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To My Parents

Preface

Accounting researchers have long been intrigued by the relation between accounting data, which periodically summarize a firm's business operations, and firm value, which investors seek to discover. This relation links the real and financial sectors of an economy and is of interest to various key economic players including market investors, business managers, and financial reporting standard setters.

The collective effort of researchers over the past 4 decades has given rise to a large literature in this area, with great strides taken towards understanding the importance of accounting events and information in affecting stock prices and returns, and impacting other aspects of market activities. For the most part, however, this line of inquiry has followed an "empirically driven" path, whereby researchers rely on economic intuition and theories from other disciplines (mainly finance and economics) as a basis for designing empirical analyses and interpreting findings. As such, this research—commonly characterized as "information perspective" research—has primarily addressed the question of *whether* accounting data convey value-relevant information, with only limited attention to the questions of *why* and *how*. Although this approach has shed important light on the relevance of accounting, it lacks a general framework needed to integrate and unify the various empirical findings from different studies.

More recently, progress has been made on the theoretical front. Two distinct approaches to modeling the value-accounting relation are: (1) the "linear information dynamic" approach, which links realized accounting data to future value generation via a linear process and (2) the "real-options-based" approach, which recognizes managerial uses of accounting information in the pursuit of value generation. This book provides a synthesis of the extant theoretical research, focusing mainly on models that adopt the real-options approach and the empirical works that follow them. A common feature of these models is in incorporating capital investment decisions that are contingent on accounting signals, which gives rise to the (nonlinear) real-options terms in the valuation function. As explained in the book, the linear dynamic approach can be viewed as a special case in this context. The book also attempts to bring previous empirical findings into the real-options framework and show that many of the salient empirical findings can be rationalized in this framework.

Through exploring and combining both theoretical and empirical dimensions of this area of research, this book aims to offer a more systematic and structured treatment of accounting-based valuation research. Note that this book is an account of the portions of the valuation literature that I am familiar with and reflects my personal view, interpretation, and bias. It, by no means, represents a comprehensive and complete coverage of the literature.

Plan of the Book

Chapter 1 starts with a discussion of the standard value concept and common methods for equity valuation within the discounted cash flow framework. The chapter then discusses in more detail the residual income model, which highlights the role of anticipated accounting data, and analyzes its properties. A core part of the chapter is devoted to understanding the restrictions imposed on accounting measurement within the context of the residual income model. The residual income model serves as a stepping-stone for the development of models that link equity value to reported (realized) accounting data, which can serve as a basis for directly examining the impact of financial reporting in the capital market.

Chapter 2 introduces the linear valuation models developed under the assumption that residual income follows a linear dynamic process and analyzes their properties. The chapter then examines the implications of these linear models and evaluates their validity in a broader economic context. The empirical studies that test these linear models are also briefly discussed.

Chapter 3 presents a simple theory to explain why residual income should follow a nonlinear (convex) dynamic process and provides empirical evidence to support the theory. In contrast to the linear models presented in Chap. 2, where a firm's capital investment is either unspecified or follows an exogenous linear path, this approach assumes that capital investment is directed towards more profitable projects, and the accounting system provides signals (such as return on investment and residual income) that guide such activity. It is this "feedback" role of accounting information that gives rise to a convex relation between current and expected future residual income.

Chapter 4 further builds on the notion of capital following profitability to develop a model of equity value. With anticipated investment decisions that are contingent on future performance, equity value is shown to comprise both the value of existing assets and the value of flexibly adjusting the course of operations. This results in a model of equity value that embodies growth and abandonment (adaptation) options.

Chapter 5 uses the theoretical model developed in Chap. 4 to test predicted nonlinear relations between equity value, earnings, and equity book value. The first part of the chapter tests those properties of the value function that are driven by economic incentives to create value (real options). The analysis features the roles of a firm's economic condition, as characterized by profitability and growth opportunity, in influencing the behavior of the value-accounting relation. The second part tests the effect of conservative accounting practices, which explains how past investment activity affects the degree of earnings conservatism and consequently the value-earnings relation.

Chapter 6 evaluates the extant empirical literature that uses accounting data to explain equity values, known as value-relevance research, within the real-options framework. The chapter has two main purposes. First, it shows that prior empirical findings can be reconciled with a real-options-based model, including convexity in the value-accounting relation, differential valuation roles of earnings and equity book value for firms in the positive and negative earnings regions, and the valuation importance of earnings dependent on financial health. Second, the chapter provides a critical evaluation of this empirical literature, pointing out problems of misspecified regressions and inadequate control for a firm's economic condition.

Chapter 7 applies the real-options approach to multiple-segment firms to examine how segment-level data are *incrementally* useful beyond consolidated firm-level data. This chapter first provides a theoretical analysis to identify the conditions under which segment-level data are useful and how they incrementally impact value. This theoretical analysis leads to testable predictions concerning the link between the characteristics of segment operations and the valuation role of segment data, which are then followed by empirical tests. The chapter also discusses the implications of the study for segment-level financial reporting.

Chapter 8 continues to examine multiple-segment firms but shifts attention to potential failures of financial reporting. It explains why, in the face of a nonlinear valuation function, firms may not report their segment-level performance truthfully and (costly) divestitures may then occur as a way to mitigate information asymmetries. The theoretical model yields predictions on the circumstances under which the firm will undertake a divestiture to correct such a misvaluation and the factors determining the magnitude of the market reaction. Following the theoretical analysis, the chapter tests these predictions empirically.

Chapter 9 shifts attention from equity value to returns. Returns arise from changes in value, so the return function is naturally derived from the value function. The chapter first develops a return model from a real-options-based model of equity value, which identifies the set of accounting variables (together with other, non-accounting information) that constitutes the "core" information for explaining returns. The economic roles of individual explanatory variables in the return model are explained from the value generation perspective. Following the theoretical analysis, the chapter presents an empirical analysis to examine the validity of the return model and its individual factors.

Chapter 10 evaluates existing empirical research aimed to explain equity returns (known as the ERC literature, both long and short window based). A characteristic of this branch of the literature is the predominant emphasis on earnings variables, with little or no attention paid to balance-sheet (and other) information. The chapter discusses both the usefulness and limitations of earnings information for explaining returns in light of the more general model derived in Chap. 9. The chapter also empirically examines the extent to which balance-sheet information is incrementally useful beyond earnings variables and for which types of firms it plays a greater incremental role.

Chapter 11 extends the return model developed in Chap. 9 to explore issues concerning reporting of an enterprise's business performance and in particular the relevance of fair value accounting for equity investors. The analysis distinguishes between financial assets which are acquired for trading purposes and operating assets which are deployed to make the final product, and shows that the usefulness of fair value information differs between these two types of economic activities. The theoretical model also yields implications for other financial reporting issues such as how accounting income should be defined and what criterion should be used to classify items as net income versus other comprehensive income.

Chapter 12 continues to look at equity returns but moves the discussion to an industry context where firms compete with one another in a common product market. A theoretical analysis is conducted by extending basic industrial organization models (such as those with Cournot or Bertrand competition) to incorporate a valuation problem, which leads to predictions of the role of relative firm profitability in an industry in affecting return sensitivity to industry news (i.e., industry beta). An empirical analysis follows that tests the theoretical predictions. The implications of this study for investment management and research are discussed.

Chapter 13 provides thoughts on future directions for further developing valuation theory and related empirical research. The chapter also discusses how valuation theory can be related to a range of other accounting topics and explains how a well-developed theoretical framework for valuation can be beneficial, directly or indirectly, to probing other accounting and reporting issues.

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Chapter 1
Accounting Measures of Value Generation: The Residual Income Model

As we embark on this book's exploration of the accounting-based valuation research, we start by defining the value concept and models set out in the finance literature. The equity value models developed in finance predate valuation research in accounting. They are built around concepts such as dividend or free cash flow which are not at the heart of accrual-based accounting. As such, the role of accounting has not been well explained. In accounting research, we are interested in how accounting data periodically reported by companies convey value generation. Understanding this issue is essential for capital market participants who rely on reported financial data to assess firm value. It is also relevant to accounting standard setters who are mandated to formulate rules governing corporate financial reporting.

This chapter begins with an introduction to the finance approaches to equity valuation. By invoking the accounting condition of clean surplus, we show that equity value can be equally expressed in terms of expected future residual income, an accounting-based measure of value generation. We introduce the different versions of the residual income model (RIM) of valuation developed in the literature (see for example Ohlson 1995; Feltham and Ohlson 1995) and explain their theoretical equivalence to the finance approaches.

A core part of this chapter is devoted to examining the accounting structure embedded in the RIM. We aim to dispel the misconception held by some researchers that the model's ability to "self-correct" for measurement errors permits accounting constructs to be measured in an arbitrary fashion (within the confines of the clean surplus condition), so accounting earnings do not need to resemble "economic earnings." We explain that this "measurement irrelevance" view is unwarranted and potentially misleading because this property of so-called self-correction is predicated on a condition which is, in practice, not feasible. Upon further investigation, it will become clear that the clean surplus condition essentially implies that accounting is based on historical cost (as is conventional practice). Once this restriction is recognized, accounting measures such as book values and earnings have meaningful economic interpretations within RIM.

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RIM sets the stage for the subsequent chapters where we develop valuation models that feature the role of *reported*, versus anticipated, accounting data. Those models enable us to better understand the impact of financial reporting on capital markets and also to draw implications for accounting standard setting.

1.1 Finance Approaches to Equity Valuation

The finance literature has contributed several approaches to equity valuation, which focus on value metrics such as dividends, free cash flow, and investment opportunities. These approaches are alternative, but theoretically equivalent, ways to characterize what a firm is worth.

1.1.1 Dividend Discount Model

The (economic) value of an asset is defined as the present value of expected future cash-flow payoffs from the asset. For equity investors, dividends are the ultimate form of payoff. It is thus natural to relate equity values to expected future dividends (see, for example, Gordon 1959; Miller and Modigliani 1961).

In a world of certainty, equity value equals the present value of future dividends. Let V_t denote a firm's equity value at date t (the end of period t), d_{t+s} the dividends to be paid in period t + s, s = 1,2,. . ., net of capital contribution by investors, and r_f the riskfree interest rate. Then, no-arbitrage requires

$$V_t = \sum_{s=1}^{\infty} \frac{d_{t+s}}{(1 + r_f)^s}. \tag{1.1}$$

To extend Eq. (1.1) to scenarios of uncertainty with investor risk aversion, the usual approach is to replace the numerators with *expected* future dividends and the denominators with a *risk adjusted* discount rate (r), that is,

$$V_t = \sum_{s=1}^{\infty} \frac{E_t(\tilde{d}_{t+s})}{(1 + r)^s}, \tag{1.2}$$

where $E_t(\cdot)$ is the expectation operator conditional on the information available at date t.

Asset pricing theories such as the capital asset pricing model and the arbitrage pricing theory explain how expected return is dependent on investment risk. Throughout this book, however, we assume a given discount rate and a flat-term structure. Our inquiries focus on the role of accounting data in forecasting future cash flows, without considering the issue of how they also help to convey firm risk.[1]

The dividend discount model (DDM) considers valuation from the perspective of value distribution, but value distribution is predicated on value generation. Although in principle what a firm generates is ultimately given back to investors, in practice, management can exercise considerable discretion over the timing of value distribution. For any given period, the value distributed may bear little obvious relationship to the value generated. For firms paying no dividends or without a well-established dividend policy (which is quite common in practice), it can be difficult for outside investors to forecast the exact timings and amounts of dividend payments.

Without a tight link between value generation and value distribution on a period-by-period basis, dividend forecasting can be problematic, potentially rendering the DDM ineffective. This calls for other models capable of connecting equity value to information that more closely reflects the activities taking place inside the firm.

1.1.2 Free Cash-Flow Model

Free cash flow-based valuation goes back at least as far as the work of Miller and Modigliani (1961). Free cash flows are those generated from business activities during a given period, net of all required cash payments for operating, financing, and investment activities (but excluding dividend payment). Thus, free cash flow is a "surplus" that can be made available for dividend payment; it is a cash-based measure of value generation.

Denote FCF_t as a firm's free cash flow (for equity investors) in period t. The free cash-flow model (FCFM) calculates equity value as

$$V_t = \sum_{s=1}^{\infty} \frac{E_t(F\tilde{C}F_{t+s})}{(1+r)^s}. \tag{1.3}$$

Free cash flows and dividends stand as two sides of the same coin. The former represent what is available for distribution to investors, and the latter what is actually distributed. In the long run, total value generated should equal total value distributed, so in theory the two approaches should yield equivalent results. This equivalence is especially clear in the case where the firm adopts a policy of paying all free cash flow as dividends in each period. Where dividends are not equal to the free cash flow in a period, the two approaches will still yield the same result insofar

[1] Feltham and Ohlson (1999) and Christensen and Feltham (2009) provide state-dependent models in which they incorporate risk and stochastic interest rates into equity valuation.

as the firm engages in zero net present value (NPV) financing/investment activities with regard to its deficit/surplus cash position (with its core investment activities held unchanged).

It is worth noting that reported financial statements do not contain a ready measure of free cash flow as required for implementing FCFM. Depending on the particular accounting standards in force in a jurisdiction, adjustments are needed to arrive at free cash flow from reported accounting data.

1.1.3 Investment Opportunities Approach

Firm value can also be viewed as deriving from existing assets and future investment opportunities (Miller and Modigliani 1961). In a steady state, the value of existing assets can be represented as the capitalization of current earnings. Firm value exceeds the value of existing assets insofar as a firm has positive NPV investment opportunities. In theory, the "investment opportunities" approach should yield the same results as the models based on dividend and free cash flow, since they all obey the discounted cash-flow principle.

It is important to note that valuation by discounting expected future earnings is not the correct approach. In general, dividend payment in a period does not coincide with earnings. Because of differences in timing between earnings generated and dividends paid, discounting future earnings is not equivalent to discounting dividends (see also Holthausen and Watts 2001, p. 57).

To give an example, consider a \$100 investment made now that will last for two periods and earn interest at a rate of 10 % per period. Assume that the first-period earnings are reinvested in the second period, and all invested capital is recovered at the end. The earnings are therefore \$10 at the end of the first period and \$11 at the end of the second. The present value of all future cash flows, discounted at 10 %, is \$100, exactly equal to the initial investment.

If, however, we were to discount future earnings together with the recovered investment capital, the calculation would be $\frac{10}{1.1} + \frac{11+100}{1.1^2} = 100.83$, which exceeds the true value of the investment. There is no double counting in this calculation as the total earnings taken into account (\$10 + \$11 = \$21) equal the total cash flow from the investment (plus the initial capital). The discrepancy is caused by a timing difference, since the earnings realized in the first period are paid out in the second period.

1.2 The RIM

Besides the models discussed above, which are based on dividends, free cash flows, and investment opportunities, in this section we demonstrate that equity value can also be represented by residual income, which is an accounting measure of a firm's generation of value from economic activities.

1.2.1 Basic Version of RIM

The RIM expresses equity value as a function of equity book value and expected future residual income:

$$V_t = B_t + \sum_{s=1}^{\infty} \frac{E_t(\tilde{X}^a_{t+s})}{(1+r)^s}, \tag{1.4}$$

where B_t is the book value of equity at date t and $X^a_{t+s} \equiv X_{t+s} - rB_{t+s-1}$ is residual income generated in period t + s, defined as earnings in period t + s (X_{t+s}) minus the cost of the equity capital employed for the period (rB_{t+s-1}).

The concept of residual income dates back as far as Hamilton (1777) and Marshall (1890).[2] Intuitively, it is a measure of the *net* value generated during a period after the firm has covered all its operational expenses including the cost of equity capital.[3] According to the RIM, equity value is made up of two components: (1) capital contributed by investors (both direct transfers and retained earnings), as measured by equity book value and (2) expected net value added through future operations. This relation has been demonstrated by various researchers including Preinreich (1938), Edwards and Bell (1961), Peasnell (1981, 1982) and, more recently, Ohlson (1995) and Feltham and Ohlson (1995). It is sometimes called the Edwards–Bell–Ohlson model.

As shown in Appendix 1, RIM is built upon two conditions. The first is the DDM, which is the original definition of value. The second is the clean surplus relation (CSR), which articulates earnings (the summary accounting "flow" variable) with equity book value (the summary accounting "stock" variable)

$$B_\tau = B_{\tau-1} + X_\tau - d_\tau. \tag{1.5}$$

CSR specifies that all changes in (recorded) assets and liabilities, other than those arising from transactions with equity investors, pass through the income statement.[4] Remarkably, CSR is the only accounting condition needed to transform

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[2] Residual income has also been referred to as excess earnings (Canning 1929; Preinreich 1938), super-profits (Edey 1957), excess realizable profit (Edwards and Bell 1961), excess income (Kay 1976), and abnormal earnings (Peasnell 1981, 1982; Ohlson 1995).

[3] "Net income" as reported in the income statement seems a misleading term as it leaves out the cost of equity capital.

[4] In practice, under either International Financial Reporting Standards (IFRS) or a specific country's general accepted accounting principles (GAAP), there exist items bypassing the income statement to enter directly into the equity account. The implications for valuation of such "dirty" surplus items are discussed later in this chapter.

DDM into (accounting-based) RIM.[5] Other than this link between earnings and equity book value, no other salient features of accounting such as conservatism and the matching principle are present.

It should be clarified that variable d_t in Eq. (1.5) stands for the *net* dividend, which is the cash dividend distributed to investors minus their capital contribution during the period (Ohlson 1995, p. 666). It is not the cash dividend per se. This distinction will prove important when we examine the properties of the Ohlson (1995) model in Chap. 2.

As a practical matter, it is not feasible to forecast future residual income to time infinity. A modified version of RIM applicable to finite horizon forecasting is

$$V_t = B_t + \sum_{s=1}^{T} \frac{E_t(X^a_{t+s})}{(1+r)^s} + \frac{E_t(V_{t+T} - B_{t+T})}{(1+r)^T}, \tag{1.6}$$

where V_{t+T} is the equity value at the terminal point of date t + T. This equation obtains if we apply the original RIM from Eq. (1.4) to valuation at date t + T to yield $V_{t+T} - B_{t+T} = \sum_{s=1}^{\infty} \frac{E_{t+T}(X^a_{t+T+s})}{(1+r)^s}$ and then replace the stream of expected residual income from period t+T+1 onwards in Eq. (1.4) by $V_{t+T} - B_{t+T}$.

1.2.2 Incorporating Financial Activities Into RIM

Feltham and Ohlson (1995) extend the basic version of RIM described above to firms conducting both financial and operating activities. They argue that the two types of activities give rise to distinct valuation issues. Financial assets (and liabilities) are traded in relatively perfect markets, which make their valuation comparatively simple, whereas operating assets typically are not individually traded and their valuation is more complicated. To capture this view, they assume that operating activities underlie value generation, whereas financial activities earn zero NPV. By setting up separate financial and operating asset accounts, the firm is able to store surplus cash from operating activities and/or withdraw cash to fund further investment in operating activities.

[5] Indeed, CSR is not just an accounting relationship. The basic idea, that the stock level at the end of a period equals the amount carried forward from the beginning of the period plus the amount added less that withdrawn during the period, almost seems to be a manifestation of a physical law that should apply to any object, be it financial, physical, or otherwise. In the context of company accounting, this condition constitutes a basic requirement of the stewardship function (to ensure preservation of resources against unnecessary loss). Although violations of CSR are found empirically, they do not necessarily amount to rejection of this basic underlying principle. See the discussion later in this chapter.

Let FA_t denote the amount of financial assets (net of financial obligations) at date t, i_t the interest income earned on FA_t in period t, OA_t the operating assets at date t, OX_t the operating earnings for period t, and c_t the cash flow transferred at date t from operating activities to the financial asset account, net of investments in those activities. Feltham and Ohlson (1995) show several alternative ways to represent equity value by invoking a number of accounting relations as described below.

The book value of equity is the sum of the book values of financial assets and operating assets, that is

$$B_t = OA_t + FA_t. \tag{1.7}$$

Earnings in period t are the total of operating earnings and interest income

$$X_t = OX_t + i_t \tag{1.8}$$

and CSR, as given by Eq. (1.5), holds.

Financial assets produce interest at a rate equal to the cost of capital (r) (implying zero NPV)

$$i_t = r\, FA_{t-1}. \tag{1.9}$$

Maintaining the financial assets account requires

$$FA_t = FA_{t-1} + i_t + c_t - d_t; \tag{1.10}$$

this is analogous to CSR being applied to the financial assets account. Equations (1.5) (that is, CSR) and (1.10) taken together imply that

$$OA_t = OA_{t-1} + OX_t - c_t; \tag{1.11}$$

which is analogous to CSR applied to the operating assets account.

Employing Eqs. (1.9) and (1.10), we get

$$d_t = c_t + (1 + r)FA_{t-1} - FA_t, \tag{1.12}$$

which is the manifestation of wealth distribution equal to wealth generation.

Employing Eq. (1.12), we transform the DDM in Eq. (1.2) into a cash-based value expression

$$V_t = FA_t + \sum_{s=1}^{\infty} \frac{E_t(c_{t+s})}{(1 + r)^s}. \tag{1.13}$$

That is, equity value equals the book value of financial assets (which are marked to market) plus the present value of free cash flows expected from operating activities. Equation (1.13), of course, represents a finance approach to valuation with a focus on cash flows. As Feltham and Ohlson (1995) observe, this cash-based approach is really a special version of the RIM that emerges if the firm's accounting is cash, as opposed to accrual, based.

To see the equivalence between Eq. (1.13) and the original RIM in Eq. (1.4), note that under cash-based accounting, the book value of operating assets would be zero, $OA_s = 0, \forall s$. Then $B_s = FA_s, X_s = i_s + c_s - dep_s = i_s + c_s$, as $dep_s = 0$ in this case. It follows that $X_s^a = X_s - rB_{s-1} = i_s + c_s - r\,FA_{s-1} = c_s$. Equation (1.13) then follows from RIM (Eq. 1.4).

As well as the value relationships captured in Eqs. (1.4) and (1.13), Feltham and Ohlson (1995) provide a third version of the RIM, which emphasizes residual *operating* income $OX_{t+s}^a = OX_{t+s} - r\,OA_{t+s-1}$. That is,

$$V_t = B_t + \sum_{s=1}^{\infty} \frac{E_t(OX_{t+s}^a)}{(1+r)^s}. \tag{1.14}$$

Equation (1.14) is equivalent to (1.4) because financial assets are assumed to earn zero residual income.

While Eq. (1.4) takes the "whole firm" view, without pinning down the exact source of value generation (financial versus operating activities), Eq. (1.14) emphasizes the unique importance of operating assets in value creation. Both of them highlight the role of profitability in valuation, something not clearly reflected in the cash-based model in Eq. (1.13).

Moving beyond the work of Feltham and Ohlson (1995), the RIM can be further extended to situations where financial activities also have nonzero NPV. In this case, the interest relation in Eq. (1.9) no longer holds, and RIM is modified as

$$V_t = B_t + \sum_{s=1}^{\infty} \frac{E_t(OX_{t+s}^a) + E_t(FX_{t+s}^a)}{(1+r)^\tau}, \tag{1.15}$$

where $FX_{t+s}^a = i_{t+s} - r\,FA_{t+s-1}$, representing the residual income earned on financial assets in period t+s.

More generally, Eq. (1.15) can be interpreted as RIM applied to a firm with two segments conducting separate businesses.

1.3 The Accounting Structure Embedded in RIM

RIM connects equity value to accounting measures of value generation. It is interesting to explore what type of accounting structure has been built into this model. It is often believed by both academics and practitioners that the method of accounting measurement (beyond CSR) is of no consequence for residual income valuation because the RIM is understood to be able to "self-correct" errors and distortions contained in accounting data. More specifically, if we arbitrarily restate equity book value and/or earnings, there will be a corresponding adjustment in the accounting amounts of the subsequent periods via the workings of CSR, such that the valuation result will be unchanged. As Ohlson (1995) puts it, "this formula [RIM] is peculiar because one interprets it by referring to accounting concepts, yet the formula works regardless of the accounting principles that measure book values and earnings. Accounting constructs beyond the clean surplus restriction are irrelevant" (p. 667). Bernard (1995) similarly suggests that the model does not assume any particular relation between accounting earnings and "economic earnings," and holds regardless of the (clear surplus) accounting methods used and even if book value and/or earnings are manipulated (p. 742). These views are echoed by others such as Holthausen and Watts (2001, p. 59) and Kothari (2001, p. 177). Such claims give the impression that RIM permits accounting variables to be measured in rather arbitrary ways and that they need not resemble accounting data in the conventional sense.

While some researchers (see for example Bernard 1995) view this self-correcting ability as a desirable feature of the model, others regard it as unappealing as it renders the model devoid of any accounting content and of "any guidance or predictions about firms' choice of accounting methods or properties of accounting standards" (Kothari 2001, p. 177). Of course, if this is true, the "irrelevance" of accounting measurements would be troubling and would undermine the efforts of the accounting profession and standard setters, who strive to achieve high-quality financial reporting. If measurement is inconsequential for valuation purposes, why should investors care about the quality of reported data?

In this section, we first illustrate how RIM's self correction is said to work. We then point out an implicit condition embedded in the underlying argument and explain that this condition, while mathematically permissible, is implausible in practice. Finally, by tracing a firm's accounting to the initial point of its establishment, we demonstrate that clean surplus actually requires measurement to be based on historical cost, a property that has not been well appreciated in the literature to date.

1.3.1 Illustrating How Self-Correction "Works"

To illustrate this, let us compare the valuation of a firm under the original accounting system with that under a revised system. Assume that in the latter, the firm's equity book value at date t, denoted as $\hat{B}_t$, is arbitrarily increased by 1 from that in the original system, that is, $\hat{B}_t \equiv B_t + 1$. We consider two alternative scenarios for the schedule for expensing this extra unit of book value. Our aim is to show that in either depreciation scenario, the equity value at date t as determined from RIM is the same under the two alternative accounting systems.

Scenario (1): the added unit of book value is not expensed within a finite time horizon. In this case, the book values at all future dates will be adjusted upward by 1 from those in the original system, that is, $\hat{B}_{t+s} = B_{t+s} + 1,\ \forall s \geq 1$, and future earnings are unaffected, $\hat{X}_{t+s} = X_{t+s}, \forall s \geq 1$. Then, future residual income under the new accounting system becomes $\hat{X}^a_{t+s} = \hat{X}_{t+s} - r\hat{B}_{t+s-1} = X_{t+s} - r(B_{t+s-1} + 1) = X^a_{t+s} - r$. It follows that the equity value at date t is $\hat{V}_t = \hat{B}_t + \sum_{s=1}^{\infty} \frac{E_t(\hat{X}^a_{t+s})}{(1+r)^s} = B_t + 1 + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})-r}{(1+r)^s} = B_t + 1 + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} - 1 = V_t$, thus confirming that the valuation result is not affected by the accounting change.

Scenario (2): the extra unit of book value is expensed over the next two periods along a straight line. In this case, future book values are $\hat{B}_{t+1} = B_{t+1} + 0.5$ and $\hat{B}_{t+s} = B_{t+s},\ s \geq 2$, whereas future earnings are $\hat{X}_{t+1} = X_{t+1} - 0.5$, $\hat{X}_{t+2} = X_{t+2} - 0.5$, and $\hat{X}_{t+s} = X_{t+s},\ s \geq 3$. Then, future residual income equals $\hat{X}^a_{t+1} = \hat{X}_{t+1} - r\hat{B}_t = (X_{t+1} - 0.5) - r(B_t + 1) = X^a_{t+1} - 0.5 - r$, $\hat{X}^a_{t+2} = \hat{X}_{t+2} - r\hat{B}_{t+1} = (X_{t+2} - 0.5) - r(B_{t+1} + 0.5) = X^a_{t+2} - 0.5 - 0.5r$, and $\hat{X}^a_{t+s} = \hat{X}_{t+s} - r\hat{B}_{t+s-1} = X_{t+s} - rB_{t+s-1} = X^a_{t+s},\ s \geq 3$.

Accordingly, the corresponding equity value at date t is $\hat{V}_t = \hat{B}_t + \sum_{s=1}^{\infty} \frac{E_t(\hat{X}^a_{t+s})}{(1+r)^s} = B_t + 1 + \frac{E_t(X^a_{t+1}) - 0.5 - r}{1+r} + \frac{E_t(X^a_{t+2}) - 0.5 - 0.5r}{(1+r)^2} + \sum_{s=3}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} = B_t + 1 - \left[\frac{0.5+r}{1+r} + \frac{0.5}{1+r}\right] + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} = B_t + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} = V_t$. Again, the valuation result is the same as that obtained under the original accounting system.

In Appendix 2, we present an example to show that equity value is also unaffected by an arbitrary restatement of earnings for period t+1.

1.3.2 *Implicit Assumption Behind Self-Correction*

While RIM's self-correction seems puzzling at first, closer scrutiny of the underlying analysis uncovers an implicit assumption, namely, that expected future dividends are unchanged by an accounting restatement and only future earnings and/or book value are adjusted via CSR as applied to date t and onwards. For example, in Scenario (i) above, $\hat{d}_{t+s} = \hat{B}_{t+s-1} + \hat{X}_{t+s} - \hat{B}_{t+s} = (B_{t+s-1} + 1) + X_{t+s} - (B_{t+s} + 1) = B_{t+s-1} + X_{t+s} - B_{t+s} = d_{t+s}, \forall s \geq 1$; that is, expected dividends remain the same. Similarly, in Scenario (ii), we have $\hat{d}_{t+1} = \hat{B}_t + \hat{X}_{t+1} - \hat{B}_{t+1} = (B_t + 1) + (X_{t+1} - 0.5) - (B_{t+1} + 0.5) = B_t + X_{t+1} - B_{t+1} = d_{t+1}$; $\hat{d}_{t+2} = \hat{B}_{t+1} + \hat{X}_{t+2} - \hat{B}_{t+2} = (B_{t+1} + 0.5) + (X_{t+2} - 0.5) - B_{t+2} = B_{t+1} + X_{t+2} - B_{t+2} = d_{t+2}$; and $\hat{d}_{t+s} = \hat{B}_{t+s-1} + \hat{X}_{t+s} - \hat{B}_{t+s} = B_{t+s-1} + X_{t+s} - B_{t+s} = d_{t+s}, s \geq 3$; again, there is no change in expected future dividends. Of course, if the dividend stream remains the same, equity value will not change either. After all, the RIM is merely a transformation of DDM, which ultimately ties value to future dividends.

In essence, the self-correction property maintains that for some reason, investors have gained knowledge of the firm's operations from sources other than financial reporting, and this knowledge (including their expectations of future dividends) is unaffected by reported accounting data. The rationale behind this might be that since the issue is purely one of measurement, the economic reality, including expected dividends, should not vary with measurement approach per se.[6]

On purely mathematical grounds, holding the dividend stream constant while changing earnings and/or book values is permissible. As explained by Lo and Lys (2000, p.341), CSR uses two accounting variables (earnings and equity book value) but imposes one time–series restriction, so one of the variables can be arbitrarily chosen as long as the other adjusts in accordance with the CSR.

However, in economic terms, this condition does not capture real-world valuation problems. In reality, accounting serves as a vital means to communicate business activities, and investors depend on accounting data to evaluate the firm's operations and project their future course. In other words, accounting information serves to guide financial forecasting and valuation. This has two implications. Firstly, given that accounting has a clear purpose, the method of measurement is important because errors and distortions introduced into accounting data make it more difficult to make inferences about the underlying business that they portray. Thus, the quality of accounting will determine the accuracy of forecasting and valuation activities. Secondly, a meaningful link is purported to exist between reported accounting data (if properly measured) and future dividends, and as such, expected dividends cannot be treated as fixed with respect to changes in reported accounting amounts. Consequently, valuation will depend on reported accounting data which serve as input for the RIM.

In conclusion, the self-correcting property of RIM is an artifact of an assumption that detaches financial forecasting from reported accounting numbers. In a world where accounting plays a nontrivial role in communicating business activities to investors, self-correction is not plausible.

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[6] In explaining RIM's self-correction, Christensen and Feltham (2003) point out that "changing the accounting policy does not change the market value so long as the accounting policy does not have any economic consequences (e.g., tax effects)" (p.285). More fundamentally, however, investors' *interpretation* of accounting data is entirely unaffected by the method of measurement or, putting it another way, they do not rely on accounting data at all in financial forecasting. In justifying such an assertion, one might argue that investors are not necessarily fooled by the "appearance" of accounting data; for example, they can correct for the effect of using one method rather than another. While it may well be that investors are able to do this in situations where the alternatives are clearly specified, it is an entirely different matter altogether to perform a complete reverse engineering of the entire accounting process (which is what self-correction of the RIM amounts to).

1.3.3 Accounting as a Closed System: Uncovering Further Restrictions in RIM

The self-correcting property illustrated above has led some to believe that accounting measurement has no consequences for residual income valuation. In this subsection, we use the CSR to develop the notion that accounting is a *closed* system and demonstrate that within this system measurement is restricted to historical cost, which conforms to conventional practice.

By a closed system, we mean that value/income as recognized in the accounting system is not created or destroyed on its own, but must arise from concrete economic activities. This notion is intuitive and consistent with the CSR. According to the CSR, once a firm has come into existence, its book value of equity at any given date t (t>0) is either inherited from the previous date or earned from operations during period t (net of the dividends paid). In this sense, for each period this relation represents a closed loop where nothing leaks into or out of the system.[7]

While the CSR is well specified for an ongoing firm (that is, where t = 1,2,3,. . .), special attention is required for the initial date (t = 0) when the firm has just come into existence. A direct extension of the CSR would yield $B_0 = B_{-1} + X_0 - d_0$. In this equation, variable d_0 is defined economically; assuming that no cash dividend is paid at date 0, net dividend at t = 0 is simply the inverse of the capital contribution (I_0), that is, $d_0 = -I$. On the other hand, terms B_{-1} and X_0 are only imaginary (in an economic sense) because they relate to a time when the firm has not yet been formed.

By extending the basic logic behind the CSR to date 0, holding that accounting is a closed system and capital stock is either inherited from the past or created through operations during the current period, it is natural to set both B_{-1} and X_0 to zero. That is, before the firm has come into existence, *no* capital stock exists and *no* value is ever generated.

We formally define a closed accounting system as follows.

Definition 1.1 A closed accounting system for a firm is characterized by the following two conditions: (1) $B_{-1} = 0$ and $X_0 = 0$ at initial point of t=0 and (2) the CSR (Eq. 1.5) for each of the subsequent dates, t>0.

Following Definition 1.1, we get $B_0 = B_{-1} + X_0 - d_0 = -d_0 = I_0$; that is, equity book value at date 0 equals the initial capital contribution, meaning that assets are recorded at historical cost. Through CSR, the initial cost is carried to subsequent dates net of depreciation charges. The same relation applied to dates after date 0 implies that new capital contributions at any subsequent date raise the asset (and equity) book value by an amount of an equal magnitude, again reflecting

[7] For our purposes, we assume that the income statement records the value created/destroyed from economic activities during a period. In a practical context, there can be changes in assets/liabilities that do not unequivocally constitute value for investors. We ignore such accounting items in this discussion.

cost-based accounting. Furthermore, depreciations are charged against the original historical cost, with any undepreciated portion kept in the book. This leads to Proposition 1.1.

Proposition 1.1 *Within a closed accounting system (Definition 1.1), measurement is restricted to historical cost.*

Thus, with a natural initial condition for date 0, the accounting structure in the RIM is considerably tidied up. Within this system, equity book value is an accumulation of the capital contributed by investors through either direct transfers or earnings retentions, thus giving this particular accounting measure a clear economic meaning. Although not yet explicitly defined, by extending the above analysis to include a suitable revenue recognition rule, earnings calculated within this system can also be meaningfully interpreted, contrary to the view that accounting constructs can be decouple from economic concepts within the RIM framework.

We will further examine the characteristics of accounting in Chap. 2 and beyond, where we discuss specific valuation models that impose various accounting structures.

1.4 What Do Violations of Clean Surplus Entail?

Clean surplus is the sole condition required to transform the DDM into the RIM. In practice, however, this condition is typically violated, and in some cases dirty surplus items—those bypassing the income statement to enter into the equity account directly—constitute a significant portion of total comprehensive income. Lo and Lys (2000) calculate dirty surplus items as a percentage of total comprehensive income for Compustat firms over the period 1962–1997. They find that although the median percentage is small (0.40 %), the mean is a significant 15.71 %. Furthermore, for 14.4 % of firm-year observations, dirty surplus exceeds 10 % of comprehensive income. It is therefore relevant to ask what violations of CSR in the empirical context might mean for residual income valuation.

Lo and Lys (2000) offer an extended RIM to incorporate dirty surplus. Denote X_t as the comprehensive income for period t which satisfies CSR, and Y_t as the net income reported in the income statement which is a subset of the items in X_t. Dirty surplus income is defined as $Z_t \equiv X_t - Y_t$. The residual income based on the two income measures is denoted as X_t^a and Y_t^a, respectively. Then, $X_t^a = Y_t^a + Z_t$. It follows that

$$V_t = B_t + \sum_{\tau=1}^{\infty} \frac{E_t(X_{t+\tau}^a)}{(1+r)^{\tau}} = B_t + \sum_{\tau=1}^{\infty} \frac{E_t(Y_{t+\tau}^a)}{(1+r)^{\tau}} + \sum_{\tau=1}^{\infty} \frac{E_t(Z_{t+\tau})}{(1+r)^{\tau}}. \tag{1.16}$$

One implication of Eq. (1.16) is that if the expected future dirty surplus is small (relative to the other terms in the equation), the RIM from Eq. (1.4) calculated using net income (Y_t) will still give a reasonable approximation even though the CSR is violated with respect to Y_t. As the original model, this modified RIM is also silent about how we should forecast future residual income (and the corresponding dividend stream).

To be clear, dirty surplus income is really an empirical phenomenon and there is no clear definition of it in an economic (as opposed to accounting) sense. The set of such items present in an empirical setting is the result of the particular GAAP standards enforced there, and its content generally differs across jurisdictions. Without knowing what the dirty surplus means economically, it would seem premature to conclude that its existence necessarily renders the net income measure deficient in capturing value generation, which in essence is what RIM aims to achieve. For example, the existence of dirty surplus might reflect standard setters' belief that some of the items affecting the equity account are not *income* in the sense of being true value to investors, or their lack of any position as to how some of the items should be classified.

Several questions need to be explored in order to better grasp the role of dirty surplus income in valuation. Firstly, what is the nature of the items classified as dirty surplus in a specific accounting regime? In particular, are they truly not income for investors (and hence do not affect the firm's ability to pay dividends)? Secondly, to the extent that dirty surplus items are of value to investors and are of nontrivial magnitude, how feasible is it to forecast those items [which make up variable Z in Eq. (1.16)]? Thirdly, if dirty surplus items are not truly income for investors but merely a byproduct of the accounting process in an "imperfect" world, how is the economic meaning (that is, information content) of the residual income measure altered if it is calculated on the basis of comprehensive income? Future theoretical and empirical research into these questions can shed light on how residual income valuation should be implemented in a practical context and which items should or should not be included in the income statement.

1.5 Empirical Research Comparing the RIM with the Alternative Discount Models

RIM represents only one of the several alternative approaches to implementing equity valuation. A number of studies have empirically compared its performance against other models such as the DDM and the FCFM; see for example, Penman and Sougiannis (1998); Courteau et al. (2001); Francis et al. (2000). They reach the general conclusion that RIM outperforms models based on cash flows and dividends.[8]

However, Lundholm and O'Keefe (2001) argue that such comparisons are not meaningful because these models are alternative representations of equity value that are theoretically equivalent and that the differences in results can be attributed

[8] See also Lo and Lys (2000) for a discussion of other studies that implement and evaluate RIM.

to the inconsistent assumptions that the researchers have made in forecasting different value metrics. Fundamentally, the different value metrics are all derived from the same underlying economic activities. It is the economic activities that determine value, and once these activities are specified, the way in which value is represented should not matter.

Notwithstanding the theoretical equivalence of the alternative models, investors may or may not, in practice, be able to implement valuation consistently across the different models. Thus, as an empirical issue, one would still be curious as to whether investors in actual applications indeed make consistent assumptions across the different approaches and, if not, how significant the discrepancies are in terms of valuation results. Of course, one of the challenges of pursuing this question is that the researcher observes only the actual price in the market, but not the process of valuation performed by analysts and investors during which different value estimates may be produced from alternative models and are then aggregated to reach a final assessment.

1.6 Summary

This chapter starts by setting out the finance models of equity value as a platform to derive the RIM, which allows equity value to be related to an accounting measure of value generation (residual income). The central condition required to transform the finance models into RIM is the CSR, which describes the evolutionary process of the equity account and its link to earnings generation and dividend payments. The chapter then examines the properties of the RIM and points out that the widely accepted belief that accounting concepts may be arbitrarily measured without affecting the valuation result is predicated on an implausible condition that essentially assumes away the role of accounting in financial forecasting. Finally, we propose the notion of accounting as a closed system, which is a generalization of the CSR, and explain that within such a system, measurement is restricted to historical cost.

Appendix A: Derivation of the RIM

Starting with the DDM given by Eq. (1.2), and employing the CSR in Eq. (1.5) to replace expected dividends with accounting variables, we have

$$
\begin{aligned}
V_t &= \frac{E_t(d_{t+1})}{(1+r)} + \frac{E_t(d_{t+2})}{(1+r)^2} + \frac{E_t(d_{t+3})}{(1+r)^3} + \dots \\
&= \frac{E_t(B_t + X_{t+1} - B_{t+1})}{(1+r)} + \frac{E_t(B_{t+1} + X_{t+2} - B_{t+2})}{(1+r)^2} + \frac{E_t(B_{t+2} + X_{t+3} - B_{t+3})}{(1+r)^3} + \dots \\
&= B_t + \frac{E_t(-rB_t + X_{t+1})}{(1+r)} + \frac{E_t[-(1+r)B_{t+1} + X_{t+2}]}{(1+r)^2} + \frac{E_t[-(1+r)B_{t+2} + X_{t+3}]}{(1+r)^3} \\
&\quad + \frac{E_t[-(1+r)B_{t+3} + ..]}{(1+r)^4} + \dots \\
&= B_t + \frac{E_t(X^a_{t+1})}{(1+r)} + \frac{E_t(X^a_{t+2})}{(1+r)^2} + \frac{E_t(X^a_{t+3})}{(1+r)^3} + \dots = B_t + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s}.
\end{aligned}
$$

Appendix B: Self-Correction of the RIM with Respect to Earnings Measurement

Restate earnings for period t+1 as $\hat{X}_{t+1} = X_{t+1} + 1$, without changing the book value at date t and the earnings and dividends of all other future periods. Then $\hat{X}^a_{t+1} = \hat{X}_{t+1} - rB_t = X_{t+1} + 1 - rB_t = X^a_{t+1} + 1$, and $\hat{B}_{t+1} = B_t + \hat{X}_{t+1} - d_{t+1}$ $= B_t + X_{t+1} + 1 - d_{t+1} = B_{t+1} + 1$. Beyond period t+1, we have $\hat{B}_{t+s} = B_{t+s} + 1$ and $\hat{X}^a_{t+s} = X_{t+s} - r(B_{t+s-1} + 1) = X^a_{t+s} - r,\ \forall s \geq 2$. Thus, equity value in the new accounting regime is

$$
\begin{aligned}
\hat{V}_t &= B_t + \sum_{s=1}^{\infty} \frac{E_t(\hat{X}^a_{t+s})}{(1+r)^s} = B_t + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} + \frac{1}{1+r} - \sum_{s=2}^{\infty} \frac{r}{(1+r)^s} \\
&= B_t + \sum_{s=1}^{\infty} \frac{E_t(X^a_{t+s})}{(1+r)^s} = V_t.
\end{aligned}
$$

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Chapter 2
Mapping Accounting Data to Value via Linear Information Dynamics: The Early Approach

The RIM introduced in Chap. 1 focuses on the valuation role of the expected residual income from future operations. Like other discount models such as the DDM and FCFM, the RIM is silent on how expectations of a firm's future operations are formed. To understand the direct impact of financial reporting on capital markets where investors set firm values, we need a forecasting model that connects future residual income to what investors observe today, particularly reported accounting data.

Financial reporting is a vital channel through which to report a firm's business activities. Investors rely on reported accounting data, in conjunction with information from other sources, to form their opinions about a firm's future operations. The premise of our discussion (and for financial analysis in real-world practice) is that a systematic and meaningful link exists between a firm's present and future business activities.

Two distinct approaches to modeling financial forecasting have emerged in the extant literature: (1) the linear information dynamic (LID) approach and (2) the real options-based approach. In this chapter, we introduce the LID approach adopted by Ohlson (1995), Feltham and Ohlson (1995, 1996), and others. We describe the various versions of the LID as proposed in these studies, develop valuation models based on these LIDs, and examine the properties of these models. We also evaluate the validity of these LIDs on both conceptual and empirical grounds.

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2.1 Ohlson's (1995) Linear Model

2.1.1 The Basic LID and the Resulting Valuation Model

The basic LID introduced by Ohlson (1995) assumes the following AR(1) process[1]:

$$\tilde{X}^a_{t+1} = \omega X^a_t + \tilde{e}_{t+1}, \tag{2.1}$$

where $X^a_t = X_t - rB_{t-1}$ is the residual income (also known as abnormal earnings) of the firm in period t; $0 \leq \omega \leq 1$ is a parameter representing the persistence of residual income from one period to the next; and $\tilde{e}_{t+1}$, with $E_t(\tilde{e}_{t+1}) = 0$, is a disturbance term which is not predictable at date t.

As explained in Chap. 1, residual income is an accounting measure of net value creation from economic activities (subject to noise and distortions introduced in the accounting process). It thus summarizes firm's performance over a given period, reflecting the organization's overall strength or weakness in the marketplace, where it interacts and competes with other economic entities. The process of generating residual income from business activities is complex, and the success or failure of a firm depends on a combination of many different factors including management ability, innovation, technology, market power, cost efficiency, and so on.[2] Fundamental factors such as these constitute the "intrinsic" quality of the firm as an economic entity. Although a firm's fundamentals can change from one period to the next due to the effect of competitive forces and evolving economic conditions, such changes tend to be gradual rather than abrupt. That is, a firm's strengths or weaknesses generally persist over time, rather than appearing or vanishing suddenly. It is this persistent nature of business fundamentals that gives financial reporting its vital role in forecasting and valuation.[3]

Equation (2.1) thus conveys the message that for an ongoing business, the residual income achieved in period t provides a basis for forecasting future residual income (provided that $\omega > 0$). In Ohlson (1995), parameter ω is treated as exogenous. Economic intuition suggests that it should depend on the characteristics of the firm (such as its ability to innovate and emulate industry best practice) and also the market environment in which it operates, such as the intensity of competition within the industry.

[1] At this point in our discussion, we omit "other" (that is, nonaccounting) information included in Ohlson's (1995) LID. Later, we will examine the role of such information as modeled in various studies.

[2] See Cheng (2005) for a discussion of the economic and accounting factors explaining a firm's residual income.

[3] Imagine an alternative scenario where a firm's strengths or weaknesses in each period are expected to vanish instantaneously, and so performance over each period becomes purely random with no serial correlation. Here, financial data pertaining to the current operational period will be of no use for forecasting future performance.

Equation (2.1) links the residual income of one period to that of the following period. Applying the relation recursively, we obtain the forecasted residual income for any future period t + τ as

$$E_t(\tilde{X}^a_{t+\tau}) = \omega^\tau X^a_t, \tau = 1, 2, 3, \ldots. \quad (2.2)$$

Substituting Eq. (2.2) into the RIM (Eq. 1.4) and simplifying, we derive equity value as a function of book value and residual income (which are both observable at date t) as

$$V_t = B_t + \alpha X^a_t, \quad (2.3)$$

where $\alpha \equiv \omega/(1 + r - \omega)$ summarizes the total persistence effect of current residual income on future periods. Parameter α increases with ω. Given $0 \leq \omega \leq 1$, the value of α will lie between 0 and $1/r$.

To relate equity value more directly to financial statement data, we replace X^a_t in Eq. (2.3) with earnings and book value to yield an alternative representation

$$V_t = k(\varphi X_t - d_t) + (1 - k)B_t, \quad (2.4)$$

where $\varphi \equiv 1 + 1/r$ is the earnings capitalization factor and $k \equiv r\alpha = r\omega/(1 + r - \omega)$, which has a value between 0 and 1.

According to Eq. (2.4), in a general case equity value is equal to a weighted average of the values corresponding to two extreme cases. At the one extreme where residual income has zero persistence ($\omega = 0$), all future residual income is expected to be zero. Accordingly, $k = 0$, and so Eq. (2.4) reduces to $V_t = B_t$. In this case, equity valuation requires only the balance sheet.

At the other extreme, where residual income is expected to remain permanent ($\omega = 1$), $k = 1$, and so Eq. (2.4) simplifies to $V_t = \varphi X_t - d_t$, which is the earnings capitalization adjusted for the dividend payment. In this case, valuation requires only the income statement.

In general, where $0 < \omega < 1$, both primary financial statements are required in valuation, and the importance of one statement versus the other depends on the persistence parameter. The income statement is more important than the balance sheet where residual income is more persistent, and vice versa.

2.1.2 *Properties of Ohlson's (1995) Linear Value Model*

Ohlson (1995) stresses several properties of the linear model in Eq. (2.4). In this subsection, we reproduce these properties and examine their implications.

2.1.2.1 Long-Term Behavior of Expected Residual Income and Equity Value

The first property concerns the long-term expected residual income and equity value.

Proposition 2.1 *LID (Eq. 2.1) implies the following results: (i)* $\lim_{\tau\to\infty} E_t(X^a_{t+\tau}) \to 0$ *and (ii)* $\lim_{\tau\to\infty} E_t(V_{t+\tau} - B_{t+\tau}) \to 0$.

That is, as we look into the far-off future, we expect residual income to approach zero and equity value to approach equity book value.

Part (i) of Proposition 2.1 follows from Eq. (2.2), which links current residual income to expected future residual income. With $\omega < 1$, a fraction of the realized residual income is expected to dissipate with the passing of each period, so the effect of current residual income will gradually diminish and eventually disappear. Thus, whatever residual income the firm currently earns, the expected residual income will approach zero in the long term.

To show part (ii) of Proposition 2.1, we start with the value function in Eq. (2.3) to derive $E_t[V_{t+\tau} - B_{t+\tau} | X^a_t] = E_t[\alpha_1 X^a_{t+\tau} | X^a_t]$. With the expected residual income approaching zero in the long run, equity value is expected to approach book value, thus proving the result.

Researchers often rationalize these properties of Ohlson's (1995) model by appealing to the economic intuition that in a competitive environment a firm's ability to earn economic rent should not be sustained forever (see for example Kothari 2001). Nevertheless, it is troubling that these theoretical predictions are usually not supported by empirical observations. In the real world, we do not observe stock prices gradually approaching equity book values in the long term. Prices typically are and remain above book values for a long time with no trend of convergence to book values. This begs the question of what economic forces may operate outside the Ohlson (1995) model to cause equity value to remain systematically above book value.

A missing element in LID (Eq. 2.1) is active decision-making on the part of the firm in pursuit of value. In the LID, the persistence component could be viewed as what is inherited from the current operation, and the random disturbance ($\tilde{e}_{t+1}$) as representing innovations due to (say) research and development (R&D) activities. The ex ante mean of this disturbance term is zero, suggesting that where such innovations are concerned, success and failure are both equally likely. The LID in Eq. (2.1) suggests that the firm remains in passive mode with regard to the outcome of R&D. Specifically, whether the realization of e_{t+1} is good or bad, it enters the linear process and affects future residual income in a symmetrical fashion; the firm takes no measures in order to treat successful and unsuccessful innovations differently.

This feature of Ohlson's (1995) LID model does not accord well with how firms actually behave. In pursuit of value maximization, rational firms will take measures to build upon successful R&D outcomes to prolong their effects, and to limit the undesirable impact of R&D failures. As a result of such asymmetrical responses, the random term $\tilde{e}_{t+1}$ is expected to have a positive effect on future residual income (even though its unconditional mean is zero), causing equity value to exceed book value.

2.1.2.2 Missing Role of Capital Investment

Capital investment is the primary economic activity driving value creation. However, Ohlson's (1995) model neglects the role of capital investment. In the LID represented in Eq. (2.1), expected future residual income is tied to realized residual income but not incremental capital investment; indeed, the latter is not explicitly shown throughout the model.

Closely tied to capital investment is the net dividend (d_t), which is cash dividend minus capital contribution. Let us define capital investment as the increase in asset book value ($I_t \equiv B_t - B_{t-1}$). Then, following the CSR, we get $I_t = X_t - d_t$. Thus, given earnings, net dividend is equivalent to negative capital investment. Capital investment increases book value, whereas net dividend reduces it.

To gain insights into how capital investment affects value generation within the Ohlson (1995) model, we next present a series of properties concerning the impact of (net) dividend on future earnings and equity value.

Proposition 2.2a *(Property 1 from Ohlson 1995, p. 672): Current dividends reduce expected period-ahead earnings at a rate equal to the cost of capital*

$$\frac{\partial E_t(\tilde{X}_{t+1})}{\partial d_t} = -r. \tag{2.5}$$

Proof Employing the definition of residual income, LID (2.1), and CSR (1.5), we get $E_t(\tilde{X}_{t+1}) = E_t(\tilde{X}^a_{t+1} + rB_t) = \omega\tilde{X}^a_t + rB_t = \omega\tilde{X}^a_t + r(B_{t-1} + X_t - d_t)$. If dividends are paid at the end of a period, d_t has no effect on X^a_t, B_{t-1}, or X_t. The proposition is demonstrated by differentiating $E_t(\tilde{X}_{t+1})$ with respect to d_t.

Next, we generalize the above result to cumulative earnings over the next two periods.

Proposition 2.2b *(Property 2 from Ohlson 1995, p. 673): Current dividends reduce expected total earnings over the two subsequent periods at a rate equal to the following compounded interest:*

$$\frac{\partial E_t(\tilde{X}_{t+2} + \tilde{X}_{t+1} + rd_{t+1})}{\partial d_t} = -[(1+r)^2 - 1]. \tag{2.6}$$

Proof Based on the definition of residual income, LID Eq. (2.1), and CRS Eq. (1.5), we have $E_t(\tilde{X}_{t+2}) = E(\tilde{X}^a_{t+2}) + rB_{t+1} = E_t[\omega^2\tilde{X}^a_t + r(B_t + \tilde{X}_{t+1} - d_{t+1})]$. Rearranging the terms, we get $E_t(\tilde{X}_{t+2} + \tilde{X}_{t+1} + rd_{t+1}) = E_t[\omega^2 X^a_t + rB_t + (1+r)\tilde{X}_{t+1}] = E_t[\omega^2 X^a_t + rB_t + (1+r)(\tilde{X}^a_{t+1} + rB_t)] = [\omega^2 + (1+r)\omega]X^a_t + r[1+(1+r)](B_{t-1} + X_t - d_t)$.

The proposition is demonstrated by differentiating this equation.

The next proposition concerns the impact of dividends on equity value.

Proposition 2.2c *(Property 3 from Ohlson 1995, p. 673): Current dividends reduce equity value dollar for dollar,*

$$\frac{\partial V_t}{\partial d_t} = -1. \tag{2.7}$$

Proof Based on the value function in Eq. (2.3), we have $V_t = B_t + \alpha X_t^a = B_{t-1} + X_t - d_t + \alpha X_t^a$. It follows that $\partial V_t / \partial d_t = -1$.

In essence, Propositions 2.2a–c all convey the same basic message that capital investment (or divestment) at date t has zero NPV. It neither enhances nor destroys value for investors. Investment is expected to generate earnings in a subsequent period at the rate *r*, exactly offsetting the cost of capital, and increases equity value dollar for dollar. Conversely, each dollar of *net* dividends (that is, divestment) reduces equity value by exactly one dollar (see further discussion of the effect of dividend policy in the next subsection). In summary, investors are made neither better off nor worse off by changes in the scale of operations. To make this point more succinctly, note that $I_t \equiv X_t - d_t$, and thus $\partial I_t / \partial d_t = -1$. It follows from Proposition 2.2c that $\partial V_t / \partial I_t = (\partial V_t / \partial d_t)(\partial d_t / \partial I_t) = 1$.

Importantly, the results stated in Propositions 2.2a–c do not just apply to capital investment (net dividends) at the margin given a particular scale; they hold for *any* level of capital investment/divestment undertaken by the firm. The implication is that the scale of operation at date t is completely irrelevant to future value generation. Putting it another way, investors would not care whether the firm undertakes a huge positive or negative investment, or makes none at all, because this will not influence expected value creation. This point should be clear from the LID as shown in Eq. (2.1), which relates expected future residual income only to realized residual income (x_t^a), irrespective of any capital investment decision made at date t and beyond.

The discussion here leads to the following conclusion about the Ohlson (1995) model, which is basically a reinterpretation of Proposition 2.2c.

Proposition 2.3 *The LID (Eq. 2.1) implies that the firm's ongoing investments all have zero NPV.*

However, in the model of Ohlson (1995), a distinction should be made between the NPV of *ongoing* (incremental) investments at any date and that of the firm's operations as a whole. While the LID (Eq. 2.1) implies that all ongoing investments incrementally have zero NPV, it is unwarranted to conclude that this is also true for the firm *as a whole*. At any given point in time, the firm can have either a positive or a negative NPV, depending on the residual income realized in the most recent period, which affects expected future residual income.

Nevertheless, the way in which residual income generation is modeled is peculiar. According to the LID (Eq. 2.1), residual income comes from two sources; it is either "inherited" from the prior period (the persisting component), or from a purely random draw ($\tilde{e}_{t+1}$). Since ex ante the random element has a zero mean, the inherited part is the only systematic source that matters for valuation purposes.

If current residual income is assumed to come from the previous period, by the same logic, previous-period residual income should have come from the period before that, and so on. Ultimately, therefore, the systematic component of residual income in the LID (Eq. 2.1) can all be traced back to date 0, when the firm was created. Thus, implicitly, while the Ohlson (1995) model gives the firm opportunities to undertake a positive NPV investment at the outset, capital investments made after date 0 are all expected to have zero NPV.

2.1.2.3 The Role of Dividends in Ohlson (1995) Versus MM's Dividend Irrelevance

According to Proposition 2.2c, (net) dividends reduce equity value dollar for dollar, so their payment is irrelevant to total investor wealth. This result has been interpreted by Ohlson (1995, p. 673) as consistent with the "dividend irrelevance theorem" demonstrated by Miller and Modigliani (1961), hereafter MM. Although this result certainly does not contradict MM's theorem that dividend policy is irrelevant to investors' total wealth, the essential message it conveys is in fact very different.

As noted above, the dividend variable in Ohlson (1995) is defined as net dividend, which is the opposite of capital investment. Because capital investments have zero NPV in the context of LID (Eq. 2.1) (Proposition 2.3), Proposition 2.2c does not just confirm that dividend policy is irrelevant, but more fundamentally that it is a manifestation of *investment irrelevance*. In other words, investors are indifferent as to how much the firm invests or divests at any given date after $t = 0$.

In contrast, in MM, dividends refer to as cash dividends paid to investors, rather than net dividends. MM's message is that in a perfect capital market, given a firm's investment activity, investors are indifferent to one particular dividend policy versus another. For any given dividend policy, investors who do not like it can simply adjust their investment portfolios to achieve the desired cash position. For example, investors who prefer to hold more cash than the amount of dividends paid by the firm can produce "homemade" dividends by selling a portion of their ownership. Conversely, investors who prefer to hold less cash can purchase more shares to increase their investment.

The central condition in MM's theorem is that as a firm adjusts its dividend policy, its investment decisions are held to be fixed. This is possible because in a perfect capital market the firm can freely adjust its financing activities to complement whatever dividend policy has been adopted, such that there is sufficient capital to fund all profitable investment projects.

In the end, investors will be neither better nor worse off under one dividend policy or another, so long as the firm's investment decisions are unchanged. Of course, the firm is implicitly assumed to have optimized its investment decisions whereby all positive NPV projects are accepted and all negative NPV projects rejected. Once these investment decisions are made, the boundary of the firm is uniquely determined. Therefore, the economic setting of MM is much more general, and more meaningful, than that underlying the LID (Eq. 2.1) where all ongoing investments are held to have zero NPV. While MM's dividend irrelevance theorem essentially stresses the importance of capital investment activities for value creation, rather than that of financial activities, Ohlson's (1995) concept of dividend irrelevance really amounts to investment irrelevance because of the restriction to a zero-NPV setting.

2.1.3 Nonaccounting (Other) Information in Ohlson (1995)

2.1.3.1 Adding Nonaccounting Information into the LID

In the original LID proposed by Ohlson (1995), expected period-ahead residual income is related not only to current residual income but also to lagged nonaccounting (other) information. The latter element of the model summarizes the impact of news or events realized in period t that are not yet reflected in the financial statements for that period, and it is intended to deal with the fact that financial statement information does not constitute the entirety of all the information relevant to valuation and that investors also rely on other sources when assessing firm value.

Let v_t denote the nonaccounting information realized in period t. The original LID of Ohlson (1995), which is an extended version of Eq. (2.1), is

$$\tilde{X}^a_{t+1} = \omega\, X^a_t + v_t + \tilde{e}_{1,t+1}, \tag{2.8a}$$

$$\tilde{v}_{t+1} = \gamma\, v_t + \tilde{e}_{2,t+1}. \tag{2.8b}$$

According to these dynamics, nonaccounting information (v_t) affects residual income with a one-period delay, and this impact lasts into the future. There are two separate channels through which v_t has this effect. Firstly, because residual income persists at a rate of ω, once the effect of v_t has entered into the residual income stream, it will persist through future periods although its effect will gradually decay. Secondly, according to Eq. (2.8b), v_t itself follows an AR (1) process and persists at a rate of γ. Thus, realized nonaccounting information in period t (v_t) affects future nonaccounting information, $v_{t+1}, v_{t+2}, \ldots$. These individual v-terms will respectively enter into the residual income stream with a one-period delay and their effects will persist at rate ω.

The total effect of v_t on future residual income $X^a_{t+\tau}, \tau = 1, 2, \ldots,$ is the sum of the effects through these two separate channels. Interestingly, as Lo and Lys (2000) demonstrate, the total effect of v_t on $X^a_{t+\tau}$ does not decrease monotonically with τ but initially increases with τ to reach a maximum after a certain number of periods and then declines gradually with τ (see Fig. 1 in Lo and Lys 2000, p. 349).

A number of questions about the way nonaccounting information is modeled in Eq. (2.8a, b) remain unanswered. Firstly, in the model of Ohlson (1995), v_t is a generic variable that is not given a specific identity. It can be anything outside the financial report that is relevant to valuation and it is an open set. One can list examples from many different sources such as changes in macroeconomic conditions, industry regulations, product inventions, and management turnover. It is pertinent to explore how the different types of nonaccounting information each affect future firm performance and, in particular, whether they affect future residual income in dissimilar ways and hence warrant separate attention in a valuation model.

Secondly, the rationale for both the dynamic of v_t and its effect on period-ahead residual income having a linear structure is not explained. Other than for technical convenience, is such a linear structure economically justifiable? The additive form used seems restrictive because it precludes potential interactions between accounting and nonaccounting information when used together to forecast future residual income. In the real world, such interactions are quite plausible. For example, the impact of a product market expansion on future profit should be assessed in conjunction with a firm's cost efficiency.

Thirdly, while arguments could be made as to why residual income (as a proxy for economic rent) might follow a mean-reversion process, it is not clear why an analogous situation would be true for nonaccounting information. Exogenous news and events taking place in one period can differ sharply from those in the previous period, and they may not be serially correlated. In addition, the (implied) nonmonotonic effect of v_t over time, as has been demonstrated by Lo and Lys (2000), is not explained.

Indeed, without knowing specifically what v_t is, there is little basis from which to address these issues in a concrete way. We will revisit them in subsequent chapters where we present other models of equity value.

2.1.3.2 Proxies for Nonaccounting Information in Empirical Studies

In empirical studies, researchers have used various measures of v_t. Myers (1999) uses order backlogs as a proxy for v in his tests of Ohlson's LID. He also proposes other possible examples such as new patents, long-term contracts, and regulatory approval of new products.

Liu and Ohlson (2000) and Ohlson (2001) propose a way to back v_t out from analyst earnings forecasts. Let $\bar{X}_t^{t+1} \equiv E_t(\tilde{X}_{t+1})$ be the expectation at time t of earnings for period t+1, and $\bar{X}_t^{a,t+1} \equiv E_t(\tilde{X}_{t+1}^a) = \bar{X}_t^{t+1} - rB_t$ the expected residual income for period t+1. Since these earnings expectations are publicly observable at date t, one can infer v_t from $\bar{X}_t^{a,t+1}$ based on Eq. (2.8a) as $v_t = \bar{X}_t^{a,t+1} - \omega X_t^a$. Several empirical studies have adopted this technique to infer other information, including Begley and Feltham (2002) and Dechow et al. (1999).

However, while this way of inferring v_t may be convenient for the researcher, it evades the original questions faced by investors, namely, what specific events and news constitute the set of "raw" nonaccounting information, and how they are summarized and transformed into v_t. By inferring v_t indirectly from earnings forecasts, such studies offer no guidance to investors on how they ought to combine accounting information with specific types of nonaccounting information in forecasting and valuation. Indeed, once expected earnings have been determined, there seems little need for nonaccounting information at all.

2.2 Introducing Conservatism and Growth: Feltham and Ohlson (1995)

2.2.1 Generalized LID with Conservatism and Growth

Feltham and Ohlson (1995) extend the LID proposed by Ohlson (1995) by introducing two more features, namely, accounting conservatism and asset growth. Their generalized dynamics take the following form (ignoring nonaccounting information):

$$\tilde{X}^a_{t+1} = \omega_{11}\, X^a_t + \omega_{12} OA_t + \tilde{e}_{1,t+1}, \tag{2.9a}$$

$$O\tilde{A}_{t+1} = \omega_{22} OA_t + \tilde{e}_{2,t+1}, \tag{2.9b}$$

where OA_t stands for the book value of operating assets at date t. In Eq. (2.9a, b), three parameters taken together determine how residual income evolves over time. These are explained below.

The first is the persistence parameter, ω_{11}, which has the same meaning as ω in the LID of Eq. (2.1) and indicates the extent to which current residual income is expected to continue in future periods. Implicitly, the portion of expected future residual income stemming from the persistence effect represents what the firm's existing assets will continue to generate; residual income arising from future growth opportunities is not included here.

The second is the conservatism parameter ω_{12}, with $\omega_{12} > 0$ corresponding to conservative accounting and $\omega_{12} = 0$ to unbiased accounting. The conservatism effect as modeled in Eq. (2.9a) may be justified as follows. Conservatism reduces the recorded book value of assets, which in turn reduces the cost of capital charges ($r\ OA_t$) and thus inflates the measured amount of residual income. Term $\omega_{12} OA_t$ is therefore included to recognize this accounting effect, with ω_{12} representing the degree of conservatism. In the special case of unbiased accounting, we have $\omega_{12} = 0$, and so (2.9a) reduces to the original LID (Eq. 2.1) of Ohlson (1995).

However, it is questionable that term $\omega_{12} OA_t$ alone is adequate to capture the full effect of conservatism. As is well known, conservatism does not just affect the measurement of book value but also earnings, but the LID in Eq. 2.9a seems to ignore its impact on residual income through earnings. The drawback in this modeling of the conservatism effect will be further elaborated on later in Chap. 3 (Proposition 3.1).

The third parameter, ω_{22}, refers to the growth of operating assets. According to Eq. (2.9b), on average, operating assets grow at a rate of ω_{22} per period. For technical reasons, this parameter is restricted to $1 \leq \omega_{22} \leq 1 + r$. In the special case where operating assets are expected to remain at a constant scale, $\omega_{22} = 1$.

The way in which asset growth is modeled in Eq. (2.9a) is somewhat peculiar. Here, asset growth per se has no effect on future residual income *unless accounting is also conservative*. This can be seen if we note that where $\omega_{12} = 0$, future residual income is related only to the realized residual income in Eq. (2.9a), and so is not influenced by asset growth. Thus, although Feltham and Ohlson (1995) explicitly introduce asset growth, whether growth indeed matters in their model hinges on the accounting method. This feature does not accord well with the economic reality where corporate investment is the primary activity driving firm value, irrespective of how such activity is accounted for.

2.2.2 The Equity Value Model Based on the Generalized LID

Using the LID in Eq. (2.9a, b), we forecast future residual income on the basis of two accounting variables, X_t^a and OA_t. Substituting the forecasts into the RIM (Eq. 1.4) and simplifying, we obtain the equity value function as

$$V_t = B_t + \alpha_1 X_t^a + \alpha_2 OA_t, \tag{2.10}$$

where $\alpha_1 = \frac{\omega_{11}}{1+r-\omega_{11}}$ and $\alpha_2 = \frac{\omega_{12}(1+r)}{(1+r-\omega_{22})(1+r-\omega_{11})}$. This function is an extended version of the Ohlson (1995) model, shown by Eq. (2.3).

In Eq. (2.10), parameter α_1 summarizes the persistence effect of current residual income on all future periods through ω_{11}. As set out in the Ohlson (1995) model, if residual income is completely transitory ($\omega_{11} = 0$), we get $\alpha_1 = 0$. On the other hand, if residual income is expected to be permanent ($\omega_{11} = 1$), we get $\alpha_1 = 1/r$. In general, α_1 lies between these two extremes.

Parameter α_2 captures the effect of conservatism, with $\alpha_2 > 0$ if accounting is conservative ($\omega_{12} > 0$) and $\alpha_2 = 0$ if accounting is unbiased ($\omega_{12} = 0$).

However, α_2 not only depends on conservatism, but is also a function of persistence (ω_{11}) and asset growth (ω_{22}). This arises from the setup of the LID in Eq. (2.9a, b). Given operating assets at date t (OA_t), growth affects operating assets at date t+1 (OA_{t+1}), which is then entered into the LID (Eq. 2.9a) to affect the residual income of period t + 1 via the conservatism parameter. That is why asset growth matters in computing the effect of conservatism based on Eq. (2.9a). Moreover, because residual income persists, the conservatism effect on the residual income in period t + 1, as captured through (2.9a), is then passed onto period t + 2 and beyond via the persistence parameter (ω_{11}). As a result, α_2 embeds all three parameters of the LID as set out above.

The value function in Eq. (2.10) can alternatively be expressed as

$$V_t = k(\varphi X_t - d_t) + (1 - k)B_t + \alpha_2 OA_t. \tag{2.11}$$

Just as the model in Eq. (2.10) is an extension of the previous version in Eq. (2.3) as set out by Ohlson (1995), Eq. (2.11) is an extension of Eq. (2.4). In the case of unbiased accounting (in the sense Feltham and Ohlson 1995, use that term), that is, $\alpha_2 = 0$, the last term in both Eqs. (2.10) and (2.11) drops out, and the equations reduce to their corresponding versions in Ohlson (1995). For this reason, some researchers refer to the Ohlson (1995) model as valuation under unbiased accounting.

2.2.3 A Closer Look at the Conservatism Notion Set Out by Feltham and Ohlson (1995)

As explained above, Feltham and Ohlson (1995) characterize conservative accounting as $\omega_{12} > 0$ in the context of their LID (Eq. 2.9a, b) and unbiased accounting as $\omega_{12} = 0$. Based on Eq. (2.10), if $\omega_{12} > 0$, expected "unrecorded goodwill" (defined as the difference between equity value and equity book value) will be positive in the long run, so

$$\lim_{\tau \to \infty} E_t(V_{t+\tau} - B_{t+\tau}) > 0. \tag{2.12}$$

On the other hand, if $\omega_{12} = 0$, then $\lim_{\tau \to \infty} E_t(V_{t+\tau} - B_{t+\tau}) \to 0$, which is a property of the Ohlson (1995) model (Proposition 2.1(ii)).

Here, conservative (versus unbiased) accounting is defined in terms of the behavior of accounting *outcome* (that is, equity book value) relative to equity value. Feltham and Ohlson (1995) do not explicitly model the process of measuring economic activities, and it is unclear what accounting rules would yield an equity book value that exhibits such conservative behavior.

Feltham and Ohlson (1995) imply that an unbiased accounting system is one that is designed to directly measure equity value, and define any system expected to yield a book value below equity value as conservative. However, to achieve their unbiased result, the accounting process not just would have to record the economic activities that have been realized, but would also have to anticipate fully the effect of future operations. To illustrate this point, consider a firm that has just invested capital (I) in a project with $NPV>0$. Assume no other assets and no debt financing. Then, the firm's equity value equals $I + NPV$. If the firm records a book value of $I + NPV/2$, which includes half of the NPV coming from *future* operations, its accounting would still be classified as conservative under the Feltham and Ohlson's (1995) definition. However, in reality, this practice would be viewed as too aggressive to be acceptable under the historical cost convention.

In a closed accounting system (Definition 1.1) which is fully compatible with the RIM, book value is measured at historical cost (Proposition 1.1). Accounting within such a system will never reach an unbiased state, in the sense meant by Feltham and Ohlson (1995), for firms with positive NPV operations. This is because for such firms, equity value exceeds equity book value as recorded at historical cost. In other words, for firms with positive NPV operations, the Feltham and Ohlson's (1995) definition of unbiased accounting is not compatible with the RIM.

This discussion leads us to the next proposition.

Proposition 2.3 *In a closed accounting system (Definition 1.1), (i) unbiased accounting as defined by Feltham and Ohlson (1995) is not possible for firms whose operations have strictly positive or negative NPV, and (ii) only firms with zero-NPV operations satisfy Feltham and Ohlson's (1995) definition of unbiased accounting.*

Feltham and Ohlson (1995) state that Ohlson's (1995) model corresponds to valuation under unbiased accounting. Following Proposition 2.3, this is yet another manifestation of Ohlson's (1995) model implying zero-NPV investment, thus reinforcing the result shown in Proposition 2.3 above.

We suggest that the view put forward by Feltham and Ohlson (1995) deviates from the role that financial reporting is intended to play in real-life investment decisions. Conventional practice dictates that a firm's accounting is based (primarily) on economic events and activities that have already taken place, so investors can use accounting data as an input for assessing firm value. In particular, this approach does not directly measure firm value which is tied to future economic activities. Within this conventional view, it is more natural to judge whether accounting is conservative or unbiased on the basis of recorded book value relative to actual resources invested as inputs to operations, rather than to the eventual output expected from such operations. This conventional view of conservatism is adopted in some of the more recent theoretical studies such as Feltham and Ohlson (1996) and Zhang (2000) and also in some empirical studies such as Penman and Zhang (2002).

2.3 Information Dynamic in Cash Flows: Feltham and Ohlson (1996)

In the work of Ohlson (1995) and Feltham and Ohlson (1995), LIDs are represented in terms of accounting variables. A drawback of this approach is that such variables are endogenous to the accounting process and are affected by the particular accounting rules adopted. Feltham and Ohlson (1996) overcome this by specifying a dynamic in cash flows. They develop the valuation function initially in terms of cash flows, and then convert it into an accounting-based model by imposing specific accounting rules.

2.3.1 The Cash Flow Dynamic and Free Cash Flow-Based Valuation

The LID proposed by Feltham and Ohlson (1996) is described in terms of cash receipts (cr) and cash investments (ci) as follows:

$$\tilde{cr}_{t+1} = \gamma\, cr_t + \kappa\, ci_t + \tilde{e}_{1,t+1}, \tag{2.13a}$$

$$\tilde{ci}_{t+1} = g\, ci_t + \tilde{e}_{2,t+1}, \tag{2.13b}$$

where $\gamma > 0$ is the persistence of cash receipts, $\kappa > 0$ is the marginal impact of cash investment at date t on cash receipts at date t+1, and g is the expected growth in investment.

Assuming risk neutrality and a constant discount rate (r), we determine equity value based on expected free cash flows as

$$V_t = \sum_{\tau=1}^{\infty} \frac{E_t(cr_{t+\tau} - ci_{t+\tau})}{(1+r)^{\tau}}. \tag{2.14}$$

With the LID as set out in Eq. (2.13a, b), the state of the firm's operations at date t is fully characterized by (ci_t, cr_t). Investors forecast future investments and the resulting cash flows on the basis of (ci_t, cr_t). As a result, equity value at date t is transformed as

$$V_t = \Phi[\gamma\, cr_t + \kappa\, ci_t] + \pi[g\, ci_t], \tag{2.15}$$

where $\Phi \equiv 1/(1+r-\gamma)$ and $\pi \equiv (\Phi\kappa - 1)/(1+r-g)$.

In Eq. (2.15), the terms in the first pair of square brackets represent the portion of value arising from existing assets. Given the state of operations (cr_t, ci_t), the expected future cash flows generated by existing assets are $E_t(\tilde{cr}_{t+1}) = \gamma\, cr_t + \kappa\, ci_t$ in period t+1, $E_t(\tilde{cr}_{t+2}) = \gamma(\gamma\, cr_t + \kappa\, ci_t)$ in period t+2, and so on. The present value of this cash flow stream as a whole sums to $\Phi[\gamma\, cr_t + \kappa\, ci_t]$.

The last term in Eq. (2.15) is the NPV of *future* growth opportunities. According to Eq. (2.13a), the present value of future cash flows from \$1 of investment today is $\kappa/(1+r) + \gamma\kappa/(1+r)^2 + \gamma^2\kappa/(1+r)^3 + \ldots = \kappa/(1+r-\gamma) = \Phi\kappa$, so the NPV equals $\Phi\kappa - 1$. As new investment is made every period and it grows at a rate of g, the NPV of all future investments from date t+1 and beyond will sum to $\pi[g\, ci_t]$.

In a manner similar to the linear models discussed above, Feltham and Ohlson (1996) do not specify whether these investment opportunities have positive or negative NPV; the firm simply adheres to the exogenous linear path in Eq. (2.13b) no matter how profitable or otherwise the investment opportunities actually are.

In the special case of zero-NPV investment ($\Phi\kappa - 1 = 0$), the value function simplifies to $V_t = \frac{\gamma}{1+r-\gamma} cr_t + ci_t$.

Another feature common to all the LIDs introduced so far is that "flow" variables (such as residual income and cash receipts) are related to their own previous states. While it is likely that serial correlations in cash receipts or residual income will be present, they do not depict any truly causal relations underlying value generation. Intuition suggests that cash receipts (or residual income) are generated from resources invested in the operation, not from past cash receipts or residual income. This modeling approach has some peculiar implications, as can be seen in the LID in Eq. (2.13a). Firstly, while the cash return earned from existing assets varies from one period to the next due to the effect of random disturbance in each period ($\tilde{e}_{1,t+1}$), the return on new investment stays at a fixed rate (κ) over time. Secondly, the firm earns nonzero cash receipts ($\tilde{e}_{1,t+1} \neq 0$) even if it has no assets inherited from past periods or invested in the current period (as implied by the case of $cr_t = 0$ and $ci_t = 0$).

2.3.2 An Accounting Model of Equity Value

Feltham and Ohlson (1996) impose the following accounting rules. Firstly, depreciation is recognized as a proportion of assets, $dep_t = (1 - \delta)OA_t$. The rate of accounting depreciation is $(1 - \delta)$, which generally differs from the rate of decline in cash receipts from existing assets, $(1 - \gamma)$. Thus, depreciation is conservative if $\delta < \gamma$, and unbiased if $\delta = \gamma$. Secondly, earnings from operating activities are defined as $OX_{t+1} = cr_{t+1} - (1 - \delta)OA_t$. Thirdly, the operating asset account evolves as $OA_{t+1} = \delta\, OA_t + ci_{t+1}$.

Although the CSR is not explicitly assumed, it is implied by the second and third rules. Note that $OA_{t+1} = OA_t + OX_{t+1} - d_{t+1} = OA_t + cr_{t+1} - (1 - \delta)OA_t - d_{t+1}$ $= \delta\, OA_t + ci_{t+1}$, where $ci_{t+1} \equiv cr_{t+1} - d_{t+1}$ is the capital investment at date t+1.

Employing these accounting rules, the cash flow-based valuation in Eq. (2.16) is transformed into accounting-based valuation as

$$V_t = OA_t + \alpha_1\, OX_t^a + \alpha_2\, OA_{t-1} + \alpha_3\, ci_t. \tag{2.16}$$

In Eq. (2.16), $\alpha_1 \equiv \Phi\gamma \equiv \gamma/(1 + r - \gamma)$ captures the effect of residual income persistence. While in the previous models in Eqs. (2.3) and (2.10), persistence is given exogenously, this model shows that residual income persistence can be traced to cash flow persistence, which can be viewed as an indication of asset "durability" in operations.

Parameter $\alpha_2 \equiv \Phi(1 + r)(\gamma - \delta)$ captures the effect of conservative depreciation: $\alpha_2 > 0$ if depreciation is conservative ($\delta < \gamma$) and $\alpha_2 = 0$ if depreciation is unbiased ($\delta = \gamma$). Note that here the conservatism effect is no longer intertwined with growth (g) as in the model of Feltham and Ohlson (1995).

Finally, $\alpha_3 \equiv [\Phi\kappa - 1](1 + r)(1 + r - g)$ summarizes the effect of investment growth: $\alpha_3 > 0$ if future investment opportunities have positive NPV (i.e., $\Phi\kappa - 1 > 0$), whereas $\alpha_3 < 0$ if they have negative NPV.

According to Eq. (2.16), equity value comprises equity book value, the present value of future residual income generated from existing assets (the persistence effect), an adjustment term for conservative depreciation (which causes equity book value to be understated), and the NPV of future investment growth. This model is an extended version of that proposed by Feltham and Ohlson (1995) and shown by Eq. (2.10), which in turn is an extension of the model of Ohlson (1995) in Eq. (2.3).

2.3.3 Different Notions of Conservatism: Feltham and Ohlson (1995 Versus 1996)

So far, we have presented two distinct notions of conservatism as defined by Feltham and Ohlson in 1995 and 1996. We pause here to highlight the differences between the two. In their 1995 work, Feltham and Ohlson define conservatism in terms of whether ex ante the accounting system is expected to report an equity book value that is below equity value. In contrast, in 1996, they reflect conservative accounting through the depreciation policy. In the latter, equity book value is systematically below equity value for firms conducting positive NPV operations even if they adopt an unbiased depreciation policy. In other words, these firms' accounting will still be considered conservative in accordance with the criterion of Feltham and Ohlson (1995) even if they adopt an unbiased depreciation policy.

A strength of the Feltham and Ohlson (1996) model is that it depicts the information dynamic in terms of economic activities (cash receipts and investments), rather than accounting variables, and explicitly specifies how the system measures such activities. This approach yields a valuation function that shows more cleanly the effect of accounting conservatism versus that of economic activities, as shown in Eq. (2.16). This contrasts with the model set out in Feltham and Ohlson (1995) (that is, in Eq. 2.10) where the two effects are intertwined and, in particular, the effect of growth hinges on conservative accounting.

2.4 Empirical Research Related to the Linear Models

A great deal of interest has been shown in testing empirically the linear models developed by Ohlson (1995) and Feltham and Ohlson (1995, 1996). Such studies include, among others, Bar-Yosef et al. (1996), Dechow et al. (1999), Myers (1999), and Callen and Segal (2005). To add an empirical dimension to our discussion, we also summarize in this subsection some salient aspects of this line of work.

Firstly, residual income does indeed exhibit positive persistence as predicted by the LIDs, with the degree of persistence varying across firms in ways that accord with economic intuition (Dechow et al. 1999). However, the equity values computed from estimated LIDs show little or only slight improvement in explaining stock prices over simple benchmarks such as capitalization of forecasted one-year-ahead earnings (Dechow et al. 1999) and equity book value (Myers 1999). Furthermore, the value estimates based on LIDs are generally too low relative to observed market prices.

It should be clear that estimating LIDs per se does not amount to testing their validity when no alternative (nonlinear) process has been specified. Studies typically impose a linear structure onto empirical data by either adopting one of the LIDs proposed by Ohlson (1995) or Feltham and Ohlson (1995, 1996) or extending them by adding more linear terms such as lagged residual income and firm characteristics (see for example Bar-Yosef et al. 1996; Dechow et al. 1999). Thus, by design, the estimated empirical dynamic will take a linear form. A positive slope estimated in this way merely indicates a positive correlation, which can arise from an underlying nonlinear as well as linear relation.[4] Therefore, it is premature to conclude, based on this body of work, whether the LIDs proposed in the theoretical research are empirically descriptive.

Secondly, the empirical evidence for the role of Feltham and Ohlson's (1995) conservatism, which predicts a separate term involving the book value of operating assets in both the LID and the valuation function, is mixed. On the one hand, Callen and Segal (2005) show that the book value term is significantly positively related to equity value, thus rejecting Ohlson's (1995) model (with "unbiased" accounting) in favor of Feltham and Ohlson's (1995) model. On the other hand, Myers (1999) finds that the estimate of the conservatism parameter of Feltham and Ohlson (1995, 1996) is negatively correlated with other market-based measures of conservatism adopted by empirical researchers (Beaver and Ryan 2000). In light of the conflicting notions of conservatism as discussed above, and without a clear understanding of how conservatism should be defined at the basic measurement level and how it impacts the relation between value and accounting, it is difficult to properly design an empirical analysis and interpret the results.

Thirdly, evidence for the role of nonaccounting information also seems to be mixed. On the one hand, nonaccounting information indirectly inferred from analyst forecasts (a method suggested by Liu and Ohlson 2000 and Ohlson 2001) exhibits significant explanatory power for stock prices. On the other hand, when order backlog is included in the LIDs as a specific example of nonaccounting

[4] For example, observations drawn from $\tilde{y}_t = x_t^2 + \tilde{e}_t$ will yield a positive correlation between x_t and y_t in a domain of positive x_t-values. Myers (1999) argues that nonlinear dynamics are not internally consistent, but his argument is derived from a special case of nonlinearity (piecewise linear specifications) and does not apply in general.

information, Myers (1999) finds it to have little effect. Together, these results point to a need for more research, both theoretical and empirical, into identifying and measuring nonaccounting information from various sources and exploring how it affects valuation. We will revisit the role of nonaccounting information in Chap. 4.

Finally, some studies use the linear models of Ohlson (1995) and Feltham and Ohlson (1995, 1996) to motivate employing linear regressions that explain stock prices with accounting variables. Lo and Lys (2000) point out some potential pitfalls for such studies. We comment further on this line of research in Chap. 6.[5]

2.5 Summary

This chapter has introduced LIDs as a way to forecast future residual income on the basis of realized accounting information. Combining these LIDs with the RIM, we determine equity value as a linear function of reported accounting data such as earnings and equity book value. Our discussion covers several formulations of LIDs as proposed by Ohlson (1995) and Feltham and Ohlson (1995, 1996), which incorporate, to varying degrees, features relevant to valuation such as persistence, growth, and conservatism. We then examined the properties of the resulting linear value models and discussed their implications.

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[5] There are other branches of valuation research, such as (i) using expected future earnings and earnings growth to determine equity value (see, for example, Frankel and Lee 1998 and Liu and Thomas 2000), which emphasize the role of expected future earnings rather than realized earnings, and (ii) relying on the RIM to infer the implied cost of capital. Both are outside the scope of our discussion.

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Chapter 3
Capital Following Profitability: Why the Residual Income Dynamic Is Nonlinear

Having introduced the LID approach in Chap. 2, we now take an alternative approach to modeling the residual income dynamic, premised on the notion of "capital following profitability." As previously explained, the linear approach ignores firms' active decision-making in the value-generation process and treats decision-making either as absent altogether (Ohlson 1995) or following a mechanical path that does not respond to the changing environment (Feltham and Ohlson 1995, 1996). In this chapter, we recognize the importance of capital investment *decisions* and assume that the accounting system yields signals which are useful for guiding these decisions. In a world where economic agents (that is, company managers and investors) seek to enhance value and increase wealth, they will rationally allocate capital to investment opportunities that yield high rather than low returns. The notion of capital following profitability accords with economic intuition and is widely reflected in actual business practice. For example, firms commonly adopt the NPV criterion to determine whether investment projects are acceptable, and rely on profitability information (such as return on assets, *ROA*) in internal resource allocation.

As we will show, in a setting where firms purposefully seek out and pursue profitable opportunities, the residual income dynamic exhibits distinctively nonlinear behavior. Our task in this chapter is to model this nonlinear dynamic theoretically and then empirically test its predictions. The content of this chapter draws primarily on the work of Biddle et al. (2001).

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3.1 Theoretical Analysis and Predictions: The Case of Unbiased Accounting

3.1.1 Basic Assumptions

The basic idea behind the Biddle et al. (2001) model is that accounting serves a dual function. On the one hand, accounting provides a means to measure a firm's performance, or the *output* of business operations. On the other hand, through such measurement, it also generates signals useful for guiding business activities; thus, accounting information is also an *input* for business operations.

We start, in this section, with the case of unbiased accounting such that accounting variables measure economic activities without systematic distortions (the specific definition of our unbiased accounting and its consequences are made clear in Sect. 3.4 and Chap. 4). Later, in Sect. 3.4, we demonstrate that the same qualitative predictions hold under conservative accounting. The reason for this is that the nonlinearity of the residual income dynamic demonstrated below stems from economic forces to create value, not from the way of accounting.

Two assumptions make up the building blocks of the Biddle et al. (2001) model. Let X_t denote the earnings in period t, B_{t-1} the equity book value at the beginning of period t (date t−1), and $X_t^a \equiv X_t - rB_{t-1}$ the residual income of period t. The first assumption specifies how profitability evolves over time.

Assumption 3.1 (Profitability Persists)

$$\tilde{p}_{t+1} = \omega p_t + \tilde{\varepsilon}_{t+1} \tag{3.1}$$

where $p_t \equiv X_t^a / B_{t-1} = X_t / B_{t-1} - r$ is a profitability measure for period t, defined as residual income normalized by beginning equity book value or, equivalently, the return on equity (ROE) minus the cost of capital; $0 < \omega \leq 1$ is the persistence parameter; and $\tilde{e}_{t+1}$ is a zero-mean random disturbance. Assuming unbiased accounting, p_t properly measures the *economic* rent per unit of invested capital (which is explained further below).

According to Assumption 3.1, profitability (normalized residual income) persists from one period to the next, but the effect of realized profitability diminishes as time goes on, and eventually disappears. As explained in Chap. 2, residual income is an accounting proxy for economic rent, reflecting a firm's overall strength or weakness in the marketplace. This strength or weakness is accumulated over years of operations and is unlikely to dissipate over the short term. In the meantime, however, there are also economic forces (such as competition and benchmarking) at work that will drive abnormally high and low profitability towards the mean. Thus, the basic intuition behind Assumption 3.1 is the same as that for Ohlson's linear dynamic as set out in Eq. (2.1).

While Ohlson (1995) treats residual income (X_t^a) as a primitive construct in his model, our focus here is on *normalized* residual income p_t (which does not exhibit the scale effect). The latter construct is a more fundamental indicator of a firm's ability to generate value, which acts as a signal to guide capital investment decisions (see further below). Also, this normalized measure is more readily compared between firms with different asset levels, which facilitates resource allocation across companies.

Following Assumption 3.1, one dollar of investment made at date t is expected to yield a stream of future residual income ωp_t, $\omega^2 p_t, \ldots$ Discounting this residual income stream yields the NPV of the \$1 investment as $\frac{\omega p_t}{1+r} + \frac{\omega^2 p_t}{(1+r)^2} + \cdots = \frac{\omega p_t}{1+r-\omega} = \Omega p_t$, where $\Omega \equiv \frac{\omega}{1+r-\omega}$.

The next assumption describes the firm's capital investment behavior, which embodies the notion that capital follows profitability.

Assumption 3.2 (Capital Investment Follows Profitability)

(i) *The case of positive investment.* If $\Omega p_t > 0$, then

$$I_t^+ = \pi_1 B_{t-1}[\Omega p_t], \tag{3.2a}$$

where $I_t^+ > 0$ is the amount of incremental capital invested in the operation, and $\pi_1 > 0$ is a parameter depicting the firm's investment opportunity;

(ii) *The case of negative investment.* If $\Omega p_t < 0$, then

$$I_t^- = -\pi_2 B_{t-1}[\Omega p_t], \tag{3.2b}$$

where $I_t^- > 0$ the amount of capital divested from the operation, and $\pi_2 > 0$ is a parameter depicting the firm's divestment opportunity.

According to Assumption 3.2(i), when faced with positive NPV investment opportunities, the firm invests to expand the scale of its operations. The (incremental) capital invested (I_t^+) depends on three factors: profitability (p_t), current scale (B_{t-1}), and external investment opportunity (π_1). A positive relation between I_t^+ and p_t is consistent with the NPV rule, which is a standard capital budgeting technique employed in the real world and which reflects capital following profitability.

A positive relation between I_t^+ and B_{t-1} is motivated by the empirical observation that larger firms generally undertake a greater amount of investment. In practice, investment projects require not only capital but also human resources (managers and frontline employees), and it takes time to acquire all the input factors required and make the organizational changes necessary for growth. Large organizations are more capable of mobilizing and expanding these various resources, and so they typically invest more than small organizations that are operating in similar environments.

How much investment a firm undertakes also depends on the external market environment. Across different industries, there will be differences in firms' investment behavior which can be attributed to different growth potential and different stages of market development. Parameter π_1 captures a firm's investment opportunities (exogenous to the model).

Assumption 3.2(ii) analogously depicts divestment behavior for firms with negative profitability ($p_t < 0$). The operations of such firms are destroying rather than creating value for investors. To contain such value destruction, it will be desirable to remove resources from these operations. Mirroring the case of positive investment, the amount of divestment (I_t^-) is assumed to depend on three factors: profitability (p_t), existing scale (B_{t-1}), and divestment opportunity (π_2). The roles of the first two are analogous to those in the positive investment case. However, as discussed below, the economic forces behind parameter π_2 are not symmetrical to those behind π_1 in the positive investment scenario.

In an ideal world where firms are free of agency problems and corporate divestments are frictionless, firms producing negative residual income ($p_t < 0$) should divest all or part of their operations insofar as this will help to stop value destruction. In practice, there are at least two important reasons why firms do not generally undertake rapid divestments. Firstly, the use value of tangible and intangible assets is firm-specific, and so assets lose productivity when they are transferred from existing to other operations. Furthermore, there are direct costs incurred in the process of dismantling and transferring assets. These frictions thus deter or delay the divestment process until losses have reached a sufficiently high level. Parameter π_2 partly reflects the severity of asset specificity and frictional costs for a specific firm.

Secondly, agency problems between a firm's managers and investors pose yet another obstacle to divestment. While it is desirable from the investors' perspective to divert resources away from value-destroying operations, managers often want to retain their current projects. Managers are employees hired to manage the firm. Divestment threatens their employment security, so they naturally resist it. The severity of such agency conflict depends on how closely managers' self-interest is aligned with that of shareholders, and is a function of factors such as inside ownership and corporate governance. Thus, parameter π_2 also reflects the effect of agency conflict on divestment decisions.[1]

3.1.2 Nonlinear Residual Income Dynamic and Its Properties

Based on Assumptions 3.1 and 3.2, we now construct the relation between residual income in period t+1 and realized residual income in period t and examine its properties. The analysis below considers the cases of positive and negative investment separately.

[1] Note, however, that managers' interests are not always in conflict with those of investors. For example, when faced with positive NPV investment opportunities, both groups would prefer to invest more.

3.1.2.1 The Case of Positive Capital Investment

When $p_t > 0$, the firm makes an investment to expand the scale of its operations. Combining Eqs. (3.1) and (3.2a), we determine the residual income in period t+1 as

$$\begin{aligned}\tilde{X}^a_{t+1} &\equiv \tilde{p}_{t+1}B_t = (\omega p_t + \tilde{\varepsilon}_{t+1})(B_{t-1} + I^+_t) \\ &= \omega p_t B_{t-1} + \pi_1 B_{t-1}\omega\Omega p_t^2 + \tilde{e}_{t+1} = \omega X^a_t + \pi_1 \frac{\omega\Omega}{B_{t-1}}(X^a_t)^2 + \tilde{e}_{t+1},\end{aligned} \tag{3.3}$$

where $\tilde{e}_{t+1} \equiv B_t\tilde{\varepsilon}_{t+1}$ is a disturbance term with $E_t(\tilde{e}_{t+1})$=$B_tE_t(\tilde{\varepsilon}_{t+1})$=0.

As reflected in the dynamic in Eq. (3.3), current residual income impacts period-ahead residual income through two channels. One is the (profitability) persistence channel, whose effect is captured by term ωX^a_t. This is what the expected residual income in period t+1 would be for a firm remaining in a steady state, that is, making no adjustment to scale (I^+_t=0).

The other is the "feedback" channel stemming from capital following profitability; this effect yields the nonlinear term $\pi_1 \frac{\omega\Omega}{B_{t-1}}(X^a_t)^2$. According to Assumption 3.2 (i), firms with higher profitability (p_t) invest more, which causes their operations to grow. As residual income in period t+1 is the multiplicative product of profitability and the total capital base in period t+1, both of which increase in p_t, this feedback role of profitability causes the residual income dynamic to be nonlinear.

We observe that the LID of Ohlson (1995) given in Eq. (2.1) (and ignoring other information v) is a special case of the nonlinear dynamic shown in Eq. (3.3). If (ongoing) investments generate zero residual income or, equivalently, if the firm makes no investment (I^+_t=0), the quadratic term in Eq. (3.3) vanishes and we are back to the LID (Eq. 2.1) of Ohlson (1995).

To examine the properties of the dynamic in Eq. (3.3), we differentiate expected period t+1 residual income, $E_t(\tilde{X}^a_{t+1})$, with respect to current residual income, X^a_t, which yields

$$\frac{dE_t(\tilde{X}^a_{t+1})}{dX^a_t} = \omega + 2\pi_1\frac{\omega\Omega}{B_{t-1}}X^a_t > 0 \tag{3.4}$$

and

$$\frac{d^2E(\tilde{X}^a_{t+1})}{d(X^a_t)^2} = 2\pi_1\frac{\omega\Omega}{B_{t-1}} > 0. \tag{3.5}$$

Thus, residual income in period t+1 is an increasing and convex function of residual income in period t.

Further differentiating Eqs. (3.4) and (3.5) with respect to the investment opportunity parameter (π_1), we get

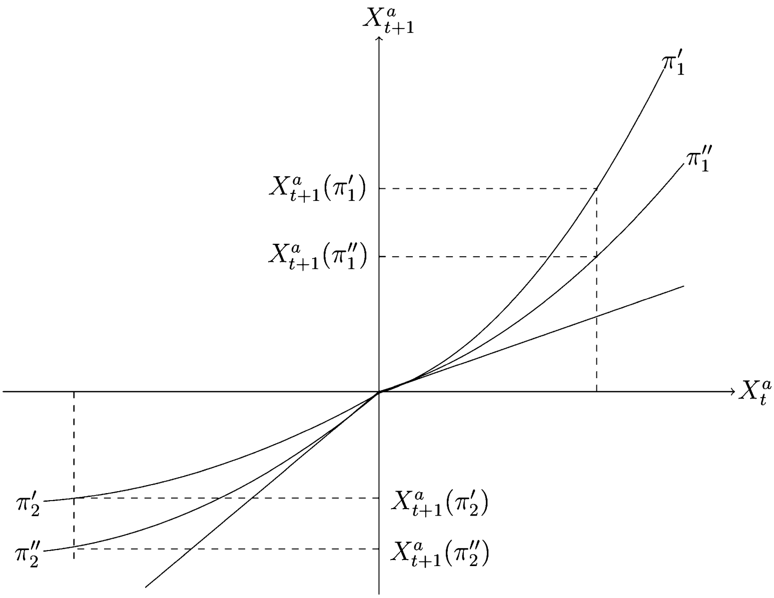

Fig. 3.1 Nonlinear relation between expected period-ahead residual income and current residual income

$$\frac{d^2E(\tilde{X}^a_{t+1})}{d(X^a_t)d\pi_1} = 2\frac{\omega\Omega}{B_{t-1}}X^a_t > 0 \tag{3.6}$$

and

$$\frac{d^3E(\tilde{X}^a_{t+1})}{d(X^a_t)^2d\pi_1} = 2\frac{\omega\Omega}{B_{t-1}} > 0. \tag{3.7}$$

Thus, both the slope of the residual income dynamic and the convexity increase with the firm's investment opportunities.

Quadrant 1 of Fig. 3.1 illustrates the behavior of the residual income dynamic in the case of positive investment. The two curves correspond to two different π_1-values (π'_1 and π''_2). Capital following profitability acts as a force to cause the dynamic to bend *upward* and hence its convexity. At a given level of current residual income (X^a_t), the expected next-period residual income is increased by exploiting profitable investment projects. The ability to do so is further enhanced if the firm is more profitable (a greater p_t), causing both the slope and convexity of the dynamic to increase further. In the absence of such a feedback role for profitability information, the dynamic would become linear, as shown by the straight line lying below the convex curves, reflecting only the persistence effect. The vertical gap between a nonlinear curve and the linear line below represents what the firm is expected to gain in period-ahead residual income by making appropriate investment decisions.

The higher of the two curves in Quadrant 1 corresponds to a greater investment opportunity than the lower, that is, $\pi'_1 > \pi''_1$. Given current residual income (X_t^a), a firm is expected to generate more residual income in the next period if it has a greater investment opportunity which allows for more rapid adjustment in scale. Accordingly, the higher curve is steeper and more convex than the one below.

3.1.2.2 The Case of Negative Capital Investment

We conduct a similar analysis for the case of divestment (that is, $p_t < 0$). Based on Eqs. (3.1) and (3.2b), we determine the residual income dynamic for a divesting firm as

$$\begin{aligned}\tilde{X}_{t+1}^a &\equiv \tilde{p}_{t+1} B_t = (\omega p_t + \tilde{\varepsilon}_{t+1})(B_{t-1} - I_t^-) \\ &= \omega X_t^a + \pi_2 \frac{\omega \Omega}{B_{t-1}} (X_t^a)^2 + \tilde{e}_{t+1}.\end{aligned} \tag{3.8}$$

As before, the first term in Eq. (3.8) arises from the persistence of profitability, but its value is now negative. The second term results from the feedback role of profitability; it is positive and hence (partially) offsets the first term.

The slope of this dynamic is

$$\frac{dE(\tilde{X}_{t+1}^a)}{dX_t^a} = \omega + 2\pi_2 \frac{\omega\Omega}{B_{t-1}} X_t^a. \tag{3.9}$$

In a "normal" case where the speed of divestment is not so high as to cause the feedback effect $\left(2\pi_2 \frac{\omega\Omega}{B_{t-1}} X_t^a\right)$ to outweigh the persistence effect (ω), we get $\frac{dE(\tilde{X}_{t+1}^a)}{dX_t^a} > 0$; in this case, if a firm's current negative residual income is large, so too will be its expected negative residual income next period.[2]

Similar to the case of positive investment, it is straightforward to show that the residual income dynamic is convex, with the degree of convexity increasing with divestment opportunity (π_2).

In contrast to the case of positive investment, however, the slope of the dynamic *decreases* with divestment opportunity. That is,

$$\frac{d^2 E(\tilde{X}_{t+1}^a)}{d(X_t^a) d\pi_2} = 2 \frac{\omega\Omega}{B_{t-1}} X_t^a < 0. \tag{3.10}$$

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[2] In the alternative, "abnormal" case, a firm that is currently losing more money can divest assets so rapidly that its expected loss for the next period is smaller than that of another firm that is currently less unprofitable. Such a result would be counterintuitive, as whatever divestment action taken by the former (more unprofitable) firm can always be duplicated by the other, which will therefore be in a better position next period than the former firm anyway.

Quadrant 3 of Fig. 3.1 illustrates the behavior of the residual income dynamic for the divestment case. The two curves correspond to different amounts of divestment opportunities, π'_2 and π''_2, with $\pi'_2 > \pi''_2$. The higher curve, which corresponds to more divestment opportunities (π'_2), is *flatter* and more convex than the one below, with fewer opportunities (π''_2).

As in the case of positive investment, firms will adjust the scale of their operations depending on profitability. Because the objective is to increase firm value, decisions are made with the aim of raising residual income and hence the convexity demonstrated above. However, unlike in the case of positive investment where the feedback effect reinforces the persistence effect and thus increases the slope of the dynamic, in this situation, the feedback effect offsets the persistence of negative residual income and thus attenuates the slope. The greater the firm's divestment opportunities, the more effective is the divestment activity in offsetting the persistence effect, and consequently the flatter the slope of the residual income dynamic.

3.2 Hypotheses

Based on the above theoretical analysis, we develop a number of hypotheses for empirical testing. These hypotheses concern the model's main assumption and the behavior of the residual income dynamic. They are stated in alternative form.

Hypothesis 3.1 (capital following profitability): A firm's capital investment in year t +1 is positively related to profitability in year t.

Hypothesis 3.2: Residual income in year t+1 is an increasing function of that in year t.

Hypothesis 3.3: Residual income in year t+1 is a convex function of that in year t.

Hypothesis 3.4: For firms with positive capital investment, (i) the slope of the residual income dynamic increases with investment opportunity and (ii) the convexity of the residual income dynamic increases with investment opportunity.

Hypothesis 3.5: For firms with negative capital investment, (i) the slope of the residual income dynamic decreases with investment opportunity and (ii) the convexity of the residual income dynamic increases with investment opportunity.

3.3 Empirical Analysis and Results

Biddle et al. (2001) test these hypotheses using a sample of 94,472 firm-year observations extracted from Compustat for the period 1981–1998. The sample comprises 64,008 observations with positive capital investment and 30,464 with negative investment.

3.3.1 Evidence for Capital Following Profitability

The regression model for testing Hypothesis 3.1 (capital following profitability) is

$$i_{t+1} = \alpha + \beta\, x_t^a + e_{t+1}, \tag{3.11}$$

where $i_{t+1} \equiv (OA_{t+1} - OA_t)/OA_t$ is capital investment, measured ex post as the percentage change in a firm's operating assets (OA) from year t to year t+1, and $x_t^a \equiv (X_t - rB_{t-1})/OA_{t-1}$ is the residual income in year t scaled by operating assets at the beginning of the year, with residual income defined as earnings (X_t) minus a charge for equity capital based on beginning book value (B_{t-1}) at a cost of capital of 12%.

For the pooled sample combining observations from 1981 through 1998, the estimated slope coefficient (β) is 0.96 (t=109.00). Annual regressions show that the slope coefficient is positive and highly significant over all 18 years; the average β is 0.98, with a Fama–MacBeth t-value of 35.73. Thus, capital investment is highly sensitive to firm profitability, supporting the model's basic assumption that capital flows towards profitable opportunities.

3.3.2 Evidence for an Increasing and Convex (Versus Linear) Residual Income Dynamic

Biddle et al. (2001) use both linear and piecewise linear regressions to examine the relation between period-ahead residual income x_{t+1}^a and current residual income x_t^a (Hypotheses 3.2 and 3.3). The linear regression has the following form:

$$x_{t+1}^a = \alpha + \omega\, x_t^a + \varepsilon_{t+1}. \tag{3.12}$$

According to Hypothesis 3.2, the slope coefficient is positive, $\omega > 0$.

The piecewise linear regression is specified as

$$x_{t+1}^a = \alpha_0 + \alpha_1 M + \alpha_2 H + \omega_0 x_t^a + \omega_1 M x_t^a + \omega_2 H x_t^a + \varepsilon_{t+1}, \tag{3.13}$$

where M and H are indicator variables for the middle and high thirds of x_t^a -values in a sample. Hypothesis 3.2 predicts $\omega_0 > 0$, $\omega_0 + \omega_1 > 0$, and $\omega_0 + \omega_2 > 0$, and Hypothesis 3.3 predicts $\omega_1 > 0$ and $\omega_2 > \omega_1$.

The pooled regression using the linear model in Eq. (3.12) yields a slope coefficient of 0.71 (t = 223.09), which is highly significant. Annual regressions show that this slope coefficient is significantly positive in all 18 years, with only minor variations in the slope estimate across years. The average slope is 0.71, with a Fama–MacBeth t-value of 62.72. These results are similar to those obtained by Dechow et al. (1999) based on a sample over the period 1976–1995.

For the piecewise linear model in Eq. (3.13), the estimates from the pooled sample are $\omega_0 = 0.62$ (t = 121.40), $\omega_1 = 0.63$ (t = 11.90), and $\omega_2 = 0.02$ (t = 1.30). Annual regressions yield the following average slope coefficients across the years: $\omega_0 = 0.62$ (Fama–MacBeth t = 30.51), $\omega_1 = 0.58$ (t = 8.70), and $\omega_2 = 0.03$ (t = 0.84).

Thus, the period-ahead residual income is positively related to the current residual income in all regions of residual income, which is consistent with Hypothesis 3.2. The slope of the residual income dynamic becomes steeper as we move from the low to the medium range, consistent with the convexity pattern predicted by Hypothesis 3.3. However, from the medium to the high range of residual income the slope becomes flatter, contrary to what is predicted by Hypothesis 3.3. These results are therefore partially supportive of Hypothesis 3.3, and inconsistent with the linearity prediction of the LIDs.

The finding that the slope of the residual income dynamic is flatter in the high (than medium) profitability region is in line with results documented in prior studies. For example, Beaver (1970), Brooks and Buckmaster (1976), Freeman et al. (1982), and Fama and French (2000) report that profitability measures such as *ROA* (which is highly correlated with scaled residual income) are mean-reverting. This phenomenon could be caused by the transitory nature of extremely high earnings due to accounting (such as earnings management) and economic forces (such as competition in the product market) that lie outside the theoretical model explained above. Such forces seem to affect the empirical results as well as does capital following profitability.

In the following subsections, we test the effects of investment and divestment opportunities on the residual income dynamic, and explore further implications of capital following profitability.

3.3.3 Evidence for the Impact of Investment Opportunity on the Residual Income Dynamic

To test the effect of investment opportunity on the residual income dynamic (Hypothesis 3.4), Biddle et al. (2001) use year t+1 capital investment as an ex post proxy for investment opportunity. They partition the subsample of positive investment firms into quartiles on this measure, and run separate regressions for each.

For the linear regression model set out in Eq. (3.12), the slope coefficient is 0.48 (t = 67.4) in the lowest investment quartile, which increases monotonically to 0.52 (t = 70.8), 0.58 (t = 75.6), and 0.66 (t = 75.8), respectively, in the higher quartiles.

For the piecewise linear model in Eq. (3.13) which separates firms into low, medium, and high regions of (scaled) residual income, the slope coefficient increases with investment opportunities in both the medium and high ranges. Specifically, the slope in the medium residual income range ($\omega_0 + \omega_1$) is 0.61 for the lowest investment quartile, and this increases monotonically to 0.74, 0.97, and 1.01, respectively, for the higher quartiles. Likewise, the slope in the high residual income range ($\omega_0 + \omega_2$) increases monotonically from a value of 0.27 for the lowest investment quartile, to 0.43, 0.63, and 0.75, respectively, for the higher quartiles. However, in the low residual income region, the slope does not exhibit an increasing trend across the investment quartiles. These results confirm that the slope of the residual income dynamic increases with investment opportunity primarily in those regions (that is, medium and high, rather than low) where the force of capital following profitability should produce more powerful effects. This is generally consistent with Hypothesis 3.4(i).

The convexity of the residual income dynamic is measured by the change in slope from the low to the medium range of residual income (ω_1), and that from the medium to the high range (ω_2). The results show that both of the slope changes exhibit a monotonically increasing trend as we move from the lowest to the highest investment quartiles, consistent with Hypothesis 3.4(ii), which predicts that convexity increases with investment opportunity.

3.3.4 Evidence for the Impact of Divestment Opportunity on the Residual Income Dynamic

The tests of Hypothesis 3.5 are performed in an analogous manner, with the negative investment subsample now divided into quartiles. For the linear regression model in Eq. (3.12), the slope coefficient (ω) is 0.48 (t = 46.0) in the lowest divestment quartile, and it decreases to 0.46 (t = 40.1), 0.45 (t = 37.8), and 0.44 (t = 33.8) for the higher quartiles. This decreasing trend is consistent with Hypothesis 3.5(i), which predicts that the slope of the residual income dynamic will decrease with divestment opportunity.

For the piecewise linear model in Eq. (3.13), the slope in the low range of residual income (ω_0) also displays a decreasing trend; it is 0.48 for the lowest divestment quartile, which decreases monotonically to 0.45, 0.44, and 0.37 as we move to the higher quartiles. However, the trend of this slope is opposite to the theoretical prediction (that is, it increases with the speed of divestment) for the medium range of residual income ($\omega_0 + \omega_1$), and the slopes actually turn negative in the high range ($\omega_0 + \omega_1$). This shows that the empirical results are consistent with the prediction of Hypothesis 3.5(i) in the region of low (that is, most negative) residual income where the profitability signal is expected to have the strongest effect in guiding divestment activities, but the results are not supportive of the model in the regions where this signal is weaker and so could have been overwhelmed by other forces affecting operations that are outside the model (such as agency conflicts).

Looking at the convexity prediction, the change in the slope from the low to the medium range of residual income (ω_1) increases with the speed of divestment; this change equals 0.12 for the lowest divestment quartile, and increases monotonically to 0.23, 0.35, and 0.45 for the higher quartiles. This is consistent with the prediction in Hypothesis 3.5(ii) that the convexity of the residual income dynamic increases with divestment opportunities. However, the slope change from the medium to the high residual income range (ω_2) is negative for all divestment groups, again suggesting that some other forces might be affecting the dynamic in these regions.

Overall, the empirical analysis of Biddle et al. (2001) supports the notion that the residual income dynamic is influenced by economic forces guiding capital towards profitable projects and away from unprofitable ones, although other forces seem to affect this dynamic as well, mainly in regions where the profitability signal is weaker. The results do not support the alternative linearity prediction of the LIDs as discussed in Chap. 2.

3.4 Incorporating Accounting Conservatism in the Residual Income Dynamic: An Extended Model

In the theoretical model presented in Sect. 3.1, we considered the case of unbiased accounting. In this section, we extend that analysis to show that the qualitative properties predicted earlier continue to hold under conservative accounting. Similar to the approach taken by Feltham and Ohlson (1996), we first model a firm's economic activities in terms of cash receipts and cash investments, and then specify the accounting rules used to measure them.

3.4.1 Economic Activities

Consider a firm that operates in a multiperiod world. At date t, the beginning of period t+1, the firm owns an asset stock, as_t. The cash receipts to be generated from this asset stock in period t+1 are

$$c\tilde{r}_{t+1} = \tilde{k}_{t+1} as_t, \tag{3.14}$$

where $\tilde{k}_{t+1}$ is the (gross) efficiency parameter for period t+1.

Existing assets lose productive capacity at a rate $1 - \gamma$ per period (due to, for example, wear and tear and obsolescence). At the same time, the firm makes new investment (ci) which adds to the asset stock level. Specifically, the asset stock at date t is equal to:

$$as_t = \gamma\, as_{t-1} + ci_t. \tag{3.15}$$

The *net* value created in period t from asset stock as_{t-1}, after considering both the direct consumption of assets and the opportunity cost of invested capital, equals $[cr_t - (1-\gamma)as_{t-1}] - ras_{t-1}$. Denote p_t as the economic rent earned per unit of assets in period t (i.e., normalized net value creation). Based on Eqs. (3.14) and (3.15), we get

$$p_t = k_t - (1 - \gamma + r). \tag{3.16}$$

That is, net value creation equals gross productivity of assets (k_t) minus economic depreciation $(1-\gamma)$ and the cost of capital (r).

The following two assumptions are the counterparts of those in Sect. 3.1, but here profitability is measured in economic (as opposed to accounting) terms.

Assumption 3.1* (Profitability Persists)

$$\tilde{p}_{t+1} = \omega p_t + \tilde{e}_{t+1}, \tag{3.17}$$

where $0 < \omega \leq 1$ is the persistence parameter and $\tilde{e}_{t+1}$ is a zero-mean random disturbance term.

Assumption 3.1* implies the following dynamic process for the efficiency parameter:

$$\tilde{k}_{t+1} = \omega k_t + (1-\omega)(1 + r - \gamma) + \tilde{e}_{t+1}. \tag{3.18}$$

Based on Eqs. (3.14), (3.15), and (3.16), we derive the NPV of an incremental unit of capital investment at date t as $\omega(k_t - 1 + \gamma - r)/(1 + r - \omega\gamma) \equiv \Omega' p_t$, where $\Omega' = \omega/(1 + r - \omega\gamma)$.

The next assumption describes the firm's investment / divestment behavior, reflecting capital following profitability.

Assumption 3.2* (Capital Follows Profitability)

(i) *The case of scale increase*. If the NPV of marginal investment is positive ($p_t > 0$), the firm invests to increase the asset stock (scale), with

$$ci_t = (1-\gamma)as_{t-1} + \pi_1 as_{t-1}\Omega' p_t; \tag{3.19a}$$

(ii) *The case of scale decrease*. If the NPV of marginal investment is negative ($p_t < 0$), the firm divests to reduce the asset stock (scale), with

$$ci_t = (1-\gamma)as_{t-1} + \pi_2 as_{t-1}\Omega' p_t, \tag{3.19b}$$

where π_1 (π_2) represents the firm's investment (divestment) opportunity.

Note that ci_t denotes gross capital expenditure, part of which compensates for the economic depreciation in period t.

Based on Assumptions 3.1* and 3.2*, the expected cash receipts in period t+1 for the case of positive NPV are

$$E_t(c\tilde{r}_{t+1}) = \frac{\pi_1\omega^2}{(1+r-\omega\gamma)as_{t-1}}cr_t^2 + \left[\frac{\pi_1\omega(1-2\omega)(1+r-\gamma)}{1+r-\omega\gamma}+\omega\right]cr_t + (1-\omega)(1+r-\gamma)\left[1-\frac{\pi_1\omega(1+r-\gamma)}{1+r-\omega\gamma}\right]as_{t-1}. \tag{3.20}$$

Similarly, the expected cash receipts for the case of negative NPV are

$$E_t(c\tilde{r}_{t+1}) = \frac{\pi_2\omega^2}{(1+r-\omega\gamma)as_{t-1}}cr_t^2 + \left[\frac{\pi_2\omega(1-2\omega)(1+r-\gamma)}{1+r-\omega\gamma}+\omega\right]cr_t + (1-\omega)(1+r-\gamma)\left[1-\frac{\pi_2\omega(1+r-\gamma)}{1+r-\omega\gamma}\right]as_{t-1}. \tag{3.21}$$

Equations (3.20) and (3.21) show that the expected period-ahead cash receipts are a nonlinear function of current cash receipts. The nonlinearity arises because the cash receipts in period t+1 are a multiplicative product of the asset stock and economic rent in period t+1, both of which are a function of current profitability (p_t).

3.4.2 Accounting Rules

We adopt the following accounting rules to measure economic activities; they are similar to those used in Feltham and Ohlson (1996).

Assumption 3.3 (Accounting Rules)

(i) Historical cost based accounting valuation: $B_0 = ci_0$;
(ii) The CSR, $B_t = B_{t-1} - dep_t + ci_t$
(iii) Conservative depreciation, $dep_t = (1\text{-}\delta)\, B_{t-1}$, where $\delta \le \gamma$.

Applying these rules, we get accounting earnings for period t as $X_t = cr_t - dep_t = k_t as_{t-1} - (1-\delta)B_{t-1}$, and the residual income in period t as $X_t^a = X_t - rB_{t-1} = k_t as_{t-1} - (1+r-\delta)B_{t-1}$.

The expected residual income for period t + 1 is

$$E_t(\tilde{X}_{t+1}^a) = X_{t+1} - rB_t = k_{t+1}as_t - (1+r-\delta)B_t = [\omega k_t + (1-\omega)(1+r-\gamma)](\gamma\, as_{t-1} + ci_t) - (1+r-\delta)B_t. \tag{3.22}$$

3.4.3 Properties of the Residual Income Dynamic

For the case of positive NPV investment, we derive expected period-ahead residual income based on Eqs. (3.19a) and (3.22) as

$$E_t(\tilde{X}^a_{t+1}) = \frac{\pi_1\omega^2}{(1+r-\omega\gamma)as_{t-1}}(X^a_t)^2 + \left[\omega + \frac{2\pi_1\omega^2(1+r-\delta)B_{t-1}}{(1+r-\omega\gamma)as_{t-1}} - \frac{2\pi_1\omega^2(1+r-\gamma)}{(1+r-\omega\gamma)} - \frac{\pi_1\omega(\gamma-\delta)}{1+r-\omega\gamma}\right]X^a_t + M, \tag{3.23}$$

where $M \equiv \frac{\pi_1\omega^2(1+r-\delta)^2B^2_{t-1}}{(1+r-\omega\gamma)as_{t-1}} - \Big\{\frac{2\pi_1\omega^2(1+r-\gamma)(1+r-\delta)}{(1+r-\omega\gamma)} + \frac{\pi_1\omega(\gamma-\delta)(1+r-\delta)}{(1+r-\omega\gamma)} + (1+r-\delta)\delta - \omega(1+r-\delta)\Big\}B_{t-1} + \Big\{[(1-\omega)(1+r-\gamma) - (1+r-\delta)(1-\gamma)] - [(1-\omega)(1+r-\gamma) - (1+r-\delta)]\frac{\pi_1\omega(1+r-\gamma)}{1+r-\omega\gamma}\Big\}as_{t-1}$ is an expression dependent on conservative depreciation but independent of residual income in period t.

In the special case of unbiased depreciation ($\delta=\gamma$), we get $B_{t-1} = as_{t-1}$ and $M=0$, such that the residual income dynamic reduces to

$$\tilde{X}^a_{t+1} = \frac{\pi_1\omega^2}{(1+r-\omega\gamma)B_{t-1}}(X^a_t)^2 + \omega X^a_t + \tilde{\varepsilon}_{t+1},$$

which is the dynamic in Eq. (3.3) derived in Sect. 3.1.

As Biddle et al. show, dynamic Eq. (3.23) has the same qualitative properties as those of dynamic Eq. (3.3) in Sect. 3.1. Specifically, expected period-ahead residual income is an increasing and convex function of current residual income, with the slope and convexity both increasing in investment opportunity (π_1). In other words, the qualitative properties determined under unbiased accounting continue to hold with conservative accounting.

Observe that the nonlinearity in Eq. (3.23) is inherited from the nonlinearity of the cash flow dynamic in Eq. (3.20), which arises from the economic force of capital following profitability but is unrelated to accounting conservatism. It shows that conservatism does not affect the degree of convexity of the residual income dynamic,

$$\frac{d^3E(\tilde{X}^a_{t+1})}{d(X^a_t)^2 d\delta} = 0. \tag{3.24}$$

However, conservatism does affect the slope of the dynamic, as shown below,

$$\frac{d^2E(\tilde{X}^a_{t+1})}{d(X^a_t)d\delta} = -\frac{\pi_1\omega}{(1+r-\omega\gamma)as_{t-1}}(2\omega B_{t-1} - as_{t-1}). \tag{3.25}$$

If $2\omega B_{t-1} - as_{t-1} > 0$, meaning that the persistence of profitability is high and, at the same time, the depreciation policy is not highly conservative (such that book value is not severely understated as a measure of true asset stock), then we have $\frac{\partial^2 E(\tilde{X}^a_{t+1})}{\partial(X^a_t)\partial\delta} < 0$; that is, in this case, the slope of the residual income dynamic *increases* as accounting becomes more conservative (i.e., $1 - \delta$ increases).

On the other hand, if $2\omega B_{t-1} - as_{t-1} < 0$, we have $\frac{\partial^2 E(\tilde{X}^a_{t+1})}{\partial(X^a_t)\partial\delta} > 0$, in which case the slope of the residual income dynamic decreases as accounting becomes more conservative.

The case with negative NPV opportunities can be examined analogously, where we reach the same general conclusions as in the positive NPV case. Below, we summarize the impact of conservatism on the residual income dynamic.

Proposition 3.1

i. *Accounting conservatism affects the residual income dynamic through both its slope and intercept, but not its convexity;*
ii. *The slope may either increase or decrease with the degree of conservatism, depending on the persistence of profitability and the extent to which book value understates the asset stock.*

The above analysis also exposes drawbacks in the way in which the conservatism effect is modeled in Feltham and Ohlson (1995). In their LIDs, Feltham and Ohlson (1995) assume that (a) the effect of conservatism is represented by a linear term $\omega_{12} oa_t$ that is separate from the persistence effect and (b) the slope of the residual income dynamic equals the persistence parameter, and it does not depend on the degree of conservatism. However, such a linear structure is not supported by the more rigorous modeling presented here. According to Proposition 3.1, the slope of the residual income dynamic is dependent on the degree of conservatism. Beyond the slope effect, an additional adjustment is required through the intercept term (M), which is more complex than what is assumed in Feltham and Ohlson (1995).

3.5 Summary

This chapter provides theory and empirical evidence to show that the residual income dynamic exhibits nonlinear behavior when firms make capital investment decisions contingently on profitability signals. A distinctive property predicted under the notion of capital following profitability is convexity, reflecting the firm's desire to increase value through capital investment/divestment decisions, which causes the dynamic to bend upward rather than downward. This nonlinear behavior contrasts with that of the linear dynamics introduced in Chap. 2. The chapter separately considers the cases of positive and negative NPV investment opportunities to predict and empirically test how the slope and convexity of the residual income dynamic are dependent on a firm's investment/divestment opportunity. Finally, we also investigate the influence of accounting conservatism on the residual income dynamic and find that the simple linear effect modeled in Feltham and Ohlson (1995) does not properly capture how conservatism indeed affects residual income.

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Chapter 4
A Basic Model of Equity Value: Incorporating Growth and Abandonment Options

In this chapter, we further develop the concept of capital following profitability in order to construct a model of equity value. As explained in Chap. 3, the essence of this notion is that firms do not commit themselves in advance to a fixed schedule of investment activities over time; instead, they adjust the course of their operations in such a way as to enable them to take advantage of investment opportunities arising in an evolving environment. This flexibility in investment decisions gives rise to real options, which are an important source of firm value.

Our purpose in this chapter is firstly to develop an accounting-based model of equity value that recognizes real options (for both growth and abandonment). Then, on the basis of this model, we go on to explain how equity value behaves in relation to key accounting variables such as earnings and equity book value. We further examine how conservatism causes biased accounting measures in representing economic variables and how accounting biases affect the valuation function. The properties of our model are then compared and contrasted with those of the linear models set out in Chap. 2. Finally, we discuss the valuation role of nonaccounting information and how it can be integrated with accounting data within a real options framework. The chapter draws primarily on the work of Zhang (2000).[1]

[1] Several other studies have explored, on a theoretical basis, the effect of adaptation (abandonment) options on the relation between equity value and accounting data (see for example Yee 2000; Ashton et al. 2003). That real options are an important part of firm value has long been noted in the finance literature (see for example Myers 1977; Brennan and Schwartz 1985; Berger et al. 1996; Dixit and Pindyck 1994).

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4.1 Economic Activities and Cash Flow-Based Valuation

We envisage a firm as an economic unit that deploys resources to conduct operations aimed at generating cash flows. Its business is ongoing and lasts over an indefinite number of periods. The assets deployed for operations typically endure for more than a single reporting period over which business performance is measured.

There are three steps in the development of the valuation model below. Firstly, we specify the production function, which is the "technology" that converts input factors (capital and managerial skills) into output (cash flows). Secondly, we describe the investment opportunities available to the firm and solve its investment problem. Thirdly, we set out the accounting rules used to measure operations and establish valuation in terms of accounting variables. While some of the assumptions used in this model have already appeared in Chap. 3 (Sect. 3.4), they are repeated here to ensure the integrity of the analysis presented in this chapter.

In developing the valuation model below, we maintain that managers make financial reporting truthfully to investors, so that the information asymmetry between them is resolved. Ohlson (1995) and Feltham and Ohlson (1995, 1996) also work from this premise, although they do not state it explicitly. On the basis of this assumption, the value-accounting relation is highlighted in a "pure" economic setting which is free from agency and information problems. As will be mentioned in Chap. 13, valuation problems involving agency conflict and information asymmetry remain as topics for future research.

4.1.1 Technology

Let date t be the (representative) valuation date. Assume a firm that has just completed its operation for period t, and is starting its activities for period t+1. The production function determining the cash flow from the operation in period t+1 is

$$c\tilde{r}_{t+1} = \tilde{\kappa}_{t+1} as_t, \tag{4.1}$$

where $c\tilde{r}_{t+1}$ is the cash receipts in period t+1 (which occur at the end of the period, date t+1), as_t is the asset stock as at the beginning of period t+1 (date t), and $\tilde{\kappa}_{t+1}$ is the efficiency of the operation in period t+1. While as_t is known at date t, there is uncertainty about the actual efficiency in period t+1, $\tilde{\kappa}_{t+1}$, so the exact amount of cash receipts in period t+1 is not known until date t+1. According to Eq. (4.1), cash generation is a function of two input factors: (1) the level of asset stock, as_t, and (2) the managerial ability to utilize capital resources as characterized by the efficiency parameter, $\tilde{\kappa}_{t+1}$.

Both input factors (efficiency and asset stock) change from one period to the next, as specified below. Firstly, efficiency evolves as a random walk,

$$\tilde{\kappa}_{t+1} = \kappa_t + \tilde{e}_{t+1}, \tag{4.2}$$

where $\tilde{e}_{t+1}$ is a zero-mean random disturbance that cannot be predicted at date t. This process is intended to capture the intuition that a firm's current efficiency level is informative about future efficiency. The qualitative properties of the model demonstrated below hold so long as there is a positive link between current and future efficiency.[2]

Secondly, the asset stock at date t (as_t) is the sum of the assets carried from the previous date (as_{t-1}) and new investment (ci_t),[3]

$$as_t = \gamma\, as_{t-1} + ci_t, \tag{4.3}$$

where $0 < \gamma < 1$, with $(1 - \gamma)$ being the rate at which existing asset stock depreciates over a period. Thus, while existing assets gradually lose their productive capacity over time, new investment can be made to replenish the stock level. We refer to $1 - \gamma$ as the rate of *economic* depreciation.

Based on Eq. (4.3), we determine the asset stock at date t as the accumulation of all previous investments,

$$as_t = ci_t + \gamma\, ci_{t-1} + \gamma^2\, ci_{t-2} + \ldots = \sum_{s=0}^{t} \gamma^{t-s}\, ci_s. \tag{4.4}$$

The above assumptions enable us to compute the internal rate of return on the firm's investment. Based on Eqs. (4.1), (4.2), and (4.3), one unit of capital invested at date t is expected to produce a stream of future cash flows as $\kappa_{t+1}, \gamma\kappa_{t+2}, \gamma^2\kappa_{t+3}$, and so forth. Since κ follows a random walk, we get $E_t(\tilde{\kappa}_{t+s}) = \kappa_t, \forall s > 0$. The internal rate of return on the investment at date t, denoted as q_t, is determined by the following condition:

$$-1 + \frac{\kappa_t}{1 + q_t} + \frac{\gamma\, \kappa_t}{(1 + q_t)^2} + \frac{\gamma^2 \kappa_t}{(1 + q_t)^3} + \ldots = 0. \tag{4.5}$$

[2] A positive link between current and future firm performance is the precondition to accounting-based valuation as a meaningful exercise at all. Without such a link, a firm's performance in each period becomes purely random, which would render financial reporting of little or no use for forecasting and valuation purposes.

[3] For simplicity, we assume that operating assets are traded at a constant price over time. This assumption is relaxed later (in Chap. 11) where we examine the valuation role of fair value accounting.

By solving Eq. (4.5), we find $q_t = \kappa_t - (1 - \gamma)$. As κ_t is a random walk, so too is q_t. (Note that q_t differs from the normalized economic rent, p_t, defined in Chap. 3 by the discount rate; that is, $q_t = p_t + r$.)

Our approach here to modeling the production process differs from Feltham and Ohlson's (1996) cash flow dynamic, as shown previously in Eq. (2.13a), in two ways. Firstly, all investments (old and new) are consolidated to form a single asset base. Investments made at different dates are converted into equivalent amounts after economic depreciation has been taken into account, so there is no longer any need to distinguish between preexisting and new assets. In contrast, in Eq. (2.14a), Feltham and Ohlson (1996) separately account for cash receipts in a period generated from (1) preexisting assets (which, implicitly, have generated the cash receipts for the previous period) and (2) new investment made in the current period. Secondly, Eq. (4.1) implies that exogenous shocks affect the productivity of the firm's assets uniformly, regardless of the date when these assets are acquired. This contrasts with the cash flow dynamic proposed by Feltham and Ohlson (1996), which suggests that while the productivity of previously invested assets fluctuates from one period to the next, the marginal return on new investment remains constant over time (see the discussion in Sect. 2.3.1).

4.1.2 Investment Opportunities

At date t (the point of valuation), the firm anticipates the following investment opportunities in the periods to follow.

Firstly, in period t+1, the firm is assumed to maintain the same scale of operations (that is, the level of asset stock) as in period t. This assumption is innocuous and is simply intended to keep the exposition tidy.

Then, in period t+2, the firm is faced with three alternative scenarios: (i) discontinuing the operation; (ii) maintaining the operation at the existing scale; and (iii) expanding the scale of the operation by amount G.

Finally, from period t+3 and onward, the firm (if not discontinued in period t+2) is expected to reach a steady state, with the scale of the operation kept at the same level as in period t+2.

4.1.3 Investment Decision at Date t+1

Determining equity value at date t requires an analysis of the firm's future investment decisions. We solve the firm's decision problem at date t+1 by computing its value under different investment scenarios and identifying the optimal choice in each set of circumstances.

Scenario (i): Discontinuation. If the firm discontinues its operation at date t+1, its assets will be sold off or adapted to other business uses. The relevant value concept here is exit value, which is the amount that can be recovered from selling or transferring existing assets. Generally speaking, exit value depends on the stock level of assets, but is detached from the future earnings (or losses) that would be produced if the present course of operations were to be continued. Let $V_{t+1}(i)$ denote the firm value at date t+1 in this scenario. We assume that this value is related to asset stock at date t+1 ($\gamma\, as_t$) as follows:

$$V_{t+1}(i) = (1 - c_a)\gamma\, as_t, \tag{4.6}$$

where $0 < c_a < 1$ is a friction cost (resource dissipation) in the process of asset adaptation.

Scenario (ii): Maintaining the existing scale. In this scenario, the asset stock deployed for operations in period t+2 remains the same as that for period t+1 (as_t), and (on the basis of the above assumptions) it will stay at this level in the future.

As the internal rate of return (q_t) follows a random walk, the expected free cash flow will equal $q_{t+1}as_t$ per period in the future. Let $V_{t+1}(ii)$ denote the firm value at date t+1 in this scenario. Then, after investing $(1 - \gamma)as_t$ at date t+1 (as this is needed to compensate for the economic depreciation in period t+1), the firm value is

$$V_{t+1}(ii) = \frac{q_{t+1}as_t}{r} = \frac{X^E_{t+1}}{r}, \tag{4.7}$$

where $X^E_{t+1} \equiv q_{t+1}as_t$ is referred to as the "economic earnings" in period t+1.

Scenario (iii): Growth. In this scenario, the firm invests to expand the scale of its operations. The amount of growth, G, is exogenous in this model. The total capital invested at date t+1 is $(1 - \gamma)as_t + G$.

From an asset stock of $as_t + G$, the expected free cash flow is $q_t(as_t + G)$ per period in future. Therefore, the firm value at date t+1, denoted as $V_{t+1}(iii)$, after investing $(1 - \gamma)as_t + G$, is

$$V_{t+1}(iii) = \frac{q_{t+1}(as_t + G)}{r}. \tag{4.8}$$

Across the three scenarios above, equity value becomes increasingly related to profitability (q_{t+1}). Initially, in scenario (i), the equity value at date t+1 is independent of q_{t+1}. It is an increasing function of q_{t+1} in scenarios (ii) and (iii), with the slope becoming steeper moving from scenario (ii) to scenario (iii) owing to the greater scale in the latter.

The optimal choice at date t+1 is the one that yields the highest value, net of the required investment, as determined by $\max\{V_{t+1}(i),\ V_{t+1}(ii) - (1 - \gamma)as_t,\ V_{t+1}(iii) - [(1 - \gamma)as_t + G]\}$. The critical factor for this decision is q_{t+1}.

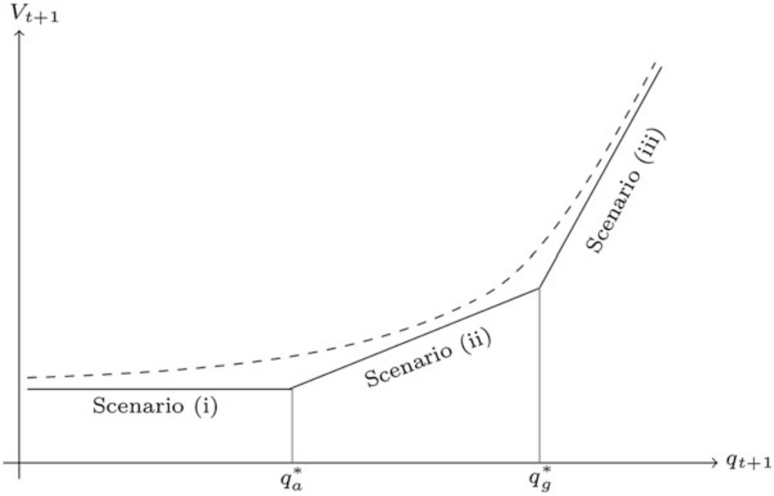

Fig. 4.1 Relation between equity value and profitability at date t+1

Comparing the three scenarios, we find that scenario (i) (discontinuation or adaptation) is the optimal choice if profitability is below a critical level, $q_{t+1} < q_a^* \equiv (1 - \gamma\, c_a)r$. Scenario (ii) (maintaining the existing scale) is optimal if profitability lies within an intermediate range, $q_a^* < q_{t+1} < q_g^* \equiv r$, and scenario (iii) (growth) is the preferred choice if profitability exceeds a critical value, $q_{t+1} > q_g^*$.

Figure 4.1 illustrates the relation between equity value (V_{t+1}) and profitability (q_{t+1}) at date t+1. It shows that the optimal investment choice (meaning the one which maximizes investor value) varies across the different ranges of profitability. In the context of the model, the firm must decide whether to exercise the real options at date t = 1, so the value function is piecewise linear. As we step back to date t (before the expiry date of the options), the value function (the superimposed broken line) is smooth and lies above the value at the expiry date.

4.1.4 Equity Value at Date t

We determine equity value at date t by forecasting cash flows from future operations on the basis of the current state of the operation, (as_t, q_t), and growth potential G. Since future profitability is not known, we cannot predict the exact course that the firm's operations will take in future. Essentially, valuation involves an assessment of the firm's value in each possible scenario for future operations, taken together with the probability of that scenario occurring.

By incorporating all three possible investment choices at date t+1, we compute the equity value at date t as

$$V_t = \int_{e_l}^{q_a^* - q_t} V_{t+1}(i) f(\tilde{e}_{t+1}) d\tilde{e}_{t+1} + \int_{q_a^* - q_t}^{q_g^* - q_t} [V_{t+1}(ii) - (1-\gamma) as_t] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}$$
$$+ \int_{q_g^* - q_t}^{e_u} [V_{t+1}(iii) - (1-\gamma) as_t - G] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}, \quad (4.9)$$

where $f(\tilde{e}_{t+1})$ is the probability density function of $\tilde{e}_{t+1} \in [e_l, e_u]$. Substituting the value expressions for $V_{t+1}(i)$, $V_{t+1}(ii)$, and $V_{t+1}(iii)$ shown above into Eq. (4.9) and simplifying, we get

$$V_t = \frac{1}{r} X_t^E + P(q_t) as_t + C(q_t) G. \quad (4.10)$$

In Eq. (4.10), $P(q_t) \equiv \frac{1}{r(1+r)} \int_{e_l}^{q_a^* - q_t} [q_a^* - q_t - \tilde{e}_{t+1}] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}$ is the value derived from having the option to discontinue (and adapt) the operation at date t+1 if this is beneficial to investors, and $C(q_t) \equiv \frac{1}{r(1+r)} \int_{q_g^* - q_t}^{e_u} [q_t + \tilde{e}_{t+1} - q_g^*] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}$ is the value derived from having the option to grow at date t+1; they resemble a put and a call, respectively. According to Eq. (4.10), firm value comprises the value of both existing assets and options to adjust the course of operations through discontinuation or growth.

4.2 An Accounting-Based Model of Equity Value

In the real world, firms use accounting systems to record their economic activities and then report the summarized data to investors. Investors then use these reported data to assess firm value. We now determine the relation between equity value and accounting data. This is achieved through introducing accounting rules and making the link between accounting and economic variables.

We adopt the same set of accounting rules as described in Chap. 3 (Sect. 3.4.2).[4] Firstly, asset value is recorded at historical cost. This means that at date 0 when the firm is newly created, the book value of equity is set to equal the initial investment cost, $B_0 = ci_0 = as_0$.

Secondly, accounting earnings are defined as $X_t = cr_t - dep_t$.

[4] We assume that the firm is solely equity financed, but it is straightforward to extend the analysis to a financially leveraged firm.

Thirdly, accounting depreciation is recognized as $dep_t = (1 - \delta)B_{t-1}$. The rate of depreciation $(1 - \delta)$ generally differs from the rate of economic depreciation $(1 - \gamma)$. Accounting depreciation is conservative if $\delta < \gamma$ and unbiased if $\delta = \gamma$.

Lastly, the CSR holds, so $B_t = B_{t-1} - dep_t + ci_t$, where dep_t is accounting depreciation in period t. Since $X_t - d_t = (cr_t - dep_t) - d_t = -dep_t + ci_t$, the CSR here is reconciled with its original version in Eq. (1.5).

Under conservative depreciation ($\delta < \gamma$), accounting variables are imperfect measures of economic constructs. Specifically, the book value of assets (or equity) deviates from the true asset stock, except at date 0 when no depreciation charge has been made; earnings differ from economic earnings; and accounting return on equity (*ROE*) differs from the internal rate of return. Let $u_t \equiv as_t - B_t$ denote the bias in book value in measuring the asset stock at date t; $\Delta u_t \equiv u_t - u_{t-1} \equiv X_t^E - X_t$ the bias in earnings (which, as will be shown below, equals the change in the book value bias over the period); and $w_t \equiv q_t - ROE_t$ the bias in *ROE*. The behaviors of these biases are examined further below (in Sect. 4.3.2).

Then, the value function in Eq. (4.10) can be transformed into an accounting-based model as

$$V_t = \frac{1}{r}(X_t + \Delta u_t) + P(ROE_t + w_t)(B_t + u_t) + C(ROE_t + w_t)G. \tag{4.11}$$

We refer to Eq. (4.11) as a real options-based model (ROM) of equity value.

The ROM in Eq. (4.11) has several distinctive features compared to the linear models in Chap. 2. Firstly, the primitive accounting variables it uses are equity book value (B_t) and profitability (ROE_t); together, they convey the present state of the operation. Book value measures the scale of (equity) investment, whereas profitability indicates the efficiency or quality of operations (albeit they are imperfect measures). These variables are conveyed jointly by the balance sheet and the income statement. Although earnings (X_t) also appear in Eq. (4.11), they are a product of book value and profitability. The ROM reflects the central role of *ROE* in valuation, which hinges on the importance of profitability in guiding capital investment decisions that underlie value creation. The emphasis on *ROE* (scaled earnings) contrasts with the previous linear models where earnings (along with book value) are considered the core information for valuation.[5]

Secondly, the ROM in Eq. (4.11) admits of the possibility that the firm earns economic rent from operations. Rent may be derived from existing assets by earning a superior profitability (over and above the cost of capital) and/or undertak-

[5] That *ROE* serves as a primitive construct in valuation accords with the view of the Financial Accounting Standards Board (FASB), which states in Statement of Financial Accounting Concepts (SFAC) No.5, paragraph 24a, that "statements of earnings and comprehensive income generally reflect a great deal about the profitability of an entity during a period, but that information can be interpreted most meaningfully . . . only if it is used in conjunction with a statement of financial position, for example, by computing rates of returns on assets or equity."

ing positive NPV growth activities. The previous linear models have been criticized for ignoring economic rent and growth options (see for example Holthausen and Watts 2001, p. 60).

Thirdly, the ROM embodies the managerial use of accounting information. In this model, the primary activity driving value creation is capital investment, guided by profitability. The firm may engage in either positive or negative investment, depending on whether its operations have been profitable or unprofitable. In the linear models discussed in Chap. 2, accounting information plays no role in influencing the course of operations.

4.3 Basic Properties of the ROM

In this section, we explore some basic properties of the ROM and contrast them with those of the linear models proposed by Ohlson (1995) and Feltham and Ohlson (1995, 1996). A more thorough exposition will be undertaken in Chap. 5, where we report and discuss empirical testing of the model.

As mentioned earlier, conservatism makes accounting constructs (earnings, equity book value, and *ROE*) biased measures of their economic counterparts (economic earnings, asset stock, and the internal rate of return). Thus, the impact of accounting variables on equity value can be divided into two components, one of which is attributable to the economic information conveyed by accounting data, and the other to the biases embedded in accounting data. Below, we discuss these two components separately.

4.3.1 Effect of Economic Information in Accounting Data

Differentiating Eq. (4.11) with respect to earnings, given book value, we get

$$\left.\frac{dV_t}{dX_t}\right|B_{t-1}. = \left[\frac{1}{R-1} + P'(.) + \frac{G}{B_{t-1}+u_{t-1}}C'(.)\right]\left(1+\frac{d(\Delta u_t)}{dX_t}\right) + \frac{\partial V_t}{\partial u_{t-1}}\frac{du_{t-1}}{dX_t}. \tag{4.12}$$

To highlight the economic effect of accounting variables, we firstly consider the case of unbiased accounting so as to suppress the bias terms. Then, Eq. (4.12) simplifies to

$$\left.\frac{dV_t}{dX_t}\right|B_{t-1}. = \frac{1}{R-1} + P'(.) + \frac{G}{B_{t-1}}C'(.) > 0. \tag{4.13}$$

From Eq. (4.13), the second-order derivative is

$$\frac{d^2V_t}{dX_t^{\,2}}\bigg|B_{t-1}\cdot = \frac{1}{B_{t-1}}P''(.) + \frac{G}{B_{t-1}}C''(.) > 0. \tag{4.14}$$

Equations (4.13) and (4.14) show that equity value is generally an increasing and convex function of earnings, given book value. Higher current earnings lead to higher expectations of future earnings, partly because future profitability is expected to increase and also because there is a greater probability that the firm will remain in business (as opposed to being discounted) and that it will exercise the growth option, all of which will cause equity value to increase with earnings. Convexity arises because the option terms essentially compound the effects through these different channels.

However, in the special case where the firm's operation remains in a steady state such that it is not expected to adjust its scale, the options can be ignored and so the valuation function is (approximately) linear, $\frac{d^2V_t}{dX_t^{\,2}}\Big|B_{t-1}\cdot \approx 0$. We summarize these results below.

Proposition 4.1 (Proposition 1 of Zhang 2000, p. 281) *Assume unbiased accounting. Given book value, equity value is an increasing and convex function of earnings. In the case where a firm's operation is expected to remain in a steady state, the equity value function becomes linear in earnings.*

Similarly, differentiating Eq. (4.11) with respect to book value at a given level of earnings yields

$$\frac{dV_t}{dB_{t-1}}\bigg|X_t\cdot = \left[-P'(.)\frac{X_t+\Delta u_t}{B_{t-1}+u_{t-1}} + P'(.) - GC'(.)\frac{X_t+\Delta u_t}{(B_{t-1}+u_{t-1})^2}\right] \times\left(1+\frac{du_{t-1}}{dB_{t-1}}\right) + \frac{dV_t}{d(\Delta u_t)}\frac{d(\Delta u_t)}{dB_{t-1}}. \tag{4.15}$$

Under the condition of unbiased accounting, we get

$$\frac{dV_t}{dB_{t-1}}\bigg|X_t\cdot = -P'(.)\frac{X_t}{B_{t-1}} + P'(.) - GC'(.)\frac{X_t}{B_{t-1}{}^2}. \tag{4.16}$$

As shown by Zhang (2000), this derivative is positive in the low-profitability region and negative in the high-profitability region (provided $G > 0$). For firms with low profitability, there is a good chance that operations will be discontinued, in which case equity value reflects mostly equity book value (which serves as a proxy for the exit value). Hence there will be a positive relation between equity value and book value.

On the other hand, for firms with high profitability, the growth option is valuable whereas the abandonment option is not. Since a firm with a higher book value has lower profitability (given earnings), its growth option is less valuable, which explains the negative relation between equity value and book value, given earnings.

From Eq. (4.16), we obtain the second-order derivative as

$$\frac{d^2V_t}{dB_{t-1}^2}\bigg|X_t = \frac{P''(.)X_t{}^2}{B_{t-1}{}^3} + \frac{GC''(.)X_t{}^2}{B_{t-1}{}^4} + \frac{2GC'(.)X_t}{B_{t-1}{}^3} > 0. \tag{4.17}$$

These results are summarized below.

Proposition 4.2 (Proposition 2 of Zhang 2000, p. 285) *Assume unbiased accounting. Given earnings, equity value is a nonmonotonic and convex function of book value; it increases with equity book value for low-profitability firms, is insensitive to book value for steady-state firms, and decreases with book value for growth firms.*

4.3.2 Effect of Accounting Conservatism

The relation between equity value and accounting data is influenced further by measurement biases introduced by the accounting process. Three types of biases appear in the ROM in Eq. (4.11), represented by $(\Delta u_t, u_t, w_t)$, and their role in the valuation model is to correct the distortions in accounting data so as to recover true economic information.

In this model, the source of accounting biases is the recognition of depreciation at a rate faster than true economic depreciation, $(1-\delta) > (1-\gamma)$. The bias in book value as a measure of asset stock can be determined as

$$u_t \equiv as_t - B_t = \sum_{s=0}^{t-1} (\gamma^{t-s} - \delta^{t-s})ci_s, \tag{4.18}$$

which is the cumulative effect of biased depreciation from the past. Given $\delta < \gamma$, we get $u_t > 0$, t = 1,2,3,... ; thus, book value always understates true asset stock.

As shown by Zhang (2000, pp. 278–279), the bias in earnings is equal to the change in the book value bias over the earnings period,

$$X_t^E - X_t = \sum_{s=1}^{t} (\gamma^{t-s} - \delta^{t-s})[ci_s - ci_{s-1}] + (\gamma^t - \delta^t)ci_0 = u_t - u_{t-1} \equiv \Delta u_t. \tag{4.19}$$

Under conservative depreciation $(\delta < \gamma)$, for firms that have previously increased the scale of investment (especially in the most recent past) (that is, $ci_s > ci_{s-1}$), we get $\Delta u_t > 0$, meaning that accounting earnings understate true economic earnings because of the heavy recognition of depreciation of recently invested assets. On the other hand, for firms that have been decreasing the scale of investment (that is, $ci_s < ci_{s-1}$), we get $\Delta u_t < 0$, meaning that accounting earnings overstate true economic earnings because of the reversal of over-recognized depreciation in earlier periods. Finally, for firms operating in a steady state where the investment scale is kept constant (that is, $ci_s \approx ci_{s-1}$), we have $\Delta u_t \approx 0$, such that there is little distortion in accounting earnings.

In other words, under conservative accounting, earnings can be either over- or understated, depending on the trend of previous changes in investment scale. Nevertheless, the cumulative earnings over the whole history of the firm are always understated, so equity book value always underrepresents the true asset stock.

Finally, the bias in accounting profitability (*ROE*) is the result of biases in earnings and book value measures. This bias is captured as

$$w_t \equiv q_t - ROE_t = \frac{u_t - (1 + ROE_t)u_{t-1}}{B_{t-1} + u_{t-1}}. \tag{4.20}$$

The sign of w_t can be positive or negative. To the extent that $ROE_t << 1$, the numerator in Eq. (4.20) is approximately Δu_t. This means that in general, w_t tends to have the same sign as that of Δu_t, which (as explained) depends primarily on previous changes in investments.

In the ROM in Eq. (4.11), the three types of accounting biases have to be separately estimated and are used, together with accounting data, to recover true economic information. ROM demonstrates that the effect of conservatism is far more complex than modeled by Feltham and Ohlson (1995) in their LID (see Chap. 2).

In the present context, the directional impact of accounting biases on equity value is unclear. To facilitate the exposition below, Zhang (2000) makes several assumptions (which are guided by the above discussion where possible).

Assumption 4.1 (Zhang 2000, p. 282) (1) $\frac{d(\Delta u_t)}{dX_t} > 0$ for firms that have experienced growth in recent periods, $\frac{d(\Delta u_t)}{dX_t} < 0$ for firms that have experienced downsizing in recent periods, and $\frac{d(\Delta u_t)}{dX_t} \approx 0$ for firms that have experienced no significant changes in operating scale and (2) $\frac{d(\Delta u_{t-1})}{dX_t} \approx 0$ and $\frac{d^2(\Delta u_t)}{dX_t^2} \approx 0$.

Assumption 4.2 (Zhang 2000, p. 285) (1) $\frac{du_{t-1}}{dB_{t-1}} > 0$; (2) $\frac{d(\Delta u_t)}{dB_{t-1}} \approx 0$; and (3) $\frac{d^2 u_{t-1}}{dB_{t-1}^2} > 0$.

With the aid of these additional assumptions, we obtain the following results concerning the impact of conservatism on the relation between equity value and accounting data. They are stated as conjectures.

Conjecture 4.1 (Hypothesis 1 of Zhang 2000, p. 283) Given book value, conservatism increases (reduces) the marginal impact of earnings on equity value for firms having experienced recent expansion (reduction) in operating scale. For firms in steady-state operations, conservatism has little effect on the value impact of earnings.

Conjecture 4.2 (Hypothesis 2 of Zhang 2000, p. 286) Conservatism increases the value impact of book value.

4.4 Incorporating Nonaccounting Information into the ROM

In Chap. 2, we touched on the valuation role of nonaccounting information. In this subsection, we employ the framework of the ROM to give the issue a more systematic treatment. By nonaccounting information, we mean any valuation-relevant information that is yet to affect a firm's financial statements (it is referred to as "other" information by Ohlson 1995 and Feltham and Ohlson 1995).

Nonaccounting information is defined in terms of what it is *not*, rather than what it is. In principle, it is an open set. Of course, in practice, investors will use a specific set of nonaccounting information in firm valuation. Thus, for the purpose of our discussion, we treat the nonaccounting information set as if it contains a finite number of elements, and denote it by $n_t \equiv \{n_{1t}, n_{2t}, \ldots, n_{Jt}\}$. The ROM [Eq. (4.11)] already incorporates three types of nonaccounting information: growth opportunity (G), the discount rate (r), and accounting biases.[6]

Below, we first sketch out a general approach to incorporating nonaccounting information into an extended ROM and then discuss some of the representative types of such information.

4.4.1 A General Approach to Incorporating Nonaccounting Information

In extending the above ROM to incorporate a broader set of nonaccounting information, we do not change our basic view of what financial reporting is for. Specifically, we view the firm as an economic entity that generates value by investing capital into profitable projects and/or divesting resources from unprofitable projects. The firm engages in capital transactions with investors, and investors rely on reported accounting, together with nonaccounting information, to forecast the firm's future operations and assess its value.

In the ROM [Eq. (4.11)], the information set that forms the basis for financial forecasting is (B_t, q_t, G). Investors forecast future profitability based on the current level q_t, the future scale of operations based on the present scale (B_t) and the anticipated investment decisions as determined by q_t and G. Nonaccounting information is valuation-relevant insofar as it is informative about future scale and/or profitability beyond that which is found in accounting reports.

[6] In Ohlson (1995) and Feltham and Ohlson (1995), the conservatism effect is modeled separately from their "other" information. Strictly speaking, however, accounting biases are a special type of nonaccounting information since they are not reported in financial statements.

Generalizing the profitability dynamic as implied by Eq. (4.2), we now assume that profitability in period t+1 depends on both realized profitability (q_t) and nonaccounting information (n_t) in period t; that is,

$$\tilde{q}_{t+1} = q(q_t, n_t) + \tilde{e}_{t+1}. \tag{4.21}$$

Furthermore, we allow the growth potential as perceived at date t to depend on n_t,

$$G = G(n_t). \tag{4.22}$$

An extended version of Eq. (4.11) that allows the incorporation of a broader set of nonaccounting information is therefore

$$V_t = \frac{1}{r}[q(ROE_t + w_t, n_t)] + P[q(ROE_t + w_t, n_t)](B_t + u_t) + C[q(ROE_t + w_t, n_t)]G(n_t), \tag{4.23}$$

where $P(q(ROE_t + w_t, n_t) \equiv \frac{1}{r(1+r)} \int_{e_l}^{q_a^* - q(ROE_t + w_t, n_t)} [q_a^* - q(ROE_t + w_t, n_t) - \tilde{e}_{t+1}] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}$ is the value of the put option to discontinue the operation at date t+1, and $C(q(ROE_t + w_t, n_t) \equiv \frac{1}{r(1+r)} \int_{q_g^* - q(ROE_t + w_t, n_t)}^{e_u} [q(ROE_t + w_t, n_t) + \tilde{e}_{t+1} - q_g^*] f(\tilde{e}_{t+1}) d\tilde{e}_{t+1}$ is the value of the call option to expand the operation at date t+1.

We acknowledge that these "generic" functions $q(p_t, n_t)$ and $G(n_t)$ offer little concrete guidance as to how exactly nonaccounting information is used in conjunction with accounting information to forecast scale and profitability. However, one also needs to realize that nonaccounting information can come in various forms, from a variety of sources, and that complicated human judgment is typically involved in processing it. Therefore, it is beyond the power of a specific mathematical function to portray how all such information can be converted into specific financial forecasts.

Below, we discuss several types of nonaccounting information that can be useful for valuation purposes.

4.4.2 Representative Types of Nonaccounting Information

A firm is an entity conducting business activities within a wider economic environment. Depending on how broad an impact it has within the economy, nonaccounting information may be divided into three different levels: firm-specific, industry-level, and economy-wide.

Firm-specific nonaccounting information encompasses news and events pertaining to the operation of the firm concerned that have not yet been reflected in its reported financial statements. It may concern a specific part of the operation along the value chain, or the firm as a whole. Examples of the former include results of R&D projects, order backlogs, contracts with new customers, and a new distribution channel; the latter might encompass strategic initiatives, a change in CEO, or a restructuring.

Industry-level nonaccounting information can be of two types. The first is general news and events that affect the whole sector, such as new regulations, the invention of a new generation product, fluctuations in input prices, and changes in market size. The second type concerns information that has direct consequences for a firm's competitive position, such as merger and acquisition activities and changes in the firm's market share and relative profitability within the industry.

Economy-wide information refers to general news and events that affect all firms in an economy across the board. It includes changes in monetary or fiscal policies, inflation, general trade agreements with foreign countries, and GDP growth.

Regardless of the level and type of information involved, the ultimate task for investors is to incorporate it into financial analysis and assess its impact on the scale and profitability of the firm's future operations. Within the framework of the ROM specified above, nonaccounting information is combined with accounting information to help investors assess a firm's investment opportunities (real options), determine the probabilities of exercising such real options, and forecast the resulting profitability and cash flows. Each piece of information, whether at the firm, industry, or economy level, is likely to have its own effect on a firm's future operations that must be ascertained on the basis of its content and the specific operational context.

4.5 Summary and Concluding Remarks

In this chapter, we develop a model of equity value in a ROM framework. The basic premise of the ROM is that a firm has the flexibility to adjust the course of its operations by making contingent investment decisions in response to the changing external environment. In particular, the model recognizes that accounting information plays a vital role in guiding a firm's investment decisions. In this real options-based framework, the primitive accounting constructs for valuation are book value and *ROE*, which are accounting representations of, respectively, the scale and profitability of the firm's operations. These measures are conveyed jointly by the balance sheet and the income statement. A salient property of the ROM is the convexity in the relation between equity value and accounting variables. Linearity arises in the special case where the firm is not expected to make a significant adjustment to the course of operations. We also examine the role of accounting conservatism in valuation and demonstrate that the conservatism effect is manifested in a more complex way than modeled by the linear information dynamic approach discussed previously. Finally, we offer a framework for accommodating nonaccounting information into valuation.

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Chapter 5
Testing the Properties of the ROM

Continuing from the theoretical development in the previous chapter, in this chapter we examine the ROM more closely in order to better understand the valuation role of accounting variables (earnings, equity book value, and *ROE*). We then empirically test the model's predictions. According to the ROM, capital investment activities play a crucial role in determining the relation between equity value and accounting data, and as shown in Chap. 4 and elaborated further below, there are two separate forces at work in this respect. Firstly, *anticipated* future investments (divestments) matter to the value-accounting relation because they determine the course of the firm's operations going forward and expected future value generation. Secondly, *past* investments also matter because under conservative accounting practice, economic activities are measured in a biased fashion, with the direction and extent of such biases dependent on the trend of past investments. As before, we refer to the former as an economic force (propelled by incentives to pursue value), and the latter as an accounting force (arising from conservatism). The objective of this chapter is to explore and test the impact of these forces on the relation between equity value and accounting variables.

The chapter is organized as follows. Firstly, we use analytics and geometry to provide a systematic view of the behavior of the ROM. In particular, we illustrate how equity value changes with each of the three accounting variables in the model—earnings, equity book value, and profitability—while holding the others constant. We then test the predictions of the ROM using partial model specifications that allow one of the accounting variables to vary. Finally, we employ full model specifications whereby the various properties of the ROM can be tested together. The sample used for the empirical analysis is described in Appendix. The material in this chapter is mostly drawn from the work of Hao et al. (2011a).

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5.1 Geometric Representations of the ROM

Let V denote a firm's equity value at the time of valuation, B the corresponding equity book value (which, by assumption, also equals the book value of assets), X the current-period earnings, g the firm's future growth potential (which is expressed in proportion to the scale measure B),[1] and k the (normal) earnings capitalization factor applicable to firms in a steady state. Profitability is measured as $ROE \equiv X/B$. (Given that the focus here is on the contemporaneous relation between value and accounting variables, there are no time subscripts on variables.)

For clarity, we initially employ a reduced version of the ROM that corresponds to unbiased accounting; this enables us to focus on the properties of the valuation function that are driven purely by economic forces. The accounting (conservatism) effect will be dealt with in a subsequent section.

Under unbiased depreciation, the original ROM [Eq. (4.11)] is simplified as

$$V = B\,[P(ROE) + k\,ROE + gC(ROE)], \tag{5.1}$$

where $P(\cdot)$ is the put option to discontinue and $C(\cdot)$ the call option to expand operations.

Figure 5.1 provides three-dimensional views of how accounting information (ROE, B) is mapped to equity value (V). Panels **a** and **b** provide a comparison of the valuation function between low and high growth (g). While both graphs display the same basic properties (which will be discussed in detail), the value surface shows steeper slopes and greater convexity for high-g than low-g firms. Note that these graphs are generalizations of the $V - q$ relation shown in Fig. 4.1, with book value B as an added third dimension.

Figure 5.2 provides an empirical counterpart to these theoretical views. The relation between V and (ROE, B) is plotted with a sample of 114,868 firm-year observations from Compustat for the period 1967–2003 (see Appendix for the sampling procedure). The observations are independently sorted into deciles on ROE and B to form 10×10 portfolios, with each represented by the mean values of V, ROE, and B (all measured on a per share basis). The empirical value surface resembles the theoretical views in Fig. 5.1, showing that equity value exhibits a generally increasing trend along both the ROE and B axes.

[1] A normalized growth parameter (g) facilitates cross-sectional comparisons. Note that parameter G in original ROM (4.11) represents the amount of growth.

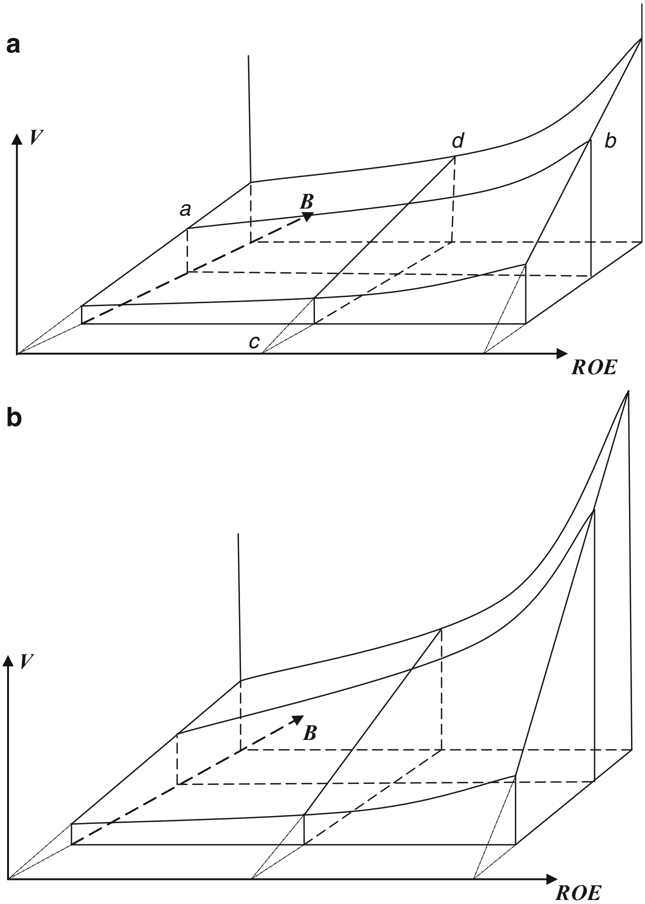

Fig. 5.1 Geometrical representations of the ROM [Eq. (5.1)]: equity value (V) as a function of profitability (ROE) and book value (B) (a, b). *Source: Figure 1 in Hao et al. (2011a)*. Reprinted with permission by the American Accounting Association

5.2 The Relation Between *V* and *X* Given *B*

5.2.1 Theoretical Predictions

At a given book value B, moving along the ROE-axis traces out equity value V as an increasing and convex function of ROE (and X), as illustrated by curve *ab* in Fig. 5.1; note that X is simply a linear transformation of ROE given B. Mathematically, we have

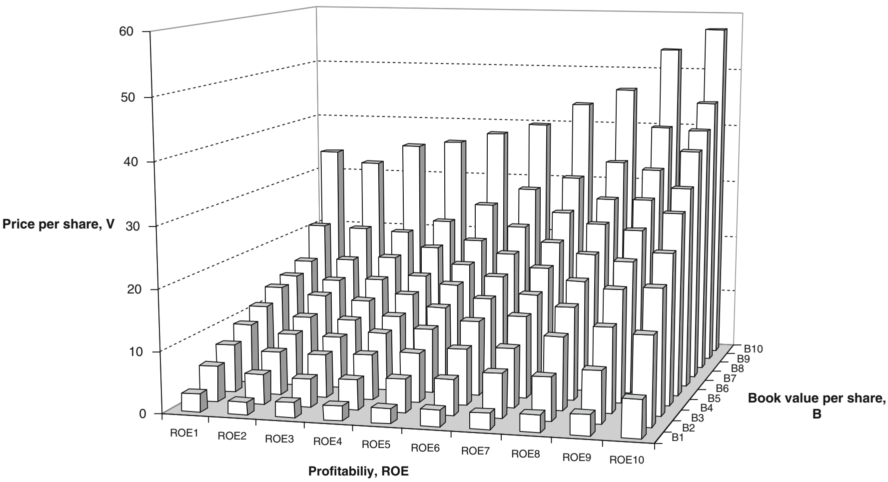

Fig. 5.2 Empirical view of equity value (V) as a function of profitability (ROE) and book value (B)

$$\left.\frac{dV}{dX}\right|_B = P'(ROE) + k + gC'(ROE) > 0 \tag{5.2}$$

and

$$\left.\frac{d^2V}{dX^2}\right|_B = \frac{1}{B}\left[P''(ROE) + gC''(ROE)\right] > 0. \tag{5.3}$$

From Eq. (5.2), the marginal effect of earnings on equity value equals $P'(ROE) + k + gC'(ROE)$. For extremely low (and possibly negative) values of X (and hence of ROE), $P(\cdot)$ is "deep in the money," meaning that the firm is likely to be wound up in order to stem the losses, and so we have $P'(\cdot) \approx -k$. At the same time, the growth option $C(\cdot)$ is "deep out of the money," and therefore $C'(\cdot) \approx 0$. As a result, $dV/dX|_B \approx 0$, or in other words, earnings have little impact on equity value in regions of extreme low profitability.

As X (and hence ROE) increases, both $P'(\cdot)$ and $C'(\cdot)$ also increase, and so does $dV/dX|_B$. When ROE reaches a sufficiently high level, the put option becomes out of the money, implying $P'(\cdot) \approx 0$, so that $dV/dX \approx k + gC'(\cdot)$. This shows that the slope of the relation between V and X can reach a magnitude above the "normal" earnings capitalization factor (k).

The value effect of earnings, given book value, is further influenced by growth opportunities g. From Eq. (5.2), we have

$$d\left(\left.\frac{dV}{dX}\right|_B\right)\Big/dg = C'(ROE) > 0. \tag{5.4}$$

Thus, the value impact of earnings is greater for firms with more growth opportunities, and this result holds especially true in high-*ROE* regions (where $C'(ROE)$ is relatively large).

The above analysis leads to Hypothesis 5.1, stated in alternative form:

Hypothesis 5.1 (i) Given B, the slope of the relation between V and X is small (close to zero) in low-*ROE* regions, and positive in high-*ROE* regions. (ii) Growth increases the slope of the $V - X$ relation, given B, in high-*ROE* regions, but its effect decreases as we move down to low *ROE*-regions.

5.2.2 Empirical Evidence

To test Hypothesis 5.1, it is necessary to control for the effect of book value. We do so by partitioning the overall sample on B into deciles; within each decile, the variation in book value is largely contained, so as to enable us to focus on the $V - X$ relation.[2]

Figure 5.3 plots the empirical $V - X$ relation by book value deciles. This is done by dividing the observations in each decile into ten portfolios of equal-size sorted on earnings (X), and then plotting their mean market values. The visual impression from Fig. 5.3 is that V is generally increasing in X and that, for the most part, the relation is convex.

To formally test Hypothesis 5.1(i), we run the following regression for the book value deciles:

$$V_i = \alpha_0 + \alpha_2 H_{ROE} + \beta_0 X_i + \beta_1 H_{ROE} X_i + \beta_2 B_i + e_i, \tag{5.5}$$

where H_{ROE} is a dummy variable set to 1 for observations in the high-, versus low-, *ROE* range and 0 otherwise (the same *ROE* cutoff is used for all book value deciles). Although the variation in B has been made much smaller in the book value deciles than in the original sample, we nonetheless still include B in the regression in Eq. (5.5) to further control for the remaining within-decile variation. Following Hypothesis 5.1(i), we predict $\beta_0 \geq 0$, with the value lying close to zero for firms with very low *ROE*s, and $\beta_1 \geq 0$.

We perform regressions separately for each of the sample years, and then compute the average coefficients across the years together with the Fama–MacBeth t-values with Newey–West adjustments. The results are shown in Table 5.1.

In the low-*ROE* region, among the small book value deciles (1–5), the earnings coefficient (β_0) is generally small; its value is positive but below 1 (well below a "normal" earnings capitalization factor of, say, 10), and is mostly insignificant at the 0.05 level (deciles 2, 3, and 5). For larger book value deciles, while the slope

[2] Hao et al. (2011a) adopt an alternative method of control whereby they scale the regression variables by the control variable. The results are qualitatively the same using this scaling approach.

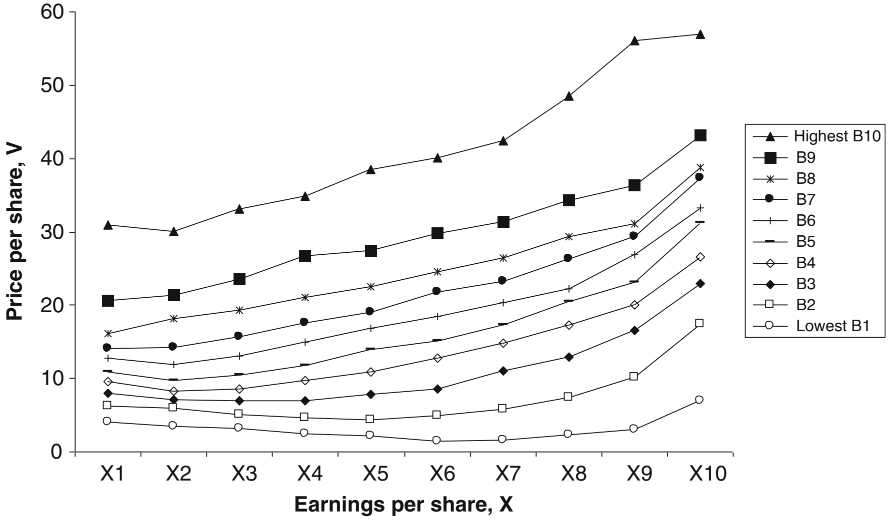

Fig. 5.3 Empirical relation between equity value (V) and earnings (X) by book value (B) deciles

Table 5.1 Regression of equity value on earnings by book value deciles: Hypothesis 5.1(i)

Variable	X	$H_{ROE}\,X$	$X + H_{ROE}\,X$
Coefficient	β_0	β_1	$\beta_0 + \beta_1$
Smallest B-decile	**0.718**[a]	**11.861**[a]	11.143[a]
2	**0.157**	**13.428**[a]	13.585[a]
3	**0.535**[c]	**13.140**[a]	13.676[a]
4	**0.914**[b]	**10.808**[a]	11.722[a]
5	**0.925**[c]	**11.946**[a]	12.871[a]
6	**1.577**[b]	**10.577**[a]	12.154[a]
7	**1.551**[b]	**8.096**[a]	9.647[a]
8	**2.047**[a]	**8.684**[a]	10.731[a]
9	**2.338**[a]	**5.147**[a]	7.485[a]
Largest B-decile	**2.418**[a]	**2.577**[a]	4.995[a]
Adj. R^2	0.82		

[a,b,c]indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels, respectively

coefficient in the low-*ROE* region becomes positive and significant (at the 0.05 level), the magnitude is still small (not exceeding 2.5).

In contrast, in the high-*ROE* region, the earnings coefficient ($\beta_0 + \beta_1$) is uniformly positive and significant for all book value deciles. It ranges from 4.995 (book value decile 10) to 13.676 (decile 3) and exceeds a value of 10 in 7 of the deciles.

Overall, the results are consistent with Hypothesis 5.1(i), which predicts that given book value, equity value is initially not sensitive to earnings in low-*ROE* regions, and the slope increases with *ROE* to reach a magnitude above the "normal" earnings capitalization factor.

Table 5.1 offers further insights into how the $V - X$ relation varies across the different book value groups. In the high-*ROE* region, the slope is typically greater in the small than in the large book value deciles. For example, the slope in the high-*ROE* range ($\beta_0 + \beta_1$) is 11.143 for book value decile 1 (the smallest) and 4.995 for decile 10 (the largest). This indicates that the market capitalizes earnings very differently for small firms as opposed to large firms. Also, the change in the slope coefficient is more drastic for the smaller book value deciles as *ROE* increases, suggesting that the valuation function is more convex for smaller firms.

To examine Hypothesis 5.1(ii) about the growth effect on the relation between V and X, we partition the observations into low- and high-growth halves (with growth proxied by the average of the realized annual growth rate in equity book value over the subsequent 3 years), and run the following regression by book value decile:

$$\begin{aligned} V_i = {} & \alpha_0 + \alpha_1 H_{ROE} + \alpha_2 H_g + \alpha_3 H_{ROE} H_g \\ & + \beta_0 X_i + \beta_1 H_{ROE} X_i + \beta_2 H_g X_i + \beta_3 H_{ROE} H_g X_i + \gamma B_i + e_i, \end{aligned} \tag{5.6}$$

where H_g is an indicator variable set to 1 in the region of high (versus low) growth and to 0 otherwise. Hypothesis 5.1(ii) predicts $\beta_3 > 0$ and $\beta_2 + \beta_3 > 0$.

We run the regression in Eq. (5.6) annually and then compute the average coefficients across the sample years together with the Fama–MacBeth t-values with Newey–West adjustments and Bonferroni corrections.[3] (The same procedure is used for the other tests reported below.)

Table 5.2 reports the regression results. In the high-*ROE* region, the effect of high (versus low) growth is captured by $\beta_2 + \beta_3$. It is significantly positive in eight of the book value deciles (deciles 1–8) and insignificant in deciles 9 and 10. Thus, it can be seen that growth generally increases the slope of the $V - X$ relation in the high-profitability region, suggesting that investors perceive growth undertaken by profitable firms as value enhancing.

In contrast, in the low-*ROE* region, the effect of high (versus low) growth (indicated by β_2) is much smaller. The estimate of β_2 fluctuates between negative and positive values and is insignificant at the 0.05 level for all deciles, which suggests that investors do not perceive investment growth to be value enhancing in firms with low *ROE*s.

More directly, the difference in the growth effect on the earnings coefficient between high- and low-*ROE* regions is given by β_3. This coefficient is positive and

[3] The Bonferroni adjustment is needed to test a hypothesis involving two or more separate parts. To accept the whole hypothesis (in alternative form) at significance level α, the significance level for each individual part must be increased. Because the precise critical t-value that is applicable to all situations is not available, the adjustment relies on an inequality $\Pr(A_1 \cup A_2) \le \Pr(A_1) + \Pr(A_2)$. Thus, if the significance level for both A_1 and A_2 is set to α/2, the significance level for accepting the whole hypothesis (which comprises A_1 and A_2) is at least α.

Table 5.2 Growth and the relation between equity value and earnings by book value deciles: Hypothesis 5.1(ii)

Variable	X	$H_{ROE}\,X$	$H_g\,X$	$H_{ROE}H_gX$	$H_gX + H_{ROE}H_gX$
Coefficient	β_0	β_1	β_2	β_3	$\beta_2 + \beta_3$
Smallest B-decile	−0.591[c]	8.880[a]	**−0.284**	**3.968****	**3.684*****
2	0.032	10.903[a]	**0.612**[c]	**2.232*****	**2.844*****
3	0.482[c]	8.917[a]	**−0.101**	**4.566*****	**4.465*****
4	0.689[b]	9.381[a]	**0.067**	**1.125*****	**1.192*****
5	0.828[b]	7.461[a]	**−0.313**	**5.129*****	**4.816*****
6	1.492[a]	7.717[a]	**0.196**	**2.519*****	**2.715*****
7	1.446[a]	5.006[a]	**0.088**	**3.149****	**3.237****
8	2.039[a]	5.928[a]	**−0.338**	**2.593****	**2.255****
9	2.285[a]	4.720[a]	**−0.184**	**−0.095**	**−0.279**
Largest B-decile	2.385[a]	2.406[a]	**−0.273**	**0.219**	**−0.054**
Adj R^2	0.83				

[a,b,c]indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels without Bonferroni corrections, respectively

*** and ** indicate one-tailed significance at the 0.01 and 0.05 levels with Bonferroni corrections, respectively

significant in eight of the book value deciles while insignificant in the remaining two, indicating that investment growth generally has a greater impact on the $V - X$ relation in high- than low-profitability regions.

To conclude, investment growth generally influences the relation between equity value and earnings, given book value, but the extent of this influence depends on profitability; growth increases the value impact of earnings for profitable firms, but has little effect on unprofitable firms. This finding is consistent with Hypothesis 5.1(ii).

5.3 Relation Between *V* and *B* Given *X*

5.3.1 Theoretical Predictions

The relation between V and B is more complex, and it matters whether we control for X or for ROE (that is, scaled earnings). Given X, changes in B trace out an iso-earnings curve, as represented by curve *ef* in Fig. 5.4, which is nonlinear in the (ROE, B)-plane. As we move along curve *ef*, starting from point *e* (where book value is small and so profitability is high, given earnings), V first decreases with B, then becomes insensitive to B in the intermediate ROE-value region, and eventually increases with B in the low-profitability (large book value) region.

Formally, we have

$$\left.\frac{dV}{dB}\right|_X = -ROE\ P'(ROE) + P(ROE) - gROE\ C'(ROE) + gC(ROE). \tag{5.7}$$

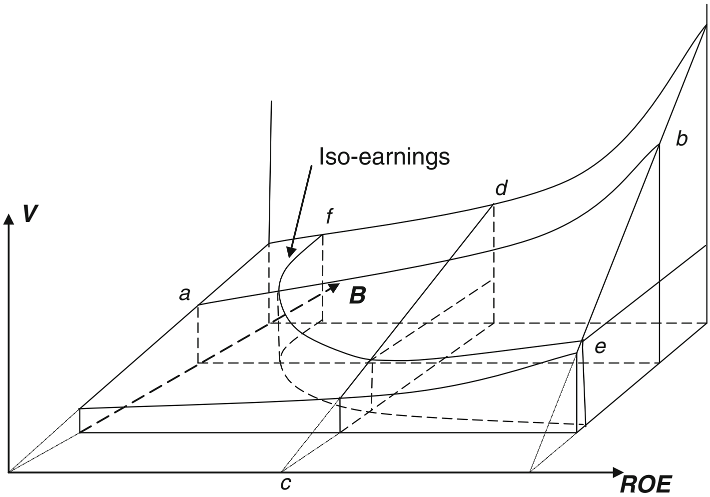

Fig. 5.4 Theoretical view of equity value (V) as a function of book value (B) given earnings (X). *Source: Figure 2 in Hao et al. (2011a)*. Reprinted with permission by the American Accounting Association

In the low-*ROE* region (near point *f* in Fig. 5.4), put option $P(ROE)$ is in the money while call option $C(ROE)$ is out of the money, in which case the first two terms in Eq. (5.7) dominate the last two such that the derivative is positive. In the extremely high-*ROE* range (near point *e*), the put option is out of the money and the call option is in the money, so it can be shown that the derivative is negative when *ROE* is high.[4] Between these two extremes, the value effect of *B* changes gradually, and in an intermediate range of *ROE*-values, *V* is barely affected by *B*, given *X*.

The negative $V - B$ relation in the low book value (that is, high-*ROE*) region might appear counterintuitive and requires further explanation. For highly profitable firms, value depends on the ability to generate earnings from both existing assets and growth opportunities, with the adaptation option having little effect. Given earnings, firms with smaller book values are more profitable than those with larger book values, and so their growth options are more valuable, reflecting their greater ability to exploit opportunities. This induces an *inverse* relation between *V* and *B* in small book value regions.

The value impact of book value, given earnings, is also influenced by growth opportunity. From Eq. (5.7), we have

$$d\left(\frac{dV}{dB}\bigg|_X\right)\bigg/dg = -ROE\ C'(ROE) + C(ROE), \tag{5.8}$$

[4] When *ROE* is close to zero, $C(ROE) \approx 0$. Given that $C(.)$ is increasing and convex in *ROE*, for $ROE > 0$, we have $ROE\ C'(ROE) > C(ROE)$.

which is negative when *ROE* is sufficiently high. This means that the slope of the relation between equity value and book value, given earnings, is smaller (or more negative) for firms with more growth opportunities.

The theoretical model, however, is silent on *how* growth affects the slope of the $V - B$ relation in the low-*ROE* region. In the context of the ROM, only firms with high profitability are expected to undertake investment growth, so the phenomenon of unprofitable firms undertaking growth is outside the model.[5]

Based on the above analysis, we develop Hypothesis 5.2.

Hypothesis 5.2 (i) V is a nonmonotonic function of B, given X; it decreases (increases) with B in the region of small (large) book values. (ii) Investment growth reduces the slope of the $V - B$ relation, given X, in high-*ROE* regions (that is, it makes the slope more negative).

5.3.2 Empirical Evidence

To examine the $V - B$ relation given X, we partition the overall sample into earnings deciles. Figure 5.5 plots the empirical relation between V and B by earnings partition. It can be seen that V generally increases with B in the low earnings deciles, but the relation exhibits nonmonotonicity for the high earnings deciles (where growth options are important).

We test Hypothesis 5.2(i) using the following regression for the earnings deciles:

$$V_i = \alpha_0 + \alpha_1 H + \beta_0 B_i + \beta_1 H_B B_i + e_i, \tag{5.9}$$

where H_B is a dummy variable set to 1 for observations in the high (versus low) book value region and 0 otherwise. Hypothesis 5.2(i) predicts that β_0 can be negative (for profitable firms) and $\beta_0 + \beta_1$ is positive. Table 5.3 presents the results.

In the low book value region, the book value coefficient (β_0) is negative in the five highest earnings deciles, exhibiting statistical significance in three of these deciles; note that profitability is particularly high in these regions, which makes growth options valuable. As we move to the smaller earnings deciles (where profitability is lower), coefficient β_0 becomes significantly positive for three of these earnings deciles.

[5] In the real world, firms with low profitability may still grow for two reasons. Firstly, low current profitability may not be indicative of low profitability in future, which can hamper the usefulness of accounting information for forecasting and valuation. Secondly, firms with low profitability may have no good investment opportunities, but their managers may make investments to gain personal benefits (at the expense of investors). Both scenarios are beyond the scope of the theoretical model discussed here (that is, the ROM).

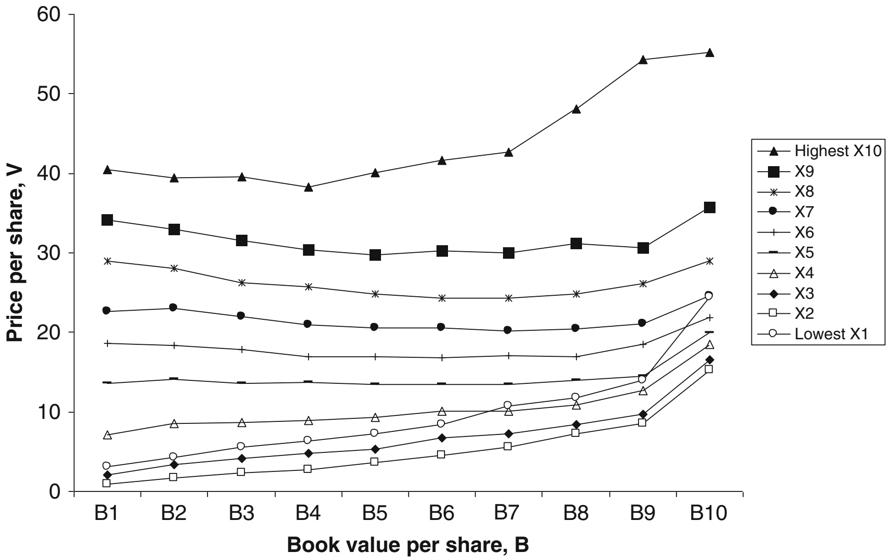

Fig. 5.5 Empirical relation between equity value (V) and book value (B) by earnings (X) deciles

Table 5.3 Regression of equity value on equity book value by earnings deciles: Hypothesis 5.2(i)

Variable	B	$H_B B$	$B + H_B B$
Coefficient	β_0	β_1	$\beta_0 + \beta_1$
Lowest X-decile	**0.824*****	−0.125[a]	**0.699*****
2	**0.798*****	−0.084	**0.714*****
3	**0.748****	−0.035	**0.713*****
4	**0.397**	0.234	**0.630*****
5	**0.100**	0.480[b]	**0.580*****
6	**−0.451**[c]	0.900[a]	**0.449*****
7	**−0.493***	0.762[a]	**0.268*****
8	**−0.259**	0.411[a]	**0.152****
9	**−1.739***	2.767[b]	**1.027****
Highest X-decile	**−3.543*****	4.585[a]	**1.043****
Adj. R^2	0.84		

[a,b,c] indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels without Bonferroni corrections, respectively

***, **, and * indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels with Bonferroni corrections, respectively

Significance with Bonferroni corrections implies significance without such corrections at the same level or better

In the high book value region, the slope coefficient on book value is given by $\beta_0 + \beta_0$ and is significantly positive across all earnings deciles.

These results are consistent with Hypothesis 5.2(i) which predicts that given earnings, equity value is negatively related to book value for firms with high profitability and positively related to book value for firms with low profitability.

Table 5.4 Growth and the relation between equity value and equity book value by earnings deciles: Hypothesis 5.2(ii)

Variable	B	$H_{ROE}\,B$	$H_g\,B$	$H_{ROE}H_g\,B$	$H_gB + H_{ROE}H_g\,B$
Coefficient	β_0	β_1	β_2	β_3	$\beta_2 + \beta_3$
Lowest X-decile	0.694[a]	0.561*	**0.189*****	−0.085	**0.104**
2	0.684[a]	2.972**	**0.297*****	−2.591**	**−2.294**
3	0.692[a]	1.423***	**0.285*****	−0.163	**0.122**
4	0.619[a]	0.457[c]	**0.282*****	−0.199	**0.083**
5	0.640[a]	0.067	**0.184*****	−0.430***	**−0.246**[c]
6	0.530[a]	−0.176[b]	**0.125***	−0.591***	**−0.466*****
7	0.531[a]	−0.388***	**−0.014**	−0.452***	**−0.465*****
8	0.422[a]	−0.486***	**0.044**	−0.365*	**−0.320****
9	0.376[a]	−0.474***	**0.257*****	−0.464***	**−0.207****
Highest X-decile	0.355[a]	−0.010	**0.921**[b]	−0.974*	**−0.053**
Adj R^2	0.85				

[a,b,c]indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels without Bonferroni corrections, respectively

***, **, and * indicate one-tailed significance at the 0.01, 0.05, and 0.1 levels with Bonferroni corrections, respectively

Significance with Bonferroni corrections implies significance without such corrections at the same level or better

To test the effect of growth as predicted by Hypothesis 5.2(ii), we further partition the observations in earnings deciles into low- and high-growth subsamples, and run the following regression:

$$V_i = \alpha_0 + \alpha_1 H_{ROE} + \alpha_2 H_g + \alpha_3 H_{ROE} H_g + \beta_0 B_i + \beta_1 H_{ROE} B_i + \beta_2 H_g B_i + \beta_3 H_{ROE} H_g B_i + e_i, \quad (5.10)$$

where H_g is a dummy variable set to 1 for observations with high growth and 0 otherwise. The growth effect on the slope of the $V - B$ relation is captured by $\beta_2 + \beta_3$ in the high-*ROE* region. From Hypothesis 5.2(ii), we expect $\beta_2 + \beta_3$ to be negative. The growth effect in the low-*ROE* region is captured by β_2; as mentioned, the ROM offers no prediction about this coefficient.

As shown in Table 5.4, $\beta_2 + \beta_3$ is negative in seven of the earnings deciles, significant at the 0.05 level in four. The phenomenon of a negative slope occurs primarily in the higher earnings deciles where firms have high profitability and so their growth options are particularly valuable. This evidence is consistent with Hypothesis 5.2(ii).

On the other hand, β_2 is significantly positive in eight of the earnings deciles, indicating that growth has a positive effect on the slope of the $V - B$ relation for firms in the low-profitability region. For low-profitability firms, adaption value becomes a more relevant notion. For firms undertaking more investment, a higher proportion of the assets will have been recently acquired (as opposed to old), which might be a reason why growth increases the slope of the $V - B$ relation in the low-*ROE* region (Hao et al. 2011a).

5.4 Relation Between *V* and *B* Given *ROE*

5.4.1 Theoretical Predictions

Given profitability (ROE), moving along axis B on the value surface, we trace out V as an increasing function of B, as illustrated by line cd in Fig. 5.1. This $V-B$ relation represents how equity value changes with the scale of (equity) investment. Its slope is predicted to be positive, as shown below:

$$\left.\frac{dV}{dB}\right|_{ROE} = P(ROE) + k\,ROE + gC(ROE) > 0. \tag{5.11}$$

From Eq. (5.11), the marginal effect of B is $P(ROE) + k\,ROE + gC(ROE)$, which remains constant for a given ROE.[6] On the other hand, the marginal value of scale (book value) increases with ROE, meaning that in Fig. 5.1, the line cd becomes steeper as it moves rightward. Formally,

$$d\left(\left.\frac{dV}{dB}\right|_{ROE}\right)/d(ROE) = P'(ROE) + k + gC'(ROE) > 0. \tag{5.12}$$

Also following Eq. (5.11), we predict that growth has a positive effect on the marginal value of book value,

$$d\left(\left.\frac{dV}{dB}\right|_{ROE}\right)/dg = C(ROE) > 0. \tag{5.13}$$

In other words, the marginal impact of book value is greater for firms with more growth opportunities. However, this prediction applies to firms with a high ROE and hence valuable growth options. And, again, the theoretical model is silent about firms with low profitability which are nonetheless undertaking investment growth.

This above analysis leads to Hypothesis 5.3.

Hypothesis 5.3 (i) The slope of the $V-B$ relation, given ROE, is positive, and it is steeper for firms with a higher ROE. (ii) In high-ROE regions, growth increases the slope of the $V-B$ relation, given ROE.

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[6] This particular feature stems from the implicit assumption of constant returns to scale in the original model. However, this assumption is nonessential for the model's properties being tested here.

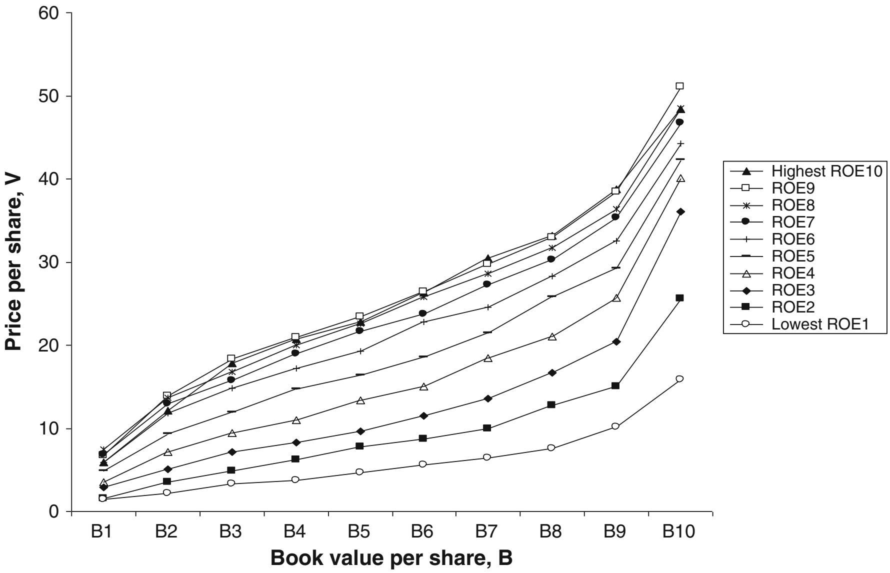

Fig. 5.6 Empirical relation between equity value (V) and book value (B) by profitability (*ROE*) deciles

5.4.2 Empirical Evidence

To test Hypothesis 5.3, we partition the overall sample on *ROE* into deciles. Figure 5.6 plots the empirical relation between V and B for the *ROE* deciles. This relation is clearly positive with the slope generally becoming steeper for higher *ROE* deciles, which is in line with the theoretical prediction in Hypothesis 5.3.

To test Hypothesis 5.3, we adopt the following regression model:

$$V_i = \alpha_0 + \alpha_1 H_g + \beta_0 B_i + \beta_1 H_g B_i + e_i. \tag{5.14}$$

The slope of the $V - B$ relation, given *ROE*, is β_0 for low-growth firms and $\beta_0 + \beta_1$ for high-growth firms, with the incremental effect of high (versus low) growth given by β_1. Hypothesis 5.3(i) predicts $\beta_0 > 0$ and $\beta_0 + \beta_1 > 0$, and Hypothesis 5.3(ii) predicts $\beta_1 > 0$.

Table 5.5 shows that the slope coefficient is uniformly positive for all *ROE* deciles in both low- and high-growth regions and is significant at the 0.01 level. Furthermore, there is a general trend for the slope to increase as we move from the low- to the high-*ROE* deciles. These results are consistent with Hypothesis 5.3(i). The result documented here on the $V - B$ relation, given *ROE*, contrasts with that from Hypothesis 5.2(i) above, which concerns the same relation but controls for X. Such a distinction highlights the importance of specifying the exact control variable when exploring the behavior of equity value.

Table 5.5 Regression of equity value on equity book value by ROE decile: Hypothesis 5.3

Variable	B	$H_g B$	$B + H_g B$
Coefficient	β_0	β_1	$\beta_0 + \beta_1$
Lowest ROE-decile	**0.917*****	**0.359*****	**1.275*****
2	**0.783*****	**0.174*****	**0.958*****
3	**0.866*****	**0.092*****	**0.958*****
4	**0.905*****	**0.145*****	**1.050*****
5	**1.019*****	**0.092*****	**1.110*****
6	**1.123*****	**0.100**[b]	**1.223*****
7	**1.287*****	**0.044****	**1.331*****
8	**1.399*****	**0.057**[c]	**1.457*****
9	**1.465*****	**0.100**[b]	**1.565*****
Highest ROE-decile	**1.537*****	**0.230*****	**1.767*****
Adj. R^2	0.84		

[b,c]indicate one-tailed significance at the 0.05 and 0.1 levels without Bonferroni corrections, respectively

***,** indicate one-tailed significance at the 0.01 and 0.05 levels with Bonferroni corrections, respectively

Significance with Bonferroni corrections implies significance without such corrections at the same level or better

Table 5.5 also shows that the effect of high (versus low) growth, β_1, is positive in all *ROE* deciles and significant in most. A positive growth effect on the slope of the $V - B$ relation for high-*ROE* firms gives support for Hypothesis 5.3(ii). On the other hand, a positive growth effect also found for low-*ROE* firms is attributable to forces outside ROM (see the discussions above).

5.5 Tests Using Full Model Specifications

The above empirical tests employ partial regression models that collapse one of the dimensions—either B, X, or ROE—to explore the behavior of equity value. In this section, we employ "full" model specifications that allow the different accounting variables to be varied simultaneously. A full specification gives a more complete view of the equity value function so that the various properties of the ROM may be tested together in the same regression equation.

We develop an empirical specification of the ROM in Eq. (5.1) using the following steps. Firstly, we transform Eq. (5.1) into $V/B = P(ROE) + kROE + gC(ROE)$, which is an increasing and convex function of ROE with the slope also increasing in g. Secondly, we linearize this transformed function as $V/B = a_0 + a_1H_g + a_2H_{ROE} + a_3H_gH_{ROE} + a_4ROE + a_5H_gROE + a_6H_{ROE}ROE + a_7H_gH_{ROE}ROE$. Thirdly, we multiply the linearized equation by B. Noting that $X = ROE \times B$, and adding the intercept terms, we get the following piecewise linear regression:

Table 5.6 Testing Hypotheses 5.1 and 5.2 using the full model

Variable	Coefficient	Predicted sign	Estimate
Base intercept			16.414[a]
H_g			3.044[a]
H_{ROE}			3.046[a]
$H_g H_{ROE}$			1.034[a]
B [**H2**: slope in low g and low ROE]	β_0	+	**0.569*****
$H_g B$	β_1		0.117[a]
$H_{ROE} B$	β_2	−	−0.644[a]
$H_g H_{ROE} B$	β_3	−	−0.299[a]
X	γ_0	+	**4.894*****
$H_g X$	γ_1		−0.050
$H_{ROE} X$	γ_2	+	**6.776*****
$H_g H_{ROE} X$ [**H1**: incremental growth effect in high vs. low ROE]	γ_3	+	**1.860*****
$H_g X + H_g H_{ROE} X$ [**H1**: growth effect in high ROE]	$\gamma_1 + \gamma_3$	+	**1.811***
$B + H_g B$ [**H2**: slope in high g and low ROE]	$\beta_0 + \beta_1$	+	**0.687*****
$B + H_{ROE} B$ [**H2**: slope in low g and high ROE]	$\beta_0 + \beta_2$	−	−**0.074****
$B + H_g B + H_{ROE} B + H_g H_{ROE} B$ [**H2**: slope in high g and high ROE]	$\beta_0 + \beta_1 + \beta_2 + \beta_3$	−	−**0.257****
$H_g B + H_g H_{ROE} B$ [**H2**: growth effect in high ROE]	$\beta_1 + \beta_3$	−	−**0.182***
Adj. R^2	0.63		

[a]indicate one-tailed significance at the 0.01 level without Bonferroni corrections
***, ** and * indicate one-tailed significance at the 0.01, 0.05 and 0.1 levels with Bonferroni corrections, respectively
Source: *Adapted from Table 8 in Hao et al. (2011a)*

$$V_i = \alpha_0 + \alpha_1 H_g + \alpha_2 H_{ROE} + \alpha_3 H_g H_{ROE} + \beta_0 B_i + \beta_1 H_g B_i + \beta_2 H_{ROE} B_i + \beta_3 H_g H_{ROE} B_i + \gamma_0 X_i + \gamma_1 H_g X_i + \gamma_2 H_{ROE} X_i + \gamma_3 H_g H_{ROE} X_i + e_i. \quad (5.15)$$

We run the regression in Eq. (5.15) with annual observations and calculate the average coefficients across the sample years together with the Fama–MacBeth t-values with Newey–West adjustments. To mitigate multicollinearity concerns, we use the demeaned X and B in the regressions. The results are reported in Table 5.6.

5.5.1 Evidence for Hypotheses 5.1 and 5.2

The regression in Eq. (5.15) permits a simultaneous test of all the properties of the ROM stated in Hypotheses 5.1 and 5.2. As before, we apply Bonferroni corrections to the test statistics. Note that for a given significance level, a test of multiple hypotheses together imposes stricter requirements for accepting the hypotheses than if we were testing them separately.

Hypothesis 5.1(i) predicts that the slope of the $V - X$ relation, given B, is nonnegative in the low-*ROE* region ($\gamma_0 \geq 0$ and $\gamma_0 + \gamma_1 \geq 0$), and increases as we move from the low- to the high-*ROE* region, ($\gamma_2 > 0$ and $\gamma_2 + \gamma_3 > 0$). As reported in Table 5.6, the estimates are $\gamma_0 = 4.894$, $\gamma_0 + \gamma_1 = 4.844$, $\gamma_2 = 6.776$, and $\gamma_2 + \gamma_3 = 8.536$, and all are significantly positive at the 0.01 level.

Hypothesis 5.1(ii) predicts that the growth effect on the slope of the $V - X$ relation, given B, is strictly positive in the high-*ROE* region ($\gamma_1 + \gamma_3 > 0$) and decreases as we move from there to the low-*ROE* region ($\gamma_3 > 0$). In Table 5.6, we see that $\gamma_1 + \gamma_3 = 1.811$ and $\gamma_3 = 1.860$, which are significantly positive at the 0.1 level or better.

Hypothesis 5.2(i) predicts that the slope of the $V - B$ relation, given X, is positive in the low-*ROE* region ($\beta_0 > 0$ and/or $\beta_0 + \beta_1 > 0$) and negative in the high-*ROE* region ($\beta_0 + \beta_2 < 0$ and/or $\beta_0 + \beta_1 + \beta_2 + \beta_3 < 0$). The results are $\beta_0 = 0.569$, $\beta_0 + \beta_1 = 0.687$, $\beta_0 + \beta_2 = -0.074$, and $\beta_0 + \beta_1 + \beta_2 + \beta_3 = -0.257$; they all have the predicted sign and are significant at the 0.05 level or better.

Hypothesis 5.2(ii) predicts that investment growth causes the slope of the above $V - B$ relation to be more negative in the high-*ROE* region, $\beta_1 + \beta_3 < 0$. The result is $\beta_1 + \beta_3 = -0.182$, which is significant at the 0.1 level.

In summary, the empirical results obtained using the regression model in Eq. (5.15) are consistent with all the properties of the ROM as set out in Hypotheses 5.1(i)–(ii) and 5.2(i)–(ii).

5.5.2 *Evidence for Hypothesis 5.3*

The predictions in Hypothesis 5.3 concern the relation between V and B when *ROE* is held constant. These predictions cannot be tested using the regression in Eq. (5.15) for general values of *ROE* because when *ROE* is held constant, X changes with B at a rate equal to *ROE* so that the resulting coefficient on B is itself a function of *ROE*. For this reason, we select two specific values of *ROE* for the test, drawn from the low- and high-*ROE* regions, respectively. The results are shown in Table 5.7.

In the low-*ROE* region, we pick the mean *ROE* of −0.090. Based on the empirical estimate of the regression in Eq. (5.15), at this value of *ROE*, the implied coefficient on B equals 0.980 for firms with low growth ($H_g = 0$) and 1.298 for firms with high growth ($H_g = 1$), both of which are significant at the 0.01 level. The difference between the two coefficients is 0.318, which again is significant at the 0.01 level.

In the high-*ROE* region, the mean *ROE* is 0.229. The coefficient on B as calculated from the estimated regression in Eq. (5.15) is 2.089 for firms with low growth ($H_g = 0$) and 2.217 for firms with high growth ($H_g = 1$), both of which are

Table 5.7 Growth and the relation between equity value and book value at low- and high-profitability points (Hypothesis 5.3)

ROE-value		Predicted sign	*B* Coefficient
$ROE_L = -0.090$	Slope in low *g* region	+	0.980***
	Incremental slope in high *g*	+	0.318***
	Slope in high *g*	+	1.298***
$ROE_H = 0.229$	Slope in low *g* region	+	2.089***
	Incremental slope in high *g*	+	0.128***
	Slope in high *g*	+	2.217***

*** indicate one-tailed significance at the 0.01 level with Bonferroni corrections
Source: *Adapted from Table 9 in Hao et al. (2011a)*

highly significant. The difference between the two coefficients equals 0.128, which is significant at the 0.01 level.

The above evidence is consistent with Hypothesis 5.3(i) and (ii).

5.6 Accounting Conservatism and the Relation Between *V* and *X*

In this section, we examine a property of the ROM attributed to conservative accounting practice. Conservatism introduces systematic biases in accounting measures and thus alters the relation between equity value and accounting variables. As we explain below, the magnitude and direction of such biases are jointly determined by conservatism and the firm's past investment activities. This differs from the valuation properties examined in the preceding section which hinge on anticipated future investment activities.

The analysis below tests how conservatism affects the valuation role of earnings, which relates to Conjecture 4.1. (The theoretical analysis in Chap. 4 yields no readily testable prediction for how conservatism affects the relation between equity value and book value.)

5.6.1 Theoretical Prediction

The original version of the ROM, given by Eq. (4.11), embodies three accounting rules: historical cost-based asset valuation, the CSR, and a conservative policy which recognizes depreciation at a rate faster than true economic depreciation (the decline in productive capacity). The bias in earnings (Δu_t), expressed in Eq. (4.19), can be positive or negative, depending on the changes in the amount of capital investment in the past, especially in recent periods.

In essence, conservatism affects the schedule for expensing a long-term asset, while the total expense recognized over the lifetime of the asset stays fixed. Under conservative accounting, an asset is over-expensed in the early stages of its life and under-expensed in subsequent periods. This has the effect of depressing reported earnings initially and inflating them later.

In general, a firm operates with a mixture of assets acquired at different times in the past, and so the overall earnings bias is the combined effect arising from all its assets. For a firm that has been rapidly increasing the amount of capital investment (especially recently), most of its assets will be relatively new and hence heavily expensed; in this scenario, earnings tend to be depressed relative to the case of unbiased depreciation. On the other hand, for a firm that has reduced its capital investment, the opposite result holds and earnings tend to be inflated. In general, the faster the rate of previous investment increases, the more depressed reported earnings will be.

Rational investors adjust accounting biases; they will increase the valuation weight on earnings when they are understated and reduce the weight when overstated. The above analysis suggests that the slope on the $V - X$ relation will be greater following periods of increasing rather than decreasing investment. This leads to the next hypothesis.

Hypothesis 5.4 *Ceteris paribus*, the slope of the $V - X$ relation is greater following a period of faster increases in investment than following periods of slower increases (or decreases).

5.6.2 Empirical Evidence

The property of the valuation function stated in Hypothesis 5.4 is a joint product of conservative accounting and changes in past investment. To test the hypothesis, we partition yearly observations into two groups based on the speed of past investment change, measured in terms of annual increase in capital expenditure scaled by the opening book value of equity, averaged over the preceding 3 years. Firms with larger increases in capital expenditure have more conservatively stated earnings than those with smaller (including negative) increases in capital expenditure, and we use dummy variables H_c and L_c to indicate the two groups, respectively.

We adopt the following regression, extended from the regression model in Eq. (5.15), to estimate the value-accounting relations separately for the L_C and H_C groups:

$$\begin{aligned} V_i = L_C\{&\alpha_{0L} + \alpha_{1L}H_g + \alpha_{2L}H_{ROE} + \alpha_{3L}H_gH_{ROE} + \beta_{0L}B_i + \beta_{1L}H_gB_i + \beta_{2L}H_{ROE}B_i \\ &+ \beta_{3L}H_gH_{ROE}B_i + \gamma_{0L}X_i + \gamma_{1L}H_gX_i + \gamma_{2L}H_{ROE}X_i + \gamma_{3L}H_gH_{ROE}X_i\} \\ &+ H_C\{\alpha_{0H} + \alpha_{1H}H_g + \alpha_{2H}H_{ROE} + \alpha_{3H}H_gH_{ROE} + \beta_{0H}B_i + \beta_{1H}H_gB_i \\ &+ \beta_{2H}H_{ROE}B_{ii} + \beta_{3H}H_gH_{ROE}B + \gamma_{0H}X_i + \gamma_{1H}H_gX_i + \gamma_{2H}H_{ROE}X_i \\ &+ \gamma_{3H}H_gH_{ROE}X_i\} + e_i. \end{aligned} \tag{5.16}$$

Table 5.8 Testing conservatism and growth effects using the full model (*Coefficient estimates for the low and high earnings conservatism groups*)

Variable	Coefficient	Predicted sign	Estimate: Low earnings conserv. (L_c)	Estimate: High earnings conserv. (H_c)
Base intercept			15.113[a]	19.159[a]
H_g			1.679[a]	2.861[a]
H_{ROE}			−0.312	2.943[a]
H_gH_{ROE}			−0.990[a]	0.906[a]
B [**H2**: slope in low g & low *ROE*]	β_{0L}; β_{0H}	+	**0.528*****	**0.426****
H_gB	β_{1L}; β_{1H}		0.010	−0.044
$H_{ROE}B$	β_{2L}; β_{2H}	−	−0.715[a]	−0.799[a]
$H_gH_{ROE}B$	β_{3L}; β_{3H}	−	−0.329[a]	−0.415[a]
X	γ_{0L}; γ_{0H}	+	**5.993*****	**6.895*****
H_gX	γ_{1L}; γ_{1H}		0.386	0.466
$H_{ROE}X$	γ_{2L}; γ_{2H}	+	**7.542*****	**7.827*****
$H_gH_{ROE}X$ [**H1**: incremental growth effect in high vs. low *ROE*]	γ_{3L}; γ_{3H}	+	**2.531*****	**2.552*****
$H_gX + H_gH_{ROE}X$ [**H1**: growth effect in high *ROE*]	$\gamma_{1L}+\gamma_{3L}$;$\gamma_{1H}+\gamma_{3H}$	+	**2.917*****	**3.018*****
$B + H_gB$ [**H2**: slope in high g & low *ROE*]	$\beta_{0L}+\beta_{1L}$;$\beta_{0H}+\beta_{1H}$	+	**0.538*****	**0.382*****
$B + H_{ROE}B$ [**H2**: slope in low g & high *ROE*]	$\beta_{0L}+\beta_{2L}$;$\beta_{0H}+\beta_{2H}$	−	−**0.187*****	−**0.373******
$B + H_gB + H_{ROE}B + H_gH_{ROE}B$ [**H2**: slope in high g & high *ROE*]	$\beta_{0L}+\beta_{1L}+\beta_{2L}+\beta_{3L}$; $\beta_{0H}+\beta_{1H}+\beta_{2H}+\beta_{3H}$	−	−**0.506*****	−**0.833*****
$H_gB + H_gH_{ROE}B$ [**H2**: growth effect in high *ROE*]	$\beta_{1L}+\beta_{3L}$;$\beta_{1H}+\beta_{3H}$	−	−**0.319*****	−**0.459*****
Adj. R^2	0.87			

[a]indicates one-tailed significance at the 0.01 level without Bonferroni corrections, respectively
*** and ** indicate one-tailed significance at the 0.01 and 0.05 levels with Bonferroni corrections, respectively
Source: *Adapted from Table 10 in Hao et al. (*2011a*)*

In running the regression in Eq. (5.16), samples are independently sorted on three dimensions (past investment, future growth, and *ROE*). Equation (5.16) is employed to achieve two purposes: firstly to test whether the valuation properties arising from economic incentives to generate value (Hypotheses 5.1 and 5.2) hold separately in the high and low earnings conservatism groups and secondly to test Hypothesis 5.4 that requires a comparison of the earnings coefficient between the high and low conservatism groups. Tables 5.8 and 5.9 report the regression results.

Table 5.9 Testing conservatism and growth effects using the full model [*Comparing earnings coefficients between H_c and L_c (Hypothesis 5.4)*]

	Coefficient	Predicted sign	Estimate
Diff. in *X* coeff. in (low *g*, low *ROE*): $H_c - L_c$	γ_{0H} - γ_{0L}	+	0.902***
Diff. in *X* coeff. in (high *g*, low *ROE*): $H_c - L_c$	$(\gamma_{0H} + \gamma_{1H})$- $(\gamma_{0L}+ \gamma_{1L})$	+	0.982***
Diff. in *X* coeff. in (low *g*, high *ROE*): $H_c - L_c$	$(\gamma_{0H} + \gamma_{2H})$- $(\gamma_{0L}+ \gamma_{2L})$	+	1.188**
Diff. in *X* coeff. in (high *g*, high *ROE*): $H_c - L_c$	$(\gamma_{0H} + \gamma_{1H}+ \gamma_{2H} + \gamma_{3H})$- $(\gamma_{0L} + \gamma_{1L}+ \gamma_{2L} + \gamma_{3L})$	+	1.289***

*** and ** indicate one-tailed significance at the 0.01 and 0.05 levels with Bonferroni corrections, respectively

Source: Adapted from Table 10 in Hao et al. (2011a)

5.6.2.1 Value-Accounting Relations in the Low and High Earnings Conservatism Groups

The coefficient estimates for both the low and high earnings conservatism groups (L_C and H_C) are reported in Table 5.8.

According to Hypothesis 5.1(i), the slope of the $V - X$ relation, given *B*, is nonnegative in the low-*ROE* region ($\gamma_0 \geq 0$ and $\gamma_0 + \gamma_1 \geq 0$) and increases as we move into the high-*ROE* region ($\gamma_2 > 0$ and $\gamma_2 + \gamma_3 > 0$). These predictions are confirmed in both the low and high earnings conservatism groups. In the former, we get γ_{0L} =5.993, $\gamma_{0L} + \gamma_{1L} = 6.379$, $\gamma_{2L} = 7.542$, and $\gamma_{2L} + \gamma_{3L} = 10.073$, all of which are significant at the 0.01 level. Similarly, in the latter, we get γ_{0H} =6.895, $\gamma_{0H} + \gamma_{1H} = 7.361$, $\gamma_{2H} = 7.827$, and $\gamma_{2H} + \gamma_{3H} = 10.399$, which are again all significant at the 0.01 level.

Hypothesis 5.1(ii) predicts that the growth effect on the slope of the $V - X$ relation, given *B*, is strictly positive in the high-*ROE* region ($\gamma_1 + \gamma_3 > 0$) and decreases as we move to the low-*ROE* region ($\gamma_3 > 0$). The results for both groups are consistent. In the low earnings conservatism group, we have $\gamma_{1L} + \gamma_{3L} = 2.917$ and $\gamma_{3L} = 2.531$, which are significant at the 0.01 level. In the high earnings conservatism group, we get $\gamma_{1H} + \gamma_{3H} = 3.018$ and $\gamma_{3H} = 2.552$, again both significant at the 0.01 level.

Hypothesis 5.2(i) predicts that the slope of the $V - B$ relation, given *X*, will be positive in the low-*ROE* region ($\beta_0 > 0$ and/or $\beta_0 + \beta_1 > 0$) and negative in the high-*ROE* region ($\beta_0 + \beta_2 < 0$ and/or $\beta_0 + \beta_1 + \beta_2 + \beta_3 < 0$). The results for both earnings conservatism groups lend support to this. In the low conservatism group, the estimates are $\beta_{0L} = 0.528$, $\beta_{0L} + \beta_{1L} = 0.538$, $\beta_{0L} + \beta_{2L} = -0.187$, and $\beta_{0L} + \beta_{1L} + \beta_{2L} + \beta_{3L} = -0.506$; they all have the predicted sign and are significant at the 0.01 level. The same is true for the estimates of the high conservatism group, $\beta_{0H} = 0.426$, $\beta_{0H} + \beta_{1H} = 0.382$, $\beta_{0H} + \beta_{2H} = -0.373$, and $\beta_{0H} + \beta_{1H} + \beta_{2H} + \beta_{3H} = -0.833$.

Hypothesis 5.2(ii) predicts that investment growth causes the slope of the above $V - B$ relation to be more negative in the high-*ROE* region, $\beta_1 + \beta_3 < 0$. The result is $\beta_{1L} + \beta_{3L} = -0.319$ in the low earnings conservatism group and $\beta_{1H} + \beta_{3H} = -0.459$ in the high conservatism group, both of which are significant at the 0.01 level.

Overall, these results are consistent with all the properties of the ROM predicted in Hypotheses 5.1 and 5.2.

5.6.2.2 Difference in the Valuation Impact of Earnings Between the Low and High Earnings Conservatism Groups (Hypothesis 5.4)

The ROM predicts that firms in the high earnings conservatism group (H_C) report earnings that are more conservatively stated than firms in the low conservatism group. As a result, if all else is held constant, the slope of the $V - X$ relation, given B, will be expected to be greater in H_C than in L_C. The regression in Eq. (5.16) identifies four different regions as characterized by the particular combinations of g and *ROE*, with a separate pair of earnings slope coefficients being estimated in each region for the L_C and H_C groups. As reported in Table 5.9, in all four regions, the earnings slope is always greater in the H_C than in the L_C group, with the difference being statistically significant at the 0.05 level or better. These results are supportive of Hypothesis 5.4.

5.7 Summary

This chapter empirically examines the behavior of equity value in relation to accounting variables such as earnings, equity book value, and profitability (*ROE*). According to the ROM, there are two fundamental forces affecting the value-accounting relation: anticipated future investment decisions aimed at increasing investor wealth (through exploiting real options) and conservative accounting as a way of recording past investment activities. The analyses in this chapter are designed to explore and test the properties of the ROM driven by these two forces.

The empirical results reported above are consistent with the theoretical predictions of the ROM. Firstly, given book value, equity value is an increasing and convex function of earnings. Investment growth increases the slope of this relation in high-*ROE* regions, but the growth effect diminishes as we move down to low-*ROE* regions. Secondly, given earnings, equity value increases with book value in the low-*ROE* region but decreases in the high-*ROE* region. Investment growth exacerbates the relation between equity value and book value in both regions; that is, growth increases its slope of this relation in the low-*ROE* region (making it more positive) and reduces the slope in the high-*ROE* region (making it more negative). Thirdly, given *ROE* (that is, scaled earnings), equity value increases with book value in all regions of *ROE*, with investment growth further increasing the slope.

Fourthly, under conservative accounting practice, the slope of the value-earnings relation, given book value, is greater for firms having experienced faster increases in capital investments in the most recent past.

The empirical evidence set out in this chapter, together with the theoretical model specified in Chap. 4, presents a more comprehensive framework for understanding the relation between equity value and accounting data, and in particular how it is driven by economic and accounting forces separately. The framework has relevance both for investors using accounting data to determine firm values and standard setters who formulate rules to govern financial reporting. It is also useful for academic researchers who are interested in exploring the impact of financial reporting and disclosures on capital markets.

Appendix A: The Empirical Sample and Variable Measurement

The sample and variable measurement are as adopted by Hao et al. (2011a). The data are extracted from the Compustat database, and the variables are measured as follows: V (market value per share) is the market price of common shares at the fiscal year end; B (book value per share) is the book value of equity divided by the number of common shares outstanding, both at the fiscal year end; X (earnings per share) is diluted earnings per share excluding extraordinary items; and ROE (profitability) is earnings before extraordinary items divided by the book value of equity at the beginning of the fiscal year. We measure growth (g) using the average realized annual growth rate of equity book value over the subsequent 3 years. The sample excludes (i) regulated and financial industries and (ii) firms with a current- or prior-year total equity book value of less than $1 million. All continuous variables are winsorized at the top and bottom 1 % of the distributions. These steps result in a sample of 101,672 observations for the period 1966–2003.

Reference

Hao, S., Jin, Q., & Zhang, G. (2011a). Investment growth and the relation between equity value, earnings, and equity book value. *The Accounting Review, 86*(2), 605–635.

Chapter 6
Casting Theoretical Light on the Empirical Valuation Literature

This chapter evaluates and critiques existing valuation research within the ROM framework. The literature on accounting-based valuation has been heavily dominated by empirical work, with discoveries of empirical relations coming long before the development of theoretical models. In the absence of formal models explaining how equity value should be related to reported accounting data, researchers have relied on economic intuition and valuation theories drawn from other disciplines (finance and economics) in order to design research studies and interpret their results. The purpose of this chapter is twofold. Firstly, we demonstrate that many of the salient empirical findings documented in the literature can be reconciled with the ROM and indeed are different manifestations of it. Secondly, we explain, in the context of the ROM, how the empirical valuation models used in the literature may have been misspecified.

Accordingly, this chapter aims to shed further theoretical light on the existing research so as to gain a more integrated view of the empirical literature. However, it does not set out to provide a comprehensive survey of this body of work. Reviews of the valuation research have been carried out by, among others, Holthausen and Watts (2001), Kothari (2001), Lo and Lys (2000). It should also be highlighted that this chapter focuses primarily on studies of equity values (price levels); the literature on equity returns is discussed in Chap. 10.

6.1 Reconciling Prior Empirical Findings with the ROM

Prior studies have extensively examined the relation between equity value and accounting variables. In this section, we revisit some of the more important findings documented in this literature, including convexity in the value-accounting relation (see for example Burgstahler and Dichev 1997), the differential valuation roles of earnings and equity book value for firms with positive and negative earnings (see for example Collins et al. 1999), and the valuation importance of earnings dependent on financial health (Barth et al. 1998). Although the results of these various

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studies initially seem fragmented and disconnected, in fact they are all consistent with the properties of the ROM and thus can be unified by its theoretical framework. We also demonstrate how the ROM can enable us to reinterpret some of the empirical findings.

6.1.1 Adaptation Options and Convex Valuation Functions

6.1.1.1 The Findings of Burgstahler and Dichev (1997)

The work of Burgstahler and Dichev (1997; hereafter BD) is among the few in the empirical literature to explicitly consider real options in valuation. BD envisage firm value as deriving from two complementary operating scenarios: (i) continuing the present course of operations and (ii) abandoning present operations and adapting resources to alternative business uses. BD interpret the term "adaptation" broadly to include both external (such as liquidations, mergers, and divestitures) and internal adaptations (such as change of CEO, restructuring, and new capital investment). The relevant value concepts corresponding to the two scenarios are recursion value and adaptation value, respectively.

BD use earnings capitalization as a proxy for recursion value, and equity book value as a proxy for adaptation value. They recognize that it will be to the firm's advantage to continue with its current strategy if the value derived from recurring earnings is high relative to the adaptation value and to abandon operations otherwise. Their reasoning yields two main predictions.

BD's Prediction 1: Equity value is an increasing and convex function of earnings for a given adaptation value.

BD's Prediction 2: Equity value is an increasing and convex function of equity book value for a given level of expected earnings.

BD recognize that in a setting with perfect markets where firms earn zero NPV from invested resources, valuations based on earnings and that based on equity book value are theoretically equivalent (see also Beaver and Demski 1979; Barth and Landsman 1995), and so they presume that the markets for real assets are not perfect in order for earnings and book value to convey complementary information.

To test Prediction 1, BD control for book value by scaling both equity value (V_t) and earnings (X_t) by equity book value at the beginning of a period (B_{t-1}) and then run the following piecewise linear regression:

$$V_t/B_{t-1} = a_0 + a_1 M + a_2 H + b_0 X_t/B_{t-1} + b_1 M X_t/B_{t-1} + b_2 H X_t/B_{t-1} + e_i, \tag{6.1}$$

where M and H are indicator variables for observations in the medium and high thirds of scaled earnings (X_t/B_{t-1}) in a sample, respectively. Thus, b_0 is the slope coefficient in the low (scaled) earnings range, and $b_0 + b_1$ and $b_0 + b_2$ are the slopes in the middle and high (scaled) earnings ranges, respectively. According to Prediction 1, $b_0 > 0$, $b_1 > 0$, and $b_2 > b_1$.

The sample BD use is drawn from Compustat covering the period 1976–1994. From the pooled sample, BD obtain $b_0 = -4.55$ (t = −25.84), $b_0 + b_1 = 1.36$ (t = 15.80 for b_1), and $b_0 + b_2 = 17.49$ (t = 53.45 for b_2). Also, b_2 is found to be significantly greater than b_1. The results from annual samples are similar. Across the sample years, BD obtain the following average coefficients: $b_0 = -3.01$ (t = −4.44), $b_0 + b_1 = 6.51$ (t = 4.94 for b_1), and $b_0 + b_2 = 15.61$ (t = 12.77 for b_2). Furthermore, b_2 is significantly greater than b_1 in 15 of the 19 sample years. Therefore, their empirical results generally support the prediction that V_t is a convex function of X_t, controlling for B_{t-1}. The results also support the prediction that V_t is an increasing function of X_t, controlling for B_{t-1}, in the medium and high thirds of scaled earnings but not in the low scaled earnings.[1]

BD use a similar design to test their Prediction 2 about the relation between equity value and equity book value. To control for earnings, they scale both equity value (V_t) and book value (B_{t-1}) by earnings (X_t) and run the following piecewise linear regression:

$$V_t/X_t = a_0 + a_1 M + a_2 H + b_0 B_{t-1}/X_t + b_1 M\, B_{t-1}/X_t + b_2 H\, B_{t-1}/X_t + e_i, \quad (6.2)$$

where M and H are indicator variables for observations in the middle- and high-thirds of scaled book value (B_{t-1}/X_t) in a sample. Thus, b_0 is the slope coefficient in the low (scaled) book value range, and $b_0 + b_1$ and $b_0 + b_2$ are the slopes in the middle and high (scaled) book value ranges, respectively. According to Prediction 2, we expect $b_0 > 0$, $b_1 > 0$, and $b_2 > b_1$.

The estimates from the pooled sample are $b_0 = -1.01$ (t = −11.29), $b_0 + b_1 = 1.18$ (t = 18.51 for b_1), and $b_0 + b_2 = 0.85$ (t = 20.80 for b_2). The slopes in the medium and high book value ranges are significantly greater than in the low book value range, but there is a decrease in the slope from the medium to the high book value range. From annual regressions, the average coefficients are $b_0 = -0.72$ (t = −1.83), $b_0 + b_1 = -0.02$ (t = 1.26 for b_1), and $b_0 + b_2 = 0.67$ (t = 3.73 for b_2, which show an increasing and convex trend. Furthermore, b_2 is significantly greater than b_1 for 13 of the 19 sample years.

These results generally confirm convexity in the $V - B$ relation, given X. However, the evidence of a negative slope in the $V - B$ relation in the low B/X range is inconsistent with BD's prediction. Below, we explain that this finding can be rationalized within the above ROM framework which incorporates growth as well as abandonment options. (The discussion below overlaps with part of Chap. 5.)

[1] The negative slope found by BD for firms with low scaled earnings appears to be a result specific to their sample and design of their regression equation. As shown in Chap. 5 based on a different sample, the slope of the V–X relation is positive, albeit small in magnitude, for firms in low profitability regions when the sample is partitioned into B-deciles (as a way to control for book value).

6.1.1.2 BD's Setting as a Special Case of the ROM

The basic idea underlying the work of BD is similar to that for the ROM as presented in Eq. (4.11). Namely, a firm has the flexibility to either maintain the present course of operations going forward or alter course if that would be desirable. The key difference is that BD consider the option to abandon the operation in low-profitability regions, but not the option to grow in high-profitability regions. In this sense, the setting they examine is a restricted version of that underlying the ROM. If we drop the growth option, then the ROM in Eq. (5.1) (the version for unbiased depreciation) can be simplified as

$$V_t = B_t\, P(ROE_t) + X_t/r, \tag{6.3}$$

which, in essence, is the theoretical basis for BD's predictions.

The model specified in Eq. (6.3) is valid for both low-profitability firms which have a significant chance of being discontinued and for firms operating in a steady state, but not for firms expected to engage in substantial growth. It is not clear whether BD's predictions can be generalized to settings where growth options are important. As we explain below, while some of the properties they predict remain qualitatively the same after introducing growth options, others need to be altered.

According to BD's Prediction 1, equity value is an increasing and convex function of earnings, given equity book value. In a more general setting that also incorporates growth options, this property continues to hold. This is because the growth option itself is an increasing and convex function of earnings (given equity book value) and so reinforces the original effect of the adaptation option. One difference, though, is that convexity caused by adaptation options is relevant to low-profitability regions, whereas convexity from growth options is relevant to high-profitability regions. Also, by introducing growth options, it becomes possible to further predict how the slope and convexity of the valuation function depend on the extent of growth (see Chaps. 3 and 5 for related analyses).

However, BD's Prediction 2 is less easily generalizable to settings involving investment growth. Although the second-order property (convexity) of equity value with respect to book value generally holds whether or not growth options are present, the first-order property is affected. According to BD's Prediction 2, equity value is an increasing function of book value, given earnings. In contrast, the ROM predicts equity value to be a nonmonotonic function of book value, given earnings. Specifically, holding earnings constant, equity value increases with book value in low-profitability regions but decreases with book value in high-profitability regions (where the growth option is valuable). The reason for this nonmonotonic behavior has been explained in Chap. 5.

The evidence presented in Chap. 5 supports the prediction of the ROM. Indeed, the empirical results reported by BD also indicate that equity value behaves in a nonmonotonic fashion, consistent with that predicted by the ROM. In their regression of equity value (scaled by earnings) on equity book value (scaled by earnings), the slope is significantly negative in the region of low values of B/X (corresponding to high profitability), but the slope is positive in the region of high values of B/X (corresponding to low profitability).

6.1.2 Exploring the Various Implications of Adaptation Options

As well as the BD study discussed above, several others have also examined the valuation implications of the adaptation option in various ways. Unlike BD, however, these studies focus only on the information content of earnings (but not equity book value), and some of them are designed to explain equity returns (that is, changes in value) rather than levels of value. Their findings are in line with the predictions of the ROM.

Hayn (1995) posits that because firms making losses are more likely to be liquidated than profitable ones, negative earnings should be less persistent than positive earnings, causing the slope coefficient of the return-earnings relation to be smaller in the region of negative (rather than positive) earnings. Her empirical results are consistent with this prediction. Furthermore, Hayn (1995) also shows that for firms with positive earnings, the slope coefficient is also smaller in the region of low (versus high) earnings, where the put option to liquidate becomes important. Additional evidence suggests that her findings are not likely to have been driven by an alternative explanation such as lack of timelines of accounting earnings (Beaver et al. 1980), accounting conservatism (Basu 1997), transitory earnings items, differences in the time series properties of earnings across firms, or mean reversion of extreme earnings.

Similarly, Subramanyam and Wild (1996) examine the effect of a firm's going concern status (using Altman's Z-score as a proxy) on the slope of the return-earnings relation. They find that as the probability of termination increases, the earnings coefficient decreases.

Although these studies employ models to explain equity returns, as opposed to values, their findings are consistent with the ROM prediction that equity value is an increasing and convex function of earnings. However, return-based models that rely only on earnings and not book value information are generally misspecified; this will become clear in Chaps. 9 and 10 where we show how equity returns are related to a broader set of accounting information.

In a related study, Berger et al. (1996) conjecture that firm value should reflect the option to abandon (exit) the operation, which is akin to an American put option. They estimate a firm's liquidation (exit) value based on the book values of the various classes of its assets and the degree of asset specificity for each class. They show that controlling for expected going-concern cash flows (using analysts' forecasts as a proxy), firm value is positively related to estimated exit value. Furthermore, exit values are more important in determining equity value for firms with a high (versus low) likelihood of experiencing financial distress, which is one of the factors that affect the probability of abandonment. Again, these findings are consistent with the prediction of the ROM that equity value derives in part from the adaptation option and this option becomes more important as the likelihood of abandoning the existing business increases.

6.1.3 Examining the Price-Earnings Relation for Firms with Negative Earnings

6.1.3.1 A Negative Slope in the Value-Earnings Relation

Several studies examining the value-earnings relation have focused specifically on firms with negative earnings. Initially, Jan and Ou (1995) find that stock prices are negatively related to the amount of loss that a firm incurs in a cross-sectional setting, as demonstrated by a negative slope coefficient in the following earnings capitalization model:

$$V_t = a + bX_t + e_t, \tag{6.4}$$

where V_t denotes a firm's market value per share and X_t earnings per share. This result appears puzzling as it gives the impression that investors are attaching a higher value to firms incurring more losses.

Collins et al. (1999) posit that an earnings capitalization model is misspecified for firms incurring losses and that the anomalous negative slope is caused by a correlated omitted variable, namely, equity book value. They argue that its omission causes the earnings coefficient to be biased downward for loss firms—resulting in a negative coefficient estimate—and biased upward for profit firms. This is inconsistent with the point made by Kothari and Zimmerman (1995) that the earnings coefficient is unbiased in a price-level model (under the condition of earnings following a random walk).

Collins et al. (1999) then employ a regression model that explains prices using both book value (B_t) and earnings (X_t), as follows:

$$V_t = a + b_1X_t + b_2B_t + e_t. \tag{6.5}$$

Using a Compustat sample for the period 1974–1993, they find evidence consistent with their conjecture. Specifically, for loss-making firms, the mean estimate of the earnings coefficient from annual regressions is -1.12 ($t = -9.42$) in the regression in Eq. (6.4), which is significantly negative, but shifts to a positive value of 0.16 ($t = 1.84$) in Eq. (6.5), which is marginally significant. The mean estimate of the book value coefficient in the regression specified in Eq. (6.5) is 0.47

(t = 11.84), which is highly significant. This confirms the importance of book value in explaining the values of loss-making firms.

Contrasting results are found for profitable firms. The mean estimate of the earnings coefficient from the annual regressions is 7.31 (t = 20.59) in Eq. (6.4), but it has a much smaller value of 4.88 (t = 19.71) in Eq. (6.5). For Eq. (6.5), the mean estimate of the book value coefficient is 0.45 (t = 9.79), which is highly significant, indicating that book value is also important in explaining market values for firms with positive earnings.

Collins et al. (1999) provide further evidence to show that the role of equity book value in price-level regressions is not just a scalar (as conjectured by Barth and Kallapur 1996) or a proxy for expected normal earnings in future periods (as suggested by Ohlson 1995; Penman 1992). On the other hand, they acknowledge that it is empirically difficult to disentangle their finding from the effect of adaptation options.

6.1.3.2 Rationalizing a Negative Earnings Coefficient Using the ROM

The above empirical results based on the regressions specified in Eqs. (6.4) and (6.5) can be rationalized using the ROM. In general, for poorly performing firms, such as those making losses, the growth option is of little importance so that ROM reduces (approximately) to Eq. (6.3). With put–call parity, the equation can be equivalently expressed as

$$V_t = \left[\frac{(1-\gamma c_a)}{1+r} + \frac{ROE_t}{1+r} + C_c(ROE_t)\right]B_t, \tag{6.6}$$

where $C_c(ROE_t)$ is the (call) option to *continue* the firm's operations relative to the scenario of abandonment. According to Eq. (6.6), equity value is a function of two fundamental factors: B_t and ROE_t.

At the same time, earnings are also explained by these same factors, (B_t, ROE_t). This is because, by definition, we have $X_t = B_{t-1} \times ROE_t$, and empirically B_{t-1} is closely correlated with B_t in a cross-sectional sample. Thus, to determine how V_t is related to X_t in Eq. (6.4), we need to examine how each of the two underlying factors (B_t and ROE_t) operates and their combined effect on the relation between V_t and X_t.

Given B_t, an increase in ROE_t causes both V_t and X_t to increase, so this alone induces a positive relation between V_t and X_t in the cross section. On the other hand, given ROE_t (which is negative in the present context), an increase in B_t causes V_t to go up while causing X_t to go down (that is, the loss is greater), thereby inducing an inverse relation between V_t and X_t. Note that, as shown in Chap. 5, equity value is primarily determined by equity book value in low-profitability regions and is bounded by zero from below due to limited liability.

Thus, in theory, it is possible to obtain either a positive or a negative slope coefficient in the regression in Eq. (6.4), depending on which factor (book value or profitability) contributes more to driving the variation in a sample. For a broad cross-sectional sample, it is typical for book value to dominate profitability in causing such variation in equity value. If this is so, we would expect a negative slope in Eq. (6.4) for a sample of loss-making firms, as found by Jan and Ou (1995).

To put this into perspective, in the sample of loss-making firms employed by Collins et al. (1999), equity book value (per share) equals 0.78 at the 1st quartile of the distribution, and 7.05 at the 3rd quartile, a difference of about ninefold. It follows from Eq. (6.6) that the difference in equity value caused by this variation in book value would also be about ninefold. However, it is unlikely that we can obtain equity value differences of such a magnitude from similar changes in ROE_t. To illustrate, we set $r = 10\,\%$. In a very optimistic scenario, where a loss-making firm is expected to immediately recover and deliver long-run profitability of twice the cost of capital, we have $V_t \approx 2B_t$. On the other hand, in a very pessimistic scenario where the same firm is expected to undergo immediate abandonment, and assuming $c_a = 0.5$ (that is, half the existing assets dissipate in the adaptation process), we have $V_t = (1 - c_a)B_t = 0.5B_t$. The resulting difference in equity value between these two rather extreme scenarios is only four times, which is small in comparison with the effect caused by book value.

Evidence from Collins et al. (1999) supports the above contention. For the regression in Eq. (6.4) where only earnings are used (which mostly captures the effect of *ROE*) to explain prices, they obtain an adjusted R^2 of 7 %. The adjusted R^2 increases to 41 % for Eq. (6.5) where book value is included along with earnings as explanatory variables, indicating that in their sample of loss-making firms, book value is more powerful in explaining equity values.

Thus, according to the ROM, the reason for the "anomalous" finding of a negative earnings coefficient is the omission of book value, as proposed by Collins et al. (1999). However, the ROM also indicates that once book value is included in the regression, the role of earnings (the original explanatory factor) is to convey information about profitability (*ROE*), not earnings information per se. Finally, the ROM suggests that a linear specification serves as an approximation, which may be justified if the range of *ROE* involved is relatively narrow, but in general the valuation function is convex.

6.1.4 Financial Health and the Valuation Effects of Earnings and Book Value

The studies discussed above consider the valuation effect of *real* options which stem from decisions concerning actual business activities. A similar type of effect can also arise from a firm's financial arrangements. It is well known that with limited liability, debt financing essentially grants a firm's equityholders a put option. Specifically, if the firm fails to meet prespecified payment obligations, they have the option to surrender the business to debtholders, which amounts to exercising a put option. The effect of this on the valuation function is analogous to that of the real option to abandon existing operations considered above.

Barth et al. (1998) explore how the valuation effects of earnings and equity book value vary with a firm's financial health, which is an indicator of how close the firm is to bankruptcy. They posit that the role of the balance sheet is primarily for debt contracting, for example, by reporting the value of assets in the event of liquidation, whereas the income statement primarily serves equity valuation by conveying the firm's ability to earn income beyond a normal return on assets. As equity value reflects the probability of financial default, they predict that the importance of book value in explaining equity value is negatively related, and that of earnings is positively related, to the firm's financial health. Note that this predicted property is qualitatively the same as that driven by the adaptation option.

Barth et al. (1998) employ the regression specified in Eq. (6.5), which relies on both earnings and equity book value to explain equity value. They employ two different samples for their analysis and find evidence consistent with their prediction. Firstly, based on a sample of firms that actually filed for bankruptcy, Barth et al. (1998) find that in the preceding years the valuation coefficient on earnings exhibits a decreasing trend as time approaches the bankruptcy event, whereas the coefficient on book value exhibits an increasing trend. Secondly, for a broad cross-sectional sample, they use bond ratings as a proxy for financial health, and find that the coefficient on earnings is smaller, while that on book value larger, for firms with low (versus high) bond ratings.

One difficulty in attributing these empirical results to financial health, rather than the adaptation option, is that the former is itself a function of operational health (which ultimately triggers the exercise of adaptation options). Typically, financially troubled firms are also those not performing well in real business operations and which are therefore relatively likely to exercise adaptation options. Equityholders originally hold a put option for abandoning business operations in the case where the firm is not leveraged. Financial leverage means that the exercise of that put option is more likely and will occur sooner, leaving it to debtholders to decide whether, and if so when, to eventually abandon the business. Therefore, the probability of a financial default is correlated with that of abandoning the operation, given that both are affected by the firm's ability to generate profit from invested assets, and this correlation is particularly high for firms with low financial leverage.

In an attempt to separate the two effects, Barth et al. (1998) use an extended regression that allows the coefficients on earnings and equity book value to change across different ranges of *ROE* (using a piecewise linear specification as in BD) and at the same time permits tests of the effect of low (versus high) financial health. They find that financial health continues to affect the slope coefficients in ways as predicted after controlling for *ROE* (which is intended to capture the effect of the adaptation option). This evidence suggests that the put option stemming from financial leverage has an effect incremental to that of adaptation options.

6.2 An Evaluation of Empirical Valuation Models

In the general literature examining the relation between equity value and accounting variables (of which the studies discussed above form a subset), researchers have adopted a range of different valuation models. In this section, we evaluate and critique the empirical valuation models within the framework of the ROM as laid down in Chaps. 4 and 5. We aim to shed light on the conditions under which these various models can be justified and point out their limitations in more general economic settings. We also discuss some econometric issues arising from model misspecification. Holthausen and Watts (2001) also critique the empirical models adopted by value relevance studies, but their discussions do not make use of a theoretical value model that incorporates real options. In the discussion below, we follow the approach of Holthausen and Watts (2001) by categorizing empirical valuation models into earnings models, balance-sheet models, and those relying on both earnings and equity book value.

6.2.1 Earnings Models

Earnings models are widely used to explain stock prices (see for example Barth et al. 1995; Barth and Clinch 1996; Dhaliwal et al. 1999). A basic version is the earnings capitalization model:

$$V_t = \frac{X_t}{r}. \tag{6.7}$$

Although there are more elaborate versions of earnings models, such as those which separately recognize different components of earnings, we use the one in Eq. (6.7) as a representative model for the purposes of the discussion below.

6.2.1.1 Conditions Under Which Earnings Models Can Be Justified

According to the ROM in Eq. (5.1) (the version for unbiased accounting), equity value equals earnings capitalization plus real options. Thus, the key limitation of the earnings capitalization model is in ignoring the real options terms which are attributable to having the flexibility to adjust the scale or scope of operations. This means that the earnings capitalization model may be justified for firms expected to continue along the present course without significant adjustment (either expansion or downsizing). In such a steady state, current earnings are expected to be repeated for each future period and equity value equals the capitalization of this expected earnings stream, hence Eq. (6.7).

In a more general context, where a firm is likely to experience either growth or downsizing (abandonment), the option terms are important, which renders the earnings model inadequate. For such a firm, earnings not only represent the value generated from existing operations but taken in conjunction with book value also convey the profitability of the operations, which serves as a signal to guide the firm on how to make adjustments. For this reason, determining the value of real options requires not only earnings information but also book value.

An earnings model may be applied to a component (segment) of a firm, if not the whole firm, insofar as this component business is expected to remain in a steady state (while the rest of the firm's businesses may be subject to significant changes). Valuation of multiple segment firms is the topic of Chap. 7.

6.2.1.2 Potential Bias in the Earnings Coefficient

Given that the earnings models are generally misspecified, it is pertinent to examine how the slope coefficient may be biased in such models. As mentioned, the key determinant of growth and adaptation options is profitability (*ROE*), and one of these options becomes particularly valuable when profitability is well above or below the cost of capital. Thus, to evaluate the bias in the earnings coefficient, we consider two stylized scenarios: (i) $ROE < r$ and (ii) $ROE > r$.

Scenario (*i*): $ROE < r$
When profitability is below the cost of capital ($ROE_t < r$), the put option in Eq. (5.1) is an important part of equity value, whereas the call option is less significant. Then, equity value can be approximated as $V_t \approx X_t/r + P(ROE_t)B_t$. Differentiating V_t with respect to X_t, and holding B_t constant, we get $\frac{dV_t}{dX_t}\Big|B_t. = P'(ROE_t) + \frac{1}{r} > 0$; this is the theoretical value of the earnings coefficient, controlling for equity book value. As shown in Chap. 5, this slope has a value close to zero in very low-profitability regions and increases in profitability.

In this situation, misspecification of the earnings model stems from omission of the adaptation option whose value is dependent on equity book value. Typically, there exists substantial variation in book value in a cross-sectional sample that is correlated with earnings (see the discussion in Sect. 6.1.3), so omission of book value will bias the coefficient on earnings. The direction and extent of the bias depend on the sign of profitability, as explained below.

If $ROE > 0$, an increase in B_t causes both V_t and X_t to increase, inducing a positive relation between V_t and X_t. To the extent that B_t and X_t are also positively correlated in the sample (which is plausible given $ROE_t > 0$), the effect of the omitted B_t is also loaded onto X_t, thus reinforcing the existing effect of X_t (or of ROE_t). As a result, the estimated slope coefficient from the earnings model will be biased upward.

On the other hand, if $ROE_t < 0$, an increase in B_t (given ROE_t) causes V_t to increase while X_t to decrease, inducing an inverse relation between V_t and X_t. Since now $X_t < 0$ and so a larger B_t is associated with a smaller (more negative) X_t but typically a higher V_t, omission of B_t in the regression should bias the coefficient on X_t downward (that is, pull it down towards zero or even make it negative). A similar point is made by Collins et al. (1999) where they examine the valuation role of negative earnings (see the previous section).

Scenario (*ii*): $ROE > r$
If $ROE_t > r$, the situation is reversed where the adaptation option is no longer important but the growth option is (assuming $g > 0$). Then, we have $V_t \approx \frac{X_t}{r} + gB_t$ $C(ROE_t)$. Holding B_t constant, the marginal effect of earnings on value is

$$\frac{dV_t}{dX_t}\bigg|B_t \approx \frac{1}{r} + gC'(ROE_t) > \frac{1}{r}. \tag{6.8}$$

This shows that the earnings coefficient can exceed the normal earnings capitalization factor $(1/r)$, when controlling for book value.

When there is considerable variation in book value within a sample, the effect of the omitted book value is also loaded onto X_t. Given $ROE_t > r$, V_t is expected to be *negatively* related to B_t given X_t (see Chap. 5), whereas X_t and B_t typically are positively correlated. If so, the omission of B_t causes the slope coefficient of the earnings model to be biased downward relative to the true value given by Eq. (6.8).

To summarize, the earnings model is generally misspecified due to omission of the options terms, except for the special case where a firm's operation is expected to remain in a steady state. Omitting equity book value in a regression will bias the earnings coefficient; the direction and extent of such a bias depend primarily on the type of real options in play and whether the firm is profitable or not.

6.2.2 Balance-Sheet models

Balance-sheet models of equity value essentially assume that balance-sheet items contribute to firm value in such a way that their effects are additively separable. Studies using this type of model include Barth et al. (1996) and Eccher et al. (1996). A basic version of the model takes the following form:

$$V = V_z + V_A - V_L, \tag{6.9}$$

where V denotes equity value, V_z the value of the particular balance-sheet item being examined (z), and V_A (V_L) the value of the asset (liability) items other than item z. Where market value data are not available for particular items, researchers often replace them with the corresponding book values.

The model in Eq. (6.9) can be justified insofar as the effect of item z on a firm's value generation can be separated from the rest of the items on the balance sheet. Correspondingly, the firm's business decisions with regard to z can also be separated from other activities, and the value additivity rule would then apply. An example of this is the financial assets that a firm holds for investment purposes. Indeed, the value additivity rule seems plausible in at least some of the studies that have employed these models (such as those examining the valuation impact of pension assets and liabilities).

Holthausen and Watts (2001, pp. 53–54) argue that balance-sheet models hold if a firm earns zero NPV from individual assets or if the economic rent earned on assets is separately traded. These are sufficient conditions for value additivity to be present. What is essential, however, is separability in the effect on value generation, not necessarily in terms of market trade. That is, a balance-sheet model can be justifiable with respect to an individual asset (a subset of assets) if it has an effect on value generation that can be separated from the firm's other assets, but the corresponding business activity may not be separately securitized. When this item is expressed as a separate term in the valuation function, the coefficient on its book value can be less than, equal to, or greater than one, depending on the profitability earned on this item.

To illustrate the point, consider a firm with two business segments. To the extent that they are operated as separately managed businesses, the firm's equity value is $V = V_1 + V_2 - V_L$, where V_1 and V_2 denote the respective values of the two segments, and V_L the value of liabilities. It is possible that each segment is a nonzero-NPV operation with a portion of its value derived from real options. Following the ROM in Eq. (5.1), the value of segment 1 may be expressed as $V_1 = B_1 v(ROE_1)$, where B_1 is the book value of its assets, and $v(ROE_1) \equiv P(ROE_1) + ROE_1/r + g_1 C(ROE_1)$, and the value of segment 2 is analogously represented. For such a firm, it is justified to adopt a balance-sheet model $V = a + b_1 B_1 + b_2 B_2 + b_3 L + e$, where L stands for the book value of liabilities. In this case, the slope coefficients on segment book values are nonlinear functions of segment ROE.

However, if assets are used in combination with each other in carrying out operations (such as buildings and equipment used in the operation of a business segment), it is inappropriate to represent them as separate terms in the valuation model. The message here is that research designs should obey and reflect the economic laws of how value is generated from assets (or asset groups).

Some researchers recognize that the balance sheet does not provide a complete account of all assets (and liabilities). For example, it does not include certain intangibles such as brand names. To address this limitation, they extend Eq. (6.9) to include unrecorded goodwill (GW):

$$V = V_z + V_A - V_L + GW. \tag{6.10}$$

This extended equation is tautological insofar as goodwill is defined as the difference between equity value and book value. Also, by separating it from other (recognized) assets/liabilities, this equation may give the misleading impression that goodwill exists separately from the assets generating it. In reality, goodwill (as defined here) is a result of the firm's investment in these assets and is inseparable from them. Therefore, it is more appropriate to view assets and the goodwill they generate as a whole (as would be reflected, for example, in $v(ROE_1)$ in the above discussion), rather than treat them as two additively separable parts.

6.2.3 Models Incorporating Both Earnings and Equity Book Value

A third category of empirical models incorporates both earnings and equity book value as explanatory variables:

$$V_t = a + b_1 X_t + b_2 B_t + e_t. \tag{6.11}$$

This model has been used, for example, in value-relevance research (see for example Collins et al. 1997; Ely and Waymire 1999; Francis and Schipper 1999; Lev and Zarowin 1999). Some researchers resort to the theoretical models of Ohlson (1995) and Feltham and Ohlson (1995) as justification for this linear regression, but as discussed in Chap. 2 the economic settings underlying these theoretical models, where accounting information serves little or no role in business decisions, are quite restrictive.

We have shown in Chaps. 4 and 5 that within the framework of the ROM, a simple linear function such as Eq. (6.11) is inadequate to explain the behavior of equity value in the cross section. For example, given equity book value (earnings), the coefficient on earnings (book value) depends on a firm's profitability and growth opportunities. Thus, without controlling for such economic factors, it is difficult to interpret the regression coefficients and draw inferences about a firm's accounting characteristics (such as accounting quality and conservatism).[2]

To further elaborate on this, we now explore how profitability (ROE) can systematically influence the coefficients on earnings and equity book value in the linear regression expressed in Eq. (6.11). Based on Eqs. (5.2) and (5.7), we have

$$d\left(\frac{dV}{dX}|_B\right)/d(ROE) = P''(ROE) + gC''(ROE) > 0 \tag{6.12}$$

and

$$d\left(\frac{dV}{dB}|_X\right)/d(ROE) = -ROE \times P''(ROE) - gROEC''(ROE) < 0. \tag{6.13}$$

Thus, the ROM predicts that the earnings coefficient in Eq. (6.11) increases with ROE, whereas the effect of book value decreases with ROE.

[2] While some of the studies discussed in Sect. 6.1 also adopt the regression in Eq. (6.11), they also make some attempt to recognize differences in the slope coefficients across firms.

Table 6.1 Fama–MacBeth regressions of equity market value on book value and earnings by *ROE* partitions

ROE Decile	Obs.	Mean *ROE*	*a*	b_1	b_2	Adj R^2
1	10,596	−0.75	2.90***	0.68***	−0.42**	0.42
2	10,284	−0.10	3.28***	0.45***	0.34	0.49
3	10,148	0.01	3.41***	0.49***	2.99**	0.56
4	10,153	0.05	4.20***	0.41***	5.13***	0.59
5	10,337	0.08	4.55***	0.27**	6.57***	0.62
6	10,390	0.11	4.75***	0.09	9.51***	0.61
7	10,438	0.13	5.17***	−0.08	10.92***	0.62
8	10,518	0.16	6.71***	−0.23	11.01***	0.57
9	10,507	0.19	7.56***	−0.27**	11.07***	0.55
10	10,431	0.41	9.64***	0.20	7.59***	0.43
1967–2003 Pooled	103,802	0.03	7.11***	0.44***	5.54***	0.56

*** and ** denote significance at the 0.01 and 0.05 levels, respectively

To provide empirical evidence, we construct a sample from Compustat for the period 1966–2003 (similar to the sample used in Chap. 5). For each year in the sample, we partition the observations by *ROE* into deciles and separately run the regression in Eq. (6.11). Table 6.1 reports the average coefficients across the years for the deciles.

From the pooled (unpartitioned) samples, the average book value coefficient across the sample years is 0.44, whereas the average earnings coefficient is 4.90, both of which are statistically significant. However, these coefficients differ substantially across the *ROE* deciles. The book value coefficient (averaged across the sample years) ranges from a high of 0.68 (decile 1) to a low of −0.27 (decile 9) and exhibits a generally decreasing trend with *ROE*. On the other hand, the coefficient on earnings ranges from a low of −0.42 (decile 1) to a high of 12.50 (decile 9) and exhibits a generally increasing trend with *ROE*.

To evaluate the statistical significance of these trends, we regress the book value coefficient (b_1) and the earnings coefficient (b_2) obtained from the *ROE* deciles on the mean profitability of a decile (denoted by $\overline{ROE}$). The results are $b_1 = 0.221 - 0.689\ \overline{ROE}$, with the slope significant at the 0.10 level (t = −2.45), and $b_2 = 6.169 + 10.409\ \overline{ROE}$, with the slope significant at the 0.05 level (t = 2.99). These results are consistent with the predictions of the ROM.

6.3 Summary

This chapter has evaluated the empirical valuation research within the framework of the ROM in an attempt to shed further theoretical light on this literature. We show that many of the salient results previously documented on the relation between equity value and accounting variables can be reconciled with the ROM.

These include the convexity of the valuation function, differing valuation properties for firms with negative and positive earnings, and the role of financial health in determining the valuation impact of earnings and book value. We have also critiqued empirical models in the light of the ROM to explain how they have been misspecified and how such misspecification leads to biased coefficient estimates. We also identify special economic settings in which these pervious empirical models may be justified. One key message from this chapter is that the economic characteristics of a firm's operation are a primary factor determining the relation between equity value and accounting variables, and research designs must obey economic laws and appropriately reflect the effect of the economic forces underlying value generation. Without controlling for such economic factors, it is difficult to draw proper inferences about accounting characteristics such as the quality of accounting data and degree of conservatism.

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Chapter 7
Valuing Multiple-Segment Firms: How Segment-Level Data Are Incrementally Relevant

In the preceding chapters looking at the value-accounting relation, we have essentially condensed a firm into a single business operation. In the real world, a reporting entity often comprises two or more business segments that operate in (largely) separate ways. Business segments may be organized along product lines or geographical regions. Typically, the individual segments of a firm can differ in terms both of the investment opportunities they encounter and their ability to profit from such investment. Naturally, it is desirable for segments to make separate decisions in ways that reflect their own particular circumstances. This means that real options to adjust and reorganize operations exist at the segment level. Outside investors need to know what opportunities are available to a firm's individual segments and incorporate this information into overall firm valuation.

From a financial reporting perspective, a pertinent question in the context of a multiple-segment firm is: Given that firms must provide financial statements for their overall operations, how does disclosure of segment-level data matter *incrementally* for valuation? Users of financial information have always expressed an interest in disaggregated data pertaining to the component businesses of a reporting entity. According to the Association for Investment Management and Research (AIMR 1993, pp. 59–60), segment information is "vital, essential, indispensible, and integral to the investment analysis process… There is little dispute over the analytic usefulness of disaggregated financial data." Indeed, over the years, standard setting agencies (such as the US Financial Accounting Standard Board (FASB), the Canadian Institute of Chartered Accountants, and the International Accounting Standards Committee) have made significant attempts to strengthen segment disclosure requirements. Conceptually, it is useful for both investors and standard setters to understand (1) how segment-level information should be incorporated into a valuation model to supplement aggregated firm-level information and (2) how the *incremental* value impact of segment information depends on a firm's operational characteristics.

In this chapter, we first develop a theoretical model to examine these questions and then provide empirical evidence to support the model's predictions. The material in this chapter is drawn mostly from the work of Chen and Zhang (2003).

G. Zhang, *Accounting Information and Equity Valuation: Theory, Evidence, and Applications*, Springer Series in Accounting Scholarship 6,
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7.1 A Simple Valuation Model for a Multiple-Segment Firm

7.1.1 The Basic Setting

Consider the valuation problem of a two-segment firm expected to operate for an indefinite number of periods. The firm's two segments, labeled 1 and 2, carry out economic activities separately in their respective environments. As time moves on, the scale of each segment's operation may expand or contract as deemed appropriate, thereby giving rise to real options on the individual segments. The investment opportunities and accounting process modeled here are similar to those discussed earlier in Chap. 4 and are described in more detail below.

To avoid issues caused by conservative accounting (which are nonessential for the purposes of this discussion), we assume unbiased depreciation. As in Chap. 4, we also assume historical cost-based valuation and the CSR. Under these accounting rules, book value properly measures the scale of the operation and ROA properly measures true economic profitability (see Chap. 4).

Let date t (end of period t) be a representative date of valuation and let B_{jt} denote the book value of assets for segment j at date t, j = 1,2. For brevity, we assume that for each segment, there is no change in the scale of the operation (that is, asset stock) between period t-1 to period t. It therefore follows that $B_{jt} = B_{jt-1}$, j = 1,2.

It is known at date t that each segment will face three possible scenarios when it reaches date t+1: (i) abandonment, (ii) maintaining the existing scale of operations, or (iii) growth. If scenario (iii) is chosen, the scale of segment j increases proportionally by g_j, which is referred to as the segment j's growth opportunity.

From date t+2 onward, the firm enters into a steady state in which both segments are expected to maintain the scale determined at date t+1.

Frictions exist in adjusting operations. We assume that a proportion of assets, c_a, is dissipated when discontinuing a segment, and a proportional cost of c_g is incurred when expanding a segment (relative to the amount of expansion), with $0 < c_a, c_g < 1$.

Let $X_{j\tau}$ be segment j's earnings in period τ, and $q_{j\tau} \equiv X_{j\tau}/B_{j\tau-1}$ be segment j's profitability in period t. We assume that the profitability of segment j (j = 1,2) follows a random walk: $\tilde{q}_{j\tau} = q_{j\tau-1} + \tilde{e}_{j\tau}, \forall\tau$, where $\tilde{e}_{j\tau}$ is a zero-mean random term unpredictable prior to date τ. We further assume that the random terms of the two segments are not perfectly correlated, so $-1 < \text{cov}(\tilde{e}_{1\tau}, \tilde{e}_{2\tau}) < 1, \forall\tau$.

7.1.2 Investment Decisions at Date t+1

As before, we assume risk neutrality and a constant discount rate, r. We further assume that in each period, all the free cash flow (cash receipts minus cash investment) of the firm is paid out as dividends.

Investment decisions are made in accordance with the NPV rule. Then, following the analysis in Chap. 4, the optimal decision at date t+1 for segment j (j = 1,2) can be derived as follows: discontinuing the operation if $q_{jt+1} \leq q_a^* \equiv r_f(1 - c_a)$, continuing the operation at the existing scale if $q_a^* < q_{jt+1} < q_g^* \equiv r_f(1 + c_g)$, and undertaking growth activity if $q_{jt+1} \geq q_g^*$.

7.1.3 Firm Value at Date t

With the investment criterion for date t+1 determined as above, we can forecast the cash flows for each segment. Let $V(B_{jt}, q_{jt})$ denote the value of segment j at date t (defined as the present value of expected free cash flows) conditional on accounting information (B_{jt}, q_{jt}). Then, from the analysis in Chap. 4, we get

$$V(B_{jt;}q_{jt}) = B_{jt}P(q_{jt}) + \frac{X_{jt}}{r} + g_j B_{jt} C(q_{jt}), \tag{7.1}$$

where $P(q_{jt}) \equiv \frac{1}{(1+r)r} \int_{e_l}^{q_a^* - q_{jt}} (q_a^* - q_{jt} - \tilde{e}_{jt+1}) f(\tilde{e}_{jt+1}) d\tilde{e}_{jt+1}$ and $C(q_{jt}) \equiv \frac{1}{(1+r)r} \int_{q_g^* - q_{jt}}^{e_u} (q_{jt} + \tilde{e}_{jt+1} - q_g^*) f(\tilde{e}_{jt+1}) d\tilde{e}_{jt+1}$ represent the real options to discontinue and expand segment j's operation, respectively, with $f(\tilde{e}_{jt+1})$ being the probability density function of $\tilde{e}_{jt+1} \in [e_l, e_u]$.

Combining the two segments, we get the firm's (ex-dividend) value at date t as[1]

$$\begin{aligned} V_t &\equiv V(B_{1t}; q_{1t}) + V(B_{2t}; q_{2t}) \\ &= B_{1t}P(q_{1t}) + B_{2t}P(q_{2t}) + \frac{X_{1t} + X_{2t}}{r} + g_1 B_{1t} C(q_{1t}) + g_2 B_{2t} C(q_{2t}). \end{aligned} \tag{7.2}$$

[1] We have assumed away the possible benefits/costs arising from interactions between the segments. These are issues outside the scope of the analysis here and including such interactions in the model will not qualitatively alter the results.

7.1.4 Conditions for Aggregation Across Segments

Because of segment-level real options, firm value is a nonlinear function of segment accounting data. This nonlinearity in valuation mapping prevents the aggregation of earnings and book value across segments. One immediate implication of this is that, in general, it is not adequate to report only aggregated firm-level earnings and book value.

Nonetheless, there are special situations where the aggregation of accounting data across the segments causes no loss of valuation-relevant information. Specifically, if $q_{1t} = q_{2t}$ and $g_1 = g_2$, then Eq. (7.2) simplifies to

$$V_t = B_t P(q_t) + \frac{X_t}{r} + gB_t C(q_t), \tag{7.3}$$

where $B_t \equiv B_{1t} + B_{2t}$, $X_t \equiv X_{1t} + X_{2t}$, $q_t = \frac{X_t}{B_t} = \frac{B_{1t}}{B_{1t}+B_{2t}} q_{1t} + \frac{B_{2t}}{B_{1t}+B_{2t}} q_{2t}$, and $g = g_1 = g_2$ are firm-level equity book value, earnings, profitability, and growth opportunities, respectively. In this case, the value function coincides with that for a single-segment firm as given by the ROM in Eq. (5.1), and there is no need for segment-level data beyond aggregated accounting data.

In practical situations, some of the value components in the function specified in Eq. (7.2) may be of minor importance and consequently the conditions for aggregation may be somewhat relaxed. We consider two such situations below.

Situation (i): Both segments are unprofitable and have little chance to grow. Then, the growth options drop out of Eq. (7.2), and aggregation is obtained if $q_{1t} = q_{2t}$. In this case, firm value can (approximately) be represented as $V_t = B_t P(q_t) + X_t/r$.

Situation (ii): Both segments are expected to remain in steady-state operations, and there is little chance that the scale of their operations will undergo substantial adjustment. In this case, the options terms contribute little value, and the valuation function reduces to $V_t = X_t/r$. Aggregation also obtains.

The conditions for aggregation characterized here are consistent with the criteria recommended by FASB. According to paragraph 17 of Statement of Financial Accounting Standards (SFAS) No.131 (FASB 1997), aggregation of two or more segments may be allowed for financial reporting purposes if the segments are similar in terms of the type of business and the environment in which they operate, since these are conditions that often lead to similar financial performance and investment opportunities across segments. Of course, in practice, segment-level disclosure can be costly to the disclosing firm (Pacter 1993). Cost–benefit tradeoffs suggest that aggregation might still be justifiable even if a firm's situation deviates slightly from the above-stated theoretical conditions.

7.2 Incremental Value Effect of Segment-Level Accounting Data

If the conditions for aggregation are not met, segment-level data have an incremental role in valuation. In this section, we examine how segment data *incrementally* affect equity value beyond what has already been conveyed through consolidated financial statements. Our focus here is on the supplementary role of segment data, which is consistent with how segment reporting is viewed by standard setters and investors.

Following the above analysis, segment data are incrementally useful if $q_{1t} \neq q_{2t}$ and/or $g_1 \neq g_2$. Of these two conditions, the former (profitability) is directly informed by financial reporting, whereas the latter (growth opportunity) relates to information outside it. The analysis below is divided into two stages. Firstly, we examine the relatively simple situation where the two segments have equal growth opportunities $g_1 = g_2$ and then we turn to the general situation of $g_1 \neq g_2$.

7.2.1 The Segments Have Equal Growth Opportunities ($g_1 = g_2$)

If $g_1 = g_2 = g$, the value function coincides for the two segments. Since the incremental value effect of segment information stems from differences in segmental profitability, it will be convenient to express the profitability of individual segments in terms of (i) overall firm profitability (q_t) and (ii) the divergence of profitability between the segments, $DOP \equiv q_{2t} - q_{1t}$. Without loss of generality, we label the less profitable segment as segment 1 and the more profitable one as segment 2, so that $q_{1t} \leq q_{2t}$ and $DOP \geq 0$. It follows that $q_{1t} = q_t - [B_{2t}/(B_{1t} + B_{2t})]DOP$, and $q_{2t} = q_t + [B_{1t}/(B_{1t} + B_{2t})]\ DOP$.

We examine how total firm value changes with DOP at given firm profitability (q_t), relative to the benchmark case of $DOP = 0$ (that is, $q_{1t} = q_{2t}$). Initially, when $q_{1t} = q_{2t}$, firm value is given by Eq. (7.3). As segments 1 and 2 move apart in profitability, while holding firm profitability constant at q_t, total firm value deviates from the initial point. Differentiating Eq. (7.2) with respect to DOP and keeping (q_t, B_{1t}, B_{2t}) unchanged, we get

$$\frac{dV}{d(DOP)}\Big|q_t, B_{1t}, B_{2t} = \frac{B_{1t}B_{2t}}{r(1+r)(B_{1t}+B_{2t})}[F(q_a^* - q_{1t}) - F(q_a^* - q_{2t})] + \frac{gB_{1t}B_{2t}}{r(1+r)(B_{1t}+B_{2t})}[F(q_g^* - q_{1t})] - F(q_g^* - q_{2t})] > 0, \tag{7.4}$$

where $F(s) \equiv \Pr(\tilde{e}_{t+1} \leq s)$ is the cumulative probability function. This shows that given aggregate profitability, firm value increases with DOP.

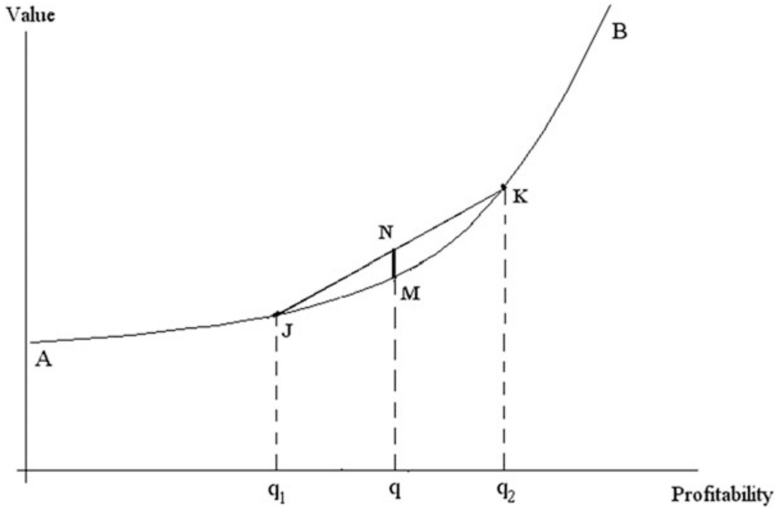

Fig. 7.1 Illustrating the incremental value effect of *DOP*: $g_1 = g_2$. *Source: Fig. 1 from Chen and Zhang (2003)*. Reprinted with permission by the American Accounting Association

Figure 7.1 illustrates how *DOP* incrementally affects firm value given firm profitability. The vertical axis is the value of each segment or the whole firm normalized by the corresponding book value of assets, and the horizontal axis is profitability, which is earnings normalized by the book value of assets. Curve *AB* represents the relation between (normalized) value and profitability for a segment, which is an increasing and convex function (see Chap. 4). This curve also represents the relation between value and profitability for the whole firm in the benchmark case where the two segments are of equal profitability.

When segments 1 and 2 both (and hence the whole firm) have a profitability level q, the (normalized) value for both segments is given by point M on curve *AB*. The (normalized) value of the firm (a weighted average of the segments' normalized values) is also indicated by M.

Now, if we let the profitability of segment 1 move down to q_1 and that of segment 2 move up to q_2, holding firm profitability unchanged at q, the value of (the less profitable) segment 1 declines to point J, and of segment 2 rises to point K. The normalized firm value, a weighted average of normalized segment values, lies at point N. Note that the weights used to aggregate segment profitability are identical to those to aggregate segment values, which are proportional to segment book values. The convexity of curve *AB* implies that N is above M. The vertical distance between N and M represents the *incremental* value effect of *DOP*, which we denote as ΔV. According to Eq. (7.4), ΔV is an increasing function of *DOP*.

Due to the behavior of real options, the valuation function displays a varying degree of convexity along the horizon axis. This causes the incremental value ΔV of a *given DOP* to also vary with overall firm profitability (q). Formally, we have

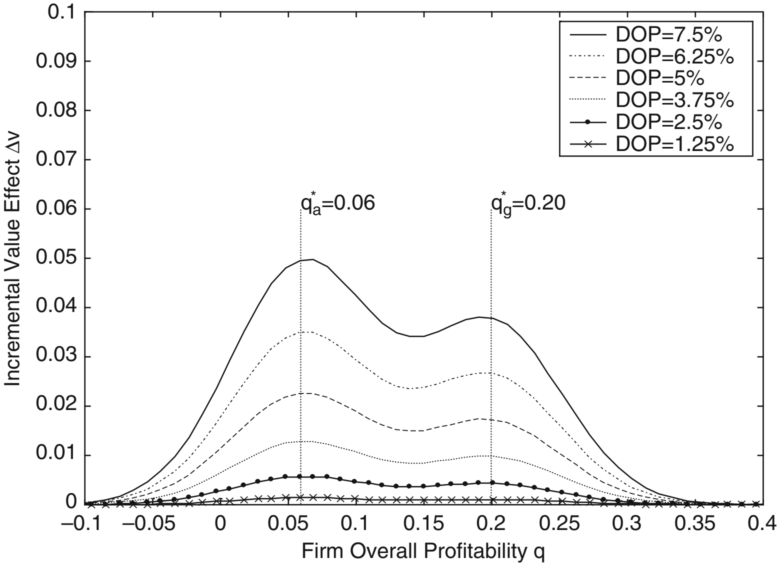

Fig. 7.2 Simulation result on firm profitability and the incremental value effect of *DOP*: $g_1 = g_2$ Each curve shows the relation between Δv and q for a particular value of *DOP*. Growth opportunities are set as $g_1 = g_2 = 0.75$ for the illustrated example, but the results are qualitatively the same for other parameter values. *Source: Fig. 2 from Chen and Zhang (2003)*. Reprinted with permission by the American Accounting Association

$$\frac{d^2 V_t}{d(DOP)\, dq_t} = \frac{B_{1t} B_{2t}}{r(1+r)(B_{1t}+B_{2t})} \left\{ \left[f\left(q_a^* - q_1 - \frac{B_{1t} DOP}{B_{1t}+B_{2t}} \right) - f\left(q_a^* - q_t + \frac{B_{2t} DOP}{B_{1t}+B_{2t}} \right) \right] + g\left[f(q_g^* - q_t - \frac{B_{1t} DOP}{B_{1t}+B_{2t}} \right) - f\left(q_g^* - q_t + \frac{B_{2t} DOP}{B_{1t}+B_{2t}} \right) \right] \right\}. \quad (7.5)$$

Because of the real options, the behavior of this derivative is somewhat complex. We employ numerical simulations to explore how the effect of *DOP* varies with q_t.

Generally speaking, *DOP* has a larger incremental effect in regions of q_t where the valuation function is more convex. It is well known that option values are most convex near to the exercise price (see for example Hull 2000); in the present context, this occurs in the regions of q_t that are close to either q_a^* or q_g^*. As q_t moves away from these critical points, the valuation function becomes less convex and so the effect of *DOP* diminishes.

Figure 7.2 presents the results of a simulation of the relation between ΔV and q_t for different values of *DOP*. The vertical axis, ΔV, is the change in firm value (normalized by book value), relative to the benchmark value given by Eq. (7.3), attributable to DOP, and the horizontal axis is overall firm profitability (q_t). Each curve in the figure corresponds to a particular DOP.

For extremely low values of q_t, ΔV is close to zero, indicating that divergence of segment profitability has little incremental effect on firm value. This arises when both segments are unprofitable and so face similar prospects of being discontinued. That is, for both segments, the put option is deep in the money.

Moving towards the right, as q_t increases, the incremental value of a given DOP (ΔV) also increases, and it reaches a maximum near $q_t = q_a^*$ (the critical point for exercising the adaptation option). In terms of the underlying investment decisions, as q_t comes close to q_a^* and so the two segments' profitability levels straddle point q_a^*, the adaption option is still in the money for the (less profitable) segment 1 but is already out of the money for segment 2. In this situation, the two segments are faced with dissimilar investment prospects; one is likely to continue operations, whereas the other is likely to be discontinued. Dissimilarity in real decisions makes it important for investors to access segment-level information, so this is when divergence of profitability has a relatively high incremental effect on firm value.

As q_t further increases away from q_a^*, ΔV begins to decline due to the gradual convergence of the two segments' investment decisions; that is, the possibility of discontinuation becomes more remote for both segments. At the same time, however, as q_t gets closer to q_g^*, the growth options start to come into play, and their effect eventually overcomes that of the put options. This causes ΔV to increase once again and reach another maximum near q_g^*. This is because as q_t gets closer to q_g^* and so the profitability levels of the segments straddle point q_g^*, they once again face dissimilar investment prospects whereby one is likely to exercise the growth option and the other is not. Beyond this second maximum point, ΔV declines monotonically with q_t and approaches zero in the far right region.

We observe from Fig. 7.2 that while the incremental firm value (ΔV) is larger for higher levels of DOP, the relation between ΔV and q_t displays similar patterns across different levels of DOP.

Finally, Eq. (7.4) shows that the incremental effect of DOP also depend on growth opportunity (g). To examine this effect, we differentiate Eq. (7.4) with respect to g to get

$$\frac{d^2 V_t}{d(DOP)dg} = \frac{B_{1t}B_{2t}}{r(1+r)(B_{1t}+B_{2t})}\left[F(q_g^* - q_{1t}) - F(q_g^* - q_{2t})\right] > 0; \tag{7.6}$$

that is, the incremental value effect of a given DOP increases with g.

The above analysis yields the following three hypotheses.

Hypothesis 7.1 (H1 of Chen and Zhang 2003) DOP has a positive incremental effect on equity value, given firm profitability

Hypothesis 7.2 (H2 of Chen and Zhang 2003) In the extremely low profitability region, the incremental value effect of DOP is close to zero. As firm profitability increases, this effect first experiences an increasing trend, followed by a decreasing trend, and then another increasing trend followed by a decreasing trend, and eventually approaches zero in the extreme high profitability region.

Hypothesis 7.3 (H3 of Chen and Zhang 2003) The incremental value effect of a given *DOP* increases with a firm's overall growth opportunities.

7.2.2 Segments Have Dissimilar Growth Opportunities ($g_1 \neq g_2$)

We now consider the more general situation where the firm's segments have different growth opportunities, $g_1 \neq g_2$. Differentiating V_t given by Eq. (7.2) with respect to *DOP*, we get

$$\frac{dV_t}{d(DOP)}\Big|q_t, B_{1t}, B_{2t} = \frac{B_{1t}B_{2t}\{[F(q_a^* - q_{1t}) - F(q_a^* - q_{2t})] + g_2[1 - F(q_g^* - q_{2t})] - g_1[1 - F(q_g^* - q_{1t})]\}}{r(1+r)(B_{1t} + B_{2t})}, \tag{7.7}$$

and

$$\frac{d\left[\frac{dV_t}{d(DOP)}\Big|q_t, B_{1t}, B_{2t}\right]}{dq_t} = \frac{B_{1t}B_{2t}}{r(1+r)(B_{1t} + B_{2t})}\Big\{\Big[f(q_a^* - q_{2t}) - f(q_a^* - q_{1t})\Big] + g_2 f(q_g^* - q_{2t}) - g_1 f(q_g^* - q_{1t})]\Big\}. \tag{7.8}$$

When both q_{1t} and q_{2t} (and hence q_t) are small relative to q_g^*, the growth options are of little importance so the terms involving g_1 and g_2 in Eqs. (7.7) and (7.8) can be ignored. In this case, the derivatives depend mainly on the put options, and so the behavior of ΔV is similar to that in the situation of $g_1 = g_2$ examined above. Namely, for a given *DOP*, ΔV is negligible where firm profitability is well below q_a^*; it then increases with q_t to reach a maximum near q_a^* and begins to decline with q_t.

As q_t moves closer to q_g^* from the left, the terms involving g_1 and g_2 in Eq. (7.7) become important, and so ΔV starts to be affected by segment growth options. For convenience, we rewrite Eq. (7.7) as

$$\frac{dV}{d(DOP)}\Big|q_t, B_{1t}, B_{2t} = \frac{B_{1t}B_{2t}}{r(1+r)(B_{1t} + B_{2t})}\Big\{\Big[F(q_a^* - q_{1t}) - F(q_a^* - q_{2t})\Big] + g_1\Big[F(q_g^* - q_{1t}) - F(q_g^* - q_{2t})\Big] + (g_2 - g_1)\Big[1 - F(q_g^* - q_{2t})\Big]\Big\}. \tag{7.9}$$

Equation (7.9) is analogous to Eq. (7.4) except for the extra term, $(g_2 - g_1)[1 - F(q_g^* - q_{2t})]$, which relates to the difference in segment growth opportunities, $(g_2 - g_1)$. In other words, in the region of high firm profitability, the value effect of *DOP* is *additionally* affected by relative growth opportunities between the segments. This additional term can be either positive or negative, depending on how growth opportunities are distributed between the segments.

If the more profitable segment also has more opportunity to grow $(g_2 > g_1)$, the difference in segment growth reinforces the previous (positive) value effect of *DOP* shown for the case of $g_1 = g_2$. On the other hand, if the more profitable segment has less opportunity to grow $(g_2 < g_1)$, the difference in segment growth attenuates the previous value effect of *DOP*. Note that in the region of $q_t \gg q_g^*$, ΔV approaches the limit of $(g_2 - g_1)B_{1t}B_{2t}/(B_{1t} + B_{2t})$, which has the same sign as $g_2 - g_1$. In other words, for a highly profitable firm, *DOP* has a positive incremental effect on equity value if, and only if, profitability and growth opportunities are positively correlated across the firm's segments.

Figure 7.3 graphically illustrates the incremental value effect of *DOP* and how this effect is influenced by the difference in growth opportunities between segments, $\Delta g \equiv g_2 - g_1$. Curve *AB* represents the value of the segment with high growth, whereas curve *AC* represents that of the one with low growth. While both curves are increasing and convex, *AB* (the high growth segment) has a steeper slope and greater convexity than *AC*. Again, the benchmark scenario occurs when the two segments have equal profitability at q and the (normalized) firm value, a weighted average of the segments' values, is given by point M (which lies between the value curves for the two segments).

As the segments' profitability levels diverge (while keeping firm profitability at q), the individual segment values move away from those in the benchmark scenario. We need to consider two cases separately.

Case (i): The segment with high growth is more profitable; that is, $g_2 > g_1$. The value of the less profitable segment is given by point J and that of the more profitable segment by point K. The overall firm value is given by point N, which lies above M. In this case, the incremental value effect of *DOP* is positive, as shown by line segment NM.

Case (ii): The segment with high growth is less profitable; that is, $g_2 < g_1$. The value of the less profitable segment is indicated by point J' and that of the more profitable segment by point K'. The firm value is given by point N', which lies below M. In this case, the incremental value effect of *DOP* is negative, as shown by line segment MN'.

Figure 7.4 illustrates the results of a simulation of the incremental effect of a given *DOP* for different values of $g_2 - g_1$. Two observations can be made. Firstly, the relative growth between the segments matters in the region of high profitability (where growth options are valuable) but not in the region of low profitability (where they are not). Secondly, in the region where relative growth matters, the incremental value effect ΔV increases with $g_2 - g_1$; the value effect can be positive or negative, depending on the sign of $g_2 - g_1$.

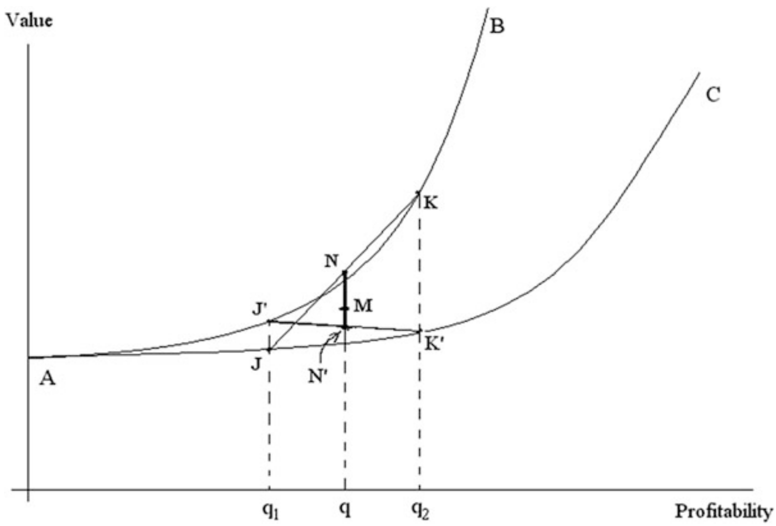

Fig. 7.3 Illustrating the incremental value effect of *DOP*: $g_1 \neq g_2$. *Source: Fig. 3 from Chen and Zhang (2003)*. Reprinted with permission by the American Accounting Association

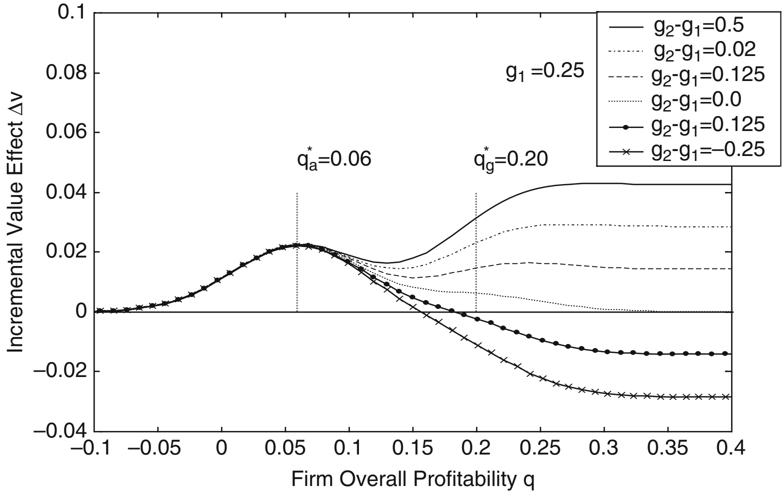

Fig. 7.4 Simulation result on the relation between Δg and the incremental value effect of *DOP*. Each curve corresponds to a particular value of $\Delta g = g_2 - g_1$. $DOP = 5\ \%$ and $g_1 = 0.25$ for all curves. The results are qualitatively the same for other parameter values. *Source: Fig. 4 from Chen and Zhang (2003)*. Reprinted with permission by the American Accounting Association

The above discussion leads to the next hypothesis.

Hypothesis 7.4 (H4 of Chen and Zhang 2003) In the high profitability region, the incremental value of *DOP* (relative to the benchmark case of no divergence in segment profitability), ΔV, increases monotonically with the difference in growth opportunity between segments 2 and 1 $(g_2 - g_1)$; specifically, $\Delta V > 0$ if $g_2 - g_1 > 0$, and $\Delta V < 0$ if $g_2 - g_1 < 0$

Intuitively, the incremental value effect of segment data hinges on the characteristics of the underlying investment activities. For a given *DOP*, the incremental effect is large when segments are expected to undertake dissimilar investment activities (for example, one is expected to grow and the other is not) and small when they are expected to undertake similar activities. In the previous subsection, where the growth opportunities for each segment are similar, *DOP* has a positive effect on firm value which increases with the growth opportunities of the firm as a whole. In the more general situation here where the segments' opportunities are dissimilar, *DOP* has a positive value effect if segmental profitabilities diverge in a way that enhances the firm's overall ability to exploit investment opportunities, as in case (i) above, but a negative effect if they diverge in a way that hinders the firm's ability to exploit investment opportunities, as in case (ii).

7.3 Empirical Results on the Incremental Effect of *DOP*

We now turn to look at empirical tests of the predicted effects of *DOP* as stated in Hypotheses 7.1 through 7.4. The tests presented here are conducted on the basis of the work of Chen and Zhang (2003) using data from the Compustat Industry File, the Compustat Annual File, and CRSP for the period 1986–1997.

7.3.1 Value Effect of DOP in Broad-Based Samples (Hypothesis 7.1)

Hypothesis 7.1 predicts that the divergence of segment profitability (DOP) generally has a positive effect on equity value over and above the effect of firm profitability. Although this hypothesis is initially derived under the condition where a firm's segments have equal growth, subsequent analysis shows that the prediction also holds so long as segment profitability and growth opportunity are not negatively correlated across a firm's segments (which is true for the sample used by Chen and Zhang 2003).

Chen and Zhang (2003) first use the following linear regression that relates (normalized) equity value to firm profitability and *DOP*:

$$v = a + b_1\, q + b_2\, DOP + e, \tag{7.10}$$

Table 7.1 The incremental value effect of *DOP* (*Model (7.10)*, $v = a + b_1 q + b_2 DOP + e$)

Coefficient	Obs.	a	b_1	$\mathbf{b_2}$	Adj. R^2
Predicted sign				+	
86–97 average	12	2.10	1.75	**4.88****	
86–97 pooled	13,463	2.13	1.80	**3.89****	0.04

** denotes significance at the 0.01 level, two-tailed
Source: Based on Table 2 from Chen and Zhang (2003)

Table 7.2 The incremental value effect of *DOP* (*Model (7.11)*, $v = a_1 + a_2 D_M + a_3 D_H + b_1 q + b_2 D_M q + b_3 D_H q + b_4 DOP + e$)

Coefficient	Obs.	a_1	a_2	a_3	b_1	b_2	b_3	$\mathbf{b_4}$	Adj. R^2
Predicted sign								+	
86–97 average	12	1.42	−0.14	−0.91	−4.29	8.65	16.39	**1.93****	
86–97 pooled	13,463	1.51	−0.41	−1.07	−3.97	10.43	16.53	**1.35****	0.24

** denotes significance at the 0.01 level, two-tailed
Source: Based on Table 3 from Chen and Zhang (2003)

where v is a firm's total market value of common equity at the end of a year scaled by the total book value of equity at the beginning of the year and q denotes earnings divided by equity book value at the beginning of a year. The empirical measure of *DOP* of a firm with n segments is calculated as $DOP = \sum_{j=1}^{n} |q_j - \bar{q}| w_j$, where segment j's profitability (q_j) equals its operating earnings scaled by the book value of its identifiable assets at the beginning of a year, and $\bar{q} = \sum_{j=1}^{n} w_j q_j$ is the weighted average profitability of the firm's segments, with weights (w_j) defined in proportion to segment assets. According to Hypothesis 7.1, $b_2 > 0$ in the regression shown in Eq. (7.10).

To recognize nonlinearity in the relation between v and q (as predicted by the ROM), Chen and Zhang (2003) also use a piecewise linear regression to test the incremental effect of *DOP* as follows:

$$v = a_1 + a_2 M + a_3 H + b_1 q + b_2 M q + b_3 H q + b_4 DOP + e, \tag{7.11}$$

where M and H are indicator variables for observations in the medium and high ranges, respectively, of profitability in a sample. According to Hypothesis 7.1, $b_4 > 0$ in regression (7.11).

Tables 7.1 and 7.2 summarize the results. For the regression model in Eq. (7.10), the coefficient on *DOP* is 3.89 from the pooled sample for the period 1986–1997, which is significant at the 0.01 level. In annual regressions, this coefficient is positive and significant across all 12 sample years, with an average value of 4.88 and significant at the 0.01 level (based on the Fama–MacBeth t-value).

Using the regression in Eq. (7.11), Chen and Zhang (2003) obtain a *DOP* coefficient of 1.35 from the pooled sample, which is significant at the 0.01 level.

Table 7.3 Firm profitability and the incremental value effect of *DOP* (*Panel A: Model (7.10),* $v = a + b_1q + b_2DOP + e$, *for the overall sample; Panel B: Model (7.10),* $v = a + b_1q + b_2DOP + e$, *for a subsample of firms with similar segment growth opportunities (N = 2,346)*)

Panel A

Partitions by firm profitability	Obs.	a	b_1	b_2	Adj. R^2
q1 ($q < 0.001$)	2,693	1.38	−4.57	**0.39**	0.10
q2 ($0.001 \leq q < 0.083$)	2,692	1.31	3.05	**2.76****	0.02
q3 ($0.083 \leq q < 0.134$)	2,692	1.11	6.08	**1.61****	0.01
q4 ($0.134 \leq q < 0.196$)	2,692	−0.22	15.68	**0.70***	0.05
q5 ($q \geq 0.196$)	2,693	0.78	11.40	**2.38****	0.21

Panel B

Partitions by firm profitability	Obs	a	b_1	b_2	Adj. R^2
q1 ($q < 0.001$)	242	1.46	−1.02	**0.27**	0.002
q2 ($0.001 \leq q < 0.083$)	341	1.09	3.84	**3.85****	0.05
q3 ($0.083 \leq q < 0.134$)	682	1.07	5.52	**2.31****	0.03
q4 ($0.134 \leq q < 0.196$)	700	−0.69	16.99	**3.01****	0.09
q5 ($q \geq 0.196$)	381	1.08	11.39	**1.31**	0.19

** and * denote two-tailed significance at the 0.01 and 0.05 levels, respectively
Source: Extracted from Table 4 from Chen and Zhang (2003)

In annual regressions, this coefficient is positive across all 12 years and significant in 10. The average coefficient across the 12 years is 1.93, which is significant at the 0.01 level.

These results show that divergence of segment profitability has a positive incremental effect on equity value controlling for overall firm profitability, which is consistent with Hypothesis 7.1.

7.3.2 Firm Profitability and the Incremental Value of DOP (Hypothesis 7.2)

Chen and Zhang (2003) first use their overall sample to test how the effect of *DOP* varies with firm profitability (q). They divide the sample into five ranges of q with equal numbers of observations. Within each range, they separately run the regression in Eq. (7.10) to examine the incremental value effect of *DOP*. The results are shown in Panel A of Table 7.3.

In the lowest q range ($q < 0.001$), the coefficient on *DOP* is 0.39 (t = 1.01), which is statistically insignificant. Moving to the second lowest range ($0.001 \leq q < 0.083$), this coefficient increases to 2.76 (t = 7.98), which is significant at the 0.01 level. In the middle range ($0.083 \leq q < 0.134$), it declines to 1.61 (t = 4.46), then reduces further to 0.70 (t = 2.29) in the fourth range ($0.134 \leq q < 0.196$). Finally, the coefficient increases to 2.38 (t = 5.66) in the highest q range ($q \geq 0.196$).

These results illustrate a trend in the incremental value effect of *DOP* that is initially consistent with Hypothesis 7.2 in the regions of low and medium q-values, where the effect is predicted to be insignificant in the extremely low-q region, and first increases then decreases with q. However, the documented trend is not consistent with Hypothesis 7.2 in the higher q range, where the effect of *DOP* should eventually come down to zero at the upper extremes.

One of the assumptions underlying Hypothesis 7.2 is that a firm's segments have equal growth opportunities $(g_1 = g_2)$, but this may not hold true for a general sample. To address this issue, Chen and Zhang (2003) use a refined sample that focuses on firms whose segments have relatively similar growth opportunities, as represented by firms with relatively small (either positive or negative) values of Δg (the computation Δg in the empirical context is described below).

The results from the refined sample are presented in Panel B of Table 7.3. The incremental effect of *DOP* now exhibits a trend along the q-dimension that closely resembles the predicted pattern. Specifically, the incremental value effect of *DOP* is insignificant in both the extremely low and extremely high regions of q, and in between there are two peaks, where the effect reaches local maxima, separated by a trough. These results are consistent with Hypothesis 7.2.

7.3.3 Firm Growth and the Value Effect of DOP (Hypothesis 7.3)

Hypothesis 7.3 predicts that the effect of *DOP* will increase with a firm's overall growth opportunities. Chen and Zhang (2003) partition their sample into quintiles by firm growth opportunity (using consensus analyst forecasts of long term earnings growth rate as a proxy). The results are presented in Tables 7.4 and 7.5.

In Table 7.4, where the linear regression in Eq. (7.10) is used, the coefficient on *DOP* exhibits an increasing trend across the growth quintiles except for the highest one where it drops. A similar pattern is shown in Table 7.5 where the piecewise linear model in Eq. (7.11) is used. These results are largely consistent with Hypothesis 7.3. (The reason for the aberration in the highest growth quintile is not clear, and this warrants further investigation.)

7.3.4 Differences in Segment Growth Opportunity and the Effect of DOP (Hypothesis 7.4)

Testing Hypothesis 7.4 requires a measure of the difference in growth opportunities between segments (Δg). Unlike *DOP*, which by definition has a positive value, Δg is directional; it is defined in the original model as the growth opportunity of the more

Table 7.4 Firm growth opportunities and the incremental value effect of *DOP*. (*Model (7.10),* $v = a + b_1q + b_2DOP + e$)

Partitions by firm growth opportunity (%)	N	a	b_1	b_2	Adj. R^2
g1 (g<8.0)	1,408	1.25	2.59	**1.87****	0.18
g2 (8.0≤g<10.0)	1,408	1.22	5.43	**1.90****	0.32
g3 (10.0≤g<12.0)	1,408	1.12	8.33	**3.19****	0.34
g4 (12.0≤g<15.0)	1,408	1.26	8.57	**4.91****	0.39
g5 (g≥15.0)	1,408	2.45	8.34	**2.30***	0.20

** and * denote two-tailed significance at the 0.01 and 0.05 levels, respectively
Source: Extracted from Table 5 from Chen and Zhang (2003)

Table 7.5 Firm growth opportunities and the incremental value effect of *DOP* (*Model (7.11),* $v = a_1 + a_2D_M + a_3D_H + b_1q + b_2D_Mq + b_3D_Hq + b_4DOP + e$)

Partitions by firm growth opportunity (%)	a_1	a_2	a_3	b_1	b_2	b_3	$\mathbf{b_4}$	Adj R^2
g1 (g<8.0)	1.15	−0.46	0.13	0.28	6.82	2.81	**0.98***	0.21
g2 (8.0≤g<10.0)	1.29	−0.52	−0.73	1.40	5.43	7.89	**1.43****	0.47
g3 (10.0≤g<12.0)	1.61	−1.65	−1.99	−0.85	14.92	16.01	**2.44****	0.57
g4 (12.0≤g<15.0)	1.67	−1.32	−1.78	−0.01	12.55	15.54	**2.80****	0.51
g5 (g≥15.0)	2.41	−0.87	−0.66	−1.02	10.86	14.19	**0.22**	0.36

** and * denote two-tailed significance at the 0.01 and 0.05 levels, respectively
Source: Extracted from Table 5 from Chen and Zhang (2003)

profitable segment minus that of the less profitable segment. Empirically, Chen and Zhang (2003) compute this variable as

$$\Delta g = \sum_i w_i(\bar{g} - g_i) + \sum_j w_j(g_j - \bar{g}), \tag{7.12}$$

where $\bar{g}$ is the (asset) weighted average growth opportunity across a firm's segments, with the proxy for segment growth being the median long-term growth forecast among those single-segment firms that are in the same (three-digit SIC) industry as the segment in question. The first (second) summation in Eq. (7.12) involves those segments of a firm whose profitability lies below (above) the firm's average ($\bar{q}$). Chen and Zhang (2003) use two alternative samples to test Hypothesis 7.4, as described below.

Panel A of Table 7.6 shows the results for the overall sample. Since the prediction stated in Hypothesis 7.4 applies only to highly profitable firms, the overall sample is first divided into low- and high-q subsamples, with the tests conducted using the latter only. The firms in this high-q subsample are further partitioned into terciles based on Δg. The mean values of Δg in the low-, medium-, and high-Δg terciles are −0.06, 0.00, and 5.36, respectively. For these mean values of Δg, we expect the incremental value effect of *DOP* to increase from the low-, to the medium-, to the high-Δg tercile and that the sign of the effect will be negative in the low- Δg and positive in the high- Δg terciles. The estimates of the *DOP*

Table 7.6 Divergence of growth opportunity (Δg) and the incremental value effect of *DOP* (*Panel A: Overall sample; Panel B: A Subsample of two-Segment Firms with Operations in Two Different 2-digit* SIC *Industries*)

Panel A				
	a	b_1	$\mathbf{b_2}$	Adj. R^2
Base model: $v = a + b_1q + e$				
Low Δg *(mean = −6.06)*	−0.31	16.79		0.45
Middle Δg *(Mean = 0.00)*	0.06	14.19		0.39
High Δg *(Mean =5.36)*	0.01	15.22		0.41
Model (7.10): $v = a + b_1q + b_2DOP + e$				
Low Δg *(mean = −6.06)*	−0.26	16.94	**−1.60***	0.45
Middle Δg *(Mean = 0.00)*	0.03	13.81	**1.83***	0.40
High Δg *(Mean =5.36)*	−0.08	14.86	**3.23****	0.42

Panel B				
	a	b_1	$\mathbf{b_2}$	Adj. R^2
Base model: $v = a + b_1q + e$				
Low $\Delta g1$ (mean = −6.86)	0.30	14.99		0.473
$\Delta g2$ (mean = −2.04)	−0.12	15.28		0.442
$\Delta g3$ (mean = 0.80)	0.30	12.89		0.471
$\Delta g4$ (mean = 3.30)	0.74	11.17		0.386
High Δg5 (mean = 6.77)	0.85	12.42		0.416
Model (7.10): $v = a + b_1q + b_2DOP + e$				
Low $\Delta g1$ (mean = −6.86)	0.49	15.06	**−7.15****	0.495
$\Delta g2$ (mean = −2.04)	−0.10	15.28	**−0.76**	0.442
$\Delta g3$ (mean = 0.80)	0.28	12.48	**2.26**	0.472
$\Delta g4$ (mean = 3.30)	0.57	10.85	**5.25****	0.419
High Δg5 (mean = 6.77)	0.71	11.52	**9.28****	0.470

** and ** denote two-tailed significance at the 0.01 and 0.05 levels, respectively

Source: Extracted from Tables 6 and 8 from Chen and Zhang (2003)

coefficient are −1.60, 1.83, and 3.23, respectively, all of which are significant at the 0.05 level. These results are consistent with Hypothesis 7.4.

Although the qualitative results from the overall sample are supportive, the economic significance of the incremental effect of *DOP* seems low, as suggested by the very small change in explanatory power after *DOP* has been added (see Panel A). Chen and Zhang (2003) then conduct tests using a refined sample consisting of firms with two segments operating in different industries, as defined using two-digit SICs. Because segment data are quite noisy relative to firm-level data due to, for example, arbitrary internal accounting rules such as cost allocation and transfer pricing, focusing on two-segment firms (which have simpler organizational structures) helps to reduce such noise in order to capture the effect of *DOP* more easily. Also, because Hypothesis 7.4 emphasizes the role of heterogeneity in segments' growth opportunities, focusing on firms with segments operating in different industries helps to highlight this role.

The results based on this refined sample are presented in Panel B of Table 7.6. The sample (in the high-q region) is partitioned into quintiles on Δg. The mean value of Δg is negative in the lowest Δg quintile and increases and turns positive as we move to higher Δg quintiles. The estimated *DOP* coefficient is significantly negative in the lowest Δg quintile, then increases monotonically with Δg and becomes significantly positive in the top two quintiles. Also, we observe a significant improvement in the explanatory power brought about by *DOP* in quintiles 1 (lowest Δg), 4, and 5 (highest Δg), where the effect of Δg is predicted to be relatively large. Thus, the results based on the refined sample provide stronger support for Hypothesis 7.4.

7.4 Summary and Concluding Remarks

This chapter has developed a theory for explaining how segment-level accounting data affect equity valuation beyond what is conveyed through aggregated, firm-level information. In a scenario where the individual segments of a firm separately have (real) options to grow or abandon their operations, we show that the incremental value effect of segment data is related to the heterogeneity of investment decisions among segments. Specifically, this effect is small in situations where segments face similar investment prospects, in terms of all being likely to grow or downsize/discontinue, and is large where they face dissimilar investment prospects (for example, if some of the segments are expected to undergo rapid growth and others to be downsized).

The key variable prompting this incremental effect is the divergence of profitability among segments (*DOP*). Profitability serves as a vital signal to guide investment activities, so in situations where segments have widely diverging profitabilities, their operational trajectories are also likely to move apart. However, the effect of *DOP* needs to be assessed in conjunction with overall firm profitability and, in particular, differences in segment growth opportunities. For firms with low overall profitability, the effect of *DOP* is generally positive but this becomes insignificant in the region of extremely low profitability. For highly profitable firms, the effect of *DOP* is positive if the more profitable segments also have more growth opportunities and is negative if the opposite is true. These theoretical predictions are generally supported by the empirical evidence presented in this chapter.

Given that the incremental usefulness of segment data is tied to the characteristics of segment-level investment decisions, it would be useful to require firms to report segment-level information in accordance with how they use it for making internal decisions. Investors need to know how a firm makes resource allocations across its various components and how such decisions are linked to information at the segment level. Two types of information are particularly useful in this regard: segment-level profitability and growth opportunity. The theoretical framework presented here is consistent with the management approach to segment reporting advocated by standard setters (such as SFAS 131 and IFRS 8). Finally, the analyses in this chapter will also help investors (and academic researchers) to understand how segment data should be processed and incorporated into valuation exercises.

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Chapter 8
A Valuation-Based Theory of Corporate Divestiture: Why Financial Reporting May Fail to Resolve Information Asymmetries

In our examinations of the value-accounting relation so far, we have treated reported accounting data as if they were in "pure" form on the assumption that firms produce and report such data in good faith with no intention of manipulating them. In this chapter, we move away from this line of inquiry to consider the potential incentives for firm insiders to misreport accounting information for rent seeking purposes. We show how such incentives can alter the value-accounting relation and, more importantly, undermine financial reporting as a means of bridging the informational gap between company managers and outside investors.

The basic valuation problem studied here extends that of a multiple-segment firm as discussed in Chap. 7. While we focused there on the role of real investment activity as the driving force behind value creation, we now assume that a firm may also attempt to influence investor perceptions of value through the means of accounting and reporting. In such a context, financial reporting is not only a channel to disseminate company information but also a way to mislead investors. In the specific problem examined below, the firm has an incentive to engage in segment-level earnings management, which is triggered by nonlinearity in valuation mapping (because of real options). Importantly, how reported earnings are "allocated" across segments is determined by the firm ex post, depending on the true performance of its segments, and ex ante external rules are ineffective as a way to curb such misreporting. Company misreporting causes market misvaluation insofar as investors lack the ability to unwind accounting manipulation. When financial reporting fails to mitigate the information asymmetry, those firms that are unfavorably affected by mispricing may decide to take drastic action by divesting some of their business segments, which causes the boundary of a reporting entity to be redrawn.

While divestitures can be motivated by a variety of considerations, misvaluation is often cited as an important reason (see Nanda and Narayanan 1997; Chen and Zhang 2007a). In this chapter, we apply the ROM framework discussed earlier in this book to develop a valuation-based theory of corporate divestiture. The theoretical model yields predictions as to the circumstances under which divestiture is likely to take place and its consequences for the firm's financial and real

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performance.[1] We then provide empirical evidence for the model's predictions. The material used in this chapter is derived primarily from Chen and Zhang (2007a).

8.1 The Theoretical Setting

Consider a two-segment firm operating in a world that lasts for three periods. The sequence of events is as follows.

At date 0 (the beginning of period one), the firm acquires two assets, one for each of its segments; the assets (segments) are labeled as j and k, respectively.

At date 1, after finishing the operations for period one, the firm decides whether or not to divest one of its segments.

At date 2, the firm faces the decision of whether to abandon its remaining segment(s). This decision is considered separately for each segment.

Finally, at date 3, the firm liquidates its remaining operations (if any).

For simplicity, we assume that for the retained segments, the amount of assets (scale of operation) is maintained at a constant level over time; in other words, we ignore growth options for the segments. All free cash flows are paid out as dividends. We also assume risk neutrality and a zero discount rate.

The firm adopts the following accounting rules (i) assets are recorded at historical cost, (ii) the CSR holds, and (iii) depreciation is recognized in an unbiased fashion.

As explained earlier, with unbiased depreciation, the book value of assets properly measures the asset stock, accounting earnings properly measures economic earnings, and accounting *ROA* is equivalent to economic profitability, that is, the internal rate of return.

The analysis below focuses on the market valuation at date 1 conditional on the firm's reported accounting data.

8.2 Market Valuation at Date 1 Under Truthful Reporting

Let B_j (B_k) be the book value of the assets of segment j (k). Under the above-stated assumptions, the book value of a segment remains constant for as long as the segment's operations are maintained within the firm. Let X_{jt} (X_{kt}) be the earnings of segment j (k) in period t (t = 1, 2, 3).

[1] Researchers have also considered other motives for divestitures, such as correcting investment mistakes (Ravenscraft and Scherer 1987; Weisback 1995), increasing corporate focus to eliminate negative synergy (John and Eli 1985; Daley et al. 1997), separating out a poorly performing division from its parent company (Desai and Jain 1999), and improving the information environment (Krishnaswami and Subramaniam 1999). The analysis presented in this chapter attempts to control for these alternative explanations.

The profitability (*ROA*) of segment j in period t is $q_{jt} = X_{jt}/B_j$, t = 1,2, 3. Over time, profitability evolves according to the following process:

$$\tilde{q}_{jt+1} = q_{jt} + \tilde{e}_{jt+1}. \tag{8.1}$$

Analogous assumptions are made for segment k.

The aggregate earnings of the firm in period one are $X_1 \equiv X_{j1} + X_{k1} \equiv B_j q_{j1} + B_k q_{k1}$, and the aggregate profitability in period one is $q_1 \equiv \frac{X_1}{B_j + B_k} = \frac{B_j}{B_j + B_k} q_{j1} + \frac{B_k}{B_j + B_k} q_{k1}$, which is a weighted average of the profitabilities of individual segments. Without loss of generality, we label the less profitable segment in period one as segment j, that is, $q_{j1} \le q_{k1}$.

Let $V(q_{j1}, A_j)$ denote the value of segment j at date 1 conditional on its accounting information (q_{j1}, A_j). By conducting an analysis similar to that set out in Chap. 4, we can show that this value comprises segment j's adaptation value as at date 2, the expected earnings achieved in period two, and the value of the (call) option to stay in business in period three. Specifically, we have

$$V(q_{j1}, A_j) = (1 - c_a)B_j + q_{j1}B_j + B_j C(q_{j1}), \tag{8.2}$$

where $C(q_{j1})$ is the call option to continue segment j at date 2 and c_a is the cost of adapting assets (in the form of dissipated asset value). While in the original ROM the adaptation is expressed as a put option (relative to the scenario of continuing the operations), the put is transformed to call $C(q_{j1})$ (via put-call parity) in Eq. (8.2), which is computed relative to the scenario of abandoning the operations. This call option is distinct from the option to grow in the original ROM (which is ignored here).

The firm value at date 1 is the sum of the two segments' values:

$$\begin{aligned} V &\equiv V(q_{j1}, B_j) + V(q_{k1}, B_k) \\ &= (1 - c_a)B_j + q_{j1}B_j + B_j C(q_{j1}) + (1 - c_a)B_k + q_{k1}B_k + B_k C(q_{k1}). \end{aligned} \tag{8.3}$$

As shown in previous chapters, real options cause firm value to be an increasing and convex function of earnings (and profitability). The results stated in Lemma 8.1 follow from this basic property (see also Chap. 7 for an explanation of the underlying rationale).

Lemma 8.1 *The valuation function expressed in Eq. (8.3) has the following properties:*

(i) *If* $q_{j1} < q_{k1}$, *we have* $\frac{\partial V}{\partial x_{j1}} < \frac{\partial V}{\partial x_{k1}}$.

(ii) *For a given* q_1, *firm value V increases with* $(q_{k1} - q_{j1})$.

According to Lemma 8.1, the impact of earnings on firm value differs across the segments insofar as they have different profitability; this impact is greater for the more profitable than for the less profitable segment. Also, given overall firm profitability, total firm value increases as the segments' profitability becomes more divergent (see also Chap. 7). These properties are central for understanding (as explained) below why the firm has an incentive to engage in cross-segment earnings manipulation.

8.3 Market Valuation Based on Manipulated Segment Data

We now assume that financial reporting does not automatically resolve the information asymmetry between company insiders and outside investors. In the present context of a multiple-segment firm, we show that the firm has incentives to shift earnings from one segment to another in an attempt to inflate its market valuation. The analysis below centers on the interplay between the firm's reporting of its business performance and investors' pricing of the firm on the basis of reported accounting data.

8.3.1 Incentives to Shift Earnings Across Segments

Let X^r_{j1} and X^r_{k1} be the earnings of segments j and k, respectively, as reported by the firm at date 1; in general, they deviate from true segment earnings, (X_{j1}, X_{k1}). We assume, however, that aggregate earnings are reported truthfully, that is, $X^r_{j1} + X^r_{k1} = X_{j1} + X_{k1}$. This assumption allows us to focus on the issues arising from cross-segment earnings shifting, while suppressing the additional complications caused by intertemporal earnings management (the latter has been extensively studied in the literature; see Ronen and Varda 2008).

Denote t as the amount of earnings transferred from segment j to segment k; that is, $X^r_{j1} = X_{j1} - t$ and $X^r_{k1} = X_{k1} + t$. Then, the relation between reported segment profitabilities (q^r_{j1}, q^r_{k1}) and true profitabilities (q_{j1}, q_{k1}) is $q^r_{j1} \equiv X^r_{j1}/B_j = q_{j1} - t/B_j$ and $q^r_{k1} \equiv X^r_{k1}/B_k = q_{k1} + t/B_k$.

A firm may shift earnings across segments by using internal accounting procedures such as transfer pricing and cost allocation; it typically has considerable leeway in choosing specific methods. Of course, the room for engaging in this type of earnings shifting is not unlimited. In this regard, the firm will be constrained by factors such as the amount of common costs for allocation and the need to balance the interests of its various subunits.

In this model, we denote t_m as the capacity for cross-segment earnings shifting within the firm (that is, the maximum amount of earnings that may be transferred between the segments). Outside investors observe neither actual earnings shifting (t) nor the capacity to do so (t_m). They form a conjecture that t_m lies within range $[0, T]$, where the upper bound T is assessed on the basis of observable firm characteristics such as the amount and type of component businesses and the complexity of the firm's organizational structure.

To provide more structure for modeling the valuation problem, we make the following assumption.

Assumption 8.1 $q^r_{j1} \leq q^r_{k1}$, given $q_{j1} \leq q_{k1}$.

Under this assumption, while reported segment profitability generally deviates from true profitability, the true rankings of segment profitabilities are preserved such that the more profitable segment is reported as being so. Intuitively, this condition seems more plausible than the converse, whereby the less profitable segment is reported as more profitable.

The next lemma precludes truthful reporting in equilibrium.

Lemma 8.2 *If* $(X^r_{j1}, X^r_{k1}) = (X_{j1}, X_{k1})$*, then* $dV/dt > 0$ *at* $t = 0$.

The result follows immediately from Lemma 8.1. It means that if investors accept reported data as being truthful, then a firm seeking a higher market valuation will find it desirable to shift earnings from segment j to segment k. Note that if investors regard reported data as true, they determine market value using Eq. (8.3) where q_{j1} and q_{k1} are replaced by q^r_{j1} and q^r_{k1}. However, the firm will then be able to increase its market value by reporting a wider profitability gap between segments j and k.

8.3.2 *Market Inferences from Reported Segment Data*

If reported data deviate from true segment performance, rational investors make adjustments to what they observe. Let (X^i_{j1}, X^i_{k1}) be the segment earnings inferred by investors on the basis of reported earnings, which satisfy $X^i_{j1} + X^i_{k1} = X^r_{j1} + X^r_{k1}$, and let ($q^i_{j1}$, q^i_{k1}) be the corresponding inferred segment profitabilities. Then, the correction made by investors to reported earnings is $\tau \equiv X^i_{j1} - X^r_{j1}$; this is the amount of earnings that investors add back into segment j from segment k based on their conjecture of shifting.

We define $D \equiv q^r_{k1} - q^r_{j1}$ as the difference in reported segment profitability. Reported segment profitabilities, (q^r_{j1}, q^r_{k1}), can be equivalently represented by (q_1, D) as follows:

$$q^r_{j1} = q_1 - \frac{B_k}{B_j + B_k} D \quad \text{and} \quad q^r_{k1} = q_1 + \frac{B_j}{B_j + B_k} D. \tag{8.4}$$

Thus, (q_1, D) is informationally equivalent to (q^r_{j1}, q^r_{k1}).

The true profitabilities of the segments are related to reported data as

$$q_{j1} = q_{j1}^r + \frac{t}{B_j} = q_1 - \frac{B_k}{B_j + B_k} D + \frac{t}{B_j} \quad \text{and}$$
$$q_{k1} = q_{k1}^r - \frac{t}{B_k} = q_1 + \frac{B_j}{B_j + B_k} D - \frac{t}{B_k}. \tag{8.5}$$

And finally, inferred profitabilities are related to reported data as

$$q_{j1}^i = q_{j1}^r + \frac{\tau}{B_j} \quad \text{and} \quad q_{k1}^i = q_{k1}^r - \frac{\tau}{B_k}. \tag{8.6}$$

In general, investors cannot fully undo earnings manipulation, that is, $\tau \neq t$. Upon observing D, they will believe that an earnings transfer has taken place from segment j to segment k, $t \in [-T, \tau_1]$, where $\tau_1 = \min\{T, \frac{A_i A_j}{A_i + A_j} D\}$, with a conditional density function $f(t; D)$. The upper bound on t, τ_1, ensures that the condition stipulated in Assumption 8.1 is not violated.

Let $MV(q_{j1}^r, q_{k1}^r)$ be the firm's market value, which is determined on the basis of reported data and investors' belief about how t is distributed. Then,

$$\begin{aligned} MV(q_{j1}^r, q_{k1}^r) &\equiv MV(D; q_1) \\ &\equiv \int_{-T}^{\tau_1} \left[V\left(q_{j1}^r + \frac{t}{B_j}; B_i \right) + V\left(q_{k1}^r - \frac{t}{B_k}; B_k \right) \right] f(t; D) dt \\ &= \int_{-T}^{\tau_1} \left[V\left(q_1 - \frac{B_k}{B_j + B_k} D + \frac{t}{B_j}; B_i \right) + V\left(q_1 + \frac{B_j}{B_j + B_k} D - \frac{t}{B_j}; B_k \right) \right] f(t; D) dt. \end{aligned} \tag{8.7}$$

Corresponding to this market value, there exists a value for τ such that

$$\begin{aligned} MV(q_{j1}^r, q_{k1}^r) &= V\left(q_{j1}^r + \frac{\tau}{B_j}; B_j \right) + V\left(q_{k1}^r - \frac{\tau}{B_k}; B_k \right) \\ &\equiv V\left(q_{j1}^i; B_j \right) + V\left(q_{k1}^i; B_k \right). \end{aligned} \tag{8.8}$$

Although market valuation takes into account the whole probability distribution of t as estimated by investors, the valuation result is equivalent to that in a particular scenario with segment profitabilities of $(q_{j1_{j1}}^i, q_{k1}^i)$. Corresponding to this scenario is a particular adjustment of τ to reported segment earnings.

8.3.3 The Equilibrium

For a given pair of true segment profitabilities, (q_{j1}, q_{k1}), the firm chooses a value of t within its feasible range so as to maximize market value:

$$\mathrm{Max_t\ MV(t; q_{j1}, q_{k1}),\quad subject\ to\quad - t_m \leq t \leq t_m,} \tag{8.9}$$

where market valuation $MV(t; q_{j1}, q_{k1}) \equiv MV(q_{j1}^r, q_{k1}^r)$ is given by Eq. (8.7), noting that $q_{j1}^r = q_{j1} - t/B_j$ and $q_{k1}^r = q_{k1} + t/B_k$.

We now define the equilibrium for the interplay between the firm's financial reporting and investors' pricing.

Definition 8.1 The equilibrium of the above reporting-pricing game comprises (i) the firm's choice t^*, conditional on (q_{j1}, q_{k1}, t_m), and (ii) market correction τ^*, conditional on (q_1, D), that simultaneously satisfy the conditions expressed in Eqs. (8.7), (8.8), and (8.9).

Lemma 8.3 explains how market valuation responds to the pair of reported segment profitabilities.

Lemma 8.3 *Under Assumption 8.1, given the firm's overall profitability (q_1), we have* $\frac{dMV(D;q_1)}{dD} > 0$.

Proof See Appendix A.

According to Lemma 8.3, given overall firm profitability, market valuation will be higher if the firm reports a greater profitability gap between its segments. This is so despite investors believing that the firm has a tendency to overreport the profitability gap between segments (D). There are two potential reasons for a firm to report a large D: one is that its segments truly have widely different profitabilities, and the other is that it has a lot of flexibility to shift earnings across segments. Without knowing which force is at work, investors will (at least partially) attribute an increase in D to a true performance change (as opposed to an accounting manipulation), prompting them to set a higher market value.

The next proposition offers further insights into the firm's reporting strategy and investor inferences.

Proposition 8.1 *The following results hold in equilibrium:*

(i) $(q_{k1}^i - q_{j1}^i)$ *increases with D.*
(ii) $t^* = t_m$ if $t_m < \frac{B_j B_k}{B_j + B_k} D$, and $t^* = \frac{A_i A_j}{A_i + A_j} D$ *otherwise.*

Proof See Appendix A.

According to part (i) of Proposition 8.1, the difference in inferred segment profitability increases with the difference in reported segment profitability, which is consistent with the result in Lemma 8.3 concerning market valuation. Part (ii) shows that the firm shifts the maximum amount of earnings possible across segments (subject to its internal constraints, including the condition set out in Assumption 8.1).

Because market value represents an "average" across all possible scenarios conjectured by investors, both under- and overvaluation can occur. Undervaluation occurs if $\tau^* > t^*$, or, equivalently, $q^i_{k1} - q^i_{j1} < q_{k1} - q_{j1}$; this is when the market overcorrects reported segment earnings relative to the amount of earnings actually transferred. On the other hand, overvaluation occurs if $\tau^* < t^*$, or equivalently $q^i_{k1} - q^i_{j1} > q_{k1} - q_{j1}$; this is when the market under-corrects reported segment earnings.

For the tractability of the analysis below, we impose an additional structure on the model using Assumption 8.2.

Assumption 8.2 (i) The random term in the profitability dynamic defined in Eq. (8.1), $\tilde{e}_{j1}$ (and analogously $\tilde{e}_{k1}$), is uniformly distributed over $[a, b]$, and (ii) t_m is uniformly distributed over $[0, T]$.

Using Assumptions 8.1 and 8.2, we can examine the link between τ^* (the extent of the market correction applied to reported data) and D (the difference in reported segment profitability). The result is shown in Lemma 8.4.

Lemma 8.4 *Under Assumptions 1 and 2, for a given* q_1*, we have* $d\tau^*/dD > 0$.

Proof See Appendix A.

8.3.4 The Decision to Divest

In situations where a firm is undervalued by investors, it may undertake divestiture in order to restore a proper valuation. By severing the organizational link between segments that were originally bundled into the same reporting entity, the firm commits itself not to shift earnings across them, which helps to enhance the credibility of reported information.

In the present context, divestiture is a means to mitigate information asymmetry in situations where the firm is unable to convince investors through "cheap talks" (mandatory or voluntary disclosures). The incentive to manage segment earnings arises endogenously in this setting owing to the nonlinearity of the valuation function (which stems from real options) and the fact that outside investors cannot observe the extent of earnings shifting. In such circumstances, merely trying to clarify the firm's situation by talking to investors is not credible.

Divestitures are undertaken only by undervalued firms. In this model, these are firms that have not undertaken significant manipulation of segment earnings, and so their reported segment information is closer to the truth than what investors believe. Relatively speaking, the financial reporting made by these firms can better withstand scrutiny.

However, as a major corporate restructuring event, divestiture also incurs a significant cost, so it is viable only if the firm is sufficiently undervalued. Let V^u be the extent to which the firm is undervalued in the market, and c_{divest} the cost of carrying out a divestiture. The decision to divest one of the firm's segments is then justified if, and only if, $V^u > c_{divest}$.

8.4 Factors Determining the Extent of Undervaluation

In this section, we probe more deeply into the model set out above in order to better understand the factors explaining the extent of undervaluation and the consequences of divestiture.

8.4.1 *Divergence of Reported Segment Profitability and Undervaluation*

The firm is undervalued if $t^* = t_m \in (0, \tau^*)$. The amount of undervaluation (V^U) is calculated as

$$\begin{aligned} V^U &\equiv [V(q_{j1}; B_j) + V(q_{k1}; B_k)] - [V(q^i_{j1}; B_j) + V(q^i_{k1}; B_k)] \\ &= [V(q_1 - \frac{B_k}{B_j + B_k}D + \frac{t_m}{B_j}; B_j) + V(q_1 + \frac{B_j}{B_j + B_k}D - \frac{t_m}{B_k}; B_k)] \\ &\quad - [V(q_1 - \frac{B_k}{B_j + B_k}D + \frac{\tau^*}{B_j}; B_j) + V(q_1 + \frac{B_j}{B_j + B_k}D - \frac{\tau^*}{B_k}; B_k)]. \end{aligned} \tag{8.10}$$

Conditional on the firm being undervalued and under Assumption 8.2, the expected undervaluation is

$$EV^U = \int_0^{\tau^*} V^u \frac{1}{\tau^*} dt_m. \tag{8.11}$$

The next proposition shows that this (conditional) expected undervaluation increases with the difference in reported profitability between segments. In other words, among all undervalued firms, undervaluation will be more severe if a firm's segments have been reported to have a greater divergence in profitability.

Proposition 8.2 *In equilibrium,* $dEV^U/dD > 0$.

Proof See Appendix A.

8.4.2 *Complexity of Organizational Structure and Undervaluation*

The upper bound of earnings transfer conjectured by investors (T) is an indication of how much leeway the firm is perceived to have in manipulating earnings via internal accounting. Intuitively, this parameter is related to the complexity of a firm's organizational structure. Generally speaking, firms with more business operations have more complex structures. The different segments within a firm typically share common facilities and resources and engage in intrafirm transactions. Thus, complex organizations also have more room to manipulate earnings across segments than do simpler organizations. Proposition 8.3 below shows that, conditional on a firm being undervalued, the expected undervaluation increases with T.

Proposition 8.3 *In equilibrium,* $dEV^U/dT > 0$.

Proof See Appendix A.

8.5 Hypotheses and Empirical Results

The above theoretical analysis leads to a number of predictions about the circumstances under which divestitures take place and their economic and financial consequences. In this section, we state these predictions as hypotheses and provide the empirical results reported in Chen and Zhang (2007a) to confirm them. The sample used by Chen and Zhang (2007a) for their empirical tests is drawn from Compustat and CRSP and consists of 554 divestitures over the period 1990–2001.

8.5.1 Circumstances in Which Divestitures Take Place

The first hypothesis concerns the circumstances in which divestitures take place. According to Proposition 8.1, conditional on a firm being undervalued, the extent of undervaluation is greater when a firm's segments have been *reported* to have wider differences in profitability. Since in the above model, divestitures are undertaken to correct undervaluation, the difference in reported profitability between segments should typically be wider at the time of divestiture (such that the firm is more significantly undervalued) than in the preceding years. Otherwise, the firm would have divested earlier. This leads to Hypothesis 8.1.

Hypothesis 8.1 The difference in reported profitability between a firm's segments will be wider at the time of the divestiture decision than in the preceding years.

Chen and Zhang (2007a) test this hypothesis by examining the reported profitability of both the divested and continuing segment(s) of the firm during the 5 years prior to the divestiture. They measure profitability by operating return (operating earnings divided by assets). The results, presented in Table 8.1, show that only a small difference of −0.01 in mean profitability exists between the divested and continuing segments in year −5 (that is, 5 years before divestiture), but this difference gradually widens as the divestiture approaches: in year −1, it has grown to −0.93. The *t*-test shows that the change in the gap in segment profitability is significantly different from zero between year −5 (and also years −4, −3, and −2)

Table 8.1 Difference in reported profitability between the divested and continuing segments in the years prior to divestiture (Hypothesis 8.1)

				Testing the differences in profitability divergence in various years relative to year −1			
				Mean		Median	
Relative year	Mean[a]	Median[a]	Std. dev.	t	p-value	z	p-value
−5	−0.010	−0.017	0.103	9.96	0.001	4.76	0.001
−4	−0.037	−0.028	0.115	9.46	0.001	4.45	0.001
−3	−0.055	−0.043	0.174	6.80	0.001	4.39	0.001
−2	−0.070	−0.049	0.181	6.13	0.001	3.95	0.001
−1	−0.093	−0.051	0.229	–	–	–	–

Source: Table 3, Panel C, from Chen and Zhang (2007a)
[a]Negative values indicate that the profitability of the divested segment is lower than that of the continuing segments. Reprinted with permission by the American Accounting Association

and year −1. Tests based on median profitability yield the same conclusion. This evidence is consistent with Hypothesis 8.1, predicting that divesting firms experience a widening gap in segment profitability over the years prior to divestiture.

8.5.2 *Market Reactions to Divestitures*

The second hypothesis concerns market reactions to divestitures. Two implications follow from the model. Firstly, because divestitures are undertaken to signal undervaluation, the market is expected to react favorably to the decision. Secondly, such favorable market reactions are not predicated on any anticipated improvement in operating performance. Here, market revaluation is the result of the reinterpretation of reported segment data, while the firm's aggregate earnings are held constant.

Hypothesis 8.2 There will be a positive stock price reaction to the divestiture decision.

Hypothesis 8.3 The positive price reaction will not be conditional on improved future operating performance.

Nearly all explanations for divestitures advanced in the literature predict a positive market reaction. In this sense, Hypothesis 8.2 is not unique. However, Hypothesis 8.3 can be distinguished from other motivations for divestiture which are predicated on improved business performance.

To test Hypothesis 8.2, Chen and Zhang (2007a) calculate the cumulative abnormal stock returns (*CAR*) over a two-day window (days −1 and 0) around the divestiture announcement. They find that the mean *CAR* is significantly positive both for their overall sample (equal to 0.022) and for the subsamples of selloffs (0.020) and spinoffs (0.033)—the two specific forms of divestitures. The results based on median *CAR*s are similar.

Table 8.2 Operating returns of the continuing segments before and after divestiture (Hypothesis 8.3)

Relative year	Overall sample (N = 554)		Non-focus-increasing subsample (N = 232)	
	Mean	Median	Mean	Median
−3	0.107	0.100	0.101	0.095
−2	0.097	0.096	0.090	0.087
−1	0.086	0.088	0.089	0.088
0	0.077	0.081	0.074*	0.078*
	(t = −0.36)	(z = −1.10)	(t = −1.82)	(z = −1.71)
1	0.085	0.086	0.076*	0.080*
	(t = −0.19)	(z = −0.29)	(t = −1.69)	(z = −1.67)
2	0.088	0.094	0.084	0.087
	(t = 0.14)	(z = 0.87)	(t = −0.75)	(z = −0.18)
3	0.090	0.094	0.088	0.093
	(t = 0.27)	(z = 0.88)	(t = −0.15)	(z = 0.65)

The t-value (z-value) tests whether there is a change in mean (median) operating return in a post-divestment year relative to year −1 (with a negative t- or z-value indicating a decrease relative to year −1)

*Significance at the 0.10 level, two-tailed

Source: Table 6 from Chen and Zhang (2007a). Reprinted with permission by the American Accounting Association

Chen and Zhang (2007a) test Hypothesis 8.3 by comparing the operating returns of the firm's continuing segments between the years before and after the divestiture. For the overall sample, they find no significant changes in either mean or median operating returns for the years after, relative to the years before, the divestiture. More interestingly, for the subsample of non-focus-increasing divestitures (which are believed to be less likely to have been motivated by efficiency considerations), there is actually a slight decline in operating performance in the years following the divestiture relative to the year before it. These results are presented in Table 8.2.

As well as conducting an analysis based on *ex post* realized performance, Chen and Zhang (2007a) also examine changes in *expected* performance and risk around the divestiture decision. They use analyst earnings forecasts as a proxy for expected performance and use beta (systematic risk) and stock return volatility as proxies for risk. The results indicate that there are no significant changes in either expected performance or firm risk.

Overall, the evidence is consistent with Hypothesis 8.3, which predicts that for divestitures motivated by the need to correct for misvaluation, positive market reactions are not predicated on improved future performance.

8.5.3 Determinants of Market Reactions to Divestitures

The next two hypotheses explore the factors determining the extent of market reaction. According to Proposition 8.2, (conditional) expected undervaluation is greater for firms with a wider divergence in *reported* segment profitability (D), and so market revaluation should correspondingly be greater as well for these firms. This leads to Hypothesis 8.4.

Hypothesis 8.4 Market revaluation upon the divestiture decision is greater for firms with a wider divergence in reported segment profitability.

Finally, Proposition 8.3 suggests that the market reacts more strongly to divestitures by firms with more complex organizational structures (using T as a proxy for this).

Hypothesis 8.5 Market revaluation upon the divestiture decision is greater for firms with more complex organizational structures.

To test Hypotheses 8.4 and 8.5, Chen and Zhang (2007a) use the following regression to explain two-day *CAR*:

$$CAR_i = a + b_1 DIVPROF_i + b_2 SPINOFF_i + b_3 Q_{j,i} + b_4 \Delta EF_{0i} + b_5 \Delta EF_{1i} + b_6 \Delta Beta_i + b_7 FOCUS_i + b_8 ASYINF_i + b_9\, M_i + e_i. \tag{8.12}$$

In Eq. (8.12), $DIVPROF_i$ measures the divergence in reported profitability between the divested and ongoing segments of firm i; $SPINOFF_i$ is a dummy variable indicating whether the divestiture is in the form of a spinoff; $Q_{j,i}$ is the operating profitability of the divested segment of firm i, which is included to control for the possibility that a divestiture is undertaken solely to get rid of a poorly performing segment; ΔEF_{0i} and ΔEF_{1i} are, respectively, the changes in consensus forecast of firm i's current-year and year-ahead earnings after the divestiture, relative to before it; $\Delta Beta_i$ is the change in systematic risk of firm i after the divestiture relative to before it; $FOCUS_i$ indicates whether the divested segment belongs to a two-digit SIC industry that is different from that of the parent firm; $ASYINF_i$ measures the information asymmetry prior to divestiture; and M_i measures the complexity of the firm's structure. The regression results, along with the measurement of the variables, are described in Table 8.3.

The columns in Table 8.3 correspond to the various versions of the regression in Eq. (8.12) with varying degrees of control. In all the columns, the main explanatory variable, $DIVPROF_i$, has a significantly positive coefficient. In fact, the coefficient estimate is not sensitive to the inclusion of the other explanatory variables in Eq. (8.12). This evidence is consistent with Hypothesis 8.4, which predicts that the market revaluation will be greater for firms reporting a greater difference in segment profitability.

Both M_i (as measured by the number of a firm's segments squared) and $ASYINF_i$ (the dispersion of analyst forecasts) serve as proxies for the complexity of a firm's structure. Each of them obtains a significantly positive coefficient, which is consistent with Hypothesis 8.5.

We also observe the following results from the regressions. Firstly, $SPINOFF_i$ is associated with an additional amount of positive market reaction, suggesting that

Table 8.3 Relation between market revaluation, divergence of segment profitability, and firm complexity (Hypotheses 8.4 and 8.5)

Variable	Pred. Sign	Dependent variable = *CAR*						
Intercept	+/−	0.016^{***}	0.014^{***}	0.015^{***}	0.0151^{***}	0.013^{***}	0.011^{***}	0.003
DIVPROF	+	$\mathbf{0.179}^{***}$	$\mathbf{0.178}^{***}$	$\mathbf{0.157}^{***}$	$\mathbf{0.1557}^{***}$	$\mathbf{0.153}^{***}$	$\mathbf{0.167}^{***}$	$\mathbf{0.188}^{***}$
SPINOFF	+		0.061^{***}	0.065^{***}	0.0636^{***}	0.060^{***}	0.056^{**}	0.055^{**}
Q_i	−			−0.041	−0.045	−0.045	−0.033	−0.020
ΔEF_0	+				−0.007			
ΔEF_1	+				−0.0004			
ΔBeta	−				−0.0003			
FOCUS	+					0.021	0.023	0.023
ASYINF	+						$\mathbf{0.014}^{**}$	$\mathbf{0.015}^{**}$
M	+							$\mathbf{0.0005}^{***}$
Adjusted R^2		0.054	0.065	0.065	0.061	0.067	0.074	0.086
Obs.		554	554	554	526	554	526	526

CAR_i is the two-day *CAR* covering day −1 and day 0 (the announcement day); $DIVPROF_i = |q_{ki} - q_{ji}| \frac{B_{ji}}{B_{ji}+B_{ki}}$ is the asset-weighted profitability divergence between the divested segment (j) and continuing segments (k) of firm i, with q_{ji} and q_{ki} being their respective operating returns, and B_{ji} and B_{ki} their respective asset book values; $SPINOFF_i$ is an asset-weighted dummy variable, equal to 1 times $B_j/(B_j + B_k)$ if the method of divestment is spinoff, and 0 otherwise; $Q_{j,i}$ is the operating profitability of the divested segment of firm i, weighted by the relative assets of the divested segment $B_j/(B_j + B_k)$; ΔEF_{0i} is the change in consensus forecast of firm i's current-year earnings after divestment versus before divestment, scaled by the absolute value of mean forecast; ΔEF_{1i} is the change in consensus forecast of firm i's year-ahead earnings after divestment versus before divestment, scaled by the absolute value of mean forecast; $\Delta Beta_i$ is the change in systematic risk of firm i after divestment versus before divestment; $FOCUS_i$ is an asset-weighted dummy variable, equal to 1 times $B_j/(B_j + B_k)$ if the divested segment is not in the two-digit SIC industry of the parent firm, and 0 otherwise; $ASYINF_i$ is information asymmetry prior to divestment, measured as the standard deviation of analyst earnings forecasts in the month prior to the divestiture announcement, scaled by the absolute value of mean forecast; and M_i is the square of the number of segments of firm i before divestment, as a proxy for the complexity of firm structure.
Source: Table 7 from Chen and Zhang (2007a). Reprinted with permission by the American Accounting Association

this form of divestiture leads to additional benefits not available to firms undertaking selloffs. Secondly, the poor performance of the divested segment ($Q_{j,i}$) does not explain revaluation, suggesting that divestiture is not driven simply by the desire to get rid of a segment that is not doing well. Thirdly, changes in analyst forecasts and systematic risk do not explain market reactions, confirming that revaluation is not related to expected changes in real performance or firm risk. Finally, focus-increasing divestitures command little *incremental* market reactions beyond non-focus-increasing divestitures.

Overall, the evidence is supportive of the valuation-driven explanation for divestitures and suggests that this explanation is distinct from those alternatives controlled for in Eq. (8.12).

Table 8.4 Results for the pre- and post-SFAS 131 subperiods

Variable	Pred. sign	Pre-SFAS 131 (1990–1997) N = 424	Post-SFAS 131 (1998–2001) N = 102
Intercept	+/−	0.0061	−0.0046
DIVPROF	+	**0.1392*****	**0.2409****
SPINOFF	+	0.0550**	0.0512
Qi	−	−0.0589	−0.0100
FOCUS	+	0.0208	0.0580
ASYINF	+	**0.0126****	**0.0240**
M	+	**0.0004****	**0.0007***
Adjusted R^2		0.065	0.081

Source: Table 7, Panel B, from Chen and Zhang (2007a). Reprinted with permission by the American Accounting Association

8.5.4 Subperiods Before and After SFAS 131

In June 1997, the US FASB issued a new standard on segment reporting, SFAS 131, which took effect from the reporting year starting after December 15, 1997. This standard marked a significant change from its predecessor, SAFS 14, in terms of the way segments are defined and specific segment data reported. However, as Berger and Han (2003) explain, there are both advantages and disadvantages in adopting the new standard. For example, SFAS 131 takes a management approach to segment classification (as opposed to an industry approach, as was the case under SFAS 14), which can better align the usefulness of reported data for external users with the role of such data in internal decisions aimed to generate value. On the other hand, the new standard allows more discretion on the definition of reported segment profit (which can deviate from the GAAP measure). Thus, exactly *how* the standard impacts on the information environment and market valuation is an empirical question (Berger and Han 2003, p. 169). In the light of this argument, it is not clear, in the context of our analysis, whether firms were more prone to undertaking divestitures to correct misvaluation after the adoption of SFAS 131 than they were before the adoption.

Chen and Zhang (2007a) find a sharp drop in the number of divestitures in the years following the adoption of SFAS 131. Specifically, in the pre-SFAS 131 years, the number of annual divestitures ranged from a low of 47 (in 1995) to a high of 63 (1993), with an average of 55.4. In contrast, in the post-SFAS 131 period, this number ranged from 19 (in 2001) to 35 (1998), with an average of 27.8 (half the pre-SFAS 131 level).

Chen and Zhang (2007a) then run the regression in Eq. (8.12) separately for the two subperiods, with the results presented in Table 8.4. Two observations can be made. Firstly, the key explanatory variables identified by the theoretical model, namely, *DIVPROF*, *ASYINF*, and *M*, generally show significant effects in both subperiods, thus reinforcing previous evidence in support of the hypotheses. However, the results for the effects of *ASYINF* and *M* (which is used as a proxy for organizational complexity) are weaker following the adoption of SFAS 131.

Overall, the above evidence seems to suggest that the information asymmetry problem was eased, with respect to segment-level performance, by the adoption of SFAS 131.

8.6 Summary and Conclusions

In this chapter, we provide a theoretical model to show that companies undertake costly divestitures as a way to unlock true value that has otherwise been under-recognized by outside investors. Due to the nonlinearity of the valuation function caused by real options, the value impact of a given amount of earnings varies with the profitability of the segment generating earnings. This property creates incentives for company insiders, who aim to increase the firm's market value, to shift earnings from less profitable to more profitable segments. This type of earnings management creates a distorted view of segment performance and causes misvaluation. In situations where firms have become severely undervalued, they may decide to take their business components apart in an attempt to restore correct valuation and hence undertake divestiture. The model yields a number of predictions concerning the circumstances under which divestitures take place, the market's reaction to such a decision, the factors explaining the amount of market reaction, and the consequences for future performance. The empirical results are consistent with the theoretical predictions.

Information asymmetry between corporate managers and outside investors is an inherent problem hindering capital transactions. Mandatory financial reporting is imposed as a way to reduce the information gap. However, as demonstrated in this chapter, financial reporting is not always effective in mitigating information asymmetry. The analysis exposes a limitation of financial reporting that is peculiar to multiple-segment firms. Given the endogenous nature of earnings management incentives in this context, it is questionable whether strengthening reporting requirements still further will really help to solve the problem. Where financial reporting fails to do its work, firms may resort to other means to unlock their true value.

Appendix A: Proofs of Theoretical Results

Proof of Lemma 8.1 Part (i). Based on (8.3), we have $\frac{\partial V}{\partial X_{j1}} = 1 + B_j C'(q_{j1})/B_j = 1 + C'(q_{j1})$ and $\frac{\partial V}{\partial X_{k1}} = 1 + C'(q_{k1}) > \frac{\partial V}{\partial X_{k1}}$, given $q_{k1} > q_{j1}$.

Part (ii). Express segment profitabilities as $q_{j1} = q_1 - \frac{B_k}{B_j + B_k}(q_{k1} - q_{j1})$ and $q_{k1} = q_1 + \frac{B_j}{B_j + B_k}(q_{k1} - q_{j1})$. Based on (8.3), we have

$$\left.\frac{\partial V}{\partial (q_{k1} - q_{j1})}\right|_{q_1} = \frac{B_j B_k}{B_j + B_k}\left[C'(q_{k1}) - C'(q_{j1})\right] > 0, \text{ given } q_{k1} > q_{j1}.$$

Proof of Lemma 8.3 Let $s \equiv \tau_1 - t$ and $h(s;D) \equiv f(t;D)$. With t distributed over $[-T, \tau_1]$, $\tau_1 = \min\{T, \frac{B_j B_k}{B_j + B_k} D\}$, s is distributed over $[0, \tau_1 + T]$. The firm's market value (Eq. 8.7) is reexpressed as

$$\begin{aligned} MV &= \int_{\tau_1+T}^{0} \left[V\left(q_1 - \frac{B_k}{B_j+B_k} D + \frac{\tau_1 - s}{B_j}; B_j\right) + V\left(q_1 + \frac{B_j}{B_j+B_k} D - \frac{\tau_1 - s}{B_k}; B_k\right)\right] \\ &\quad h(s;D)(-ds) \\ &= \int_{0}^{\tau_1+T} \left[V\left(q_1 - \frac{B_k}{B_j+B_k} D + \frac{\tau_1 - s}{B_j}; B_j\right) + V\left(q_1 + \frac{B_j}{B_j+B_k} D - \frac{\tau_1 - s}{B_k}; B_k\right)\right] \\ &\quad h(s;D)ds. \end{aligned} \tag{8.13}$$

Differentiating MV with respect to D and recognizing that τ_1 and $h(s;D)$ are dependent on D, we get

$$\begin{aligned} \frac{dMV}{dD} = &\left(\left[V\left(q_1 - \frac{B_k}{B_j+B_k} D - \frac{T}{B_j}; B_j\right) + V\left(q_1 + \frac{B_j}{B_j+B_k} D + \frac{T}{B_k}; B_k\right)\right] h\left(\tau_1 + T; D)\frac{d\tau_1}{dD}\right) \\ &+ \left(\int_0^{\tau_1+T} \left\{ V'(q_{j1}; B_j)\left[-\frac{B_k}{B_j+B_k} + \frac{1}{B_j}\frac{d\tau_1}{dD}\right] + V'(q_{k1}; B_k)\left[\frac{B_j}{B_j+B_k} - \frac{1}{B_k}\frac{d\tau_1}{dD}\right]\right\} h(s;D)ds\right) \\ &+ \left(\int_0^{\tau_1+T} \left[V(q_{j1}; B_i) + V(q_{k1}; B_j)\right] \frac{\partial h}{\partial D} ds\right). \end{aligned} \tag{8.14}$$

As s increases (for a given τ_1), the divergence of true segment profitability, which equals $D + \frac{B_j + B_k}{B_j B_k}(s - \tau_1)$, also increases. Then, following part (ii) of Lemma 8.1, we have

$$\begin{aligned} &V\left(q_1 - \frac{B_k}{B_j+B_k} D - \frac{T}{B_j}; B_j\right) + V\left(q_1 + \frac{B_j}{B_j+B_k} D + \frac{T}{B_k}; B_k\right) \\ &\quad > V\left(q_1 - \frac{B_k}{B_j+B_k} D + \frac{\tau_1 - s}{B_j}; B_j\right) \\ &\qquad + V\left(q_1 + \frac{B_j}{B_j+B_k} D - \frac{\tau_1 - s}{B_k}; B_k\right), \ \forall s[0, \tau_1 + T]. \end{aligned} \tag{8.15}$$

Note that the left-hand side of Eq. (8.15) represents firm value at the greatest divergence of segment profitability.

Let $H(D) = \int_0^{\tau_1+T} h(s;D)ds \equiv 1$. We have

$$\frac{dH}{dD} = h(\tau_1 + T; D)\frac{d\tau_1}{dD} + \int_0^{\tau_1+T} \frac{\partial h}{\partial D} ds = 0. \tag{8.16}$$

Then, based on (8.15) and (8.16), the first and third terms on the right-hand side of Eq. (8.14) together are positive, as shown below[2]:

$$
\begin{aligned}
&V\left(q_1-\frac{B_k}{B_j+B_k}D-\frac{T}{B_j};B_j\right)+V\left(q_1+\frac{B_j}{B_j+B_k}D+\frac{T}{B_k};B_k\right)h(\tau_1+T,D)\frac{d\tau_1}{dD}\\
&+\int_0^{\tau_1+T}\left[V\left(q_1-\frac{B_k}{B_j+B_k}D+\frac{\tau_1-s}{B_j};B_j\right)+V\left(q_1+\frac{B_j}{B_j+B_k}D-\frac{\tau_1-s}{B_k};B_k\right)\right]\frac{\partial h}{\partial D}ds\\
&>\left[V\left(q_1-\frac{B_k}{B_j+B_k}D-\frac{T}{A_i};B_j\right)+V\left(q_1+\frac{B_j}{B_j+B_k}D+\frac{T}{B_k};B_k\right)\right]\\
&\left[h(\tau_1+T,D)\frac{d\tau_1}{dD}+\int_0^{\tau_1+T}\frac{\partial h}{\partial D}dsn\right]=0.
\end{aligned}
$$

To determine the sign of the second term in Eq. (8.14), we need to consider two possible cases. In both of these cases, this term is either positive or zero, as shown below. Firstly, for the case of $\tau_1 = T$, we have $d\tau_1/dD = 0$. Making use of the value expression in Eq. (8.2), we get

$$
\begin{aligned}
&[V'(q_{i1};B_j)]\left[-\frac{B_k}{B_j+B_k}+\frac{1}{B_j}\frac{d\tau_1}{dD}\right]+V'(q_{j1};B_k)]\left[\frac{B_j}{B_j+B_k}-\frac{1}{B_k}\frac{d\tau_1}{dD}\right]\\
&\quad=-V'(q_{j1};B_j)\frac{B_k}{B_j+B_k}+V'(q_{k1};B_k)\frac{B_j}{B_j+B_k}=\frac{B_jB_k}{B_j+B_k}[C'(q_{k1})-C'(q_{j1})]>0,
\end{aligned}
$$

given $q_{k1} > q_{j1}$ and $C(.)$ being increasing and convex.

Secondly, for the case of $\tau_1 = \frac{B_jB_k}{B_j+B_k}D$, we have $\frac{d\tau_1}{dD} = \frac{B_jB_k}{B_j+B_k}$, and thus $-\frac{B_k}{B_j+B_k} + \frac{1}{B_j}\frac{d\tau_1}{dD} = \frac{B_j}{B_j+B_k} - \frac{1}{B_k}\frac{d\tau_1}{dD} = 0$, so that the second term in Eq. (8.14) equals zero.

Together, the above analysis shows that $\frac{dMV}{dD} > 0$.

Proof of Proposition 8.1 Part (i). Following Proposition 8.1, MV increases with D, given q_1. This, together with Lemma 8.1, implies that the divergence of inferred profitabilities, $q^i_{k1} - q^i_{j1}$, must increase with the divergence of reported profitability, D, to keep the equality in Eq. (8.8) intact. In the special case of $D = 0$, the market's inferences are $q^i_{k1} = q^i_{j1} = q_1$ and $\tau^* = 0$ (arising from the belief that $t_m = 0$ and $q_{k1} = q_{j1}$).

Part (ii). Given part (i), the firm is always better off by increasing the divergence of reported segment profitabilities. Thus, the firm transfers earnings from segment j to segment k to the maximum extent possible (subject to the condition specified in Assumption 8.1). □

[2] Here we impose the mild condition of $\partial h/\partial D \leq 0$; that is, as the reported divergence of segment profitability (D) increases, and hence the conditional range over which t is distributed becomes wider, the probability density becomes (weakly) thinner (so that the cumulative probability over the whole range remains one).

Proof of Lemma 8.4 The incentives to misrepresent segment earnings arise from the option terms of value in Eq. (8.3). Without loss of generality, we focus here only on the option terms of value (to make the expressions less cumbersome). Thus, from Eq. (8.2), the reduced value expression is $V\left(q_{j1};B_j\right)=B_jC\left(q_{j1}\right)$ $=B_j\int_{-q_{j1}}^{b}\left(q_{j1}+e\right)g(e)de.$[3] The derivative with respect to profitability is $V'\left(q_{j1};B_j\right)$ $=B_jC'\left(q_{j1}\right)=B_j[0+\int_{-q_{j1}}^{b}g(e)de]$. With e_{j2} uniformly distributed over $[a,b]$, this simplifies to $V'\left(q_{j1};B_j\right)=B_j\frac{b+q_{j1}}{b-a}$, for $-q_{j1}>a$.

Based on Eqs. (8.7) and (8.8), we define

$$G(D,\tau^*)=V(q^i_{j1};B_j)+V(q^i_{k1};B_j)-MV(q^r_{j1},q^r_{k1})\equiv 0, \tag{8.17}$$

which implicitly determines the relation between τ^* and D. The partial derivative of G with respect to τ^* is

$$\begin{aligned}\frac{\partial G}{\partial\tau^*}&=V'(q^i_{j1};B_j)\frac{\partial q^i_{j1}}{\partial\tau^*}+V'(q^i_{k1};B_k)\frac{\partial q^i_{k1}}{\partial\tau^*}=B_j\frac{b+q_{j1}}{b-a}\frac{1}{B_j}-B_k\frac{b+q_{k1}}{b-a}\frac{1}{B_k}\\&=\frac{q_{j1}-q_{k1}}{b-a}<0.\end{aligned} \tag{8.18}$$

The remaining steps are intended to show $\frac{\partial G}{\partial D}>0$, and we examine the derivatives of the different terms in Eq. (8.17) separately.

Firstly, for a given q_1, we have

$$\begin{aligned}\frac{\partial[V(q^i_{j1};B_j)+V(q^i_{k1};B_k)]}{\partial D}&=V'(q^i_{j1};B_j)\left(-\frac{B_k}{B_j+B_k}\right)+V'(q^i_{k1};B_k)\left(\frac{B_j}{B_j+B_k}\right)\\&=\frac{B_jB_k}{B_j+B_k}\frac{q^i_{k1}-q^i_{j1}}{b-a}=\frac{1}{b-a}\frac{B_jB_k}{B_j+B_k}\left(D-\frac{\tau^*}{B_k}-\frac{\tau^*}{B_j}\right)=\frac{1}{b-a}\frac{B_jB_k}{B_j+B_k}D-\frac{1}{b-a}\tau^*.\end{aligned} \tag{8.19}$$

Next, we examine the derivative of the second part of Eq. (8.17), MV. According to part (ii) of Proposition 8.1, in equilibrium, investors believe that t^* is distributed over $[0,\tau_1]$, with $\tau_1=\min\left\{T,\frac{B_jB_k}{B_j+B_k}D\right\}$. Then, applying (8.7) to equilibrium strategies, we get

[3] The constant term of V plays no role in the proof, and the linear term can also be ignored given $X^r_{j1}+X^r_{k1}=X_{j1}+X_{k1}$.

$$\frac{\partial MV}{\partial D} = \int_0^{\tau_1} \left[V'\left(q_{j1}; B_j\right)\left(-\frac{B_k}{B_j + B_k}\right) + V'\left(q_{k1}; B_k\right)\left(\frac{B_j}{B_j + B_k}\right)\right] f\left(t^*; D\right) dt^*. \quad (8.20)$$

We need to consider two possible cases regarding the value of τ_1.

Case (i): If D is small such that $\frac{B_j B_k}{B_j + B_k} D < T$, then $\tau_1 = \frac{B_j B_k}{B_j + B_k} D$. Given that the distribution of t_m is uniform over [0, T], with density 1/T, the market forms beliefs about t^*, conditional on D, as $t^* = \frac{B_j B_k}{B_j + B_k} D$ if $t_m \in \left[\frac{B_j B_k}{B_j + B_k} D,\ T\right]$, with probability $1 - \frac{1}{T}\frac{B_j B_k}{B_j + B_k} D$, and $t^* = t_m$, if $t_m \in [0, \frac{B_j B_k}{B_j + B_k} D]$, with density $f(t^*; D) = 1/T$. Then,

$$\begin{aligned} \frac{\partial MV}{\partial D} &= \frac{1}{b-a} \frac{B_j B_k}{B_j + B_k} D \frac{t^*}{T}\Bigg|_{t^*=0}^{t^*=\tau_1} - \frac{1}{b-a} \frac{t^{*2}}{2T}\Bigg|_{t^*=0}^{t^*=\tau_1} \\ &= \frac{1}{2(b-a)T}\left(\frac{B_j B_k}{B_j + B_k}\right)^2 D^2. \end{aligned} \quad (8.21)$$

Let $Y \equiv \partial G / \partial D$. Then, combining Eqs. (8.19) and (8.21) yields

$$\begin{aligned} Y &= \frac{\partial [V'(q_{j1}^i; B_j) + V'(q_{k1}^i; B_k)]}{\partial D} - \frac{\partial MV}{\partial D} \\ &= \frac{1}{(b-a)}\left(\frac{B_j B_k}{B_j + B_k}\right) D - \frac{1}{b-a}\tau^* - \frac{1}{2(b-a)T}\left(\frac{B_j B_k}{B_j + B_k}\right)^2 D^2. \end{aligned} \quad (8.22)$$

At the point where reported profitabilities are equal, $D = 0$, implying $t^* = 0$ and hence $\tau^* = 0$, we have $Y = 0$ according to Eq. (8.22). Starting from this point, as D increases,

$$\frac{\partial Y}{\partial D} = \frac{1}{(b-a)}\left(\frac{B_j B_k}{B_j + B_k}\right) - \frac{1}{(b-a)T}\left(\frac{B_j B_k}{B_j + B_k}\right)^2 D > 0 \quad (8.23)$$

given $T > \frac{B_j B_k}{B_j + B_k} D$. Therefore, $Y > 0$ for $0 < D < \frac{B_j B_k}{B_j + B_k} T$.

Case (ii). As D becomes sufficiently large, such that $\frac{B_j B_k}{B_j + B_k} D > T$, then $\tau_1 = \min\{T, \frac{B_j B_k}{B_j + B_k} D\} = T$, and the market belief is $t^* = t_m$, and therefore $f(t^*; D) = 1/T$, $t^* \in [0, T]$. It follows that

$$\begin{aligned} \frac{\partial MV}{\partial D} &= \frac{1}{b-a} \frac{B_j B_k}{B_j + B_k} D \frac{t^*}{T}\Bigg|_{t^*=0}^{t^*=T} - \frac{1}{b-a} \frac{t^{*2}}{2T}\Bigg|_{t^*=0}^{t^*=T} \\ &= \frac{1}{(b-a)}\left[\frac{B_j B_k}{B_j + B_k} D - \frac{T}{2}\right]. \end{aligned} \quad (8.24)$$

Combining Eqs. (8.19) and (8.24), we get $Y = \frac{\partial [V'(q_{j1}^i; B_j) + V'(q_{j1}^i; B_k)]}{\partial D} - \frac{\partial MV}{\partial D} = \frac{T - 2\tau^*}{2(b-a)}$, and it follows that $\frac{\partial Y}{\partial D} = 0$.

The analysis for case (i) and case (ii) together implies the following: At the starting point $D = 0$, $Y = 0$, Y first increases with D up to $D = T(B_j + B_k)/(B_jB_k)$ and thereafter remains constant. Thus, $Y > 0$ for all $D > 0$.

This leads to the conclusion that

$$\frac{d\tau^*}{dD} = -\frac{\partial G(D,\tau^*)/\partial D^*}{\partial G(D,\tau^*)/\partial\tau^*} = -\frac{Y}{\partial G(D,\tau^*)/\partial\tau^*} > 0. \qquad \square$$

Proof of Proposition 8.2 Define $s \equiv \tau^* - t_m$, $s \in (0, \tau^*)$, which is the amount of market *over*correction to reported segment earnings. Then, $q_{j1} = q^i_{j1} - \frac{s}{B_j}$ and $q_{k1} = q^i_{k1} + \frac{s}{B_k}$, and the undervaluation set out in Eq. (8.10) is more intuitively expressed as

$$V^u = \left[V\left(q^i_{j1} - \frac{s}{B_j}; B_j\right) + V\left(q^i_{k1} + \frac{s}{B_k}; B_k\right)\right] - \left[V\left(q^i_{j1}; B_j\right) + V\left(q^i_{k1}; B_k\right)\right]. \tag{8.25}$$

With t_m uniformly distributed, then, conditional on the firm being undervalued, the distribution of s is also uniform over $(0, \tau^*)$, with (conditional) density $1/\tau^*$. The (conditional) expected undervaluation in Eq. (8.11) can be reexpressed as

$$\begin{aligned} EV^u &= \int_0^{\tau^*} V^u \frac{1}{\tau^*} ds \\ &= \int_0^{\tau^*} [V(q^i_{j1} - \frac{s}{B_j}; B_j) + V(q^i_{k1} + \frac{s}{B_k}; B_k)] \frac{1}{\tau^*} ds - [V(q^i_{j1}; B_j) + V(q^i_{k1}; B_k)]. \end{aligned} \tag{8.26}$$

Totally differentiating EV^u, and noting $q^i_{j1} = q_1 - \frac{B_k}{B_j + B_k} D + \frac{\tau^*}{B_j}$ and $q^i_{k1} = q_1 + \frac{B_j}{B_j + B_k} D - \frac{\tau^*}{B_k}$, and recognizing that τ^* in general is dependent on D, we get

$$\begin{aligned} \frac{dEV^u}{dD} =& \left[V\left(q_1 - \frac{B_k}{B_j + B_k} D; B_j\right) + V\left(q_1 + \frac{B_j}{B_j + B_k} D; B_k\right)\right] \frac{1}{\tau^*} \frac{d\tau^*}{dD} \\ &+ \int_0^{\tau^*} \left[V'(q_{j1}; B_j)\left(-\frac{B_k}{B_j + B_k}\right) + V'(q_{k1}; B_k) \frac{B_j}{B_j + B_k}\right] \frac{1}{\tau^*} ds \\ &- \int_0^{\tau^*} \left[V(q_{j1}; B_j) + V(q_{k1}; B_k)\right] \left(\frac{1}{\tau^*}\right)^2 \frac{d\tau^*}{dD} ds \\ &- \left[V'\left(q^i_{j1}; B_j\right)\left(-\frac{B_k}{B_j + B_k}\right) + V'\left(q^i_{k1}; B_k\right) \frac{B_j}{B_j + B_k}\right] \\ &- \left[V'\left(q^i_{j1}; B_j\right) \frac{1}{B_j} - V'\left(q^i_{k1}; B_k\right) \frac{1}{B_k}\right] \frac{d\tau^*}{dD}. \end{aligned} \tag{8.27}$$

Observe that $V\left(q_1 - \frac{B_k}{B_j+B_k}D; B_j\right) + V\left(q_1 + \frac{B_j}{B_j+B_k}D; B_k\right)$ corresponds to firm value at $s = \tau^*$, where undervaluation is the most severe. Thus,

$$V\left(q_1 - \frac{B_k}{B_j + B_k}D; B_j\right) + V\left(q_1 + \frac{B_j}{B_j + B_k}D; B_k\right) > \left(q_{j1}; B_j\right) + V(q_{k1}; B_k)$$

for $s \in (0, \tau^*)$. Then, following Lemma 8.4, the first and third terms on the right-hand side of Eq. (8.27) together are positive.

The second and the fourth terms of Eq. (8.27) together can be simplified as

$$\frac{1}{B_j + B_k}\left\{\int_0^{\tau^*}\left[C'(q_{k1}) - C'\left(q_{j1}\right)\right]\frac{1}{\tau^*}ds - \left[C'(q^i_{k1}) - C'(q^i_{j1})\right]\right\} > 0,$$

where the inequality follows from Lemma 8.1, given that actual profitability divergence $(q_{k1} - q_{j1})$ is greater than the inferred divergence $(q^i_{k1} - q^i_{j1})$ within the undervaluation range. The last term of Eq. (8.27) (including the minus sign) equals $\left[C'(q_{k1}) - C'\left(q_{j1}\right)\right]\frac{d\tau^*}{dD} > 0$.

Therefore, $\frac{dEV^u}{dD} > 0$ □

Proof of Proposition 8.3 To prove $\frac{dEV^u}{dT} = \frac{\partial EV^u}{\partial \tau^*}\frac{d\tau^*}{dT} > 0$, we will show that the two component terms are both positive. First, defining $s \equiv \tau^* - t_m$ as in the proof of Proposition 8.2 above and noting $q^i_{j1} = q_1 - \frac{B_k}{B_j+B_k}D + \frac{\tau^*}{B_j}$ and $q^i_{k1} = q_1 + \frac{B_j}{B_j+B_k}D - \frac{\tau^*}{B_k}$, we get from Eq. (8.26):

$$\frac{\partial EV^u}{\partial \tau^*} = \left[V\left(q_1 - \frac{B_k}{B_j + B_k}D; B_j\right) + V\left(q_1 + \frac{B_j}{B_j + B_k}D; B_k\right)\right]\frac{1}{\tau^*} - \int_0^{\tau^*}\left[V\left(q_{j1}; B_j\right) + V(q_{k1}; B_k)\right]\left(\frac{1}{\tau^*}\right)^2 ds - \left[V'\left(q^i_{j1}; B_j\right)\frac{1}{B_j} - V'\left(q^i_{k1}; B_k\right)\frac{1}{B_k}\right] > 0, \tag{8.28}$$

where the inequality follows because, using the same arguments as in the proof of Proposition 8.2, the first and second terms in Eq. (8.28) together are positive, and the third (with the minus sign) is also positive.

The proof of $\frac{d\tau^*}{dT} > 0$ follows similar steps to those for Lemma 8.4, as shown below. Applying Eqs. (8.7) and (8.8) to equilibrium strategies, and defining

$$G(T, \tau^*) \equiv V(q^i_{j1}; B_j) + V(q^i_{k1}; B_k) - MV(q^r_{j1}, q^r_{k1}) = 0, \tag{8.29}$$

which implicitly determines τ^* as a function of T, we have

$$\frac{\partial G}{\partial \tau^*} = V'(q^r_{j1}; B_j)\frac{\partial q^i_{j1}}{\partial \tau^*} + V'(q^i_{k1}; B_k)\frac{\partial q^i_{k1}}{\partial \tau^*} = B_j\frac{b + q_{j1}}{b - a}\frac{1}{B_j} - B_k\frac{b + q_{k1}}{b - a}\frac{1}{B_k}$$
$$= \frac{q_{j1} - q_{k1}}{b - a} < 0. \quad (8.30)$$

The remaining task is to determine the sign of $\frac{\partial G}{\partial T}$.

For the case of $\frac{B_jB_k}{B_j+B_k}D < T$, $\tau_1 = \frac{B_jB_k}{B_j+B_k}D$. In equilibrium, $t^* \in [0, \tau_1]$, and $MV = \int_0^{\tau_1} [V(q_{j1}; B_j) + V(q_{k1}; B_k)]\frac{1}{T}dt^* + [V(q_1; B_j) + V(q_1; B_k)][1- \frac{1}{T}\frac{B_jB_k}{B_j+B_k}D]$.
Thus, we have

$$\frac{\partial G}{\partial T} = -\frac{\partial MV}{\partial T} = -\int_0^{\tau_1} [V(q_{j1}; B_j) + V(q_{k1}; B_k)]\left(-\frac{1}{T^2}\right)dt^* + [V(q_1; B_j)$$
$$+ V(q_1; B_k)]\left[\frac{1}{T^2}\frac{B_jB_k}{B_j + B_k}D\right] > 0. \quad (8.31)$$

On the other hand, for the case of $\frac{B_jB_k}{B_j+B_k}D > T$, we have $\tau_1 = T$ and

$$\frac{\partial G}{\partial T} = -\frac{\partial MV}{\partial T} = -\left[V\left(q_{j1} - \frac{B_k}{B_j + B_k}D + \frac{T}{B_j}; B_j\right) + V\left(q_{k1} + \frac{B_j}{B_j + B_k}D - \frac{T}{B_k}; B_k\right)\right]$$
$$- \int_0^{T} [V(q_{j1}; B_j) + V(q_{k1}; B_k)]\left(-\frac{1}{T^2}\right)dt^* > 0,$$
$$(8.32)$$

where inequality follows from Lemma 8.1 and the fact that the divergence of true profitability is the smallest at $t^* = T$.

Therefore, based on Eqs. (8.30), (8.31), and (8.32), we have $\frac{d\tau^*}{dT} = -\frac{\partial G/\partial T}{\partial G/\partial \tau^*} > 0$. It follows that $\frac{dEV^u}{dT} = \frac{\partial EV^u}{\partial \tau^*}\frac{d\tau^*}{dT} > 0$. □

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Chapter 9
Accounting Information and Equity Returns: A Derivative of the Value Function

Having examined the relation between equity value and accounting data, we now shift the focus of discussion to equity return. Returns arise from *changes* in value (plus dividends); so the return function is a derivative of the value function. We continue to use the ROM framework in this chapter. Our objective is to gain a better understanding of how equity returns relate to specific accounting variables that convey a firm's value generating activities.

Understanding the behavior of equity return has been an important objective for both accounting and finance research. We start the chapter by explaining how the accounting research on this topic differs from the asset pricing research in finance and outlining the special contributions it can make that are useful to market participants and accounting standard setters. We then use the ROM to derive a theoretical model of return, which identifies a set of fundamental factors comprising both accounting and nonaccounting information that drives changes in investor wealth. The factors in the model complement one another in terms of the economic information conveyed and together constitute a "full" view of how a firm's operations have changed over a given period of time. After this theoretical exposition, we provide an empirical analysis to test the model's predictions and assess the importance of the individual factors. The material for this chapter is drawn primarily from Chen and Zhang (2007b).

9.1 A Comparison Between Accounting and Finance Research on Equity Returns

9.1.1 Expected Versus Realized Returns

Accounting researchers are interested in the question of how financial reporting affects investors' assessment of firm value, which causes movements in stock price. Naturally, a dependent variable of particular interest to them is the *realized* returns

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over a reporting period or during an accounting event, and accounting variables such as earnings serve as explanatory factors for this return.

This line of inquiry is distinct from the asset pricing research in two respects. Firstly, that body of research focuses on *expected* returns, which is what investors require at the time of investment decisions; it is therefore an ex ante, rather than ex post, view of return. Secondly, the explanatory factor in asset pricing models is investment risk as perceived by investors, and the measures of such risk defined in these models have not been explicitly linked through a rigorous theory to the observable characteristics of business operations, particularly accounting measures of performance.

Ex post realized returns can deviate from expected returns for a number of reasons. To illustrate this, consider a firm operating in a two-period world. For simplicity, we assume that the firm maintains a constant scale of operations over the two periods and any free cash flow is paid out as dividends. Let d_1 and d_2 be the dividends paid in period one and period two, respectively. The firm value at date 0 is therefore $V_0 = \frac{E_0(\tilde{d}_1)}{1+r_0} + \frac{E_0(\tilde{d}_2)}{(1+r_0)^2}$, where r_0 is the expected return at date 0. By rearranging the value function, we can express the expected return at date 0 for period one as $r_0 = \frac{1}{V_0}\left[E_0(\tilde{d}_1) + \frac{E_0(\tilde{d}_2)}{(1+r_0)}\right] - 1$.

At date 1, the dividend for period one (d_1) is realized. At the same time, investors revise both the expected future dividend and the expected return for the remaining period, so the return actually realized in period one (R_1) is $R_1 = \frac{1}{V_0}[d_1 + \frac{E_1(\tilde{d}_2)}{1+r_1}] - 1$.

Comparing the realized return for period one (R_1) with the expected return (r_0) reveals three different reasons for them to be different. Firstly, the realized dividend in period one deviates from the expected dividend, $d_1 \neq E_0(\tilde{d}_1)$; this can happen because investors are unable to perfectly predict the firm's value generation and the need for further investment. Secondly, the expected dividend for the future period (period two) has changed between date 0 and date 1, so $E_1(\tilde{d}_2) \neq E_0(\tilde{d}_2)$; this can be due to changes in the conditions of the firm's operation. Thirdly, the discount rate has changed from date 0 to date 1, $r_0 \neq r_1$, which can be caused by changes in the risk-free rate and/or the required risk premium on the firm's equity.

The question faced by accounting researchers is how accounting data can help to inform investors about the value generated during the reporting period and to update their beliefs about future value generation and business risk.

9.1.2 How Does the Accounting Research Complement Asset Pricing Theories?

To appreciate the usefulness of accounting research which emphasizes the role of business fundamentals in explaining realized returns, one should keep in mind what asset pricing theories do *not* address. Firstly, their development has not been tied to the valuation research. Although, by definition, returns arise from changes in equity value, asset pricing models are not anchored to a model of equity value that is connected to the economic activities underpinning the firm's value generation. Rather, these models consider the risk characteristics exhibited by the firm in the capital markets as the central determinant of expected returns.

Secondly, asset pricing models are theories of *relative* pricing (or, more precisely, relative return determination), not absolute pricing. For example, the capital asset pricing model specifies how the expected return on an asset is related to that on the market portfolio, but it does not explain how the expected return on the market portfolio itself is to be separately determined. By definition, the market portfolio consists of all the assets in an economy combined, so in essence, the model is about how expected returns on individual assets within an economy are related to one another. To break up this circularity, a model of absolute pricing is needed that links returns in the capital market to activities taking place in the real economy.

Understanding the relation between realized returns and (firm-specific) accounting information is important because the former are what investors ultimately care about. Intuitively, what investors gain or lose on their investment should be directly tied to the firm's economic activities, and accounting data are intended to summarize and convey those activities. In a world where investors face a vast amount of financial data, they need to be able to process them in an effective and meaningful way. A theoretical model explaining how returns are related to business operations offers guidance on which types of data investors should collect and how they should be processed and mapped to value (and changes in value). In this sense, a model of realized return can facilitate financial analysis and ultimately improve market efficiency.

9.2 A Model of Equity Return Based on the ROM

In this section, we employ the ROM examined in Chaps. 4 and 5 as the basis for developing an equity return function. To suppress the effect of accounting conservatism, we assume unbiased accounting. We modify the original ROM to allow the model's parameters to vary over time. This leads to the following modified version of the ROM:

$$V_t = B_t\ [P(ROE_t) + ROE_t/r_t + g_t C(ROE_t)] \equiv B_t\ v(ROE_t, g_t, r_t), \tag{9.1}$$

where B_t is the book value at the end of period t; ROE_t is the profitability (return on equity) for period t; g_t is the growth opportunity as perceived at date t; and r_t is the discount rate as at date t; and $P(.)$ and $C(.)$ are the adaptation and growth options, respectively. For convenience, we have defined $v(ROE_t, g_t, r_t) \equiv P(ROE_t) + ROE_t/r_t + g_t C(ROE_t)$.

Taking changes of the function in Eq. (9.1), but ignoring the second and higher order terms, yields

$$\Delta V_{t+1} = \Delta B_{t+1}\, v(ROE_t, g_t, r_t) + B_t\left[v_1\ \Delta ROE_{t+1} + C(ROE_t)\,\Delta g_{t+1} + v_3\,\Delta r_{t+1}\right], \tag{9.2}$$

where the partial derivatives are $v_1 \equiv dv/dROE_t$ and $v_3 \equiv dv/dr_t$; note that $dv/dg_t = C(ROE_t)$.

The equity return over period t + 1 (a representative period starting at date t) is defined as $R_{t+1} \equiv \frac{\Delta V_{t+1}+d_{t+1}}{V_t}$. Replacing ΔV_{t+1} with its expression in Eq. (9.2), we get

$$R_{t+1} = v\left[\frac{\Delta B_{t+1}}{V_t}\right] + v_1\left[\frac{B_t}{V_t}\Delta ROE_{t+1}\right] + C(ROE_t)\left[\frac{B_t}{V_t}\Delta g_{t+1}\right] + v_3\left[\frac{B_t}{V_t}\Delta r_{t+1}\right] + \frac{d_{t+1}}{V_t}$$

$$= \frac{\Delta B_{t+1}}{B_t} + v_1\left[\frac{B_t}{V_t}\Delta ROE_{t+1}\right] + C(ROE_t)\left[\frac{B_t}{V_t}\Delta g_{t+1}\right] + v_3\left[\frac{B_t}{V_t}\Delta r_{t+1}\right] + \frac{d_{t+1}}{V_t}. \tag{9.3}$$

With the CSR, the dividend term can be replaced by accounting variables as $d_{t+1} = X_{t+1} - \Delta B_{t+1}$. Then, the return function becomes

$$R_{t+1} = \left[\frac{X_{t+1}}{V_t}\right] + v_1\left[\frac{B_t}{V_t}\Delta ROE_{t+1}\right] + \left[\left(1-\frac{B_t}{V_t}\right)\frac{\Delta B_{t+1}}{B_t}\right] + C(ROE_t)\left[\frac{B_t}{V_t}\Delta g_{t+1}\right] + v_3\left[\frac{B_t}{V_t}\Delta r_{t+1}\right]. \tag{9.4}$$

According to Eq. (9.4), equity return is related to five fundamental factors: earnings generated over the contemporaneous period, the profitability change over the period, the equity capital investment undertaken, the change in growth opportunity, and the change in the discount rate. In the discounted cash-flow framework, the first four factors relate to cash flows and the fifth to the discount rate.

Equation (9.4) identifies which attributes of business operations are important in determining equity returns. According to the ROM, the primitive accounting variables for conveying value generation are book value (B) and profitability (ROE), representing the scale of equity capital investment and the efficiency in deploying invested capital, respectively. It follows that changes in B and in ROE together form the basis for revising equity value changes. This return model computes equity return from the perspective of value generation, which contrasts with the traditional (finance) approach that takes the perspective of value distribution (i.e., dividends).

Below, we further explain the theoretical roles of the individual factors in the model specified in Eq. (9.4).

1. *Earnings* (X_{t+1})
   Earnings represent value generation from operations over a given time period. This *realized* value constitutes part of the gain that equity investors achieve during that period. Traditionally, accounting research has emphasized changes in expected future earnings as a source of equity returns, but ultimately what

matters to investors is the realization of earnings at the end of each period. In other words, expected earnings only matter because investors care about what is eventually gained.

Because return is defined relative to equity value at the beginning of a period, earnings need to be normalized by reference to the beginning equity value when translated to returns. According to the model in Eq. (9.4), the predicted coefficient on X_{t+1}/V_t is 1, after controlling for the rest of the factors.

2. *Change in profitability* (ΔROE_{t+1})
The profitability change over a period has consequences for future value generation, and hence is another key factor driving equity return. *Ceteris paribus*, an increase in profitability signals an improvement in efficiency, which thus raises expectations about future cash flows.

In the model in Eq. (9.4), ΔROE_{t+1} is adjusted by the ratio of the book value to the market value of equity, B_t/V_t. This is because profitability affects earnings (value generation) through the use of invested capital ($X_{t+1} = q_{t+1}B_t$), and earnings are translated to return after being scaled by the beginning equity value (V_t).

The coefficient on this adjusted profitability change is $v_1 \equiv dv/dROE_t$. From the properties of the ROM examined in Chaps. 4 and 5, v is an increasing and convex function of ROE_t. This suggests that the coefficient on the (adjusted) profitability change is greater for more profitable firms.

3. *Equity capital investment* (ΔB_{t+1})
Capital investment in the contemporaneous period affects returns because it changes the scale of the operations. A larger capital stock provides a greater capacity to generate earnings. However, as elaborated below, the impact of capital investment on returns can be either positive or negative, depending on how efficiently capital is utilized.

In the return function in Eq. (9.4), the coefficient on ΔB_{t+1} is equal to $(V_t/B_t - 1)/V_t$. Expression $(V_t/B_t - 1)$ represents the NPV per unit of invested capital. This means that the predicted coefficient on capital investment is positive if investment has positive NPV and is negative if it has negative NPV. Thus, although a capital base that has been expanded through more investment typically increases earnings, capital investment increases equity value only if the firm can generate earnings at a rate exceeding the cost of capital. Equation (9.4) thus is a manifestation of the fact that positive NPV investments enhance investor wealth, whereas negative NPV investments destroy wealth.

The predicted coefficient on the adjusted capital investment variable is 1.

4. *Change in growth opportunity* (Δg_{t+1})
Growth affects the scale of operations, so changes in growth opportunity (Δg_t) have implications for future cash flows and hence affect equity return. In Eq. (9.4), Δg_t is adjusted by B_t/V_t. The coefficient on the adjusted growth opportunity change is $C(ROE_t)$; it is positive and increases with ROE_t.

5. *Change in the discount rate* (Δr_{t+1})
The discount rate determines how future cash flows are priced. As the discount rate increases, future cash flows are discounted more heavily, causing the

present value to go down. The predicted coefficient on discount rate changes is negative.

9.3 Estimating the Return Model

The empirical analysis in this section serves two purposes. Firstly, it tests whether the predicted effects of the individual factors in the return model in Eq. (9.4) hold. Second, it compares the performance of this return model with those previously advanced in the empirical literature.

9.3.1 Regression Models

Chen and Zhang (2007b) adopt two regression specifications for the return model in Eq. (9.4). The first is a linear regression that incorporates the five factors in Eq. (9.4), as follows:

$$R_{it} = \alpha + \beta_1 x_{it} + \beta_2 \Delta roe_{it} + \beta_3 \Delta b_{it} + \beta_4 \Delta g_{it} + \beta_5 \Delta r_{it} + e_{it}, \tag{9.5}$$

where R_{it} is firm i's equity return over year t; $x_{it} = X_{it}/V_{it-1}$ is firm i's earnings per share for year t scaled by the share price at the beginning of year t (the earnings yield); $\Delta roe_{it} = (roe_{it} - roe_{it-1})B_{it-1}/V_{it-1}$ is the change in firm i's *ROE* in year t relative to year t-1, adjusted by the ratio of the book value to the market value of equity at the beginning of year t; $\Delta b_{it} = [(B_{it} - B_{it-1})/V_{it-1}](V_{it-1}/B_{it-1} - 1)$ is firm i's capital investment undertaken in year t, adjusted by the NPV per unit of investment; $\Delta g_{it} = (g_{it} - g_{it-1})B_{it-1}/V_{it-1}$ is the change in firm i's growth opportunity over year t, adjusted by the equity book-to-market ratio at the beginning of year t; and $\Delta r_{it-1} = (r_t - r_{t-1})B_{it-1}/V_{it-1}$ is the change in the discount rate over year t, adjusted by the equity book-to-market ratio at the beginning of year t.

The theoretical return model yields the following predictions. Firstly, the coefficient on earnings yield is one ($\beta_1 = 1$). Secondly, the coefficient on the profitability change is positive ($\beta_2 > 0$). Thirdly, the coefficient on adjusted capital investment is one ($\beta_3 = 1$). Fourthly, the coefficient on the growth opportunity change is positive ($\beta_4 > 0$). Finally, the coefficient on the discount rate change is negative ($\beta_5 < 0$).

The second regression extends the first to allow the coefficients on the changes in profitability and growth opportunity to vary with a firm's profitability, as predicted by the theoretical model. Specifically, it takes the following piecewise linear form:

$$R_{it} = \alpha + \beta_1 x_{it} + \beta_2 \Delta roe_{it} + \beta_2^M M\Delta roe_{it} + \beta_2^H H\Delta roe_{it} + \beta_3 \Delta b_{it} + \beta_4 \Delta g_{it} + \beta_4^M M\Delta g_{it} + \beta_4^H H\Delta g_{it} + \beta_5 \Delta r_{it} + e_{it}, \tag{9.6}$$

where M is an indicator variable for observations in the medium-profitability (ROE) range of a sample and H is an indicator variable for observations in the high-profitability range of a sample. Samples are partitioned on ROE such that each range contains one-third of the observations. The theoretical predictions are $0 \leq \beta_2^M \leq \beta_2^H$ and $0 \leq \beta_4^M \leq \beta_4^H$.

The performance of these regressions originating from the model in Eq. (9.4) is then compared with that of the following earnings-based benchmark model, which has been widely used in the literature:

$$R_{it} = \alpha + \gamma_1 x_{it} + \gamma_2 \Delta x_{it} + e_{it}, \tag{9.7}$$

where $\Delta x_{it} = (X_{it} - X_{it-1})/V_{it-1}$ is the change in firm i's earnings per share in year t relative to year t−1 scaled by the share price at the beginning of year t.

9.3.2 Estimation Results

The empirical sample used in Chen and Zhang (2007b) is extracted from the CRSP daily file, Compustat quarterly and annual files, and I/B/E/S. The sample consists of 27,897 firm-year observations covering the period 1983–2001. The measurement of the regression variables is described in Appendix A. The results discussed below are based on the pooled sample combining all the sample years. The results based on annual regressions are qualitatively the same.

Table 9.1 presents the estimation results for the two regressions in Eqs. (9.5) and (9.6), translated from the theoretical model, and also for the benchmark regression in Eq. (9.7). All five explanatory factors identified in the theory yield a coefficient that is highly significant and has the sign as predicted by the model. The detailed findings are as follows.

Firstly, the coefficient estimate for the earnings variable is close to the theoretical value of one for both regressions models (9.5) and (9.6). It is 0.97 (t = 27.71) in the linear specification, which is not significantly different from one at the 0.05 level and 1.09 (t = 30.79) in the piecewise linear specification which is significantly different from one.

Secondly, the coefficient on the profitability change is 0.76 (t = 20.34) in the linear specification, which is highly significant. In the piecewise linear regression, the base coefficient for the low-profitability range is 0.32 (t = 7.37), which increases to 1.62 in the medium and 1.67 in the high range. The slope increase from the low- to the medium-profitability range is significant and so is the slope incremental from the low- to the high-profitability range.

Table 9.1 Estimation results of the return models

		Model (9.5)		Model (9.6)		Model (9.7)	
Variable	Predicted Value/sign	Estimate (t-value)		Estimate (t-value)		Estimate (t-value)	
Intercept	+/−	0.07**	(19.44)	0.05**	(13.43)	0.08**	(25.52)
x	+1	0.97**,a	(27.71)	1.09**,b	(30.79)	1.21**	(37.26)
Δx	+					0.64**	(21.57)
Δroe	+	0.76**	(20.34)	0.32**	(7.37)		
$M\ \Delta roe$	+			1.30**	(13.54)		
$H\ \Delta roe$	+			1.35**	(15.30)		
Δb	+1	0.31**	(23.38)	0.31**	(23.35)		
Δg	+	2.97**	(26.17)	2.49**	(17.54)		
$M\ \Delta g$	+			0.20	(0.74)		
$H\ \Delta g$	+			2.85**	(8.61)		
Δr	−	−0.08**	(−27.52)	−0.08**	(−27.11)		
Adj. R^2 (%)		16.01[c]		17.40[c]		10.01	

**Significance at the 0.01 level

[a]The coefficient is not significantly different from the predicted value of one at the 0.05 level

[b]The coefficient is significantly different from the predicted value of one at the 0.05 level

[c]Vuong's Z-tests for comparing the models in Eqs. (9.5) and (9.6) with that in Eq. (9.7) yield statistics of 14.53 and 16.17, respectively, both of which are significant at the 0.01 level, indicating Eqs. (9.5) and (9.6) are favored over Eq. (9.7)

Source: Adapted from Table 2 from Chen and Zhang (2007b)

According to the estimated linear model, an *ROE* increase of 1 % is, on average, associated with an equity return increase of 0.45 % (= coefficient (0.76) * median B/M of 0.59). Furthermore, according to the piecewise linear model, the corresponding return increases are 0.19 %, 0.96 %, and 0.99 % for the low-, medium-, and high-profitability ranges, separately.

Thirdly, the coefficient on capital investment, after adjusting by $(1 - B/V)$, is 0.31. While a positive coefficient is consistent with capital investment creating positive NPV, its magnitude here is significantly below the predicted value of one. This might be a sign that the marginal returns earned on incremental investments are below the average returns of a firm (that is, diminishing returns to scale). The prediction that this coefficient is one hinges on the assumption of constant returns to scale in the original ROM.

Fourthly, the slope coefficient on the change in growth opportunity is 2.97 (t = 26.17) in the linear specification. In the piecewise linear model, the estimates are 2.49, 2.69, and 5.34, respectively, for the low-, medium-, and high-profitability ranges, showing an increasing trend as predicted.

Finally, the coefficient on the discount rate change is −0.08 in both regressions. This suggests that on average a discount rate increase of 1 % is associated with a drop in stock price of 4.72 % (= 0.08 * 0.59).

The linear specification in Eq. (9.5) has an explanatory power (adjusted R^2) of 16.0 %, and the piecewise linear specification in Eq. (9.6) has an explanatory power of 17.4 %. In comparison, the benchmark model in Eq. (9.7) obtains an explanatory power of 10.01 % for the pooled sample. Vuong's Z-statistic is 14.53 when comparing the linear regression in Eq. (9.5) with the benchmark model (9.7) and 16.17 when comparing the piecewise linear regression in Eq. (9.6) with Eq. (9.7), both of which are significant at the 0.01 level. This result is in favor of Eqs. (9.5) and (9.6) over the benchmark model.

Chen and Zhang (2007b) also report results from annual regressions (not included in Table 9.1). The average adjusted R^2 across the sample years is 19.65 % for the linear model in Eq. (9.5) and 21.67 % for the piecewise linear model in Eq. (9.6). In comparison, the average adjusted R^2 is 13.26 % for the regression in Eq. (9.7).

9.3.3 Importance of Individual Factors

We now examine the importance of the individual factors in explaining returns. We use two approaches to measure the importance of a factor (and, similarly, a group of factors). Firstly, we evaluate the "standalone explanatory power" (SEP) of a factor, which is the explanatory power of a regression that uses only that factor to explain returns, disregarding the other factors in the theoretical return model. For example, for factor x, SEP(x) = R^2 of the regression using x alone to explain returns.

The second measure, referred to as the "incremental explanatory power" (IEP), indicates the extent to which a particular factor incrementally explains the returns beyond what is already explained by the other factors in the model. For factor x, IEP (x) = [R^2 of the regression in Eq. (9.6) − R^2 of regression in Eq. (9.6) excluding x].

Thus, the SEP measures the total information content of a factor concerning returns (which may or may not overlap the information content of other factors), whereas the IEP measures the unique information content of a factor that is not conveyed by others. The statistical significance of the two measures can be tested using the F-statistic.[1]

The SEP and IEP of a group of factors are defined similarly. In the discounted cash-flow framework, factors may be grouped into the cash flow- and discount rate-related groups. In the return model in Eq. (9.4), four factors are related to cash flows, namely earnings, profitability changes, capital investment, and growth opportunity changes; the fifth factor, discount rate changes, is discounted rate related. In the ROM, a business operation is portrayed in terms of profitability and investment scale, so we may further divide the cash flow-related factors into profitability (earnings and profitability changes) and scale related (capital investment and growth opportunity changes).

[1] These measures have been proposed by Biddle et al. (1995), where they use the term "relative information content" for what we mean by "standalone" information content. The R^2s used to compute the SEPs and IEPs are unadjusted R^2s (as in Vuong 1989; Brown et al. 1999).

Table 9.2 SEPs and IEPs of individual factors in the return model (9.4)

	SEP (%)	IEP (%)
Subset of factors		
Cash-flow factors ($x, \Delta roe, \Delta b, \Delta g$)	15.22**	15.75**
Profitability related ($x, \Delta roe$)	11.59**	9.45**
Scale related ($\Delta b, \Delta g$)	5.88**	4.00**
Discount rate change (Δr)	1.68**	2.21**
Single factor		
Earnings yield x	8.52**	2.84**
Profitability change Δroe	8.49**	2.31**
Capital investment Δb	2.61**	1.65**
Growth opportunity change Δg	3.55**	2.28**
Discount rate change Δr	1.68**	2.21**

**Significance at the 0.01 level

Source: Adapted from Table 4 from Chen and Zhang (2007b)

Table 9.2 presents the empirical results. All five factors of the theoretical return model have a statistically significant explanatory power in explaining returns, in terms of either SEP or IEP, as indicated by the F-statistics. Of these five factors, the earnings yield and the profitability change are the most important, with each alone capable of explaining nearly half of the return variation accounted for by the full model; the SEP of the earnings yield is 8.52 % and that of the change in profitability is 8.49 %. These are followed by the two scale-related factors, with the SEP of the growth opportunity change equal to 3.55 % and that of capital investment equal to 2.61 %.

In terms of the unique information conveyed by individual factors, the earnings yield is most important (IEP = 2.84 %), followed by the profitability change (2.31 %), the growth opportunity change (2.28 %), the discount rate change (2.21 %), and the capital investment (1.65 %). It can be observed that the IEPs of individual cash-flow factors are much smaller than their SEPs, suggesting considerable overlaps in the information content of these variables.

Thus, the cash-flow factors as a group play a much greater role in explaining cross-sectional returns than the discount rate change. Indeed, as already mentioned, each of the cash-flow factors alone has a SEP higher than that of the discount rate change. The SEP of the cash-flow factors as a group is 15.22 %, accounting for 87.5 % of the overall model's explanatory power, whereas the SEP of the discount rate change is 1.68 %, constituting 9.66 % of the model's explanatory power. Among the cash-flow factors, profitability-related factors have a SEP of 11.59 % and an IEP of 9.45 %, whereas scale-related factors (capital investment and growth opportunity shocks) have a SEP of 5.88 % and an IEP of 4.00 %. Thus, information related to firm profitability explains more cross-sectional price movement than information related to scale changes.

9.4 Summary

In this chapter, we provide theory and empirical evidence to show how equity return is related to accounting variables, along with nonaccounting information, that portray a firm's business operations. Based on the ROM of equity value developed in Chap. 4, we derive returns as a function of earnings yield, change in profitability, capital investment, and change in growth opportunity. These cash flow-related factors are complemented by the discount rate change to constitute the "full" set of information which explains returns. Each is linked to a particular aspect of the firm's operations and so plays a unique role in depicting a specific aspect of change in equity value. Empirical evidence generally confirms the predicted effects of the fundamental factors.

Nearly one-fifth of the cross-sectional variations in firm-level returns can be explained by the return model, which is substantially higher than that of the return models adopted in the prior empirical literature. The factors pertaining to cash flow play a greater role in explaining returns, compared with the discount rate change. Among the cash-flow factors, those related to profitability (earnings yield and profitability change) have a greater explanatory power than scale-related factors (capital investment and growth opportunity change).

It has been shown previously that the common risk factors identified in asset pricing research, such as the three factors of Fama and French (1992, 1993, 1995), only have a small power to explain cross-sectional returns at the individual firm level. The empirical results presented in this chapter indicate that accounting variables portraying a firm's business fundamentals are more effective in explaining returns. This suggests that conducting a fundamental analysis which aims to understand a firm's business operations and taking investment positions in accordance with fundamental information can be a fruitful strategy for investors. The theoretical model developed in this chapter offers guidance on what specific accounting information is crucial and how it is translated into equity returns.

Appendix A: Variable Measurement for Empirical Analysis

The stock return (R_t) is the return from 2 days after the prior year's earnings announcement to 1 day after the current year's earnings announcement; earnings yield (x_t) is earnings (X_t) divided by the beginning-of-period market value of equity (V_{t-1}); profitability change (Δroe_{it}) is year t profitability ROE_t minus year t-1 profitability, ROE_{t-1}, multiplied by the beginning-of-period book-to-market ratio (B_{it-1}/V_{it-1}); capital investment (Δb) is the change in the book value of equity relative to the prior year multiplied by $(V_{it-1}/B_{it-1} - 1)/V_{it-1}$; growth opportunity change (Δg_{it}) is the change in the median analyst forecast of the long-term growth rate following the current year earnings announcement relative to that of the prior year multiplied by B_{it-1}/V_{it-1}; discount rate change (Δr_{it}) is the change of the 10-year US Treasury bond yield over the return period multiplied by B_{it-1}/V_{it-1}.

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Chapter 10
An Evaluation of the Return-Earnings Research

Capital markets research in accounting began with inquiries into the relation between equity return and accounting earnings. The collective efforts made by numerous researchers over the past four decades or so have produced a vast body of work on this topic, which is commonly known as the "ERC" (earnings response coefficient) literature. In this chapter, we firstly give a brief account of this research and evaluate it in the context of the return model developed in Chap. 9. Previously, Lev (1989) and Kothari (2001), and others have surveyed and evaluated this literature at its various stages, but not in relation to a specific theoretical model.

A prominent feature of the ERC literature is the overwhelming emphasis on earnings (the income statement) in explaining returns, to the exclusion of information on the other financial statements as well as information from other sources. Although earnings information is vital in driving stock price movement, there is no obvious reason why, say, the balance sheet—the other primary financial statement—should be ignored. In this chapter, we also examine the incremental role of balance-sheet information beyond earnings, both theoretically and empirically.

10.1 A Brief Account of the Return-Earnings Research

Since its inception in the late 1960s, research into the return-earnings relation has been pursued primarily along an empirical path. This line of inquiry has gone through several stages of development, each marked by a series of empirical discoveries that enhance the understanding of the usefulness and limitations of earnings in explaining equity returns. However, the emergence of an extensive empirical literature has not been accompanied by a parallel process of theoretical development that can shed light on how return *should* be related to earnings along with other accounting and nonaccounting information. We therefore have lacked a theoretical framework to unify and integrate the various empirical findings from different studies.

G. Zhang, *Accounting Information and Equity Valuation: Theory, Evidence, and Applications*, Springer Series in Accounting Scholarship 6,
DOI 10.1007/978-1-4614-8160-7_10,

The review in this section is divided into five parts: initial evidence on earnings informativeness, finding the determinants of ERC, mitigating the issue of prices leading earnings, incorporating earnings levels as well as changes, and issues about model specifications.

10.1.1 Initial Evidence on Earnings Informativeness: The Ball and Brown (1968) Study

The ERC literature initially explored the question of whether accounting earnings contain information of use for market investors. While this seems like a modest goal to achieve, it was a significant question at the time, given a backdrop of widespread skepticism over whether accounting data, derived from a mixture of historical costs on transactions occurred at various points in time, was indeed useful to investors. Systematic empirical evidence to shed light on the question was yet to be established.

Ball and Brown (1968) made an initial attempt to document a link between earnings and stock prices.[1] In the absence of a theoretical model to explain the relation between the two variables, a couple of issues needed to be circumvented through careful research design. Firstly, stock prices are influenced by information from different sources, of which corporate reporting is only one. To the extent that reported information overlaps or is correlated with information from other sources, it is difficult to draw causal inferences based on statistical relations between earnings and prices. To mitigate this problem, Ball and Brown (1968) employed the event study methodology to concentrate on the release of annual earnings, a major reporting event.

Secondly, measurement of both the independent (earnings news) and the dependent (the impact on stock price) variables is complicated. The news content of an earnings report is not merely the reported earnings amount because investors already have an expectation prior to its release, and so only the *unexpected* portion is news to them. To compute unexpected earnings, Ball and Brown (1968) use two different proxies for expected earnings. One is the "systematic" portion of earnings which co-moves with an aggregate earnings index (this is analogous to the notion of systematic risk in asset pricing theory), and the other is the prior year's earnings, as justified by the assumption that the time series of earnings is a random walk.

Likewise, the dependent variable should not be measured as the stock price movement around the time of earnings release per se. It is the portion of price changes attributable to earnings news that is of interest; thus, one needs to filter out "normal," or expected, price movement that would have occurred in the absence of earnings news. Ball and Brown apply the capital asset pricing model to determine

[1] A concurrent study by Beaver (1968) examines the impact of earnings reports on return volatility and trading volumes, both of which are beyond the scope of this discussion.

expected returns. The differences between actual and expected returns, referred to as *abnormal* returns, are then attributable to earnings news.

Ball and Brown (1968) divide their sample into good news (GN) and bad news (BN) groups, consisting of observations with reported earnings that are above and below expectations, respectively. They accumulate the mean abnormal returns for both groups over a period from 12 months prior to the earnings announcement to 6 months after it. They find positive cumulative abnormal returns for GN firms that increase gradually, and negative cumulative abnormal returns for BN firms that decrease gradually, over the study period. This is evidence that the earnings report does indeed contain information that is systematically correlated with stock price movement.

Also noteworthy from their study is that prices adjust to the information contained in (or correlated with) reported earnings in a slow and gradual way during the months before and after the earnings announcement. The substantial price run-ups for the GN group, and run-downs for the BN group, over the 12-month period prior to the announcement which they document in their study suggest that the earnings report is not a timely source of information as most of its content has been preempted by other channels by the time it is released. On the other hand, prices continue to drift upward for the GN group and downward for the BN group in the months following the earnings announcement, suggesting that the market does not process the information conveyed in the earnings report quickly. This raises the further question of how efficiently the market is able to process information from earnings releases.[2]

10.1.2 Searching for the Determinants of ERC

The evidence established by Ball and Brown (1968) pertains to *average* price movements of firms in each of the GN and BN groups. Their study does not differentiate between firms within a group. To further understand how earnings information impacts stock prices, subsequent research sought to understand the factors determining the magnitude of ERC; that is, the slope of the return-earnings relation. Evidence in this respect can shed light on when (or for what types of firms) earnings information is more important.

A commonly adopted regression model in short window event studies is

$$AR_t = a + b\Delta X_t + e_t, \tag{10.1}$$

[2] A premise for this type of event study is that the market at least partially reacts to the information in the earnings report. However, it is not necessary that such a reaction be fully efficient. In other words, researchers can still obtain qualitative results that are consistent with a priori predictions even if the market over- or under-reacts to the news from the event.

where AR_t is the abnormal return on a firm's stock over the event window, ΔX_t is the unexpected earnings, and the slope coefficient (b) is ERC. A short event window enables the researcher to reduce the possibility of other, confounding information also affecting returns.

In long event window studies, researchers often use raw returns as the dependent variable and the earnings change (relative to the prior year) as the independent variable. Long window studies are also known as association studies because of the difficulties in drawing causal inferences. The factors influencing ERC should generally be the same in both types of study.

A number of factors have been examined as possible determinants of ERC, including earnings persistence, growth, beta (systematic market risk), financial leverage, and earnings quality. Below, we discuss these factors and related empirical findings. Later, in Sect. 10.2, we show that the effects of these various factors can be reconciled with the predictions of the ROM.

10.1.2.1 Earnings Persistence

Earnings persistence refers to the strength of the relation between current earnings and future earnings. If investors take realized earnings as a basis for forecasting future earnings (cash flows), the strength of this relation determines how powerful earnings news is in causing changes of expectations of future earnings and hence stock prices. Therefore, firms with more persistent earnings will be predicted to have a greater ERC. Consistent with this reasoning, Kormendi and Lipe (1987) and Collins and Kothari (1989), among others, find that ERC is positively correlated with earnings persistence.

However, earnings persistence is conceived primarily as a statistical attribute. While one may estimate it using a sequence of realized earnings (assuming a particular time-series model), it is not a construct naturally revealed by financial statement data. For example, there is no exact correspondence between the classification of earnings items and the level (or range) of persistence. Although persistence helps to explain the impact of earnings on equity value, such a notion is not founded on a well-established theory or solid economic reasoning.[3] It is important to distinguish between a statistical association and an economic (causal) relation. Earnings do not have a life of their own and they do not persist automatically from

[3] The concept is adapted from "the permanent income hypothesis" advanced in the macroeconomics literature (see for example Kormendi and Lipe 1987). However, permanent income as defined in economics is a future-oriented concept whereas accounting income is derived from past transactions. Their distinctly different orientations make it questionable as to whether the former concept can be taken as a suitable benchmark to characterize the latter one. In particular, given that a typical firm's course of operations may evolve along many different directions due to the inherent and evolving uncertainty of the business environment, it is unclear how an accounting system can produce a measure of permanent income on the basis of past transactions.

one period to the next. Rather, they are generated through deploying resources and conducting economic activities.

Thus, a more in-depth view of earnings behavior should be based on an economic analysis of real activities, for example, by looking at a firm's capital investment activity and forecasting the earnings generated from these activities. This is the approach advocated in the ROM framework described in previous chapters. (In Chap. 13, we will further discuss the implications of real options-based valuation for the time-series properties of earnings.)

10.1.2.2 Growth

Collins and Kothari (1989) propose growth as another economic determinant of ERC. In their study, growth refers to capital investments that may or may not be within a firm's existing lines of business. In particular, they argue that since future investment opportunities are not fully conveyed by past earnings (which are the basis for estimating persistence), growth should have an incremental role in explaining ERC beyond persistence. Their empirical evidence is consistent with this prediction.

10.1.2.3 Risk and the Discount Rate

For a given level of expected future earnings and cash flows, equity value decreases with the discount rate. Thus, *ceteris paribus*, the impact of unexpected earnings on stock price will be small for firms with a high discount rate, and vice versa. Several studies have examined how ERC is related to measures of risk and interest rates, which are the key factors determining the discount rate. Easton and Zmijewski (1989) find that ERC is negatively related to systematic market risk (beta). Collins and Kothari (1989) show that ERC is negatively related to the interest rate (a component of the discount rate). Finally, Dhaliwal et al. (1991) report that ERC is smaller for firms with higher financial leverage, which affects a firm's default risk.

10.1.3 Mitigating the Problem of Price Leading Earnings

A concern with contemporaneous return-earnings regressions is that the independent and dependent variables are mismatched in the scope of the information content they cover. Stock prices (and returns) are forward looking in that they anticipate earnings beyond the current period, whereas reported earnings for a given period reflect the activities and transactions which occurred during the period and are generally separate from those in the future.

The inconsistency in the information content between returns and earnings has been considered one of the reasons why the empirical estimate of ERC may be much lower than expected.[4] As Kothari and Zimmerman (1995) and Kothari (2001) observe, the ERC estimate typically ranges from 1 to 3, which is far smaller than the predicted value, say, from the earnings capitalization model of $1+1/r$, which suggests a plausible value of about 7 or higher.

One branch of the ERC research is devoted to mitigating the price-leading-earnings problem. Various refinements to the regression in Eq. (10.1) have been proposed, all of which aim to better align the information content of the dependent and independent variables. These refined regressions mostly involve altering the measurement interval for returns and/or earnings. Although they generally attenuate the original problem to some degree, these models introduce new econometric problems, as explained below.

1. *Extending the earnings period into the future*. Because returns reflect (changes in) expected future earnings, some studies address the price-leading-earnings problem by stretching the measurement interval for earnings forward to include future years, that is, by bringing in actual future earnings as additional explanatory variables (see for example Warfield and Wild 1992). However, realized future earnings contain both the expected and unexpected components, but only the former is reflected in price. Therefore, when actual future earnings are used as a proxy for *expected* future earnings, there is an error (unexpected earnings) in the independent variables, causing an errors-in-variables problem.
2. *Extending the return period into the past*. A second method is to stretch the measurement internal for returns backward to include the previous as well as the current year (see, for example, Kothari and Sloan 1992). The rationale for this is that a portion of the information in current earnings should have already been anticipated by the market in the previous period, so the independent variable in Eq. (10.1) is related not only to the current return but also to the previous period return. A limitation in this method is that past returns are partly related to past earnings that are not included in the regression. As a result, simply altering the measurement window this way for returns causes an omitted variables problem (i.e., omission of past earnings).
3. *Expanding the measurement periods for both returns and earnings*. Association studies typically measure earnings and returns over a natural reporting period, such as a year. Easton et al. (1992) extend the measurement window for both returns and earnings to multiple years, ranging from 2 to 5 years, in their analyses. As the measurement window widens, there is more overlap in the information captured by the dependent and independent variables, which then eases the price-leading-earnings problem. A drawback of this design is that it amounts to altering the original research question: how earnings information

[4] Other reasons for a low ERC which have been suggested in the literature include transitory earnings (see for example Freeman and Tse 1992) and noise in reported earnings (see for example Beaver et al. 1980). See Kothari (2001) for a detailed discussion of this point.

reported over regular time intervals helps to update firm value. Investors need to reassess a firm's value when an earnings report is released; they do not wait for 2 or 3 years.

4. *Incorporating analyst forecasts*. Unlike the above methods, all of which focus on expanding the measurement window, Liu and Thomas (2000) address the price-leading-earnings problem by directly incorporating expected future earnings in return regressions. They start with the RIM and show that unexpected returns should be related to both contemporaneous unexpected earnings, as in the original regression in Eq. (10.1), and changes in expected future earnings, for which they use revisions in analyst earnings forecasts as a proxy. With this extension, the earnings change variable in Eq. (10.1) is no longer required to also convey future earnings. Liu and Thomas (2000) predict that, after controlling for changes in expected future earnings information, the coefficient on the earnings change has a theoretical value of 1. They find evidence that is largely consistent with this prediction. Although their model, so specified, is theoretically sound and does not suffer from the same econometric issues as the other refinement methods described above, it no longer addresses the original research objective, which is to understand how information from financial reporting affects stock prices. The return model of Liu and Thomas (2000) involves not only reported information but also information already processed by market participants. A missing link is how analysts generate earnings forecasts based on the raw data reported by the firm (together with information from other sources).

A feature common to all the above return models is that only earnings variables (past, current, and future) are used as explanatory factors. While this appears to be a natural extension of the early studies such as Ball and Brown (1968) and Beaver (1968) that focus on earnings releases, there is no theoretical basis on which to conclude that earnings alone carry all the financial information that investors need. If the reported earnings for a period do not adequately explain contemporaneous returns (due to, for example, price leading earnings), a pertinent question is how the explanatory variables used for explaining returns should be expanded to incorporate other financial statement information and information outside financial statements. The return model in Chap. 9 addresses this question to some extent (see the discussion in Sect. 10.2 below).

10.1.4 Incorporating Both Earnings Levels and Changes in a Return Model

While early ERC studies focused on using unexpected earnings (or earnings changes or growth) to explain (abnormal) returns, later research also introduced the earnings level alongside with the earnings change in a return model. Easton and Harris (1991) show that the two earnings variables can be justified based on two different views of how financial statements convey value-relevant information.

Easton and Harris (1991) first take a balance-sheet perspective to demonstrate that the level of earnings is a valid explanatory factor. Specifically, by viewing equity book value as a proxy for equity value, they assume $V_t = B_t + u_t$, with the discrepancy, $u_t \equiv V_t - B_t$ treated as a residual term.[5] Taking changes of this equation from date t−1 and to date t yields $\Delta V_t = \Delta B_t + u_t'$ where $u_t' \equiv u_t - u_{t-1}$. Assuming the CSR so that $\Delta B_t = X_t - d_t$, they express return as a function of earnings as

$$R_t \equiv \frac{\Delta V_t + d_t}{P_{t-1}} = \frac{X_t}{P_{t-1}} + u_t'' \tag{10.2}$$

where $u_t'' \equiv u_t'/P_{t-1}$ is also treated as a residual. Equation (10.2) justifies using the earnings level as an explanatory factor for returns.

Alternatively, from the income-statement perspective, Easton and Harris set equity value to equal earnings capitalization, $V_t = kX_t + \varepsilon_t$, where ε_t is random noise. They then argue that because of dividends irrelevance (Miller and Modigliani 1961), this equation can be "rewritten" as $V_t + d_t = kX_t + \varepsilon_t$. From here, Easton and Harris obtain an alternative return function, expressed in terms of the earnings change:

$$R_t \equiv \frac{\Delta V_t + d_t}{P_{t-1}} = k\frac{\Delta X_t}{P_{t-1}} + \varepsilon_t', \tag{10.3}$$

where $\varepsilon_t' \equiv \varepsilon_t/P_{t-1}$ is a residual term.[6]

Finally, Easton and Harris (1991) pool the two earnings variables to form a more comprehensive model for empirical analysis

$$R_t = a + b_1(X/P_{t-1}) + b_2(\Delta X_t/P_{t-1}) + e_t. \tag{10.4}$$

The regression in Eq. (10.4) has been widely adopted in empirical studies. Evidence shows that returns are indeed significantly correlated with both contemporaneous earnings and earnings changes.

On a theoretical basis, however, the above analysis does not justify including both the earnings level and the change in a single regression. In Easton and Harris (1991), the two specifications stem from alternative (and seemingly mutually exclusive) views of how equity value is related to accounting variables. They do

5 Generally speaking, it is overly simplistic to treat the difference between market value and book value (u_t) as a random noise. In essence, this difference, known as unrecorded goodwill, represents what a firm contributes to investors, and determining the amount of value creation is at the heart of the valuation exercise.

6 There appear to be two technical flaws in the derivations of Easton and Harris (1991). Firstly, they initially treat V_t as cum-dividend value but then switch its meaning to ex-dividend value after bringing d_t into the equation. Secondly, after taking changes of the value function, they retain d_t in its original (unchanged) form.

not explain the circumstances under which one specification prevails over the other, and why (and how) the two should be combined into one equation.

Issues concerning variable specifications are discussed further below.

10.1.5 Alternative Specifications for Earnings and Return Variables

There has been much debate in the ERC literature over how the dependent and independent variables should be specified in a return-earnings regression. This subsection provides a summary of the various viewpoints expressed in the extant literature.[7]

10.1.5.1 Justification for Regressions of Abnormal Return on Unexpected Earnings

If earnings follow a random walk, then abnormal return is simply a function of unexpected earnings. Ohlson and Shroff (1992) provide a model to show that unexpected earnings are the theoretically correct explanatory factor for returns if investors forecast future earnings solely on the basis of current earnings, but this conclusion does not hold if information other than current earnings *also* aids in earnings forecasting. In the latter scenario, unexpected earnings are no longer sufficient for predicting future earnings, and consequently the regression in Eq. (10.1)—which relies on unexpected earnings alone to explain abnormal returns—becomes misspecified.

10.1.5.2 The Earnings Level Versus the Earnings Change

As described above, Easton and Harris (1991) justify earnings levels and earnings changes as explanatory factors from two different views of equity value, but they do not evaluate the validity of one versus the other on a theoretical basis. Ali and Zarowin (1992) posit that the usefulness of earnings levels and changes depends on whether earnings are transitory or permanent. If the former, the level specification should be adopted whereas, if the latter, the change specification should be used. Note that if earnings are transitory (and hence will vanish next period), the change in earnings next period (relative to the current period) is expected to become equivalent to the earnings level.

[7] Some of the studies discussed below also touch on using price levels (versus returns) as the dependent variable.

Kothari (1992) shows that in a price-earnings regression, the earnings level (not the change) is the correct explanatory factor if prices anticipate earnings *changes* one period ahead. If, however, prices anticipate future earnings changes for two or more periods, neither the earnings level nor the change is a proper proxy for unexpected earnings (the theoretically correct explanatory factor in the setting Kothari (1992) examines), and the coefficient will be biased if either variable is used to explain returns. But between the two specifications, the coefficient will be less biased for the earnings level (versus the change).

Ohlson and Shroff (1992) show that whether the level or the change should be used depends on the time-series properties of earnings. They assume that earnings follow a linear stochastic process in which current earnings and (unidentified) "other" information combine to form expectations of future earnings. In their theoretical setting, unexpected earnings are *not* the correct explanatory variable insofar as future earnings depend on innovations in other information in addition to current earnings. One observation is that in Ohlson and Shroff (1992), dividends are modeled in such a way that capital investments implicitly have zero NPV.

10.1.5.3 Regressions of Prices Versus Returns

In earnings-based valuation studies, the dependent variable can be either equity value or equity return. The general objective of this line of research, known as the "information-perspective" research, is to demonstrate the usefulness of earnings information for equity investors in general. In the absence of a theoretical model for either value or return, researchers typically prefer regression models that are less subject to misspecifications and econometric issues; they do not particularly care which dependent variable is involved in statistical analysis even though value and return represent two distinct (albeit related) economic variables. What *is* generally acknowledged is that earnings information alone is not sufficient for explaining either value or return.

Gonedes and Dopuch (1974) claim that in the absence of a rigorously developed theoretical model, return regressions should be preferred to price regressions because they mitigate the problem of omitted variables in price functions.

On the other hand, Kothari and Zimmerman (1995) express a preference for price regressions. They argue that because prices anticipate future earnings, a portion of the information in current earnings is already stale for explaining returns, thus causing an errors-in-variables problem with return regressions. In contrast, price regressions are not subject to this problem as prices reflect the total information in earnings including the stale portion. A drawback of this, however, is that because prices reflect future earnings beyond current earnings, price regressions cause an omitted variables problem when only realized earnings are used as the explanatory factor. Nonetheless, Kothari and Zimmerman (1995) argue that this does not bias the earnings coefficient insofar as future earnings changes are not correlated with current earnings.

10.2 A Critique of the Return-Earnings Research in the Framework of the ROM

In this section, we evaluate the ERC literature within the framework of the ROM in order to understand better both the validity and limitations of this line of research. We first explain that the setting implicitly assumed in the ERC research is quite restrictive and so is of limited interest economically. We then show that many of the empirical findings concerning the properties of ERC can be reconciled with the ROM. Finally, we further evaluate the conceptual validity of earnings levels and changes as explanatory factors for returns.

10.2.1 Restrictive Economic Settings Underlying ERC Research

A characteristic of the ERC research is its exclusive focus on using earnings information to explain returns, with little attention being paid to the balance sheet and other sources of information. Underlying this research is the assumption that the earnings dynamic can be represented by a specific time-series process (see Kothari 2001).

According to the ROM, equity value comprises both earnings capitalization and the options to abandon and grow the operation. In assuming that equity value or returns depend only on earnings, this literature essentially ignores the part of value that is attributable to real options. This can be justified only in special cases, for example, where a firm's operations are expected to remain in a steady state, with little or no chance of undergoing significant changes in scale or scope, or where capital investments have zero NPV (as in Ohlson and Shroff 1992) so that changes in scale entail no consequence for investor wealth. However, such settings are restrictive and economically uninteresting because they correspond to an environment where managing business operations is a trivial task and accounting takes no substantive role in decision making.

Due to the restrictiveness of the underlying economic settings, only a limited set of information is required for explaining returns. With earnings assumed to follow a specific time-series process whereby future earnings are forecasted solely on the basis of realized earnings, there is no need for information from the balance sheet and beyond.[8] Because the earnings process is assumed to be linear, the ERC research has been conducted in the context of linear models of value and returns.

[8] An exception is Ohlson and Shroff (1992), who incorporate (unspecified) "other" information in their linear dynamic, thus giving rise to other information as an additional factor in explaining returns. However, they do not elaborate on the source of this other information nor how it affects earnings generation.

As shown in the previous chapters, the ROM approach addresses these limitations. When firms have flexibility to adjust operations, balance-sheet information also becomes important for investment decisions, and equity value (and return) emerges as a nonlinear function of accounting variables.

10.2.2 Properties of the ERC as Implied by the ROM

We now reexamine the return-earnings relation in the framework of ROM. We show that the properties of ERC implied by the ROM are consistent with the empirical findings documented in the ERC research. Furthermore, according to the ROM, the magnitude of the ERC can be either greater than or less than the often accepted benchmark value of (1+1/r) which is derived from the earnings capitalization model. It can vary widely depending on a firm's operational status.

For the discussion below, we employ the return model in Eq. (9.4) in Chap. 9 as the theoretical basis (which is derived from the original ROM), but ignore the nonaccounting variables in the model, namely changes in both growth opportunities and the discount rate. We also focus on short event windows for measuring returns. As a result, the capital investment variable in the model specified in Eq. (9.4) can also be ignored. This leads to a simplified return function

$$AR_t = \frac{\Delta X_t}{V_{t-1}} + \left(v_1 \frac{B_{t-1}}{V_{t-1}}\right) \Delta ROE_t, \tag{10.5}$$

where $v_1 \equiv dv/d(ROE_{t-1})$.

With book value changing little over the return period, we have $\Delta X_t \approx \Delta ROE_t \times B_{t-1}$, implying that ΔX_t is highly correlated with ΔROE_t. Therefore, over a short event window, we have

$$AR_t \approx \frac{\Delta X_t}{V_{t-1}} + \left(v_1 \frac{B_{t-1}}{V_{t-1}}\right) \Delta ROE_t \approx [1 + v_1(ROE_{t-1}, g, r)] \frac{\Delta X_t}{V_{t-1}}, \tag{10.6}$$

where ΔX_t and ΔROE_t in Eq. (10.6) should be interpreted as unexpected changes in earnings and in profitability, respectively, as conveyed by the earnings report.

Equation (10.6) predicts the following properties of ERC (the slope coefficient). Firstly, ERC increases with profitability (*ROE*); secondly, it increases with growth opportunity (g); and thirdly, it decreases with the discount rate (r). Furthermore, in the original ROM in Eq. (4.11), which underlies Eq. (10.6), profitability is assumed to follow a random walk, so by extension, it would be easy to envisage a fourth property, namely, that ERC should increase with the persistence of profitability. These qualitative properties thus provide theoretical support for the empirical results concerning the determinants of ERC that are summarized in Sect. 10.1.2. Equation (10.6) thus rationalizes and unifies these findings.

In Eq. (10.6), the magnitude of the ERC is given by $1 + v_1(ROE_{t-1}, g, r)$. As discussed in Chap. 5, the theoretical value of $v_1(ROE_{t-1}, g, r)$ varies over a wide range, from near to zero for firms with very low (including negative) profitability to an amount above the earnings capitalization factor. Therefore, within the ROM framework, ERC is predicted to span a wide range from near 1 in the very low profitability region to a value exceeding (1+1/r) in the high profitability regions, and it also increases with a firm's growth opportunities. The benchmark value of (1 + 1/r) often considered in the ERC literature is appropriate only for firms operating in a steady state.

10.2.3 Does the ROM Justify Both Earnings Levels and Earnings Changes for Returns?

As described above, Easton and Harris (1991) develop a regression model that incorporates both the earnings level and change to explain returns. In Eq. (9.4), equity return is a function of earnings (among other factors), but not the earnings change. Thus, in the context of the ROM, using the earnings level as an explanatory variable is theoretically justified, as it represents the value generated (realized) during the period. However, the ROM does not also justify using the earnings change as a theoretical construct for return.

Notwithstanding its lack of theoretical status, the earnings change can still play a *statistically* significant role in a return regression. In Eq. (9.4), return is also related to the profitability change, a variable that is typically highly correlated with the earnings change. Thus, if controlling for earnings, the earnings change is expected to have a statistically significant effect (insofar as the regression does not also include the profitability change). However, it needs to be clear that in this context, the earnings change merely serves as a surrogate for the profitability change. An exception is when firms are operating in a steady state such that their capital basis stays constant from one period to the next, and so the profitability change is equivalently represented by the earnings change, in which case the latter has a clear *economic* meaning.

In general, therefore, earnings change should not be treated as a primitive variable. It can be triggered by a change in profitability or book value (due to capital investment), and the implication for return is different for earnings arising from these two sources. Specifically, an earnings increase caused by increased *ROE* is unequivocally good news for investors and so it always has a positive impact on returns. On the other hand, an earnings increase caused by increased equity capital may or may not be good news for investors, depending on whether the amount of the increase is sufficient to compensate for the cost of the additionally invested capital; as a result, this can have either a positive or negative impact on return. These points have been demonstrated in Chap. 9. On a related note, Balachandran and Mohanram (2012) also find that changes in earnings related to profitability changes are more highly associated with return than changes in earnings resulting from capital investment.

In short event windows, return arises from the earnings surprise. In this case, the earnings level variable in Eq. (9.4) should be replaced with unexpected earnings, and the profitability change replaced with unexpected profitability. To the extent that equity book value does not change over a short window, the unexpected profitability change is equivalently represented by unexpected earnings, thus yielding a simplified function that depends only on the latter. As a result, over a short event window, balance-sheet information may be ignored.

10.2.4 How Does the ROM Address Prices Leading Earnings?

We discussed the issue of price leading earnings in Sect. 10.1.3. Studies in the ERC literature attempt to mitigate this issue by adjusting the measurement intervals for either returns or earnings so as to achieve a closer alignment in the scope of the information covered by earnings and returns. However, as explained, these studies also suffer from other econometric issues.

The return model in Eq. (9.4) and its simplified version in Eq. (10.5) provide an alternative way to address the concern of price leading earnings. The original problem in return-earnings regressions arises because prices reflect a richer set of information relevant to forecasting future earnings (cash flows) than do current earnings. But whatever information is reflected in prices, it must be observable to investors. Accordingly, we ought to expand the scope of the information set by bringing in other *observable* information over and above earnings, rather than actual future earnings not yet observed by investors.

The model specified in Eq. (9.4) is consistent with this approach, whereby return is related to an expanded set of accounting and nonaccounting information observable to investors. In this model, balance-sheet information is used to compute capital investment and profitability, and nonaccounting information concerns changes in growth opportunity and the discount rate. In addition, earnings information remains a vital part of the information set. It is important to note that these individual variables all have clear economic roles to play, and they complement each other to tell a coherent story about how investors' wealth has changed over a given period. This approach is more relevant to investors in regard to carrying out financial analyses and valuation exercises based on the information available to them.

10.3 Further Examining the Incremental Usefulness of Balance-Sheet Information

Having explained the limitations of earnings-based valuation research in the previous section, we now explore what incremental role the other primary financial statement, the balance sheet, plays in explaining returns. While the return model discussed in Chap. 9 already involves balance-sheet and nonaccounting information, our discussion in this section focuses exclusively on the (incremental) usefulness of the balance sheet beyond earnings. We first employ existing equity value models to illustrate how balance-sheet information matters to returns and then empirically assess its usefulness. The material in this section is drawn from Huang and Zhang (2012).

10.3.1 Bringing Balance-Sheet Information into Return Models

Huang and Zhang (2012) employ two different models of equity value to identify which balance-sheet information is relevant to returns: Ohlson's (1995) linear model and Zhang's (2000) ROM. Both models have been investigated in previous chapters.

The return model developed on the basis of Zhang (2000) involves five explanatory factors, which are shown by Eq. (9.4) in Chap. 9. To focus on the role of accounting variables, Huang and Zhang (2012) consider a reduced version of Eq. (9.4) that ignores nonaccounting information as follows:

$$R_{t+1} = \left[\frac{X_{t+1}}{V_t}\right] + v' \left[\frac{B_t}{V_t}\Delta ROE_{t+1}\right] + \left[\left(\frac{V_t}{B_t} - 1\right)\frac{\Delta B_{t+1}}{V_t}\right]. \tag{10.7}$$

The accounting variables in Eq. (10.7) are earnings (X_{t+1}), changes in *ROE* relative to the prior period (ΔROE_{t+1}), and equity capital investment (ΔB_{t+1}). The balance sheet is useful in two ways: (1) it reports capital investment, and (2) in conjunction with earnings, it helps to determine profitability (*ROE*).

Ohlson (1995) provides an alternative equity value function. Assuming that residual income follows an AR(1) process, he derives the following linear function (see Chap. 2)

$$V_t = k(\varphi X_t - d_t) + (1 - k)B_t, \tag{10.8}$$

where $k \equiv r\omega/(1 + r - \omega)$, with ω being the persistence of residual income, and $\varphi \equiv (1 + r)/r$. The return model following from Eq. (10.8) is

$$R_{t+1} = \frac{X_{t+1}}{V_t} + k(\varphi - 1)\frac{\Delta X_{t+1}}{V_t} - k\frac{\Delta B_t}{V_t}, \tag{10.9}$$

where $\Delta X_{t+1} \equiv X_{t+1} - X_t$. In Eq. (10.9), return is related to the prior period's capital investment in addition to earnings and the earnings change. Given earnings, lagged capital investment (ΔB_t) matters for returns (R_{t+1}) due to the need to recognize the cost of the additional capital invested in the previous period. The coefficient on ΔB_t is predicted to be negative. Note, however, that in the work of Ohlson (1995) where capital investments have zero NPV (see Chap. 2), return does not depend on contemporaneous capital investment.

10.3.2 Empirical Research Design

Huang and Zhang (2012) recognize that certain aspects of the models of Ohlson (1995) and Zhang (2000) are complementary. Specifically, Zhang (2000) incorporates the effect of real options on equity value, reflecting a firm's ability to change the course of operations as circumstances warrant, a feature missing from the model specified by Ohlson (1995). On the other hand, Zhang (2000) assumes that the firm keeps the scale of operations constant in the period prior to the valuation date such that lagged capital investment can be ignored, a restriction not imposed by Ohlson (1995). For this reason, Huang and Zhang (2012) use the following regression that encompasses all explanatory factors identified in Eqs. (10.7) and (10.9):

$$R_{it} = \alpha + \beta_1 x_{it} + \beta_2 \Delta x_{it} + \beta_3 \Delta ROE_{it} + \beta_4 H_{ROE} \Delta ROE_{it} + \beta_5 \Delta b_{it} + \beta_6 \Delta b_{it-1} + e_{it}. \tag{10.10}$$

In Eq. (10.10), equity return is regressed on five different accounting variables; earnings yield $(x_{it} = X_{it}/V_{it-1})$, scaled earnings change ($\Delta x_{it} = (X_{it} - X_{it-1})/V_{it-1})$, profitability change $(\Delta ROE_{it} = ROE_{it} - ROE_{it-1})$, scaled capital investment $(\Delta b_{it} = (B_{it} - B_{it-1})/V_{it-1})$, and scaled lagged capital investment $(\Delta b_{it-1} = (B_{it-1} - B_{it-2})/V_{it-1})$. This regression also allows the coefficient on ΔROE_{it} to change from the low-*ROE* to the high-*ROE* region of a sample, with H_{ROE} as an indicator variable for observations in the high- (versus low-) *ROE* region; the theoretical prediction is that the coefficient on ΔROE_{it} increases with *ROE* (see Chap. 9), $\beta_4 > 0$. In the regression specified in Eq. (10.10), Δx_{it} and Δb_{it-1} originate from Ohlson (1995), ΔROE_{it} and Δb_{it} from Zhang (2000), and x_{it} from both models.

To evaluate the incremental usefulness of balance-sheet information beyond earnings, Huang and Zhang (2012) compare the performance of the regression specified in Eq. (10.10) with the following earnings-only-based regression (Easton and Harris 1991),

Table 10.1 Incremental role of balance sheet-related variables in explaining returns

Variable	Intercept	x_{it}	Δx_{it}	ΔROE_{it}	$H_{ROE}\,\Delta ROE_{it}$	Δb_{it}	Δb_{it-1}	R2
Predicted sign		+	+	+	+	+	−	
Reg. (10.10)	0.09[a]	1.02[a]	0.30[b]	**0.15**[a]	**0.38**[a]	**0.28**[a]	**−0.13**[b]	0.090
	(3.23)	(3.56)	(2.56)	**(4.02)**	**(7.19)**	**(4.89)**	**(−2.56)**	
Reg. (10.11)	0.10[a]	1.11[a]	0.84[a]					0.076
	(3.27)	(4.27)	(7.08)					

[a] and [b] indicate that the coefficient is significantly different from zero at the 0.01 and 0.05 levels, respectively

Source: Extracted from Table 2 from Huang and Zhang (2012)

$$R_{it} = \alpha + \beta_1\, x_{it} + \beta_2\, \Delta x_{it} + e_{it}. \qquad (10.11)$$

Empirical analysis is conducted to address two issues: (1) whether the variables involving balance-sheet information (Δq_{it}, Δb_{it} and Δb_{it-1}) all have the predicted effect and (2) whether the balance-sheet variables improve the explanatory power, as measured by the IEP (defined in Chap. 9). The sample used by Huang and Zhang (2012) is obtained from the Compustat annual file, which comprises 87,439 firm-year observations for the period 1968–2007.

10.3.3 Evidence from Overall Samples

Table 10.1 presents the regression results based on the pooled sample. For the regression in Eq. (10.10), the three balance sheet-related variables all have a significant effect on return. The coefficient on ΔROE_{it} is 0.15 in the low-*ROE* region and increases to 0.53 (=0.15+0.38) in the high-*ROE* region, both of which are significant at the 0.01 level. The coefficient on capital investment (Δb_{it}) has a positive value of 0.28, which is significant at the 0.01 level, whereas that on lagged capital investment (Δb_{it-1}) has a negative value of −0.13, significant at the 0.05 level. These results are consistent with the theoretical predictions. In addition, the two earnings variables—levels and changes—both have a significantly positive effect on returns.

For the benchmark model specified in Eq. (10.11), the two earnings variables are also highly significant, but the magnitude of these coefficients changes substantially from that in the regression in Eq. (10.10) because the effects of the omitted balance-sheet variables have also been loaded onto them. In particular, the coefficient on the earnings change is highly sensitive to whether or not balance-sheet information is also present. This coefficient is only marginally significant in Eq. (10.10), where the balance sheet-related variables are included, and is substantially greater in Eq. (10.11) where they are omitted.

Vuong's Z-test for comparing the two models indicates that by including the balance-sheet variables, the model in Eq. (10.10) performs significantly better than that in Eq. (10.11). Further analysis conducted by Huang and Zhang (2012) demonstrates that each of the three balance sheet-related variables alone statistically improves the performance of the return model. Among the three, the change in *ROE* has the greatest impact, with the effect of the two capital investment variables being smaller.

10.3.4 Complementarity Between Balance-Sheet and Income-Statement Information

Having demonstrated the incremental usefulness of balance-sheet information in general, we now examine how its usefulness complements that of earnings. We take both a time-series and a cross-sectional perspective to address this question.

10.3.4.1 Time-Series Evidence

For each annual sample, Huang and Zhang (2012) compute the explanatory power of earnings obtained from regression model Eq. (10.11), denoted as $R^2(earnings)$, and the incremental explanatory power of balance-sheet information, denoted as *IEP*(*BS*), which is calculated as the R^2 difference between the models in Eqs. (10.10) and (10.11). To explore the relation between the two measures, they regress *IEP*(*BS*) on $R^2(earnings)$ with a control for a possible time trend. The slope coefficient is −0.19, which is significant at the 0.01 level. This indicates that balance-sheet information plays a greater incremental role in the years when earnings are less informative, and vice versa. This complementary is also evident from Fig. 10.1, which plots the trends of the two informativeness measures over time.

10.3.4.2 Cross-Sectional Evidence

Huang and Zhang (2012) also examine how the usefulness of balance-sheet variables varies across different firm groups. The general finding is that balance-sheet variables are incrementally more informative beyond earnings for firm groups where earnings are less informative; these include firms making losses (as opposed to profitable ones), firms with a shorter history of being publicly listed, and firms with greater uncertainty about future earnings (using dispersion of analyst earnings forecasts as a proxy).

Also, for all the subsamples considered, the three balance-sheet variables as a group significantly improve the explanatory power of the return model relative to the earnings-based benchmark model in Eq. (10.11), which reaffirms the finding from the overall sample. Individually, the change in *ROE* and contemporaneous

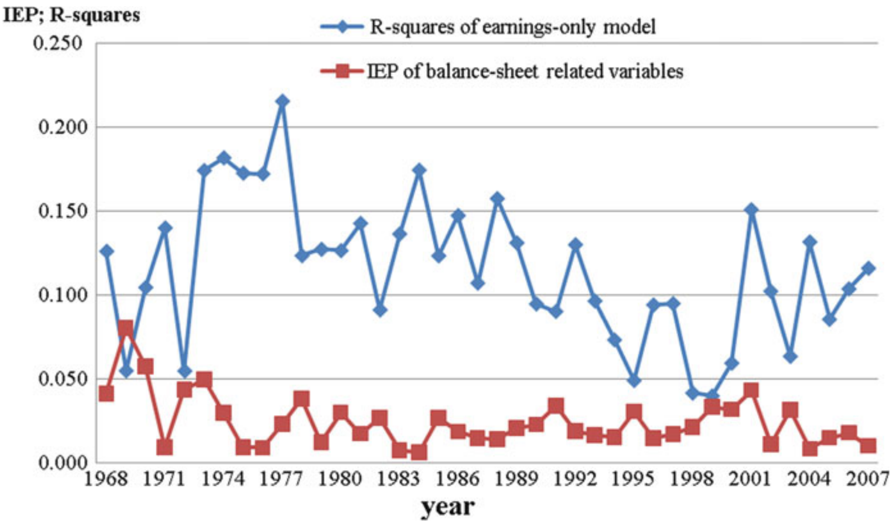

Fig. 10.1 IEP of balance-sheet information versus the explanatory power of earnings over time. *Source: Fig. 1 from Huang and Zhang (2012)*

capital investment both have a significant effect, but the effect of lagged capital investment becomes insignificant in some of the subsamples.

10.4 Summary

This chapter revisits the long line of research examining return-earnings relations, the so-called ERC literature. We firstly give a brief account of this literature and then summarize its main findings, before evaluating it in the context of the ROM. Many of the empirical findings about the ERC can be rationalized by the ROM. A key limitation of this literature is its exclusive focus on earnings information without considering the usefulness of balance-sheet data. Finally, this chapter shows how balance-sheet information augments earnings in a return model and how it complements the role of earnings.

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Chapter 11
Fair Value Accounting and Income Measurement: An Application to Standard Setting

In this chapter, we employ the ROM framework outlined in previous chapters to address the relevance of fair value accounting for equity valuation purposes. In recent times, companies worldwide are increasingly required to adopt fair value measurement for financial reporting, moving gradually away from the historical cost convention. This shift is widely believed to have important ramifications for both firms and user groups, but its exact impact is not yet well understood. By extending the ROM developed in previous chapters, we explore here how, and to what extent, fair value measures help to convey an enterprise's income generation in a way that is pertinent to equity investors.

More specifically, we adopt here a "financial analysis" perspective to investigate the usefulness of fair value accounting for conveying valuation-relevant information, given the economic activities undertaken by the firm. This position is consistent with the expressed objective of financial reporting (for example, the FASB SFAC5) of facilitating valuation by investors and other users.[1] This line of research has potential for informing standard setters on issues such as the scope for adopting fair value measurement within financial statements and how to define and measure an enterprise's performance.

[1] Issues related to debt and executive contracting are outside of the scope of this discussion. Also, we do not adopt a "general-equilibrium" approach to probing the effect of fair value accounting on firms' real decisions and on economy-wide resource allocation that operates through the information set which firms face. We implicitly maintain that when investors receive more relevant information about a firm's operations, prices will be more informationally efficient, and this in turn will improve resource allocation.

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11.1 Motivation

The US FASB began to make significant moves towards fair value accounting in the 1990s with the releases of such standards as SFAS 115 (for investment securities) and SFAS 133 (for derivative securities), aimed to make financial statement information more closely reflect *current* economic transactions. To date, a series of fair value standards have been issued by the FASB and the International Accounting Standard Board (IASB) for selected assets and liabilities, and the scope of adaptation is likely to be further broadened. As countries around the world strive to converge their respective GAAP standards with the IFRS, a global trend is underway to embrace the expanded use of fair value accounting.

Despite its intuitive appeal, however, fair value accounting remains controversial, not only because in many instances such measures are not readily observable (and so need to be subjectively estimated) but more fundamentally because the conceptual basis for using fair value (as opposed to historical cost) is yet to be firmly established. Thus far, much of the debate has centered on whether fair value measures are reliable and whether managers can misuse the rules for personal gains (see, for example, Barth (2004) and Benston (2008) for views both for and against fair value accounting). However, there is still very little theoretical research demonstrating the usefulness (or lack thereof) of fair value accounting for the purposes of investor valuation.[2]

Meanwhile, there is clearly demand in standard setting circles for conceptual research that can potentially guide the formulation of reporting standards. To give an example, in the joint work of the IASB and the FASB on the Financial Performance Reporting Project (FPR) which started in 2004, both conceptual and presentational issues pertaining to performance reporting have been raised and discussed, many of which either directly concern fair value measures or are intertwined with them. They include, among others, the meaning of income (IASB/FASB 2005a), the distinction between net income (NI) and other comprehensive income (OCI) (IASB/FASB 2005a), whether it is a good idea to separately present fair value changes (remeasurements) from other income and expenses (IASB/FASB 2005b), and what criteria/characteristics should be used when determining whether a transaction or item should be included in NI versus OCI (IASB/FASB 2005b). This last point concerns a long list of items such as unrealized gains and losses in available for sale (AFS) securities, gains and losses from foreign currency translation adjustments, revaluation of property, plant, and equipment (PP&E), pension liability adjustments, and so on.

[2] Indeed, as Lambert (2010, p. 294) observes, there is a lack of theoretical research into the valuation role of accounting in general. In contrast, several studies have explored the desirability of fair value accounting in resolving issues related to debt financing (see for example Bleck and Gao 2010; Lu et al. 2011).

In the absence of a considered theoretical framework, individuals tend to make subjective judgments from their own vantage points based on their own unique experiences. Presently, views on the above-mentioned and other issues related to fair value accounting often diverge among standard setters, and practices differ across individual jurisdictions. To shed theoretical light on these debates and discussions, it will be useful to develop a rigorous model that can explain how and why fair value information is relevant to investors. This chapter makes an initial attempt towards this aim.

11.2 Economic Setting and Equity Valuation

The valuation problems examined in previous chapters have typically been simplified, with firms conducting only "operating" activities. To make the topic of fair value accounting nontrivial, we extend such basic settings along two dimensions. Firstly, we assume that a firm conducts "financial" as well as operating activities (as in Feltham and Ohlson 1995). Financial activities are of a *trading* nature whereby the firm acquires assets and holds them passively for subsequent resale. Financial activities correspond to the exchange sector of an economy, and in performing them, the firm's role is merely one of a trader. In contrast, in conducting operating activities, the firm uses (and typically consumes) assets as an input to producing the final product. Operating activities correspond to the real sector of the economy, which most directly contributes to wealth creation.[3]

Secondly, we assume that both financial and operating assets are traded in their respective markets, and their prices fluctuate over time in ways exogenous to the firm. The scope of the analysis is limited to the financial reporting aspects of a firm, and we treat as given the firm's economic activities and the external environment (in particular, the market conditions) facing the firm. For simplicity, the firm is assumed to be fully equity financed. In the analysis below, we take period t+1 (starting from date t) as a representative period for measuring firm performance.

Let P_t^f be the combined market price of the firm's financial assets held at date t. At date t+1, the price of these same assets changes to $P_{t+1,existing}^f$. During period t+1, the firm receives interest FX_{t+1} on its financial assets (paid at the end of the period).

[3] The terms "financial" and "operating" here identify activities or assets based on the firm's intended business purposes, and their meanings do not necessarily coincide with the conventional use of these terms. For example, a financial asset here can be a security or a physical asset such as land. We consider the two types of activities in their "pure" form in order to highlight their different implications for accounting. In more general settings, the boundary separating the two classes of activities can sometimes be blurred as the firm may potentially switch from one intention to the other when circumstances change. Research into this type of mixed scenario is a topic for the future.

The set of financial assets held by the firm at date t+1 generally differs from that at date t owing to transfers between financial and operating activities, on the one hand, and transactions with the firm's investors on the other. We denote P^f_{t+1} as the combined market price of the financial assets held at date t+1.

The firm's operating assets have a total market price of P^o_t at date t. During period t+1, the price index of operating assets changes by θ_{t+1} (in proportional terms). This means that the same set of operating assets at date t would have a market price of $(1 + \theta_{t+1})P^o_t$ at date t+1. To keep the exposition simple, we assume that the firm employs a single operating asset (this can be interpreted as the mixture of the different individual assets actually used).

The firm generates cash flow cr_{t+1} from its operating activities in period t+1. However, during this process of operation, wear and tear causes the productive capacity of the asset to decline, which results in (true) economic depreciation. Let AS_t be the level of (operating) asset stock at date t, $Edept_{t+1}$ the economic depreciation in period t+1 (that is, the decline in asset stock), and ci_{t+1} the cash investment made at date t+1 to replenish the asset stock. (Here, asset stock is synonymous with the productive capacity of the asset.)

Without loss of generality, we express asset stocks at all dates in terms of the constant price of date t. Then, $AS_t = P^o_t$ and

$$AS_{t+1} = AS_t - Edep_{t+1} + ci_{t+1}/(1 + \theta_{t+1}). \tag{11.1}$$

In Eq. (11.1), the cash investment at date t+1 needs to be "discounted" when it is converted into asset stock (as measured at the date t price) because of the change in asset price.

By definition, the firm's operating asset at date t+1 has a market price of $P^o_{t+1} = (1 + \theta_{t+1})AS_{t+1}$. Applying Eq. (11.1), we get

$$P^o_{t+1} = (1 + \theta_{t+1})(AS_t - Edep_{t+1}) + ci_{t+1} = (1 + \theta_{t+1})(P^o_t - Edep_{t+1}) + ci_{t+1} \tag{11.2}$$

Following Chap. 4, we define $OX^E_{t+1} \equiv cr_{t+1} - Edep_{t+1}$ as the "economic earnings" in period t+1 generated from operating activities, and $q_{t+1} \equiv OX^E_{t+1}/AS_t$ as the corresponding "economic profitability,"[4] which measures the firm's efficiency in using assets to generate value.

As for the original ROM set out in Chap. 4, we assume that profitability follows a random walk (implying that business fundamentals tend to persist from one period

[4] As explained in Chap. 4, "economic earnings" means what accounting earnings would be under the (ideal) condition of unbiased depreciation. Correspondingly, the economic profitability of operating assets, q_{t+1}, is equivalent to the internal rate of return on operating assets.

to the next), and that the firm has the flexibility to adjust the course of its operations by either exercising the abandonment option when profitability falls to a sufficiently low level or exercising the growth option when it climbs sufficiently high. Then, the value at date t of the firm's operating activities (V_t^o) is determined in the same way as in Chap. 4, which is

$$V_t^o = E_t(O\tilde{X}_{t+1}^E)/r + AS_t\,[P(q_t) + gC(q_t)] = AS_t\,[q_t/r + P(q_t) + gC(q_t)]. \quad (11.3)$$

In Eq. (11.3), $E_t(O\tilde{X}_{t+1}^E)/r$ is the baseline value in a steady-state operation, whereas $P(\cdot)$ and $C(\cdot)$ are, respectively, the abandonment and growth options, both of which are normalized by asset stock (AS_t). The option values depend on the distribution of profitability in period t+1, given current profitability (q_t). Parameter g is the firm's growth potential, defined as the percentage by which the scale of invested capital may grow.

It is important to distinguish between the intrinsic value of operating activities and the market value of the operating *asset* (which is an input for operating activities). The former is the value derived from a business operation and is determined on the basis of the expected cash flows it generates (through making and selling the firm's products), whereas the latter represents the cost of one of the input factors for the operation (such as equipment and buildings) and must be used in combination with other necessary factors such as raw materials and labor. Equating the two notions of value would amount to ignoring the role of other factors such as human resource that are necessary for organizing and carrying out business activities (which would also render valuation a trivial task). Furthermore, since the ability of the management to employ capital resource efficiently is firm specific—as some managers are competent and others less so—there is no fixed relation between firm value and operating assets that is applicable to all firms. As in the ROM, investors need to determine this relation based on a firm's specific efficiency (q_t) and growth environment (g).

The firm's value is the sum of the value it generates from financial activities (which equals the value of financial assets given that they are held for trading purposes only) and the value of operating *activities* (which is distinct from the market price of operating assets):

$$V_t = V_t^f + V_t^o = P_t^f + AS_t\,[q_t/r + P(q_t) + gC(q_t)]. \quad (11.4)$$

Note that value additivity for the two types of activities follows from value being defined as the present value of expected future cash flows.

Equation (11.4) shows that firm value depends on the following attributes of the firm's economic activities: the market value of financial assets (P_t^f), operating asset stock (AS_t), and profitability (q_t). To compute the return over period t+1, we take changes in Eq. (11.4) with respect to these attributes:

$$V_{t+1} - V_t = (P^f_{t+1} - P^f_t) + v \times (AS_{t+1} - AS_t) + AS_t\, v'(.)(q_{t+1} - q_t), \qquad (11.5)$$

where $v \equiv q_t/r + P(q_t) + gC(q_t)$ and $v'(.) \equiv dv/dq_t = 1/r + P'(.) + gC'(.)$.

The stock return over the period is

$$\begin{aligned} R_{t+1} &\equiv \frac{V_{t+1} - V_t + d_{t+1}}{V_t} \\ &= \frac{P^f_{t+1} - P^f_t + d_{t+1}}{V_t} + v\frac{1}{V_t}(AS_{t+1} - AS_t) + v'\frac{AS_t}{V_t}(q_{t+1} - q_t). \end{aligned} \qquad (11.6)$$

Maintaining the financial asset account implies

$$P^f_{t+1} = P^f_{t+1,existing} + FX_{t+1} + cr_{t+1} - ci_{t+1} - d_{t+1}. \qquad (11.7)$$

Denote $\Delta P^f_{t,existing} \equiv P^f_{t+1,existing} - P^f_t$ as the capital gain on the financial assets held in period t+1. We have

$$\begin{aligned} P^f_{t+1} - P^f_t + d_{t+1} &= [P^f_{t+1,existing} - P^f_t] + FX_{t+1} + cr_{t+1} - ci_{t+1} \\ &= \Delta P^f_{t,existing} + (FX_{t+1} + OX^E_{t+1}) - (ci_{t+1} - Edep_{t+1}). \end{aligned} \qquad (11.8)$$

Rewrite Eq. (11.1) as $ci_{t+1} - Edep_{t+1} = (AS_{t+1} - AS_t)(1 + \theta_{t+1}) + \theta_{t+1}Edep_{t+1}$. Then, Eq. (11.6) becomes

$$\begin{aligned} R_{t+1} &= \frac{1}{V_t}\left\{ \Delta P^f_{t,existing} + (FX_{t+1} + OX^E_{t+1}) - \theta_{t+1}Edep_{t+1} \right\} \\ &\quad + \frac{1}{V_t}\{ v'AS_t\,(q_{t+1} - q_t) + [v - (1 + \theta_{t+1})](AS_{t+1} - AS_t)\}. \end{aligned} \qquad (11.9)$$

In Eq. (11.9), the equity return over period t+1 arises from two principal sources. The first is the value generated (both realized and readily realizable) over period t+1 from both financial and operating activities, which totals $\Delta P^f_{t,existing} + FX_{t+1} + OX^E_{t+1}$. The second is the change in expected future value generation from operating activities, which is caused by the change in profitability $(q_{t+1} - q_t)$ and in asset stock $(AS_{t+1} - AS_t)$. In addition, the equity return is also affected by the change in the price index of operating assets (θ_{t+1}) because that affects the amount of cash investment required to both replenish the depreciated asset stock and build up the stock level.

11.3 Accounting Representation of Equity Value and Return

We assume the following accounting rules for measuring economic activities. Firstly, both financial and operating assets are measured at fair (market) value. Thus, at any given date τ, $FA_\tau = P^f_\tau$ and $OA_\tau = P^o_\tau$, where FA_τ and OA_τ denote the book values of operating and financial assets at date τ, respectively.[5]

Secondly, a conservative depreciation policy is adopted. Let dep_τ be the accounting deprecation for period τ. Then, the bias in depreciation recognition for period τ is $u_\tau \equiv dep_\tau - Edep_\tau$. A conservative policy suggests that the cumulative bias in recognized depreciation over time is nonnegative. In the special case where the depreciation policy is unbiased, we have $dep_\tau = Edep_\tau$, and hence $u_\tau = 0, \forall \tau$.

It is worth clarifying that adopting a conservative depreciation policy to compute operating income does not contradict fair value accounting for operating assets. The former affects the measurement of operating income, whereas the latter determines the total change in asset value; any discrepancy can be reconciled by an additional item that may either be included in the income statement or bypasses the statement to be entered directly into the equity account.

Thirdly, earnings from operating activities are defined as $OX_\tau \equiv cr_\tau - dep_\tau$. In the case of unbiased depreciation, accounting earnings coincide with economic earnings (see Chap. 4).

Finally, the book value of equity at date τ (B_τ) is the sum of the book values of financial assets and operating assets: $B_\tau = FA_\tau + OA_\tau$.

Once the accounting rules have been specified, we can represent the (economic) attributes of business operations by accounting measures of "stocks" and "flows."[6] With asset stock stated at the date t price level, we have $OA_t = P^o_t (= AS_t)$ and

$$OA_{t+1} = P^o_{t+1} = (1 + \theta_{t+1})AS_{t+1} = (1 + \theta_{t+1})(P^o_t - Edep_{t+1}) + ci_{t+1}. \quad (11.10)$$

It follows that the change in asset stock over period t+1 can be expressed as $AS_{t+1} - AS_t = \frac{OA_{t+1}}{1+\theta_{t+1}} - OA_t = (OA_{t+1} - OA_t) - \theta_{t+1}AS_{t+1}$. Employing Eq. (11.1) and denoting $w_{t+1} \equiv \theta_{t+1}(OA_t - Edep_{t+1})$ (which is the price change of the firm's operating assets in period t+1, net of economic depreciation), we get

[5] A similar valuation model can also be derived by (alternatively) assuming historical cost-based accounting for operating assets. While the mathematical expression of that model would be somewhat different, it has the same implications for income measurement and performance reporting.

[6] If we alternatively assume historical cost-based accounting (instead of fair value accounting) for operating assets, the relations between the accounting and economic variables will be similar, except for the measurement bias terms.

$$AS_{t+1} - AS_t = (OA_{t+1} - OA_t) - w_{t+1} - \frac{\theta_{t+1}}{1+\theta_{t+1}} ci_{t+1}. \tag{11.11}$$

Thus, the change in asset stock over period t+1 is approximated by the change in asset book value, with a discrepancy caused by the fluctuation in asset price.

Economic earnings generated from operating activities are measured by accounting earnings with a bias

$$OX^E_{t+1} = OX_{t+1} + u_{t+1}. \tag{11.12}$$

The accounting profitability of operating activities for period t+1 is defined as $ROA_{t+1} \equiv OX_{t+1}/OA_t$. It measures economic profitability (q_{t+1}) with a bias

$$ROA_{t+1} = \frac{OX_{t+1}}{OA_t} = \frac{OX^E_{t+1} - u_{t+1}}{AS_t} = q_{t+1} - \frac{u_{t+1}}{AS_t}. \tag{11.13}$$

The return model specified in Eq. (11.9) also depends on the prior period's profitability ($q_t \equiv OX^E_t/AS_{t-1}$), which is derived from the prior period's operating income and beginning asset stock. Since, by definition, $OA_{t-1} = P^o_{t-1} = AS_{t-1}/(1+\theta_t)$, where θ_t is the change in period t of the price index of operating assets, the accounting profitability for period t can be expressed as

$$ROA_t \equiv \frac{OX_t}{OA_{t-1}} = \frac{OX^E_t - u_t}{AS_{t-1}/(1+\theta_t)} = \left(q_t - \frac{u_t}{AS_{t-1}}\right)(1+\theta_t). \tag{11.14}$$

It follows from Eqs. (11.13) and (11.14) that

$$q_{t+1} - q_t = (ROA_{t+1} - ROA_t) + \frac{\theta_t}{1+\theta_t} ROA_t + \left(\frac{u_{t+1}}{AS_t} - \frac{u_t}{AS_{t-1}}\right). \tag{11.15}$$

That is, the change in economic profitability is approximated by the change in accounting profitability, with the discrepancy caused by (1) the price change of operating assets and (2) biased depreciation recognition.

The total comprehensive income for period t+1 (TCI_{t+1}) is defined as the total change in assets and liabilities (excluding those arising from equity transactions with investors); that is,

$$TCI_{t+1} \equiv B_{t+1} - B_t + d_{t+1} = (P^f_{t+1} + P^o_{t+1}) - (P^f_t + P^o_t) + d_{t+1}. \tag{11.16}$$

Employing the financial asset relation in Eq. (11.7) and simplifying, we get

$$TCI_{t+1} = \Delta P^f_{t,existing} + FX_{t+1} + OX_{t+1} + u_{t+1} + \theta_{t+1}(OA_t - Edep_{t+1}). \tag{11.17}$$

Thus, total comprehensive income is equal to the sum of the interest income on financial assets (FX_{t+1}), earnings from operating activities (OX_{t+1}), and gains or losses resulting from the remeasurement of both financial and operating assets ($\Delta P^f_{t,existing} + \theta_{t+1}(OA_t - Edep_{t+})$), with an adjustment for accounting bias u_{t+1}.

Based on the above assumptions and derivations, we can represent the original return function in Eq. (11.9) in accounting terms as

$$R_{t+1} = \frac{1}{V_t}\left\{ \Delta P^f_{t,existing} + FX_{t+1} + OX_{t+1} + u_{t+1} - \theta_{t+1} Edep_{t+1} \right\} + \frac{1}{V_t}\{ v' OA_t\ (ROA_{t+1} - ROA_t) + [v - (1 + \theta_{t+1})][(OA_{t+1} - OA_t) + \beta]\}, \tag{11.18}$$

where $\alpha \equiv \frac{\theta_t}{1+\theta_t} ROA_t + \left(\frac{u_{t+1}}{AS_t} - \frac{u_t}{AS_{t-1}}\right)$ and $\beta \equiv -w_{t+1} - \frac{\theta_{t+1}}{1+\theta_{t+1}} ci_{t+1}$ are adjustments required owing to changes in operating asset prices and accounting biases.

In Eq. (11.18), the equity return over a time period has two distinct components. The first (enclosed in the first pair of curly brackets) is the value generated from economic activities over the *contemporaneous* period. From financial activities, the firm generates value in the form of capital gains, $\Delta P^f_{t,existing}$, and interest income, FX_{t+1}, and from operating activities it generates value in the form of earnings, OX_{t+1}. To identify the true amount of value being generated, investors also need to adjust for both conservative depreciation (u_{t+1}) and the price change of operating assets (which affects the cash investment required to refill the depreciated asset stock, $\theta_{t+1} Edep_{t+1}$).

On the other hand, the second return component (the expression in the second pair of curly brackets) represents changes in expected *future* value generation, which is caused by the change in profitability ($ROA_{t+1} - ROA_t$) and the change in operating assets ($OA_{t+1} - OA_t$). To determine this second component, investors need to compare operations in the current period with those of the period before, which requires information derived from the comparative balance sheets and income statements for the two periods.

11.4 Implications for the Role of Fair Value Accounting

On the basis of the return model in Eq. (11.18), we infer the relevance of fair value accounting to equity investors and identify its implications for other, related issues such as how accounting income should be defined for valuation purposes and what criteria should be applied to determine OCI.[7] The point we highlight is that in

[7] Parts of the discussion below overlap somewhat in substance, but the specific issues addressed have been separately raised and deliberated on by standard setters.

addressing these and other related reporting issues, one should draw a distinction between financial and operating activities, because of the differential economic roles of both the firm and the assets employed in each type of activities.

11.4.1 Relevance of Fair Value Accounting for Financial and Operating Activities

The model shown in Eq. (11.18) indicates that fair value gains or losses on financial assets are part of the value generated over the reporting period; they affect returns in the same way as other sources of income such as earnings from operations because they directly add wealth to investors. In contrast, gains or losses on operating assets are not equivalent to value generation for investors, and in general it is not immediately clear how they affect investors' wealth. This means that fair value accounting for financial (trading) assets yields information that is directly relevant to equity investors, whereas the usefulness of fair value accounting for operating assets is unclear. Here, the relevance of fair value gains or losses is not predicated on the *realization principle*, that is, whether or not these gains or losses have indeed been realized (the implicit assumption here is that assets are not systematically mispriced in markets).

The differential valuation relevance of gains or losses with respect to financial and operating assets is a result of the different economic roles played by these assets in the firm's value generation activities. Financial assets are held passively for trading purposes, and the firm as a business entity acts merely as an investor. From the firm's standpoint *as an investor*, gains or losses on these assets directly translate to changes in firm value (and hence investor wealth). In this sense, they are equivalent to value generated (or lost).

In contrast, operating assets serve as an input factor for producing the firm's final product. They are used in the process of value generation, and their usefulness to the firm lies in their capacity to produce a final product, rather than resale. Insofar as the firm remains a going concern, fair value changes for operating assets are neither value generation nor do they affect the productive capacity of these assets.[8] In this sense, the well-being of investors is not necessarily increased by fair value gains or reduced by losses on operating assets.[9]

The differential usefulness of fair value accounting for financial and operating assets has implications for standard setting organizations, which have been advocating expanded use of fair value accounting but have not yet decided how

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[8] One exception is the situation when existing operating assets are disposed of, but in this case such assets have ceased to be "operating" for the firm concerned.

[9] Consistent with this theoretical result, Christensen and Nikolaev (2013) report that they find no evidence indicating that investors demand fair value accounting for nonfinancial assets. Dichev (2008) and Nissim and Penman (2007) also argue for the differential treatment of financial and operating assets, but do not develop a formal valuation model to support their arguments.

far this should go; in other words, they are undecided about whether this measurement approach should be applied to all assets and liabilities on the balance sheet or a subset of these items and, if the latter, which ones. As Barth (2006a, p. 98) observes, "in almost every standard-setting project of the FASB and IASB, the boards consider fair value as a possible measurement attribute."[10] The model delineated above suggests that standard setters should distinguish between assets that play dissimilar economic roles in value generation and that the uniform adoption of fair value accounting across all items on the balance sheet does not serve the information needs of investors well.

11.4.2 Implications for Income Measurement

Conceptually, what constitutes accounting income is still subject to debate among standard setters and academics. In this subsection, we explain how accounting income should be defined on the basis of the above specified return model. We go on to use this definition to evaluate the existing income measures adopted in various accounting jurisdictions and those being actively considered by standard setting bodies.

11.4.2.1 Definition of Income

Following the above model, a natural definition of income for valuation purposes is the value generated by the business entity over a time period. This definition grants income an unequivocal *economic* interpretation and is compatible with the discounted cash-flow framework (which underpins the above return model). However, because of conservative accounting and changing asset prices, the accounting system provides a distorted measure of this theoretical construct, so users must adjust the reported accounting data.

In the above model, "value generated" makes up a portion of equity return. This portion is distinctly different from "changes in expected *future* value generation," in terms of whether the underlying economic activities have already been conducted and, correspondingly, whether operational data have become observable.

11.4.2.2 Evaluation of Some Existing and Potential Income Measures

It is noteworthy that the income measures adopted in prevailing GAAPs and those under consideration by standard setting bodies do not fully conform to the above definition, although, for the most part, they overlap with it. Below, we evaluate some of these measures in relation to the above definition.

[10] See also Johnson (2005) and Schipper (2005).

Income measures reported under existing GAAPs. Generally speaking, the income measures adopted by existing GAAPs deviate from the notion of value generated either because they exclude some items that constitute value (wealth) for investors or include some items that do not. As such, their economic meaning is not unequivocally clear (at least from a valuation perspective). For example, the net income amount reported under the US GAAP excludes some items that constitute value generation, such as unrealized gains or losses on financial instruments in the categories of available-for-sale and held-to-maturity; these items are instead reported as OCI (FAS 115). On the other hand, the summary measure under the IFRS includes both losses and, under certain circumstances, gains arising from revalued PP&E (IAS 39 and IAS 16), which are not (economic) value generated from an investor standpoint.

Total comprehensive income. Total comprehensive income is the total change in (recognized) assets and liabilities over a period excluding those arising from transactions with the firm's owners. This measure stems from the "enterprise approach" to income recognition, which would include all accounting gains or losses within the scope of the enterprise (IASB/FASB 2005b), and is advocated by the IASB (Barth 2006b). This measure is rooted in Hicks' (1946) notion of income, but has been adapted to the practical context (where the balance sheet does not recognize all expected future gains).

In the above model, total comprehensive income is given by the expression $[\Delta P^{f}_{t,existing} + FX_{t+1} + OX_{t+1} + u_{t+1} + \theta_{t+1}(OA_t - Edep_{t+1})]$. Because of its all-inclusiveness, total comprehensive income encompasses both value-generated items ($\Delta P^{f}_{t,existing} + FX_{t+1} + OX_{t+1}$) and non-value-generated items such as changes in the market value of operating assets ($\theta_{t+1}(OA_t - Edep_{t+1})$).[11] As such, this measure lacks a clear economic interpretation and does not effectively or clearly convey what investors need to know.

Other measures of income under consideration. During the deliberations of the IASB/FASB's joint project on financial statement presentation, four alternative illustrative formats were presented for the statement of comprehensive income (IASB/FASB 2007); however, none of them contains a subtotal or summary measure that fully conforms to the notion of value generated. The formats under Alternatives 1 and 2 provide a subtotal called "total operating income," which is a partial account of value generation, excluding, for example, gains or losses on financial assets. The format under Alternative 3 provides a subtotal called "total short-term income before tax," which again is a partial account of value generation, excluding, for example, gains or losses on available-for-sale securities. More

[11] In situations where a firm involves foreign operations, gains or losses resulting from foreign currency translation adjustments are also not value generation.

strikingly, the format under Alternative 4, which represents the IASB/FASB's long-term goal to eliminate the category of OCI, provides a subtotal called "comprehensive operating income" that is even less clear in terms of economic meaning: not only does it exclude some value-generated items (such as gains or losses on financial assets), it is also contaminated by non-value-generated items (such as gains on revaluation of fixed assets). Finally, all four alternative formats report "total comprehensive income" as the summary measure, which mixes value-generated items with non-value-generated items. The above theoretical model suggests that none of these illustrative formats effectively serves the needs of equity investors by reporting the total comprehensive income and the subtotals.

11.4.3 Boundary Between Income and OCI

As discussed, the summary income measures under existing GAAPs (such as NI in the US GAAP) lack a clear theoretical foundation, and the economic basis for the separation between NI (or an equivalent construct) and OCI has not been made clear. Furthermore, inconsistencies exist among the summary measures adopted in different jurisdictions. The notion of value generated arising from the above model serves a theoretical anchor for accounting income, which sets a well-defined boundary between income and OCI. The theoretical underpinnings help standard setters to resolve the long-standing issue of which accounting gains or losses should be included in, and which should be excluded from, the concept of summary income (and why) (IASB/FASB 2005a).

By defining what income is, we also define its complement, namely OCI. In the context of the above model, OCI should be defined as the collection of those changes in assets and liabilities during the reporting period (other than those resulting from equity transactions) that do not generate value for investors.

Moving beyond the simplified setting for the above model, items that are value generated and hence should be recognized as income further include (1) unrealized gains or losses on trading securities, available-for-sale securities, and held-to-maturity securities; (2) gains or losses resulting from cash flow or foreign currency hedges; (3) pension liability adjustments; and (4) impairments of operating assets arising from loss (damage) of physical productive capacity.

Items that do not contribute to value generation and thus should not be recognized as income include (1) gains or losses on PP&E used for operating activities that arise from changes in market prices; (2) gains or losses from foreign currency translation adjustments on net investments; and (3) adjustments arising from accounting policy changes.

11.5 Summary

In this chapter, we examine theoretically the relevance of fair value accounting to income measurement from the standpoint of equity investors and identify implications for other financial reporting issues. We show that fair value accounting for financial assets facilitates valuation because it conveys value generation over the reporting period, whereas fair value accounting for operating activities serves no clear purpose. This differential usefulness of fair value information stems from the dissimilar economic functions played by financial and operating assets in the value generation process, which causes investors to have differential information needs with regard to these assets. There are two implications from this. Firstly, as a means to summarize business transactions and report information for economic decisions, the approach to accounting depends on economic activities; accounting should respond to the specific economic roles played by assets and liabilities in business operations. Secondly, for firms engaging in real (as opposed to financial) operations, fair value accounting does not fundamentally ease the valuation problem for investors. This is because the fair values of operating assets (primarily) represent the cost of input for operations, whereas what investors ultimately need to figure out is the value generated by those operations.

The chapter also addresses other issues about financial reporting. Firstly, it establishes a theoretical underpinning for accounting income measures, namely, the notion of the value generated from economic activities as viewed from an investor's standpoint. This theoretical construct sets a benchmark for evaluating both the income measures adopted in practice and those being considered by standard setting bodies. Secondly, we explain that accounting gains or losses are not necessarily economic gains or losses for investors (albeit the two overlap to a large extent).

It should be noted, however, that the theoretical model developed here is limited by its simplifying assumptions, and many issues pertinent to a practical scenario have been excluded. One such issue is that in practice the separation between "financial" and "operating" assets is not always clear-cut. For example, when a firm holds an equity claim in another firm (which is a financial activity in itself) and the investment gives the (investing) firm a significant right of control over the issuing firm, the boundary between financial and operating activities becomes blurred. Nonetheless, the analysis in this chapter is one of the first to lay down a theoretical basis for addressing specific standard-setting issues in a valuation context. Further work along this line of analysis will be important to the development of a more comprehensive framework for examining various financial reporting issues.

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Chapter 12
Interpreting Financial Information in an Industry Context

In the previous chapters where we have examined the valuation role of accounting data, we have treated firms as if they were operating\ in isolation, with no attention being paid to possible interactions between them. In the real world, different firms are bound together through explicit or implicit relations, and they must interact with one another in various markets. In this chapter, we extend the previous analyses by considering a particular type of interfirm interaction, one that takes place in the product market. When firms compete in a common market, their operational decisions are intertwined because actions taken by one firm have consequences for others, and vice versa. Within such a context, we examine how a firm's profitability relative to that of its industry peers affects its economic decisions and hence its value.

The chapter consists of both a theoretical and an empirical dimension. We first employ standard industry organization models to study the behavior of the equity returns of firms operating in the same industry. This theoretical analysis yields predictions on how relative profitability influences the sensitivity of a firm's return to industry-wide news, and how the impact of this differs across various industries facing different levels of capacity constraints. We then perform a range of empirical tests to provide evidence for the predictions. The chapter ends with a discussion of the implications of the findings for investment management and academic research. The material in this chapter is primarily drawn from the work of Hao et al. (2011b).

G. Zhang, *Accounting Information and Equity Valuation: Theory, Evidence, and Applications*, Springer Series in Accounting Scholarship 6,
DOI 10.1007/978-1-4614-8160-7_12,

12.1 Modeling the Valuation Role of Relative Firm Profitability in an Industry

12.1.1 A Basic Model with Cournot Competition

Consider an industry that comprises three firms producing a homogeneous product. The firms engage in Cournot (quantity) competition.[1] Let C_j denote the variable production cost of firm j (j = 1,2,3) incurred per unit of product. We assume that the firms have identical fixed costs, which, for convenience, are set to zero. Without loss of generality, we label the most cost efficient firm as firm 1, and the least efficient firm as firm 3, that is, $C_1 < C_2 < C_3$.

The demand function for the industry is $P = a - bQ$, where P is the unit product price, Q the total quantity demanded by the market, and a and b are constants.

Each firm's decision involves selecting a production quantity (Q_j, j = 1,2,3) to maximize its profit, conditional on the (conjectured) quantities of the other firms:

$$\underset{Q_j}{Max} \quad [a - b(Q_j + \sum_{k \neq j} Q_k) - C_j]Q_j. \tag{12.1}$$

The first-order conditions are

$$a - 2bQ_j - b\sum_{k \neq j} Q_k - C_j = 0, \ \text{j} = 1, 2, 3. \tag{12.2}$$

From Eq. (12.2), we obtain the optimal quantities as

$$Q_j = \frac{1}{4b}[a - 4C_j + (C_1 + C_2 + C_3)], \ \text{j} = 1, 2, 3. \tag{12.3}$$

Substituting Eq. (12.3) back into Eq. (12.1) yields the earnings of firm j (X_j) as

$$X_j = \frac{1}{16b}[a - 4C_j + (C_1 + C_2 + C_3)]^2, \ \text{j} = 1, 2, 3. \tag{12.4}$$

Let V_j be the market value of firm j, which is assumed to equal earnings capitalization.[2] Then

[1] As shown in Hao et al. (2011b), the qualitative predictions are the same if firms engage in Bertrand-type competition with differentiated products.

[2] As our focus here is on how industry-wide common shocks impact different firms, we ignore, for simplicity, firm-level real options. Nonetheless, when we test the predicted role of relative profitability later, we will control for those variables affecting returns that arise from real options.

$$V_j = \frac{X_j}{r_j} = \frac{1}{16br_j}[a - 4C_j + (C_1 + C_2 + C_3)]^2, \text{ j} = 1, 2, 3, \tag{12.5}$$

where r_j is the discount rate appropriate for firm j.

To examine the impact of industry-wide news, we now assume an unexpected shock, Δa, that causes the demand curve to shift to $P = a + \Delta a - bQ$. Following the above analysis, the value of firm j after the shock is revised to $V_j' = \frac{1}{16br_j}[a + \Delta a - 4C_j + (C_1 + C_2 + C_3)]^2$. Thus, the equity return triggered by the shock (ignoring the second-order effect) is

$$R_j \equiv \frac{V_j' - V_j}{V_j} = \frac{2(\Delta a)}{a - 4C_j + (C_1 + C_2 + C_3)}; \text{ j} = 1, 2, 3. \tag{12.6}$$

Given that $C_1 < C_2 < C_3$, we have $R_1 < R_2 < R_3$; that is, the return impact of an industry-wide shock is greater for firms that have higher production costs or, equivalently, lower profitability.

Several implications follow from this Cournot equilibrium. Firstly, from Eq. (12.3), we get $dQ_j/da > 0, j = 1, 2, 3$; that is, all firms adjust output in the same direction when faced with a common shock.

Secondly, from Eq. (12.4), the marginal impact of the common shock on firm j's earnings is $dX_j/da = [a - 4C_j + (C_1 + C_2 + C_3)]/(8b)$, which is decreasing in cost C_j. Thus, firms with higher profitability gain a greater amount of incremental earnings when the industry shock is favorable, but also relinquish a greater amount when it is unfavorable.

Thirdly, as already explained, the gains to investors (in terms of stock returns) arising from a favorable industry shock (and, similarly, the losses arising from an unfavorable one) are greater for *less* profitable firms. In other words, the returns of the less profitable firms within an industry are more sensitive to industry-wide news.

Given that highly profitable firms capture more earnings gains as industry conditions improve, it might be counterintuitive to suggest that investors in *less* profitable firms actually benefit more from such conditions. To understand this result, it should be noted that the impact on investors is measured in terms of equity return, which is calculated *as a proportion of* the initial firm value. As the initial value of a less profitable firm is lower, the industry shock has a greater proportional impact.

12.1.2 Profitability Differences Caused by Market Share

In the Cournot model specified above, the competing firms have different levels of profitability because of their different cost efficiencies. However, profitability differences can also be caused by market share. For a given cost function for production, firms with greater market share achieve more sales and hence are more profitable.[3] In this case, we can apply the notion of operating leverage to compare earnings and returns between firms. It is well known that, given the cost function, operating leverage declines as sales increase, which induces an inverse relation between operating leverage and firm profitability in the context we are studying. The implication is that for a given percentage change in sales, the percentage change in earnings is greater for firms with a small (versus large) market share and, therefore, their stock return will also be greater.

To the extent that the sales changes of individual firms in an industry are in line with existing market shares, we again come to the prediction that the returns of less profitable firms (which will have smaller market shares) are more sensitive to industry-wide shocks.

12.1.3 Effect of Capacity Constraints

In a realistic setting, capacity constraints exist (at least in the short term), which potentially limit firms' ability to adjust output upward when faced with a favorable industry shock. In situations where firms are prevented from raising output to the desired levels when the demand function shifts upward, they will not be able to gain as much as predicted in our theoretical model. This phenomenon is especially germane to firms with higher profitability as they are already producing more output and therefore are closer to the capacity limit. Capacity limit thus dampens the impact of *positive* industry shocks, especially for highly profitable firms. This further exacerbates the inverse relation between relative profitability and return sensitivity to positive industry shocks.

On the other hand, when faced with a negative industry shock, firms adjust their output downward, in which case capacity limits should not play a role. Thus, an asymmetry arises in the effect of relative profitability on return sensitivity between positive and negative industry shocks.

Further extending this line of reasoning, we propose that the effect of capacity constraints should vary across industries. For example, some industries are more capital (versus labor) intensive than others, and so it is more difficult for firms in these sectors to expand capacity immediately as needed. As a result, the aforementioned asymmetrical effect of relative profitability should be more pronounced in industries that are more (rather than less) capital intensive. Likewise, for a given industry, capacity constraints pose more of an urgent issue at times when firms are operating closer to full capacity. In those periods, the asymmetry in the effect of relative profitability should also be more pronounced.

[3] The problem in this case is different from that characterized under either Cournot or Bertrand competition. Here, differences in quantities exist for exogenous reasons, such as firms having built up different customer bases from previous operations.

12.2 Hypotheses

The above analysis yields several testable hypotheses about the role of relative profitability in influencing the behavior of returns and earnings in an industry context, which are stated below.

Hypothesis 12.1 The stock returns of firms ranked lower in profitability in an industry will be more sensitive to industry-wide shocks.

Hypothesis 12.2 The effect of relative profitability on return sensitivity to industry shocks will be more pronounced in situations of positive, rather than negative, industry shocks.

Hypothesis 12.3 The asymmetry in the effect of relative profitability on return sensitivity between positive and negative industry shocks will be more pronounced for industries facing tighter (or more rigid) capacity constraints.

Hypothesis 12.4 The earnings of firms ranked higher in profitability will be more sensitive to industry-wide shocks.

12.3 Testing the Effect of Relative Profitability on Return Sensitivity to Industry News

This section presents empirical evidence for the role of relative profitability in influencing the behavior of stock returns, as reported by Hao et al. (2011b). The data used are retrieved from the Compustat Quarterly File and CRSP Monthly Return Files. The sample consists of 43,768 firm-year observations from 138 four-digit SIC industries for the period 1973–2004 (excluding utility and financial firms).

12.3.1 The Empirical Return Model

The main regression model to test the role of relative profitability in influencing equity return is

$$R^i_{k,t} = \alpha + \beta_1\, IR^i_t + \beta_2\, rp^i_{k,t-1} + \beta_3\, IR^i_{k,t} * rp^i_{k,t-1} + \sum \gamma_j\, Control_j + \varepsilon_{k,t}, \quad (12.7)$$

where $R^i_{k,t}$ is the equity return for period t of firm k belonging to industry i; $IR^i_t \equiv \sum_{s \neq k} R^i_{s,t}/(N_i - 1)$ is the average return in period t of firms in industry i excluding firm k (whose return is being explained), as a proxy for the industry news of the period; and $rp^i_{k,t-1}$ is the relative profitability of firm k in industry i in the previous period, represented by the (normalized) ranking of the firm's *ROE* that has a value ranging between 0 and 1 and increases with profitability.

Hypothesis 12.1 predicts $\beta_3 < 0$ in the above regression. The sensitivity of firm k's return to industry news is equal to $\beta_1 + \beta_3 * rp_{t-1}$, which can be viewed as the firm's industry beta (systematic risk).

There are three groups of control variables used in regression model (12.7), which come from both the finance and accounting literatures. The first group contains variables known as risk characteristics, including systematic market risk (*lagMbeta*), firm size (*lagSize*), financial leverage (*lagDE*), and the book-to-market ratio of equity (*lagBM*), all measured with a one-period lag.

The second group of control variables conveys information about a firm's business operation including earnings yield (x), change in profitability (Δroe), and equity capital investment (Δb). In Chap. 9, we used the ROM to show that a firm's realized return is a function of these accounting variables. Interaction terms between relative profitability and these accounting variables are also included, consistent with the previous findings. We also include the change in the discount rate change (Δr), as in Chap. 9.

Finally, we control for market-wide returns (*MR*) in Eq. (12.7).

12.3.2 Effect of Relative Profitability from the Pooled Sample

The results of the regression in Eq. (12.7) are presented in Table 12.1. For the sample combining observations with positive and negative industry news, the interaction term between relative profitability and industry returns, $IR^{*}rp_{t-1}$, has a coefficient of −0.660, which is significant at the 0.01 level. The coefficient on industry returns (*IR*) is significantly positive, equaling 1.065. These coefficients taken together indicate that in a given industry, the returns of less profitable firms (that is, those with smaller values of rp_{t-1}) are more sensitive to industry returns.

For the subsample with positive industry news, the coefficient on $IR^{*}rp_{t-1}$ is −0.799, and that on *IR* is 1.119, both of which are highly significant. Similarly, for the subsample with negative industry news, the coefficient on $IR^{*}rp_{t-1}$ is −0.226, and that on *IR* is 0.783, again both highly significant. Thus, the same qualitative results hold for the effect of relative profitability in both subsamples as well as the combined sample.

Importantly, the magnitude of the coefficient on $IR^{*}rp_{t-1}$ is greater in the case of positive (−0.799) than negative news (−0.226). The difference of −0.573 is highly significant. Overall, the results are consistent with Hypotheses 12.1 and 12.2.

In addition, the control variables are generally significant. The effect of the risk characteristics is similar to that shown in the asset pricing literature (see, for example, Fama and French 1992, 1993, 1996), and the effects of the firm-specific variables are similar to those in the accounting literature (discussed in Chap. 9). Finally, the coefficient on market returns is significantly positive. These results

Table 12.1 Relative firm profitability and return sensitivity to industry news: overall sample

Variable	Combined news (A)	Positive industry news (B)	Negative industry news (C)
Cons	−0.200***	−0.278***	−0.108***
IR	1.065***	1.119***	0.783***
rp_{t-1}	0.199***	0.324***	0.111***
$\boldsymbol{IR*rp_{t-1}}$	**−0.660*****	**−0.799*****	**−0.226*****
MR	0.214***	0.154***	0.212***
lagMbeta	0.049***	0.089***	−0.041***
lagSize	−0.021***	−0.027***	−0.002
lagBM	0.149***	0.159***	0.121***
lagDE	−0.008**	−0.003	−0.021***
x	0.201***	0.214***	0.237***
$x*rp_{t-1}$	0.326***	0.300***	0.281***
Δroe	0.163***	0.173***	0.134***
$\Delta roe*rp_{t-1}$	−0.001	0.002	0.006
Δb	0.279***	0.319***	0.143***
$\Delta b*rp_{t-1}$	−0.005	0.011	0.001
Δr	0.142	0.188	−0.429
Diff. in $\boldsymbol{IR*rp_{t-1}}$***: (B) − (C)***		**−0.573*****	
(χ^2***-statistic)***[a]		**(27.03)**	
Obs.	43,768	29,865	13,903
Adj R^2	0.294	0.248	0.214

The results are based on the OLS procedure, with standard errors corrected for heteroscedasticity and the cross and serial correlations of the residuals

*** indicates significance at the 0.01 level

[a]Tests for cross-model differences in the coefficient on $IR*rp_{t-1}$ are based on the seemingly unrelated estimation (SUE) procedure

Source: Table 3, Panel B, from Hao et al. (2011b). Reprinted with permission by the American Accounting Association

indicate that the predicted role of relative profitability (which works through its interaction with industry news) in explaining returns is separate from that of (1) risk characteristics, (2) accounting variables, and (3) market-wide returns. Furthermore, the three groups of control variables each have distinctive effects.

12.3.3 Tracing the Effects to Fundamentals: Cost Efficiency and Market Share

Two fundamental factors driving profitability are cost efficiency and market share. The above theoretical analysis suggests that the predicted effects of relative profitability, as stated in Hypotheses 12.1 and 12.2, should hold irrespective of whether profitability differences across firms are induced by cost efficiency or market share. The regression in Eq. (12.8) below tests the separate effects of the two fundamental drivers of profitability, which replaces relative profitability (rp_{t-1}) in Eq. (12.7) with

Table 12.2 Relative cost efficiency and market share and return sensitivity to industry news

Variable	Combined news (A)	Positive industry news (B)	Negative industry news (C)
$\boldsymbol{IR^{*}rc_{t-1}}$	**−0.400*****	**−0.461*****	**−0.176*****
$\boldsymbol{IR^{*}rm_{t-1}}$	**−0.315*****	**−0.383*****	**−0.054**
Controls	Yes	Yes	Yes
Diff. in $\boldsymbol{IR^{*}rc_{t-1}}$***: (B) − (C)*** ***(*** $\boldsymbol{\chi^2}$ ***-statistic)***[a]		**−0.285***** **(12.68)**	
Diff. in $\boldsymbol{IR^{*}rm_{t-1}}$***: (B) − (C)*** ***(*** $\boldsymbol{\chi^2}$ ***-statistic)***[a]		**−0.329***** **(18.22)**	
Obs.	41,949	28,723	13,226
Adj R^2	0.297	0.263	0.248

*** indicates significance at the 0.01 level

Source: Table 4 from Hao et al. (2011b) Reprinted with permission by the American Accounting Association.

analogously constructed measures of relative cost efficiency (rc_{t-1}) and relative market share (rm_{t-1}):

$$R^i_{k,t} = \alpha + \beta_1 IR^i_t + \beta_2 rc^i_{k,t-1} + \beta_3 IR^i_{k,t} * rc^i_{k,t-1} + \beta_4 rm^i_{k,t-1} + \beta_5 IR^i_{k,t} * rm^i_{k,t-1} + \sum \gamma_j Control_j + \varepsilon^i_{k,t}, \tag{12.8}$$

where rc_{t-1} and rm_{t-1} are, respectively, normalized rankings (independently sorted) in an industry of a firm's prior-year cost efficiency (earnings divided by sales) and market share and each of the measures is set to a value between 0 and 1, with a lower value representing lower cost efficiency or market share. This design is intended to reveal whether each of the fundamentals has an effect on return that is incremental to that of the other. Hao et al. (2011b) report that for their empirical sample, rc_{t-1} and rm_{t-1} has a moderate correlation of 0.270, which is significant at the 0.01 level.

The results of the regression in Eq. (12.8) are presented in Table 12.2. Similar to the effect of relative profitability as predicted in Hypotheses 12.1 and 12.2, we observe that $IR^{*}rc_{t-1}$ and $IR^{*}rm_{t-1}$ both display a negative coefficient, with the magnitude significantly larger for positive than for negative industry news. Thus, cost efficiency and market share as the underlying drivers of profitability each play a role in the return function that is analogous to that of profitability. This provides further evidence to support Hypotheses 12.1 and 12.2.

12.3.4 *Effect of Capacity Limits: Distinguishing Between Industries*

The presence of capacity constraints exacerbates variations in cross-sectional returns induced by relative profitability in the scenario of positive, but not negative, industry news, hence creating an asymmetry. According to Hypothesis 12.3, this asymmetry

Table 12.3 Effects of capacity constraints: high versus low capital intensity

Variable	High capacity intensity: Positive industry news (A)	High capacity intensity: Negative industry news (B)	Low capacity intensity: Positive industry news (C)	Low capacity intensity: Negative industry news (D)
IR	1.398***	0.851***	1.208***	0.959***
Rp_{t-1}	0.328***	0.102***	0.134***	0.035
$\boldsymbol{IR^*rp_{t-1}}$	**−1.135*****	**−0.233***	**−0.798*****	**−0.351****
Controls	Yes	Yes	Yes	Yes
Diff. in $\boldsymbol{IR^*rp_{t-1}}$***:*** ***(A) − (B); (C) − (D)***	**−0.902*****		**−0.447****	
(χ^2***-statistic)***	**(25.93)**		**(5.27)**	
Diff. in $\boldsymbol{IR^*rp_{t-1}}$***:*** ***[(A) − (B)] − [(C) − (D)]***	**−0.455*****			
(χ^2***-statistic)***	**(6.60)**			
Obs.	11,565	5,814	12,670	6,252
Adj R^2	0.232	0.170	0.228	0.186

** and *** indicate significance at the 0.05 and 0.01 levels, respectively

*Source: Table 5 from Hao et al. (*2011b*).* Reprinted with permission by the American Accounting Association

should be more pronounced for industries that have rigid capacity constraints or, for a given industry, in periods when firms are operating near full capacity. The analyses below distinguish between industries or years along these dimensions.

12.3.4.1 High Versus Low Capital Intensity

Hao et al. (2011b) take an industry's capital intensity as a proxy for capacity rigidity. Following the economics literature (see for example Leontief 1953; Baldwin 1971; Winston 1979; Arai 2003), capital intensity is defined as the ratio of PP&E to the number of employees. Industries that are more capital intensive should take more time to expand capacity owing to the time required to plan investment projects, raise capital, and install assets. Consequently, the asymmetrical effect of relative profitability arising from capacity constraints (Hypothesis 12.3) should be more pronounced for industries with high, rather than low, capital intensity. The results are presented in Table 12.3.

In the high capital intensity group, the coefficient on IR^*rp_{t-1} is −1.135 in the case of positive industry news and −0.233 in the case of negative industry news, with the difference being significant at the 0.01 level. In the low capital intensity group, IR^*rp_{t-1} has coefficients of −0.798 and −0.351 for positive and negative industry news, respectively, with the difference being significant at the 0.05 level. These results support Hypotheses 12.1 and 12.2.

For the high capital intensity group, the difference in the IR^*rp_{t-1} coefficient between positive and negative industry news equals 0.902, which is significantly

Table 12.4 Effects of capacity constraints: high versus low asset turnover

Variable	Low asset turnover		High asset turnover	
	Positive industry news (A)	Negative industry news (B)	Positive industry news (C)	Negative industry news (D)
IR	1.103***	0.942***	1.101***	0.684***
Rp_{t-1}	0.258***	0.084***	0.312***	0.126***
$\boldsymbol{IR^{*}rp_{t-1}}$	**−0.603*****	**−0.365*****	**−0.788*****	**−0.183**
Controls	Yes	Yes	Yes	Yes
Diff. in $\boldsymbol{IR^{*}rp_{t-1}}$***: (A)–(B); (C)–(D)***	**−0.238****		**−0.605*****	
($\boldsymbol{X^2}$***-statistic)***[a]	**(4.64)**		**(18.85)**	
Diff. in $\boldsymbol{IR^{*}rp_{t-1}}$***: [(C)–(D)]-[(A)–(B)]***	**−0.367*****			
($\boldsymbol{X^2}$***-statistic)***[a]	**(6.67)**			
Obs.	21,721	8,117	21,973	9,173
Adj R^2	0.2495	0.1990	0.2747	0.2432

** and *** indicate significance at the 0.05 and 0.01 levels, respectively

greater than that of 0.447 for the low capital intensity group. This result is consistent with Hypothesis 12.3, which predicts that the asymmetrical effect of relative profitability will be more pronounced for industries with more rigid capacity constraints.

12.3.4.2 High Versus Low Asset Turnover

Asset turnover, defined as the ratio of sales to total assets, measures how efficiently assets are used to generate revenues, and so gives an indication of capacity utilization. Because it is not meaningful to compare asset turnover across industries, we now take a time-series perspective to differentiate years in which a given industry has high rather than low levels of asset turnover. This analysis was not originally reported in Hao et al. (2011b), but the results here are based on the same sample as used in their study. We sort industry-years into two groups based on whether an industry's asset turnover in a given year is below or above its own median over the sample period, and then form two corresponding subsamples pooled across industries. According to Hypothesis 12.3, the predicted asymmetry in the role of relative profitability should be more pronounced in the years when asset turnover is high (excess capacity is low) than in the years when it is low (excess capacity is high).

Table 12.4 presents the results. In the low asset turnover subsample, the coefficient on $IR^{*}rp_{t-1}$ is −0.603 conditional on positive industry news and −0.365 conditional on negative industry news; the difference between the two coefficients is significant at the 0.05 level. In the high turnover subsample, the coefficient on $IR^{*}rp_{t-1}$ is −0.788 conditional on positive industry news and −0.183 conditional on negative industry news; the difference is significant at the 0.01 level. Thus, the results from each individual subsample are consistent with Hypotheses 12.1 and 12.2.

For the high asset turnover group, the difference in the $IR^{*}rp_{t-1}$ coefficient between positive and negative industry news equals 0.605, which is significantly greater than that of 0.238 for the low turnover group. This result is consistent with Hypothesis 12.3, which predicts that the asymmetrical effect of relative profitability will be more pronounced for an industry operating with low excess capacity.

12.4 Effect of Relative Profitability on Earnings Sensitivity to Industry News

Next, we examine the role of relative profitability in affecting the sensitivity of a firm's earnings to industry news. According to Hypothesis 12.4, the earnings of the more profitable firms in an industry are more sensitive to industry-wide shocks than those of less profitable firms, which is in contrast to the variation in returns. The regression to test earnings behavior is analogously designed to the return regression in Eq. (11–7) as follows:

$$\Delta E^{i}_{k,t} = \alpha + \beta_1\, \Delta IE^{i}_{t} + \beta_2\, rp^{i}_{k,t-1} + \beta_3\, \Delta IE^{i}_{t} * rp^{i}_{k,t-1} + \varepsilon^{i}_{k,t}, \tag{12.9}$$

where $\Delta E^{i}_{k,t}$ equals the operating income of firm k in industry i for year t minus that for year t-1, scaled by the book value of operating assets at the beginning of year t, and ΔIE^{i}_{t} is an analogous measure for industry i as a whole (but excluding firm k). Hypothesis 12.4 predicts that the coefficient on $IE * rp_{t-1}$ will be positive, $\beta_3 > 0$.

Empirically, earnings data can be quite noisy due to biased (conservative) accounting rules and managers' intentional distortions, causing reported profitability to be unrepresentative of long term performance in some situations. To mitigate the potential influence of noise and distortions, Hao et al. (2011b) truncate observations with extremely high or low profitability in their sample. For this test, they rank firm profitability within an industry based on operating profitability (operating income divided by asset book value), instead of *ROE*, which more directly measures a firm's business as a whole.

The result of the regression in Eq. (12.9) is shown in Table 12.5, which is based on those observations with (1) operating profitability between −1.0 and +1.0 and

Table 12.5 Relative firm profitability and earnings sensitivity to industry news

Variable	Combined news	Positive industry news	Negative industry news
Cons	0.004***	0.005***	0.002
ΔIE	0.481***	0.463***	0.387***
rp_{t-1}	−0.003***	−0.001	0.001
ΔIE $\boldsymbol{*rp_{t-1}}$	**0.259***	**0.144***	**0.701***
Obs.	31,988	25,970	6,018
Adj R^2	0.122	0.063	0.065

*** indicates significance at the 0.01 level

Source: Table 8, Panel A, from Hao et al. (2011b). Reprinted with permission by the American Accounting Association

(2) (scaled) change in industry earnings (ΔE) further truncated at the top and bottom 10 % of the distribution. The coefficient on $\Delta IE * rp_{t-1}$ is significantly positive in both the combined group and in the subgroups of positive and negative industry news. The results are similar when the sample is further limited to the profitability range between −0.75 and +0.75. Thus, in contrast to the behavior of returns, the earnings of firms with higher profitability in an industry exhibit a greater degree of sensitivity to industry shocks, consistent with Hypothesis 12.4.

12.5 Implications

The above analyses show that relative firm profitability plays a distinctive role in explaining return behavior in an industry context. This has implications for both investment decisions and academic research, which we discuss below.

12.5.1 Implications for Factors Explaining Equity Returns

Traditional asset pricing theory shows that equity returns are driven by firm characteristics relative to common (market-wide) risk factors. The capital asset pricing model presented by Sharpe (1964) and Lintner (1965) identifies systematic market risk (beta) as one such characteristic. Empirically, Fama and French (1992, 1993, 1996) show that cross-sectional variations in returns are also predicted by firm size and the ratio of book value to market value of equity. This literature emphasizes the influence of aggregate-level factors on equity prices, and shows that individual firms can have different sensitivities to these factors.

In accounting research, the focus has been on the role of firm-specific accounting variables in explaining equity returns. As explained in Chap. 9, models such as that developed by Chen and Zhang (2007b) show that a firm's equity return over a given period relates to its earnings generated during the period, the change in profitability from the previous period, and the change in equity capital deployed in operations (along with other nonaccounting variables).

Although they both aim to explain equity returns, the accounting and finance literatures are motivated by different questions and focus on different kinds of information. At the same time, the extant research has paid little attention to whether, and if so how, aggregate-level and firm-specific factors may interact with each other.

The above theoretical analysis demonstrates that there are interactions between one specific form of aggregate information (namely, industry-wide news) and firm-specific information (profitability) to jointly influence returns. This interactive effect is rooted in the way in which firms operate when competing in a common product market, which leads to interdependencies in business decisions. Thus, a more complete model of equity return should incorporate not only aggregate risk factors and firm-specific variables but also the interactions between them.

12.5.2 Implications for Investment Strategies

The finding discussed above, that less profitable firms within an industry systematically demonstrate better market performance at times when the industry as a whole is moving upward but worse performance when it is in decline, is useful for designing investment strategies. Investors performing industry analysis and seeking special insights about an industry's prospects (before these views have been reflected in market prices) are advised to place more weight on less profitable firms when the outlook is positive and shift to more profitable ones when it becomes negative.

To investigate the profitability of such a strategy, we further draw on the study of Hao et al. (2011b), who also perform a portfolio based analysis. Specifically, for each year, they sort firms in an industry into deciles based on previous year profitability and then group firms in the same decile across industries. The performance of the decile portfolios are measured by abnormal returns (α), determined from the following four-factor model:

$$R_t - R_f = \alpha + \beta_1 RMRF_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 Momentum_t + \varepsilon_t, \quad (12.10)$$

where R_t is the portfolio return in year t; R_f is the risk-free rate in year t; $RMRF_t$ is the return earned on the market portfolio over and above the risk-free rate; and SMB_t, HML_t, and $Momenum_t$ are, respectively, the returns earned on factor-mimicking portfolios for size, book-to-market, and momentum.

Hao et al. (2011b) find that in periods of positive industry returns, the abnormal return (α) generally decreases with the profitability ranking of the portfolio; the Spearman rank correlation between them equals −0.936, which is significant at the 0.01 level. A strategy of taking a long position in the lowest profitability decile and a short position in the highest decile yields an annual abnormal return of 0.245 (which is what could be earned by an investor with perfect hindsight about industry returns), which is significant at the 0.01 level.

In contrast, in periods of negative industry returns, the abnormal return generally increases with the profitability ranking of the portfolio; the Spearman correlation is 0.564 between the two, and this is significant at the 0.1 level. A strategy of taking a long position in the highest profitability decile and a short position in the lowest decile yields an annual abnormal return of 0.086, which is significant at the 0.05 level.

12.5.3 Implications for the ERC Research

The analysis presented above also helps us to understand market responses to unexpected earnings. Traditionally, the ERC literature has used a firm's own characteristics such as risk and earnings persistence to explain the magnitude of

ERC. Generally speaking, unexpected earnings can arise from aggregate events or firm-specific news. Our theoretical model permits an examination of how ERC depends on relative firm profitability when unexpected earnings are driven by industry-wide events.

From Eq. (12.4), the unexpected earnings triggered by an industry shock (Δa) is

$$\Delta X_j = \frac{1}{8b}[a - 4C_j + (C_1 + C_2 + C_3)](\Delta a), \tag{12.11}$$

whereas the (unexpected) return triggered by the shock is given by Eq. (12.6).

Thus, the ERC of firm j (j = 1,2,3) equals

$$ERC = \frac{R_j}{\Delta X_j} = \frac{16b}{[a - 4C_j + (C_1 + C_2 + C_3)]^2}, \tag{12.12}$$

which increases with cost C_j or, equivalently, decreases with firm profitability. This indicates that the less profitable firms in an industry will have a greater ERC when unexpected earnings are driven by industry-wide events. This result contrasts with the previous prediction that the ERC is smaller for less profitable firms based on the argument that firms have flexibility to exploit real options specific to their own operations (Sect. 10.2.2).

12.6 Summary

In this chapter, we employ standard industrial organization models to show how a firm's profitability relative to its industry peers is related to its return sensitivity to industry-level news. We show that *ceteris paribus,* firms ranked low in their industry in terms of profitability are subject to greater volatilities in stock returns in response to changing industry conditions. Specifically, less profitable firms are expected to not only gain more in equity return from favorable industry shocks but also lose more from unfavorable ones. We further predict that the return variations induced by profitability differences will be more pronounced in the case of positive rather than negative shocks, with this asymmetry being particularly prominent for industries facing tight or rigid capacity constraints. On the other hand, the behavior of earnings is distinctly different from that of return in the industry context; specifically, the less profitable firms in an industry experience smaller earnings changes upon industry-wide shocks. The results of our empirical analysis lend support to these predictions.

The analysis in this chapter opens up a new dimension for interpreting financial reporting. It shows that one can derive a better understanding of a firm's future cash flow and risk by interpreting its financial information in conjunction with information from its industry peers. The chapter also discusses the implications of the results for investment decisions and academic research.

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Chapter 13
Limitations and Future Directions

In this, the closing chapter, we discuss the limitations of the extant valuation research and suggest possible directions for moving the literature forward. We also explore the links between accounting-based valuation and other research topics and provide our thoughts on how the development of valuation theory can benefit inquiries into other accounting issues.

13.1 Directions for Future Research

The theoretical research so far has tackled problems of financial reporting and valuation only in rather primitive settings. For example, in the models of equity value and returns examined in this book, it is assumed that the firm operates in the environment of a (near) perfect capital market. (However, perfect markets for assets and products are not necessarily assumed). In particular, these models implicitly assume that financial reporting alone can resolve the information asymmetry between firm managers and outside investors. There are no roles for, say, corporate voluntary disclosures and information intermediaries. To understand the usefulness of financial reporting for equity investors more thoroughly, future research needs to broaden the scope of the examination by recognizing the various imperfections in the market and considering the conflicting interests of different parties who take part in, or are otherwise affected by, corporate financial reporting.

Theoretical developments along this line can offer better guidance for empirical research in respect of hypothesis development, research design, and interpretation of the results. In return, empirical research can help to validate (or refute) theory and provide inspiration for further improvement and enhancement of theory. With financial reporting treated as a "choice" for managers, the issue of endogeneity inevitably arises, which substantially complicates the analysis of the problem. This

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makes it more compelling that we develop a more thoroughly grounded foundation for understanding firms' reporting behavior and investors' responses.

Below, we comment further on what specific directions may be taken in future research.

13.1.1 Impact of Accounting Manipulation on the Value-Accounting Relation

One of the simplifying assumptions in existing accounting-based models of equity value is that company managers behave as benevolent agents who truthfully measure and report the firm's activities (in accordance with prescribed accounting rules); that is, their personal preferences play no part in shaping the financial report.[1] For a start, the advantage of adopting such a "pure" setting is that it helps to crystallize the link between equity value and the economic forces underpinning value generation without getting bogged down in the complications caused by management incentives to manipulate accounting data.

In reality, managers' self-interests are invariably tied to reported accounting data in some way, so they have a lot at stake when deciding *how* to present the firm's operations. This means that they are likely to engage actively in accounting manipulation to advance their personal interests. Such behavior interferes with the ability of accounting data to faithfully represent the firm's economic reality and consequently hampers users' ability to discern the true state of operations.

Accounting manipulations can affect the value-accounting relation for two reasons. Firstly, they affect the measurement of economic activities (the independent variables of the valuation function). Thus, even if investors can fully recover true economic information from reported data, the mapping of accounting data to value is altered. Secondly, and more importantly, because investors lack the ability to undo accounting manipulation since they are ignorant of the exact circumstances of managers and the accounting discretion available to them, their inferences about the firm's performance become blurred, which affects the outcome and quality of their valuation (the dependent variable).

Once managers are recognized as active players who face an "accounting choice," the analysis becomes more difficult because the reporting-valuation problem becomes a simultaneous game between managers and investors. Such an analysis would require to specify (1) the objective pursued by managers and the tools available for accounting manipulation and (2) the response strategy of investors in mapping observed accounting data to value. The interaction between

[1] This does not mean, however, that these models deny that an information asymmetry exists in the absence of financial reporting. What is implicitly maintained is that accounting is a necessary means to portray the firm's operation and that reported accounting data serve as the basis for market valuation; this premise is in line with the objectives of financial reporting.

the two sides leads to an equilibrium. An example of such is shown in Chap. 8 in the specific context of a multiple-segment firm managing earnings across its segments.

Related to the discussion here is the literature on "earnings management," which investigates how managers exploit accounting flexibility to pursue personal gains, often leading to unfavorable consequences for investors. See Ronen and Varda (2008) for a comprehensive coverage of this literature, including a discussion of the specific incentives behind earnings management. By and large, this literature has evolved on its own and has little connection with the valuation research. An exception is the work of Lee et al. (2006), who exploit valuation theory to predict that earnings management is likely to be more severe for high growth firms where earnings have a greater impact on value and demonstrate empirical evidence consistent with this prediction. In future valuation research which explicitly considers management incentives, the two streams of research will become more interconnected.

13.1.2 The Role of Nonaccounting Information

In emphasizing the valuation importance of accounting data, the research so far has largely neglected how nonaccounting information may also come into play. While mandatory reporting is a vital part of corporate communication with outside investors, this channel is handicapped by the particular ways in which accounting measurement and reporting are conducted. Firstly, accounting data are derived from *realized* business transactions, whereas valuation looks to future operations. Whether, and if so to what extent, past activities can speak for future operations are issues of a largely empirical nature; they depend on the particular circumstances in which a firm operates and the decisions and judgments it makes in responding to a changing environment. Although accounting data generally convey a great deal of information about what the firm has done so far, per se they do not and cannot explain what the firm will do in the future. Accounting data come alive only if they are placed in the context of the firm's operations. That is, by indicating where the firm is at now, the financial report serves as an anchor for forecasting future operations, but to actually forecast the future we need to evaluate past performance with an understanding of the internal and external conditions facing the firm.

Secondly, because of its periodic nature, financial reporting lacks timeliness as a source of information. Some of the economic activities summarized in a report may already have been made public. At the same time, the emphasis on realized transactions means that the financial report captures only a portion of the events that have taken place during the period, so it is incomplete in terms of conveying value-relevant information.

Nonaccounting information can be important in valuation insofar as it mitigates the limitations of accounting data. It may take the form of information about the environment of the firm's operations, which provides a context for interpreting reported data and forecasting future operations. It can also constitute data about activities and events that have not had an impact on the firm's performance. Chapter 4 gives a treatment of the issue at a general level. Future research may aim to conduct more in-depth examinations of specific types of nonaccounting information.

13.1.3 Recognizing the Importance of the Information Environment

The theoretical and empirical research on the relation between equity value and accounting data has paid little attention to the information environment in which valuation exercises are actually conducted. This is determined collectively by the activities of the firm as the information provider through mandatory and other disclosures, intermediaries such as analysts who facilitate the discovery and processing of company information, and investors as the ultimate users. It concerns the total amount of value-relevant information possessed by market participants, its distribution among them, and the speed with which investors process information and absorb it into prices. It will be useful to investigate how the information environment influences and confounds the relation between equity value and accounting variables.

13.1.4 Looking into the Process via Which Reported Information Is Incorporated in Prices

It is often maintained in the empirical research examining the relation between equity value and accounting variables that prices are informationally efficient with respect to reported accounting information. However, the evidence suggests that prices may not be efficient in some situations. Realistically, investors require both time and complementary information to digest reported accounting data and understand their implications, and so discovering true intrinsic value is likely to be a gradual process. Investors can be slow to process accounting data because, for example, the valuation implications of reported data stated at historical cost are not immediately clear or they have difficulty in unwinding the distortions in reported data. Thus, at any given point in time, prices can deviate from true intrinsic values.

A relevant question for empirical research is how efficiently the market is able to process various accounting items. Although there has been much research to address this general topic [such as studies examining the post earnings announcement drift (e.g., Ball and Brown (1968) and Bernard and Thomas (1989) and those investigating the accrual anomaly initially documented by Sloan (1996)], this body of work is mostly disconnected from the formal valuation models. Theoretical models of equity value can facilitate empirical investigations by, for example, identifying the key factors driving value and changes in value. To the extent that investors are not consciously aware of such drivers and the ways in which they impact value, price adjustment to reported information can be slow, causing predictable return patterns. A few studies (see for example Hwang and Sohn 2010; Yue and Zhou 2011) have exploited certain features of real options-based valuation models to identify under or overvalued stocks. There is scope for further work along this line.

13.1.5 Interdependency Across Firms

In modeling the reporting-valuation problem, extant research typically treats a firm as if it functions in solitude; there are no firm interdependencies through economic activities or financial reporting. To bring valuation theory closer to the practical setting, it would be useful to recognize the various forms of interdependencies and interactions between firms and explore their implications for the value-accounting relation.

One form of interfirm interaction takes place in the product market, where firms compete with one another through decisions on sales quantity and price. The study of Hao et al. (2011b) discussed in Chap. 12 is an example of how product market competition induces interfirm dependency in interpreting financial information. Another form of interdependency arises because individual firms are subject to common economic forces, causing their business performance to comove. As a result, performance data reported by one firm also convey information about the performance of other firms operating in a similar environment. The literature on information spillover has examined such interdependency in specific settings such as earnings announcements (see for example Foster 1981; Han and Wild 1997; Ramnath 2002; Thomas and Zhang 2008). It is of interest to further explore how interfirm dependency of various forms alters the relation between equity value and accounting variables.

13.1.6 Coping with Potential Endogeneity

Despite the emphasis placed on objectivity and verifiability in financial reporting, an integral part of accrual-based accounting is the use of subjective judgment that reflects management's expectations of future events (as opposed to those which have already occurred). According to Demski (2004, p. 519), accruals are estimates which can be interpreted as expectations stemming from both the choice of accounting method and that of the underlying economic transactions themselves. Thus, the measurement and reporting of a given set of realized economic events are endogenous to the circumstances of firm management and the particular objective it aims to achieve. This means that research that uses reported accounting data to explain market variables (value or return) is likely to be subject to endogeneity,[2] an issue that has been neglected in the mainstream empirical valuation research. In general, endogeneity renders problematic the use of OLS procedures in which regressors (accounting variables) are treated as though they were exogenous, possibly resulting in coefficients that are asymptotically inconsistent.

Schroeder (2010, p. 123) points out that "econometric analysis of endogeneity is a three-legged problem: theory, data, and model specification." Ideally, theoretical research should play a leading role in this inquiry. However, existing theoretical models of equity value or return such as those examined in this book have only considered primitive settings that suppress accounting choice issues; in these models, firms report accounting data truthfully and there are no strategic interactions between it (via managers) and investors. Theoretical research needs to move forward from this view of accounting as purely a communication tool, to shed light on how managers make accounting choices, and how these choices affect the equilibrium mapping of the resulting accounting data to value. It is important to develop the micro-foundations on which to explore the decisions of managers on the one hand, and investor responses to financial reporting on the other, whereby each side is consciously aware of the strategic considerations of the other, and hence to establish the equilibrium relation of the variables of interest from an analysis of interactions (Demski 2004).

In the complex empirical world, the motives behind accounting manipulation can be diverse, and correspondingly the accounting choice problem and the behavior exhibited by managers can vary greatly. For example, managers' considerations at the time of public share offerings are likely to be very different from those arising prior to granting stock options.

Depending on the specific problem with which we are concerned, the econometric treatment of endogeneity should differ; see Schroeder (2010) who explains the range of econometric tools which are appropriate for different endogeneity problems. Two specific techniques seem particularly pertinent to valuation research. One treats endogenous regressors with instrumental variables and performs a two-stage regression analysis (Heckman 1979). It is applicable to situations where accounting choice affects market price (the dependent variable), but the level of price itself is not a major factor behind accounting choices. An example of this would be when managers hoping to meet an earnings target use accruals to manage reported earnings upward. A vital step in implementing this technique is identification (hopefully based on theory) of instrumental variables that affect accounting choices but are themselves not correlated with price.

Another tool is simultaneous equations, which are applicable to situations where the dependent and independent variables affect each other in both directions and at the same time are both affected by other, exogenous factors. In a setting where

[2] Indeed, Demski (2004) observes that endogeneity is present over a wide spectrum of research topics in accounting.

accounting manipulation causes misvaluation, managers may also view mispricing as an opportunity to carry out certain financing and/or investment activities, which in turn influence their accounting choices. For example, managers may decide to issue new shares at times when they feel that prices are high relative to intrinsic values (see for example Jung et al. 1996; Graham and Harvey 2001); this can give them a further incentive to manipulate accounting to inflate prices still higher, thus causing the effects to operate in both directions between share price and accounting choice.

Proper use of econometric techniques is predicated on a sound theoretical understanding of the underlying factors driving the respective choices of managers and the other players involved. As Lennox et al. (2012) point out in their discussion of the implementation of the Heckman procedure, accounting researchers often mistakenly or inappropriately use the technique, mainly because they do not know which exogenous factors drive the variables under investigation. In the valuation context, a further challenge arises due to the assumed linear structure in standard econometric techniques for treating endogeneity. Linearity generally does not hold because of the effect of real options on the valuation function. Whether the issue can be addressed by modifying an existing technique or whether an entirely new technique will be required is as yet unclear and awaits further investigation.

13.2 Linking Valuation Theory to Other Accounting Topics

Theoretical development on accounting-based valuation is not only of interest in its own right but can also benefit inquiries into other topics. Value assessment is at the heart of many financial and business decisions, and so it is no surprise that valuation is intricately tied to other research issues. In the preceding section, we have already touched on the links between valuation research and several other areas including earnings management, the role of financial intermediaries such as analysts, market efficiency, and so on. In this section, we offer thoughts on how valuation theory is also relevant to other branches of accounting research. These are intended as some examples of topics that can be linked to valuation research, rather than a complete list.

13.2.1 Voluntary Disclosures

Mandatory reporting has limitations in the scope of what is reported and the timeliness of the report. That is why firms frequently provide additional information through voluntary disclosures. These can play either a supplementary role to make up for deficiencies in the quality or amount of information from mandatory reporting or a complementary role to enhance the interpretation of the reported data. A more comprehensive theory of accounting-based valuation could be developed to incorporate the role of voluntary disclosure as well as reported data. Such a model has the potential to serve as a platform for probing the circumstances under which a firm is likely to provide voluntary disclosure and what types of information are likely to be disclosed. In particular, through such an extended theory, the connection between voluntary disclosure behavior and the characteristics of reported accounting data can be more clearly understood. Although there is already a large body of theoretical work on discretionary disclosures [see the survey by Verrecchia (2001) and discussion by Dye (2001)], efforts so far have not been directed at understanding accounting-based valuation.

13.2.2 Time-Series Properties of Earnings and Fundamental Analysis

One stream of research explores the time-series behavior of earnings, which can be a useful tool for forecasting future earnings; see Brown (1993) and Kothari (2001, pp. 145–151). Earnings forecasting is intertwined with valuation, and so the insights gained from each line of research can be applicable to the other.

The research examining the time-series properties of earnings typically takes the view that earnings behavior follows a standard time-series process such as a random walk or a mean reversion. Indeed, this view is reflected in the broader empirical literature examining the capital market impact of accounting data such as the return-earnings research (see Kothari 2001). Following this view, once the parameters of the process are known, all that is needed to forecast future earnings is past earnings. A time-series model, however, is mechanical and lacks economic foundation. Intuition suggests that earnings are an outcome of business operations employing capital and other resources; they are not generated from past earnings. Studies based on time series thus capture only a statistical and not a cause-and-effect relation founded on an economic-based analysis.

To develop a model of earnings behavior based on the economics of value generation, one needs to examine a firm's behavior in terms of real investment decisions and consider a broader set of information. In the framework of the ROM, earnings are generated by directing capital towards profitable projects, and it is scale and profitability—not earnings, the product of the two elements—that constitute primitive information for forecasting and valuation. Accordingly, it is not a theoretically sound approach to forecasting future earnings based on a mechanical extrapolation of past earnings.

Also related to this discussion are the studies falling into the area of fundamental analysis, which employs a variety of accounting items and ratios to predict future earnings (see for example Ou and Stephen 1989a, b). Unlike time series-based research, these studies make use of a much wider set of accounting data than just earnings. However, this area of research is also statistical in nature. It starts with a large number of accounting items and then narrows down the scope by eliminating those that lack significant correlations with future earnings. The weakness, again, is that no formal (economic-based) theory is used as the basis for forecasting.

13.2.3 Analyst Earnings Forecasts

The research on financial analysts has examined many facets of analyst activities and forecast outcomes such as the properties of forecast errors, analyst incentives, and the association of earnings forecasts with stock prices; see Bradshaw (2011) for a comprehensive survey. On the other hand, there is a paucity of work looking into the decision process that generates earnings forecasts; that is, what is going on inside the "black box." There are many relevant questions to address in this respect. For example, what types of information (such as accounting and nonaccounting) do analysts use as input? To what extent do they rely on private versus public sources of information? And what models do they use to convert raw data into earnings forecasts? To the extent that analysts are interested in producing accurate forecasts, it seems that their decisions should be predicated on an "economic-based" analysis of how firms generate value from operations (versus a statistical-based analysis), just like investors. Theoretical models of accounting-based valuation can help to sharpen the focus of analysis when investigating these and related questions.

13.2.4 Accounting Conservatism

Conservatism is a pervasive characteristic of accounting practice, and one which has been extensively studied. Most studies have aimed to examine the reasons for and consequences of conservatism in contracting settings (Watts 2003a, b). From a valuation standpoint, conservatism matters because it alters the accounting measurement of given economic activities, which potentially blurs the true economic information in accounting data. So far, valuation models have treated accounting conservatism as exogenous, without providing a reason for its existence; see, for example, the models proposed by Feltham and Ohlson (1995, 1996) and Zhang (2000) described in Chaps. 2 and 4. A challenging task for future research is to explore whether there is a demand for conservatism from a valuation perspective.

13.2.5 Standard Setting

Insofar as the valuation research enhances our understanding of the link between firm value and accounting data, it is of relevance to standard setting organizations which are mandated to formulate measurement and reporting rules to enhance the usefulness of financial reporting. There have been many empirical studies evaluating the valuation relevance of specific accounting standards. However, archival-based research has a natural limitation in that the data used for analysis are a result of the particular set of accounting standards actually in force. While it is useful to gather evidence ex post on the association between stock prices and accounting data generated under a particular standard that has already been implemented, such an approach does not seem well suited to an ex ante comparison between alternative standards, which is the situation typically facing standard setters. Theoretical research has a comparative advantage in addressing conceptual-level issues such as how and why one alternative may be more relevant to investors than another. The work presented in Chap. 11 is a preliminary attempt at this.

Comprehensive models of equity value have the potential to inform standard setters, in a systematic way, about how value is related to information extracted from the financial report and what distinctive roles individual items on the statement play. The development of such models can contribute to establishing an overarching (valuation-based) framework to integrate various aspects of standard setting issues, which can then serve as a common ground for facilitating discussions and debates with regard to specific standards of interest. At present, we lack a well-grounded theoretical framework to conceptually guide the standard setting process. This is one area where academic research, especially theoretical work, has the potential to make an important contribution.

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