv > 0$. To assure $bv_t = mv_t$ the *npv* must be recognized upfront. The asset is initially written up when recognized in $t = 0$ according to $bv_0 = mv_0 = ic_0 + npv$. The related sequence of ri-charges ($\vec{ri}^V$) is detailed in (10). Lemma 2 illustrates that this implies $bv_t = mv_t$, which is easily shown to hold provided that relation $bv_0 = mv_0 = ic_0 + npv$ follows from initial recognition of *npv* and as a consequence ri_t is equal to zero for any subsequent period.[7]

$$ri_t^V = \begin{cases} npv, & \text{for } t = 0 \\ 0, & \text{for } t > 0 \end{cases} \tag{10}$$

Lemma 2: Any project with $npv > 0$ meets the requirement of IVA, where $mv_t = bv_t$ for any $0 \leq t \leq T$, if under the economic accounting process the npv is allocated according to sequence $\vec{ri}^V$.

In the following, we analyze the ideal accounting paradigms based on the criterion of unconditional conservatism. We define conservatism on a single project basis in Definition 1 referring to residual income.[8]

Definition 1: For a given project, a sequence of ri-charges $\vec{ri}^{\bullet} = (ri_0^{\bullet}, ri_1^{\bullet}, \ldots, ri_T^{\bullet})$ is more conservative than sequence $\vec{ri} = (ri_0, ri_1, \ldots, ri_T)$, if $\sum_{i=0}^{t} ri_i^{\bullet} \cdot \gamma^i \leq \sum_{i=0}^{t} ri_i \cdot \gamma^i$, for any $0 \leq t \leq T-1$.

Based on Definition 1 we compare the ri-charges that relate to ICA and IVA. For $npv = 0$ ICA and IVA both result in economic depreciation as proposed by Hotelling (1925). The economic accounting process then coincides with the invested capital sequence, since no residual income is charged to the book value sequence. For $npv > 0$ the ri-charges are the only difference to the scenario with $npv = 0$ and it suffices to compare the respective sequences of residual income based on Definition 1. In Proposition 1 we identify an unambiguous ordering of ICA and IVA based on the criterion of unconditional conservatism given that $npv > 0$, where IVA is always more liberal than ICA.

Proposition 1: For $npv > 0$, IVA is more liberal than ICA, as relation $\sum_{i=0}^{t} ri_i^V \cdot \gamma^i \geq \sum_{i=0}^{t} ri_i^C \cdot \gamma^i$ holds for all $0 \leq t \leq T$.

For $npv = 0$ the ri-charges are zero for ICA as well as for IVA for all $0 \leq t \leq T$. As a consequence, the inequality in Proposition 1 resolves to an equality of both concepts, i.e. $\sum_{i=0}^{t} ri_i^V \cdot \gamma^i = \sum_{i=0}^{t} ri_i^C \cdot \gamma^i$. With $npv > 0$ the frontloading property of IVA ensures that $ri_0^V = npv$ and $ri_t^V = 0$ for $t > 0$ such that $\sum_{i=0}^{t} ri_i^V \cdot \gamma^i = npv$ for any t. Given that for ICA the last ri-charge in T must be positive as related cash flows are positive and provided that the sum of discounted ri-charges is equal to the npv for the entire sequence, the accumulated and discounted residual income for ICA must be lower for each intermediate period, i.e. $\sum_{i=0}^{t} ri_i^V \cdot \gamma^i > \sum_{i=0}^{t} ri_i^C \cdot \gamma^i$ for any $0 \leq t \leq T-1$.

We next analyze the recognition of excess return related to ICA and IVA on firm level, where (11) depicts the firm residual income ($RI_T(\vec{\lambda}, \vec{ri})$) in period T. $RI_T(\vec{\lambda}, \vec{ri})$ entails the cumulative amount of residual income attributable to all single projects available scaled by the history of growth rates $\vec{\lambda}$.

$$RI_T(\vec{\lambda}, \vec{ri}) = ri_T + ri_{T-1}(1+\lambda_1) + \ldots + ri_1 \prod_{i=1}^{T-1}(1+\lambda_i) + ri_0 \prod_{i=1}^{T}(1+\lambda_i) \quad (11)$$

Again, in analogy to the single project, firm residual income is the natural complement to Average Historic Cost (*AHC*), i.e. $CF - AHC = RI$. We can therefore infer the complementary mapping of unconditional conservatism and historic growth on residual income from the analysis of *AHC* by Rajan and Reichelstein (2009, pp. 833–834): Based on the conservatism-criterion of Definition 1, RI_T is increasing [decreasing] in conservatism for given growth rates below [above] the cost of capital. For any sequence of

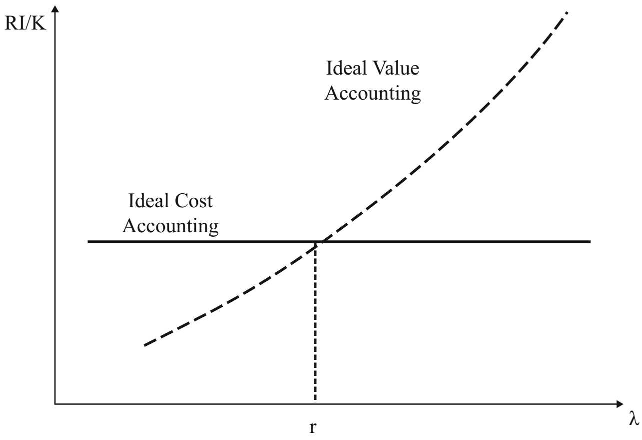

Fig. 1: $RI_T(\vec{\lambda}, \vec{ri})/K_T(\vec{\lambda})$-allocations for varying growth rates: The horizontal line results from ICA and is independent of growth. IVA represents a more liberal accounting regime compared to ICA and allocates more [less] value for constant growth above [below] the cost of capital

ri-charges $\vec{ri}^{\bullet} = (ri_0^{\bullet}, ri_1^{\bullet}, \dots, ri_T^{\bullet})$, which is more conservative [liberal] than sequence $\vec{ri} = (ri_0, ri_1, \dots, ri_T)$, (12) holds if $\lambda_t \leq r\{\lambda_t \geq r\}$ for any $0 \leq t \leq T-1$ and $npv > 0$.

$$RI_T(\vec{\lambda}, \vec{ri}^{\bullet}) \geq \{\leq\} RI_T(\vec{\lambda}, \vec{ri}), \quad [RI_T(\vec{\lambda}, \vec{ri}^{\bullet}) \leq \{\geq\} RI_T(\vec{\lambda}, \vec{ri})] \tag{12}$$

For the analysis of ICA and IVA we infer Proposition 2 from Proposition 1. Provided that IVA is more liberal than ICA, IVA implies lower [higher] value charges for growth below [above] cost of capital than ICA.

Proposition 2: In any period of the firm, relation $RI_T^C(\vec{\lambda}, \vec{ri}^C) \geq [\leq] RI_T^V(\vec{\lambda}, \vec{ri}^V)$ holds, if $\lambda_t \leq r[\lambda_t \geq r]$ for any $1 \leq t \leq T$.

We illustrate our findings in Fig. 1 which depicts $RI_T(\vec{\lambda}, \vec{ri})/K_T(\vec{\lambda})$, i.e. residual income per unit of capacity, for various constant growth rates with $\vec{\lambda} = \lambda$. ICA is not affected by past growth rates, which follows from an application of the RBD-rule (Rajan and Reichelstein 2009). For growth below [above] the cost of capital, liberal accounting recognizes less [more] excess returns than ICA (Proposition 2). Note that for any pattern of ri-charges related to single projects the RI_T of ICA and IVA coincide if all growth rates are equal to the cost of capital. Rajan and Reichelstein (2009, p. 832) refer to this point as the pivot point when analyzing average historic cost. Additionally, ICA possesses the unique property that residual income per unit of capacity is independent of past growth rates. This is a property which we exploit further.

4 Implications for stewardship

This section evaluates whether ICA and/or IVA provide sufficient information to create robust investment incentives in the context of stewardship. We introduce a standard stewardship framework in which owners of a firm delegate the investment decision to managers, possibly because the manager has superior knowledge regarding the investment opportunities. In case of robust incentives the manager maximizes the owner's wealth by selecting the wealth maximizing investment plan. We analyze three different settings with increasing complexity: In Setting 1 a single project is assessed. In Setting 2 and 3 the data of an aggregate firm with joint overlapping capacity investments is considered. Setting 2 in particular captures the incentives to invest in an additional project independent of an existing investment plan and Setting 3 evaluates an investment in one additional unit of output, i.e. applies a marginal measure.

Stewardship Setup: We assume that the manager is paid a constant share of value created measured by residual income in each period. A conflict of interest might arise between principal and agent if managers are impatient, i.e. myopic, and as a consequence discount the expected compensation payments with their personal rate r_m, where rate r_m is higher than the owners' cost of capital, i.e. $r_m \geq r$. In analogy to the definition by Dutta and Reichelstein (2005, p. 531) an accounting regime creates robust incentives, if the manager maximizes value created from the owners perspective irrespective of his individual preferences. Given robust incentives, the owners' interests are respected if the manager maximizes $\sum_{i=0}^{\infty} k \cdot E[RI_{T+i}] \cdot \gamma_m^i$, where k denotes the manager's constant share of residual income, $\gamma_m = 1/(1+r_m)$ denotes the personal discount rate of the manager, and $E[\cdot]$ refers to future realizations of residual income expected at the time of the investment T.

Any project which provides positive expected present value to the owner as well as to the manager should be selected under the criterion. We restrict the investment decision to one period where the manager must make a choice regarding existing investment opportunities. A manager should then accept a project with positive NPV, or, respectively the project with higher NPV, if he must choose between different projects (Mohnen and Bareket 2007). Issues related to Moral Hazard are not considered.

Setting 1: This setting evaluates a situation where the manager receives a bonus based on a constant share of residual income of a single additional investment project available. The net present value of the project to owners is detailed in (13).

$$npv = ri_0 + ri_1 \cdot \gamma^1 + \ldots + ri_{T-1} \cdot \gamma^{T-1} + ri_T \cdot \gamma^T \tag{13}$$

Referring to the well-known findings of Reichelstein (1997) and Rogerson (1997) we acknowledge that ICA results in robust incentives, since the RBD-rule implies constant residual income per unit of capacity in each period. As a consequence, for any discount rate r_m the *npv* assessed by the manager is positive if the project is profitable from the owners point of view (Rogerson 1997, p. 791). For IVA the *npv* is frontloaded and maps directly on the performance measure. As a consequence, the managerial incentives to invest under IVA are not affected by his personal discount rate. However, it should be noted that in $t = 0$, the period of the investment, ICA provides a different total contribution of the single project expressed in present values due to the higher discount rate applied. This effect might be relevant under certain circumstances as illustrated by Mohnen and Bareket (2007). We argue based on the stewardship literature, that for each relevant period of the single project, ICA, as well as IVA, provide sufficient information to create robust incentives independent of the preferences of the manager in charge. For ICA this is a well-known result of Rogerson (1997) and Reichelstein (1997).

Setting 2: This setting evaluates a situation where the manager receives a bonus based on a constant share of residual income of the aggregated firm. The residual income is determined jointly by the presently available capacities according to (11). Investment into an additional project in t affects the future realizations of residual income in period $t+1$ to $t+\mathrm{T}$. Firm residual income is biased dependent on past growth according to the analysis of Proposition 2. However, these biases, originating from past transactions, are not relevant when considering investment incentives, since the manager assesses the contribution from the investment opportunity to his compensation, i.e. the manager conducts a forward-looking assessment. As a consequence, (14) isolates the value (ΔRI_t) realized from this investment by comparing total residual income, including the additional investment (RI_t^*), to residual income without the investment (RI_t), i.e. based on the already existing capacities.

$$\Delta RI_t = \sum_{i=t+1}^{t+T} E[RI_i^*(\vec{\lambda}, \vec{ri})] \cdot \gamma^{i-t} - \sum_{i=t+1}^{t+T} E[RI_i(\vec{\lambda}, \vec{ri})] \cdot \gamma^{i-t} \tag{14}$$

Positive ΔRI_t imply a signal to invest, where the myopic manager utilizes r_m and the owner utilizes r to discount future expected realizations of value in (14). ICA ensures that in each period a portion of residual income, derived from the additional investment, and constant per unit of capacity, is allocated. The frontloading property of IVA, on the other hand, ensures that the performance measure is affected instantly based on the *npv* of the additional investment in the period of investment. For ICA, as well as IVA, ΔRI_t is positive independent of the discount rate whenever the additional investment provides excess returns. As a consequence, ICA and IVA provide robust incentives for Setting 2. However, ΔRI_t determined based on ICA is lower for a myopic manager than for the owner, who always infers *npv* as a consequence from the conservation property of residual income. Traditionally the stewardship literature is not concerned with this effect, provided that the manager determines a positive and constant contribution for all future periods, i.e. $ri_t/x_t = const.$ as a property of ICA.

Setting 3: This setting evaluates the incentives of the manager to invest into an additional unit of output, which are evaluated by measuring the marginal present value (*mpv*). The *mpv* is derived from an additional unit of output in period T and requires investment in period $T-1$. The *mpv* is defined in (15) as the complement to marginal cost, i.e. to $c = v/\sum_{i=1}^{T} x_i \cdot \gamma^i$ (Rajan and Reichelstein 2009, p. 832). This marginal measure derives directly from the *npv* and capacities and is therefore not subject to accounting accruals. It is the relevant measure for the owner.[9]

$$mpv = \frac{npv}{\sum_{i=1}^{T} x_i \cdot \gamma^i} \tag{15}$$

Given the multi-period productive life of investments and myopic preferences, the manager assesses the additional unit of production differently. The hypothetical one-time increase by one unit of output, i.e. the marginal impact, requires that future capacities derived from the additional investment are off-set by a reduction in future investments. As a consequence, the manager cannot consider an additional investment independently of the entire investment sequence. We refer to Rajan and Reichelstein (2009), who illustrate how the marginal cost of capacity perceived by a myopic manager is calculated. Following their approach we propose to measure *mpv* of the manager according to (16) which is subject to the accounting regime in place. The derivation is outlined in appendix A, where we set $T=2$ for notational tractability and without loss of generality.

$$mpv(\vec{ri}, r_m) = \frac{ri_0 + ri_1 \cdot \gamma_m + ri_2 \cdot \gamma_m^2}{x_1 \cdot \gamma_m + x_2 \cdot \gamma_m^2} \tag{16}$$

To analyze the consequences of ICA and IVA, we transform (16) to a representation which we are able to analyze by means of (12). We expand (16) by $(1+r_m)^T/(1+r_m)^T$ and simplify in (17).

$$mpv(\vec{ri}, r_m) = \frac{ri_2 + ri_1 \cdot (1+r_m) + ri_0 \cdot (1+r_m)^2}{x_2 + x_1 \cdot (1+r_m)} \tag{17}$$

Provided the structure of the numerator of (17) corresponds to the structure of (11) the findings of Proposition 2 can be applied. For ICA, myopia affects the numerator and denominator of (17) by the same relative amount, such that it has no effect, i.e. $mpv(\vec{ri}^C, r_m) = mpv$. Marginal present value resulting from IVA, on the other hand, is subject to time preferences. As a consequence, IVA and differences in the discount rates jointly map on the $mpv(\vec{ri}^V, r_m)$, as illustrated in Observation 1, which is inferred from Proposition 2 and illustrated in Fig. 1. $RI_T(\vec{\lambda}, \vec{ri})/K_T(\vec{\lambda})$ is structurally equivalent to (17) when assuming that discount rates correspond to growth rates.

Observation 1: For $npv > 0$, ICA has the unique property of $mpv(\vec{ri}^C, r_m) = mpv$. For IVA, which implies $\vec{ri}^V$, (18) holds for $r_m \leq r$ $[r_m \geq r]$.

$$mpv(\vec{ri}^V, r_m) \leq [\geq]\, mpv \tag{18}$$

As a consequence, for IVA the marginal present value to the manager is higher than the marginal present value to the owners given $r < r_m$. Myopic managers thus associate a higher $mpv(\vec{ri}^V, r_m)$ with an additional unit of output. With regards to investment incentives it must be acknowledged that, for $npv > 0$ ICA, as well as IVA, result in positive marginal contributions to the performance measure of the manager. Accordingly, for the defined robustness criterion, where the manager undertakes all value-increasing investments, both accounting regimes create robust incentives for Setting 3. On the other hand, the *mpv*-criterion is a marginal measure that reflects an increase of one unit in one specific period derived from a multi-period investment project. As a technical feature, the isolation of a marginal measure implies an assumption of future adjustments to the investment sequence. These future adjustments are valued differently by the owner and by the manager. Provided that an investment in the ongoing period involves a foregone investment in a future period, one unit of investment in period T from a $T-1$ point of view, is valued by the manager and owner according to $npv/(1+r_m)$ and $npv/(1+r)$, respectively. Under IVA, where $ri_0 = npv$, inequality $npv/(1+r_m) < npv/(1+r)$ results for $r \leq r_m$. As a consequence, the lower future investments are less relevant for the manager than for the owner. One current additional unit of investment is more valuable to the manager than to the owner given $mpv(\vec{ri}^V, r_m)$ is higher than *mpv*. Within the framework of our model this effect could be relevant for example if the additional unit of capacity has to provide some minimum *mpv* to be accepted.[10] As a consequence, IVA might provide wrong incentives if the manager assesses investment as described by the marginal criterion.

5 Implications for valuation

In this section we analyze whether ICA or IVA serve the purpose of valuation by providing sufficient information when observing current firm accounting data. ICA and IVA both aggregate information on past transactions. For the purpose of valuation, forecasting beyond currently existing assets is required. The issue in this section is therefore: Which additional information is necessary for valuation purposes, assuming the information to implement ICA or IVA is available? We first introduce the setup and subsequently contrast three valuation settings with increasing complexity: Setting 1 assumes no excess returns for future investments but possibly for existing projects. Setting 2 assumes that excess returns prevail for all future projects with constant growth. Setting 3 assumes that excess returns prevail and that the expected future investment growth is not restricted to a constant rate.

Valuation Setup: The value of the firm (MV_T) is equal to the present value of the expected future stream of dividends ($E[DIV_T]$) to the owners of the firm with E[·] denoting the expectation of future realizations. The market value of equity can be calculated, assuming a perpetuity, according to (19).[11]

$$MV_T(\vec{\lambda}) = \sum_{i=T+1}^{\infty} E[DIV_i(\vec{\lambda})] \cdot \gamma^{i-T} \tag{19}$$

Given (19), the clean surplus relation ($BV_T(\vec{\lambda}, \vec{ri}) = BV_{T-1}(\vec{\lambda}, \vec{ri}) + Inc_T(\vec{\lambda}, \vec{ri}) - DIV_T(\vec{\lambda})$) suffices for a representation of market values based on expected future residual income according to (20) (Feltham and Ohlson 1995; Ohlson 1995).

$$MV_T(\vec{\lambda}) = BV_T(\vec{\lambda}, \vec{ri}) + \sum_{i=T+1}^{\infty} E[RI_i(\vec{\lambda}, \vec{ri}) \cdot \gamma^{i-T}] \tag{20}$$

In accordance with (20) we formulate (21) and (22) for ICA and IVA, respectively.

$$MV_T(\vec{\lambda}) = BV_T^C(\vec{\lambda}, \vec{ri}^C) + \sum_{i=T+1}^{\infty} E\left[RI_i^C(\vec{\lambda}, \vec{ri}^C)\right] \cdot \gamma^{i-T} \tag{21}$$

$$MV_T(\vec{\lambda}) = BV_T^V(\vec{\lambda}, \vec{ri}^V) + \sum_{i=T+1}^{\infty} E\left[RI_i^V(\vec{\lambda}, \vec{ri}^V)\right] \cdot \gamma^{i-T} \tag{22}$$

From these specifications, a number of observations are possible: We acknowledge that (21) and (22) differ only for excess returns. Zero excess returns imply a residual income equal to zero and valuation is achieved by the book value component such that both ideal accounting regimes provide informationally sufficient data for valuation. For $npv > 0$, Proposition 1 implies $BV_T^V(\vec{\lambda}, \vec{ri}^V) > BV_T^C(\vec{\lambda}, \vec{ri}^C)$ and sequences of future expected residual income differ. Given the infinite forecast horizon, $npv > 0$, and unrestricted future growth, the valuation models in (21) and (22) require a forecast of future residual income.

For further analysis we introduce a more detailed notation regarding the investments of the firm, where we define the history of the existing investment sequence until period

τ with $\tau \geq T, \vec{I_\tau} = (I_0, I_1, I_2, \ldots, I_\tau)$, and the expected future investment sequence $\vec{I_\infty} = (E[I_{\tau+1}], E[I_{\tau+2}], [I_{\tau+3}], \ldots)$. These jointly add to the description of past and expected future investment sequence $\vec{I_E}$ according to $\vec{I_E} = (\vec{I_\tau}, \vec{I_\infty})$. Throughout the valuation analysis we assume that growth λ_t is limited to $\lambda_t < r$.

Setting 1: We assume that current projects are profitable. However, the firm does not have the possibility to invest into projects with excess returns in the future. For the purpose of analytical tractability we utilize formulation (23) that separates value into three components. First, book values are separated from residual income according to the analysis of Ohlson (1995) and Feltham and Ohlson (1995). Second, the residual income component is split into a part that captures the residual income expected from future projects and a component related to expected residual income from projects which are already in place, with τ denoting the time of investment and $\tau + T$ the period where the last profitable project is replaced by a $npv = 0$ project.

$$MV_\tau(\vec{I_E}) = BV_\tau(\vec{I_\tau}, \vec{ri}) + \sum_{i=\tau+1}^{\tau+T} E[RI_i(\vec{I_\tau}, \vec{ri})] \cdot \gamma^{i-\tau} + \sum_{i=\tau+1}^{\infty} E[RI_i(\vec{I_\infty}, \vec{ri})] \cdot \gamma^{i-\tau} \tag{23}$$

Due to the restriction that future investments do not earn excess returns, expected residual income earned from future investments is zero, i.e. component $\sum_{i=\tau+1}^{\infty} E[RI_i(\vec{I_\infty}, \vec{ri})] \cdot \gamma^{i-\tau} = 0$ for ICA and IVA.

For IVA current accounting data captures the value of projects currently in place in book values in period τ. This is a direct implication of the frontloading under IVA and implies zero excess returns in all future periods according to (24). Residual income is not expected to be earned from existing projects as their value added has been anticipated at the time of the investment.

$$MV_\tau(\vec{I_E}) = BV_\tau^V(\vec{I_\tau}, \vec{ri}^V) + \sum_{i=\tau+1}^{\tau+T} E[0] \cdot \gamma^{i-\tau} + \sum_{i=\tau+1}^{\infty} E[0] \cdot \gamma^{i-\tau} \tag{24}$$

Valuation utilizing ICA captures two components: Book values and value created by existing projects in future periods as detailed in (25), i.e. positive excess returns until all existing projects with excess returns expire.

$$MV_\tau(\vec{I_E}) = BV_\tau^C(\vec{I_\tau}, \vec{ri}^C) + \sum_{i=\tau+1}^{\tau+T} E\left[RI_i^C(\vec{I_\tau}, \vec{ri}^C)\right] \cdot \gamma^{i-\tau} + \sum_{i=\tau+1}^{\infty} E[0] \cdot \gamma^{i-\tau} \tag{25}$$

Given that all information concerning the currently existing projects is assumed to be available and given that the valuation approach requires only information which is related to these currently existing projects, ICA and IVA both provide informationally sufficient data and serve the purpose of valuation for Stetting 1.

Setting 2: This setting assumes constant profitability of current and future projects and $\lambda_t = \lambda$ characterizes for all t the constant historic and future growth for which the growth vector of investment sequence $\vec{I_E}$ is unambiguously determined. (19) can be reformulated according to a Gordon-Growth-formula based on expected dividends ($E[DIV_{\tau+1}(\vec{I_E})]$), constant growth, and constant cost of capital. Then the market value is given by $MV_\tau(\vec{I_E}) = E[DIV_{\tau+1}(\vec{I_E})]/(r-\lambda)$. A corresponding equation based on accounting data is straightforwardly achieved by reformulation in (26).

$$MV_\tau(\vec{I_E}) = BV_\tau(\vec{I_E}, \vec{ri}) + \frac{E[RI_{\tau+1}(\vec{I_E}, \vec{ri})]}{r-\lambda} \tag{26}$$

Given constant growth conditions the conservation property of residual income allows to represent value independent of different accruals as detailed in (27). For a proof of this result refer to appendix B.

$$BV_\tau^V(\lambda, \vec{ri}^V) + \frac{RI_{\tau+1}^V(\lambda, \vec{ri}^V)}{r-\lambda} = BV_\tau^C(\lambda, \vec{ri}^C) + \frac{RI_{\tau+1}^C(\lambda, \vec{ri}^C)}{r-\lambda} \tag{27}$$

In conclusion, the accounting regime is irrelevant for valuation in a setting with constant past and future profitability and constant growth rates. As a consequence, ICA as well as IVA provide sufficient information for valuation for Setting 2.

Setting 3: Here we assume that the expected future investment growth is not restricted. As a consequence, the valuation equation requires an explicit formulation for expected future growth. Analyzing ICA we utilize its property of constant residual income per unit of capacity, which we refer to as the profitability of historic investments $P(\vec{I_\tau})$ in (28). Note that $P(\vec{I_\tau})$ differs from the concept of marginal profits, *mpv*, analyzed in section IV, as it refers to historic accounting data, i.e. depends on past growth rates.

$$P(\vec{I_\tau}) = \frac{RI_{\tau+1}^C(\vec{I_\tau}, \vec{ri}^C)}{K_\tau(\vec{I_\tau})} = \text{constant} \tag{28}$$

Additionally, following Nezlobin (2010), we express book values under ICA ($BV_\tau^C(\vec{I_\tau}, \vec{ri}^C)$) as the replacement cost of assets ($RP_\tau(\vec{I_\tau})$), with $RP_\tau(\vec{I_\tau})$ defined according to (29), where I_t determines the investment in period t and rp_t characterizes the replacement cost of capacities related to the remaining productive life of single assets. The derivation is illustrated in appendix C.

$$\begin{aligned} RP_\tau(\vec{I_\tau}) &= I_{\tau-T} \cdot rp_T + I_{\tau-(T-1)} \cdot rp_{T-1} + \ldots + I_\tau \cdot rp_0, \\ \text{with} \quad rp_t &= v \cdot \frac{x_{t+1} \cdot \gamma + \ldots + x_T \cdot \gamma^{T-\tau}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} \end{aligned} \tag{29}$$

It is transparent that (29) is independent of accounting accruals as $RP_\tau(\vec{I_\tau})$ is not based on accounting data. Given these properties, (20) can be expressed based on replacement cost $RP_\tau(\vec{I_\tau})$ and the profitability component $P(\vec{I_\tau})$ according to (30).

$$MV_\tau(\vec{I_E}) = RP_\tau(\vec{I_\tau}) + P(\vec{I_\tau}) \cdot \sum_{i=\tau+1}^{\infty} E[K_{i-1}(\vec{I_E})] \cdot \gamma^{i-\tau} \tag{30}$$

$\sum_{i=\tau+1}^{\infty} E[K_i(\vec{I}_E)] \cdot \gamma^{i-\tau} = K_\tau(\vec{I}_\tau) \cdot \sum_{i=1}^{\infty} \left[\prod_{j=\tau+1}^{\tau+i} (1 + E[\lambda_j^K | \vec{I}_E]) \cdot \gamma^i\right]$, where $\sum_{i=\tau+1}^{\infty} E[K_i(\vec{I}_E)] \cdot \gamma^{i-\tau}$ corresponds to current capacities $(K_\tau(\vec{I}_\tau))$ scaled with the present value of expected growth of capacities $\left(\sum_{i=1}^{\infty} \left[\prod_{j=\tau+1}^{\tau+i} (1 + E[\lambda_j^K | \vec{I}_E]) \cdot \gamma^i\right]\right)$. Note that $\vec{\lambda}_j^K$ does not correspond to the growth rate of investments $\vec{\lambda}$ if either one is not assumed to be constant. As a consequence, we can, in analogy to Nezlobin (2010, p. 22), restate the valuation equation according to (31), which is based on current residual income multiplied by a component that reflects future expected capacity growth discounted with the cost of capital.

$$\begin{aligned} MV_\tau(\vec{I}_E) &= BV_\tau^C(\vec{I}_\tau, \vec{ri}^C) + RI_\tau^C(\vec{I}_\tau, \vec{ri}^C) \cdot \sum_{i=1}^{\infty} \left[\prod_{j=\tau+1}^{\tau+i} \left(1 + E\left[\lambda_j^K | \vec{I}_E\right]\right) \cdot \gamma^i \right] \\ &= RP_\tau(\vec{I}_\tau) + P(\vec{I}_\tau) \cdot K_\tau(\vec{I}_\tau) \cdot \sum_{i=1}^{\infty} \left[\prod_{j=\tau+1}^{\tau+i} \left(1 + E\left[\lambda_j^K | \vec{I}_E\right]\right) \cdot \gamma^i \right] \end{aligned} \tag{31}$$

In (31) it is essential that the valuation equation does not depend on future accounting realizations. Particularly, the forecast of residual income is a scaled figure of current residual income. As a consequence, current firm accounting data under ICA provides sufficient information.

In the following we illustrate that the parsimonious representation of (31) can only be derived for ICA. Reference to Proposition 2 shows that for IVA, which is the more liberal accounting regime, residual income per unit of capacity depends on past investment growth and profitability and as a consequence implies that $P(\vec{I}_\tau)$ and $RP_\tau(\vec{I}_\tau)$ cannot be extrapolated for variable future growth rates. As a result, current firm-level accounting data under IVA does not provide sufficient information for valuation as past growth of single projects is relevant whilst not observable. We state this result in Observation 2.

Observation 2: For $npv > 0$, ICA possesses the unique property of providing sufficient information for valuation when utilizing $P(\vec{I}_\tau)$ and $RP_\tau(\vec{I}_\tau)$ based on current accounting data whereas IVA does not.

We conclude that when assuming a slightly more complex setup than in Setting 1 and 2 that allows for future growth to follow a variable path, only ICA provides a sufficient amount of information to serve the task of valuation. This outcome results from the timing of excess return recognition as the particular virtue of ICA. Given ideal matching of cost and revenues current residual income illustrates the profitability of the representative project and can be extrapolated to future periods. The IVA regime, on the other hand, anticipates all profits from existing projects in book values at the time of valuation. This property results in accounting data, as well as in residual income per unit of capacity, that is susceptible to past investment growth. As a consequence it is not possible to scale current residual income with future growth rates and IVA does not provide a sufficient amount of information for valuation based on current accounting data.

6 Conclusion

We evaluate whether two ideal accounting regimes provide a sufficient amount of information for valuation and stewardship based on current accounting data. The firm consists of overlapping capacity investments earning excess returns. The investments are accounted for utilizing the RBD-rule (Ideal cost accounting, ICA), or by disclosure of the value-in-use (Ideal value accounting, IVA). IVA presumes the value creation to occur at initial recognition, whereas ICA matches costs with the respective revenues. As a consequence, ICA and IVA differ based on the criterion of unconditional conservatism, where ICA is more conservative than IVA.

We exploit these differences to analyze investment incentives for a possibly myopic manager, who evaluates an additional investment in three different settings with increasing complexity. In Setting 1 the manager evaluates single project residual income. In Setting 2 he refers to firm level residual income, which is influenced by other projects in place. In Setting 3 the manager assesses the marginal present value of an additional unit of investment. Although ICA and IVA are able to provide robust incentives in all settings, the marginal measure under IVA in Setting 3 is biased. The isolation of a marginal measure in a multi-period setting technically requires future adjustments to the investment sequences, which are valued differently by the owner and by the manager.

For the purpose of valuation we distinguish three different settings with increasing complexity. In Settings 1 we assume no profitability of future projects. In Setting 2 we assume constant future profitability and constant growth. In Setting 3 we consider the possibility that future growth varies. Whereas for Setting 1 and 2 both ICA and IVA provide a sufficient amount of information for a valuation of the firm, for Setting 3 only ICA provides a sufficient amount of information to allow for a valuation of the firm.

Evaluating the central question, whether the ideal accounting regimes are useful for valuation and stewardship, we find that both ICA and IVA provide useful information in most instances. However, under specific assumptions and with more complex settings firm accounting data under IVA is not informationally sufficient. These insights could serve as a starting point to reevaluate the dominating focus on value in accounting, since the shortcoming detected in idealized accounting regimes might apply to less idealized settings as well.

Appendix

A Deriving marginal profitability

For the derivation of marginal profitability (*mpv*) we follow the technique introduced by Rajan and Reichelstein (2009, p. 863) to derive a measure of subjective marginal cost of a manager.

To achieve one additional unit of output in t, a manager must acquire an additional unit of output in $t-1$, which results in additional charges to profitability in period $t-1$ (ri_0), t (ri_1), and $t+1$ (ri_2). An investment of v in $t-1$ results in $x_1 = 1$ and x_2 with the respective profitability charges $(1+r)\, ri_0, ri_1$, and $ri_2 \cdot \gamma$ attributable to the *mpv* in period t.

For all future capacities to be unchanged, the amount of investment in t has to be reduced by $v \cdot x_2$, resulting in a reduction of $ri_0 \cdot x_2$, $ri_1 \cdot x_2$, and $ri_2 \cdot x_2$, and affects the *mpv* in period t ($ri_0 \cdot x_2$, $ri_1 \cdot x_2 \cdot \gamma$, and $ri_2 \cdot x_2 \cdot \gamma^2$). In turn, these savings have to be offset by investing $v \cdot x_2^2$ in $t+1$, incurring $ri_0 \cdot x_2^2 \cdot \gamma$, $ri_1 \cdot x_2^2 \cdot \gamma^2$, and $ri_2 \cdot x_2^2 \cdot \gamma^3$, and so forth. The *mpv* at date t of an increase in one unit of output represents the sum of value of all these adjustments to the manager, as detailed in (32).

$$\begin{aligned} mpv(\vec{ri}, r_m) = {} & ri_0 \cdot \left[(1+r) - 1 \cdot x_2 + \gamma_m \cdot x_2^2 - \gamma_m^2 \cdot x_2^3 + \dots\right] \\ & + ri_1 \cdot \left[1 - \gamma_m \cdot x_2 + \gamma_m^2 \cdot x_2^2 - \gamma_m^3 \cdot x_2^3 + \dots\right] \\ & + ri_2 \cdot \left[\gamma_m - \gamma_m^2 \cdot x_2 + \gamma_m^3 \cdot x_2^2 - \gamma_m^4 \cdot x_2^3 + \dots\right] \end{aligned} \tag{32}$$

Collecting terms results in (33).

$$\begin{aligned} mpv\left(\vec{ri}, r_m\right) = {} & ri_0 \cdot \left[(1+r)\,(1 - \gamma_m \cdot x_2) \cdot \sum_{i=0}^{\infty} (\gamma_m \cdot x_2)^{2i}\right] \\ & + ri_1 \cdot \left[1 \cdot (1 - \gamma_m \cdot x_2) \cdot \sum_{i=0}^{\infty} (\gamma_m \cdot x_2)^{2i}\right] \\ & + ri_2 \cdot \left[\gamma_m \cdot (1 - \gamma_m \cdot x_2) \cdot \sum_{i=0}^{\infty} (\gamma_m \cdot x_2)^{2i}\right] \end{aligned} \tag{33}$$

Since $\sum_{i=0}^{\infty} (\gamma_m \cdot x_2)^{2i} = \dfrac{1}{1 - (\gamma_m \cdot x_2)^2}$, a reformulation of (33) results in (34).

$$mpv(\vec{ri}, r_m) = ri_0 \cdot (1+r) \cdot \frac{1}{1 + \gamma_m \cdot x_2} + ri_1 \cdot \frac{1}{1 + \gamma_m \cdot x_2} + ri_2 \cdot \gamma_m \cdot \frac{1}{1 + \gamma_m \cdot x_2} \tag{34}$$

Multiplication by $1 = \gamma_m / \gamma_m$ and given that $x_1 = 1$ results in (35).

$$mpv(\vec{ri}, r_m) = \frac{ri_0 + ri_1 \cdot \gamma_m + ri_2 \cdot \gamma_m^2}{x_1 \cdot \gamma_m + x_2 \cdot \gamma_m^2} \tag{35}$$

B Valuation identity

We show that given constant past and future growth, accounting accruals are irrelevant. This claim is based on the conservation property of residual income. Reformulating (27) results in $INC_{\tau+1}^{V}(\lambda, \vec{ri}^{V}) - \lambda \cdot BV_{\tau}^{V}(\lambda, \vec{ri}^{V}) = INC_{\tau+1}^{C}(\lambda, \vec{ri}^{C}) - \lambda \cdot BV_{\tau}^{C}(\lambda, \vec{ri}^{C})$. Firm variables are decomposed utilizing the accounting data related to the single projects in place. To simplify notation we drop descriptors for dependent variables in brackets, e.g. $BV_{\tau}(\lambda, \vec{ri}) \equiv BV_{\tau}$. In (36) $ri_T = inc_T - \lambda \cdot bv_{T-1}$ corresponds to the residual income of the asset in place which is in the last period of its productive life. This asset was invested in in period $\tau - T$.

$$
\begin{aligned}
&(1+\lambda)^{\tau-T}\left[inc_T^V - \lambda \cdot bv_{T-1}^V\right] + (1+\lambda)^{\tau-(T-1)}[inc_{T-1}^V - \lambda \cdot bv_{T-2}^V] \\
&\quad + \ldots + (1+\lambda)^{\tau-1}\left[inc_1^V - \lambda \cdot bv_0^V\right] \\
&\quad = (1+\lambda)^{\tau-T}\left[inc_T^C - \lambda \cdot bv_{T-1}^C\right] + (1-\lambda)^{\tau-(T-1)}[inc_{T-1}^C - \lambda \cdot bv_{T-2}^C] \\
&\quad + \ldots + (1+\lambda)^{\tau-1}\left[inc_1^C - \lambda \cdot bv_0^C\right] \qquad (36)
\end{aligned}
$$

Dividing both sides by $(1+\lambda)^{\tau}$ results in (37). For constant λ, the identity is complied with for any accounting schedule. Given the Conservation Property applies to both sides, the accounting regime is irrelevant for valuation assuming constant growth.

$$
\begin{aligned}
&\left[inc_1^V - \lambda \cdot bv_0^V\right]\frac{1}{1+\lambda} + \left[inc_2^V - \lambda \cdot bv_1^V\right]\frac{1}{(1+\lambda)^2} + \ldots + \left[inc_T^V - \lambda \cdot bv_{T-1}^V\right] \\
&\quad \frac{1}{(1+\lambda)^T} = \left[inc_1^C - \lambda \cdot bv_0^C\right]\frac{1}{1+\lambda} + \left[inc_2^C - \lambda \cdot bv_1^C\right] \\
&\quad \frac{1}{(1+\lambda)^2} + \ldots + \left[inc_T^C - \lambda \cdot bv_{T-1}^C\right]\frac{1}{(1+\lambda)^T} \qquad (37)
\end{aligned}
$$

C Derivation of replacement cost

The proof applies the characterization of replacement cost utilized by Nezlobin (2010, p. 16 and 32). We first infer the replacement cost per unit of capacity rp_t according to (38), which captures the replacement value related to a single project on a present value basis.

$$rp_t = c \cdot x_{t+1} \cdot \gamma + c \cdot x_{t+2} \cdot \gamma^2 + \ldots + c \cdot x_T \cdot \gamma^T \qquad (38)$$

Substituting $c = v/\sum_{i=1}^{T} x_i \cdot \gamma^i$ and reformulation results in (39).

$$rp_t = v \cdot \frac{x_{t+1} \cdot \gamma + \ldots + x_T \cdot \gamma^{T-t}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} \qquad (39)$$

To illustrate that rp_t corresponds to book values under ICA, we equate the cost related to the sequence of replacement cost $(rp_{t-1} - rp_t + r \cdot rp_{t-1})$ to the ICA cost charge $\left(z_t^C\right)$, i.e. $rp_{t-1} - rp_t + r \cdot rp_{t-1} = z_t^C$, with $z_t^C = v \cdot \frac{x_t}{\sum_{i=1}^{T} x_i \cdot \gamma^i}$. Reformulation yields (40).

$$
\begin{aligned}
&v \cdot (1+r) \cdot \frac{x_t \cdot \gamma + \ldots + x_T \cdot \gamma^{T-t+1}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} - v \cdot \frac{x_{t+1} \cdot \gamma + \ldots + x_T \cdot \gamma^{T-t}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} \\
&\quad = v \cdot \frac{x_t + \ldots + x_T \cdot \gamma^{T-t}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} - v \cdot \frac{x_{t+1} \cdot \gamma + \ldots + x_T \cdot \gamma^{T-t}}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} \\
&\quad = v \cdot \frac{x_t}{x_1 \cdot \gamma + \ldots + x_T \cdot \gamma^T} = v \cdot \frac{x_t}{\sum_{i=1}^{T} x_i \cdot \gamma^i} = z_t^C \qquad (40)
\end{aligned}
$$

Endnotes

1 Standard setters refer to both principles: The matching principle, as formulated in SFAC No. 6.146, requires that costs and revenues are jointly considered when resulting from the same transactions or events. In IFRS the notion of matching is related to depreciation as regulated in IAS 16.60, where the depreciation method used shall reflect the pattern in which the asset's future economic benefits are expected to be consumed by the entity. The asset/liability-principle is expressed in IFRS F.4.47 of the Conceptual Framework, where "Income is recognised in the income statement when an increase in future economic benefits related to an increase in an asset or a decrease of a liability has arisen that can be measured reliably."

2 Unconditional conservatism is not related to events (Beaver and Ryan 2005). Conditional conservatism, on the other hand, implies a different treatment of earnings and losses. Earnings require a higher degree of verification than losses (Basu 1997). Alternative terminologies for this dichotomy between unconditional and conditional conservatism are balance sheet vs. income statement conservatism (Ball et al. 2000a, 2000b), ex-ante vs. ex-post conservatism (Pope and Walker 1999), and news-independent vs. news-dependent conservatism (Chandra et al. 2004).

3 The article is also based on Staehle (2012).

4 Variables referring to the single representative project p are denoted by lowercase letters; steady-state data by capital letters.

5 We note that the economic accounting process complies with clean surplus accounting, which is defined as $bv_t = bv_{t-1} + inc_t - div_t$, where any change in book values originates from the income statement (inc_t), with $inc_t = r \cdot bv_{t-1} + ri_t$, or from distributions to owners, i.e. dividends (div_t).

6 This is satisfied through our assumption of weak growth with $\lambda_t \in (0, 1)$.

7 An upfront recognition of value results in subsequent residual income figures of zero (Bierman 1961; Bodenhorn 1961). This upfront recognition corresponds to accounting for the value-in-use or value-to-the-business. We do not utilize the term 'deprival value', since it refers to replacement-cost, see Zijl and Whittington (2006) for these concepts. Penman (2007, p. 36) promotes value-in-use as a prototype for accounting for value.

8 Definition 1 corresponds to the definition of conservatism by Rajan et al. (2007, p. 330) given the complementary relation of ri and ahc, where $\vec{d}^{\bullet} = (d_0^{\bullet}, d_1^{\bullet}, ..., d_T^{\bullet})$ is more conservative than $\vec{d} = (d_0, d_1, ..., d_T)$ if $\sum_{i=1}^{t} d_i^{\bullet} \geq \sum_{i=1}^{t} d_i$ for any $0 \leq t \leq T-1$, i.e. $bv_t^{\bullet} \leq bv_t$, for any $0 \leq t \leq T-1$.

9 Marginal present value is the complement to marginal cost in a setting where the additional unit of capacity might earn excess returns. It is derived under the assumption that there exist no excess capacities in future periods (Rajan and Reichelstein 2009, p. 829).

10 It should be noted that the *mpv* refers to the period where the additional unit of output is provided. Evaluating the period where the investment decision has to be made requires further discounting.

11 In our model dividends $DIV_T(\vec{\lambda})$ are equal to free cash flows $FCF_T(\vec{\lambda})$ of the firm, i.e. $DIV_T(\vec{\lambda}) = S_T(\vec{\lambda}) - I_0 \prod_{i=1}^{T}(1+\lambda_i) = FCF_T(\vec{\lambda})$.

References

Ball R, Kothari SP, Robin A (2000a) Corrigendum to "The effect of international institutional factors on properties of accounting earnings" [Journal of Accounting and Economics 29 (2000) 1–51]. J Account Econ 30:241–241

Ball R, Kothari SP, Robin A (2000b) The effect of international institutional factors on properties of accounting earnings. J Account Econ 29(1):1–51

Barth ME (2006) Including estimates of the future in today's financial statements. Accounting Horizons 20(3):271–285

Barth ME (2007) Standard-setting measurement issues and the relevance of research. Account Bus Res 37(3):7–15

Basu S (1997) The conservatism principle and the asymmetric timeliness of earnings. J Account Econ 24(1):3–37

Beaver WH, Ryan SG (2005) Conditional and unconditional conservatism: Concepts and modeling. Rev Acc Stud 10(2–3):269–309

Bierman H (1961) Depreciable assets—timing of expense recognition. Account Rev 36(1):613–618

Bodenhorn D (1961) An economist looks at industrial accounting and depreciation. Account Rev 36(4):583–588

Chandra U, Wasley CE, Waymire GB (2004) Income conservatism in the U.S. technology sector. SSRN eLibrary.

Dutta S, Reichelstein S (2005) Accrual accounting for performance evaluation. Rev Account Stud 10(4):527–552

Ewert R, Wagenhofer A (2000) Rechnungslegung und Kennzahlen für das Wertorientierte Management. In: Wagenhofer A, Hrebicek G (eds) Wertoprientiertes management. Schäffer-Poeschel, Stuttgart, pp 3–64

FASB (2008) Statements of financial accounting concept 6. Retrieved from http://www.fasb.org

Feltham GA, Ohlson JA (1995) Valuation and clean surplus accounting for operating and financial activities. Contemp Account Res 11(2):689–731

Hitz J-M (2007) The decision usefulness of fair value accounting—a theoretical perspective. Eur Account Rev 16(2):323–362

Hotelling H (1925) A general mathematical theory of depreciation. J Am Stat Assoc 340–353

IASB (2000) International accounting standard 16. Retrieved from www.ifrs.org

IASB (2010) Conceptual framework. Retrieved from www.ifrs.org

Laux C, Leuz C (2009) The crisis of fair-value accounting: making sense of the recent debate. Account Org Soc 34(6/7):826–834

Lücke W (1955) Investitionsrechnung auf der Basis von Ausgaben oder Kosten? Z Handelswirtsch Forschung 7:310–324

Mohnen A, Bareket M (2007) Performance measurement for investment decisions under capital constraints. Rev Account Stud 12(1):1–22

Nezlobin A (2010) Accrual accounting, informational sufficiency, and equity valuation. Working paper Stanford University

Nissim D, Penman SH (2008) Principles for the application of fair value accounting. Columbia business school: Centre for Excellence in Accounting and Security Analysis (CEASA)

Ohlson JA (1995) Earnings, book values, and dividends in equity valuation. Contemp Account Res 11(2):661–687

Penman SH (2007) Financial reporting quality: is fair value a plus or a minus? Account Bus Res 33–44 (Special Issue: International Accounting Policy Forum)

Pope PF, Walker M (1999) International differences in the timeliness, conservatism, and classification of earnings. J Account Res 37(3):53–87

Preinreich GAD (1938) Annual survey of economic theory: the theory of depreciation. Econometrica 6:219–241

Rajan MV, Reichelstein S (2009) Depreciation rules and the relation between marginal and historical cost. J Account Res 47(3):823–865

Rajan MV, Reichelstein S, Soliman MT (2007) Conservatism, growth, and return on investment. Rev Account Stud 12:325–370

Reichelstein S (1997) Investment decision and managerial performance evaluation. Rev Account Stud 2:157–180
Reichelstein S (2000) Providing managerial incentives: cash flows versus accrual accounting. J Account Res 38(2):243–269
Rogerson WP (1997) Intertemporal cost allocation and managerial investment incentives: a theory explaining the use. J Polit Econ 105(4):770–795
Rogerson WP (2008) Intertemporal cost allocation and investment decisions. J Polit Econ 116(5):931–950
Ronen J (2008) To fair value or not to fair value: a broader perspective. Abacus 44(2):181–208
Staehle M (2012) The informational sufficiency of accounting data. Stuttgart-Hohenheim
van Zijl T, Whittington G (2006) Deprival value and fair value: a reinterpretation and a reconciliation. Account Bus Res 36(2):121–130