Chapter 2
The Ohlson and Feltham Ohlson Models

Abstract This chapter analyses the phenomenon of "positive valuation of losses" in the new economy companies in the US. One of the potential explanations of this phenomenon is that these companies are *start-up companies*, mostly technology-based, that invest massively in intangible assets, in particular research and development (R&D) and advertising. Under Generally Accepted Accounting Principles (GAAP), these investments should be considered at full cost in the year they occur. Thus, in this chapter, we analyse the Ohlson (OM) (Contemp Acc Rev 11(2):661–687, 1995) and Feltham and Ohlson (FOM) (Contemp Acc Rev 11(2):689–731, 1995) valuation models. Feltham and Ohlson (Contemp Acc Rev 11(2):689–731, 1995) demonstrated analytically, using dynamic information, that losses, particularly at the stage of *start-up* in growth and technology-based companies, are considered to be costs that create an effect of *conservatism accounting*, consequently, there is an undervaluation of assets, hence the results and equity. However, this situation tends to be reversed over time, because given the principle of rationality, the investors continue to invest in the company if those investments are associated with abnormal profitability expectations.

Keywords Technology-based companies · Positive valuation of losses · Ohlson and Feltham and Ohlson models

2.1 The Ohlson Model (OM)

Beaver (2002: 457) states: 'The F–O approach [Ohlson 1995 (OM) and Feltham and Ohlson 1995 (FOM)] is, in my opinion, one of the most important research developments in the past ten years'. The advantage of the Ohlson model (OM) is that it defined a conceptual framework that relates the market value of the company

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(MVE) with the past and the future financial information of the company, i.e. with current and future expected net income, with the book value of equity (BVE), and with dividends.[1]

The initial theoretical framework of OM was the neoclassical model of dividends developed by Williams (1938), but known as the Gordon and Shapiro (1956) model. Gordon postulates that: (i) the growth rate for dividends is constant; (ii) the preferences/beliefs of the agents are homogeneous; and (iii) they are neutral to risk. Hence, the dividend model is defined as follows:

$$P_t = \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t(d_{t+\tau}) \tag{2.1}$$

where

P_t share price at time t;

d_t net dividends paid at time t. The d_t variable reflects all net transactions with shareholders, such as the payment of dividends, new shares issued to finance new investments, and/or repurchase of shares. For simplicity, we designate this variable only for dividends;

$R = (1 + r_{\mathrm{f}})$, where r_{f} is the free-risk rate;

E_t [.] the expected value operator, conditional on information available at time t.

In this context, and assuming two principles:

(i) The principle of clean surplus relation (CSR), which states that

$$\mathrm{bv}_t = \mathrm{bv}_{t-1} + x_t - d_t \tag{2.2}$$

where

bv_t value of equity at the end of the period t. By analogy, bv_{t-1} corresponds to the value of equity in the previous period $(t - 1)$;

x_t the net results for the year t.

The variables "bv_t" and "x_t" are exogenous to the model.[2]

[1]According to Lo and Lys (2001), in 1999, and with reference to the OM model, the mean number of citations was already higher than nine.

[2]Holthausan and Watts (2001) criticize the OM model because it is a partial equilibrium model, where the financial variables used are defined exogenously to the model. But as Beaver (2002: 458) claims, parsimony is also a very important quality in any model, arguing that: "*By analogy, the capital asset pricing model* (*CAPM*) *has the demand for financial institutions, financial institutions yet we observe empirically*". With this reasoning, Barth et al. (2001: 90) state: *To our knowledge, there is no academic theory of accounting that derives the demand for accounting*

According to the CSR principle, any changes to the book value of the company (bv_t) are the result of income generated and retained in the company, i.e. $\Delta bv_t = x_t - d_t$, where d_t reflects all transactions directly with shareholders (i.e. distribution of dividends, issue of new shares to finance new investment projects and/or repurchases). The intuition behind this principle is that all transactions affecting the assets and liabilities of the company, and consequently, the value of equity, should be reflected in the income statement, and its effect is reflected in the net income variable. This property, and according to Zhang (2000), reconciles any changes in the value of the assets held by the company with the flow of income generated by them. Thus, Ohlson (1995) does not "force" that new investments are financed only via retained earnings, unlike the closed models of self-sustained growth (e.g. Gordon's model). Thus and in accordance with Miller and Modigliani (1961) the financing of new investment by retained earnings or issuing shares are perfect substitutes.

Dividends affect the level of capital (bv) in t, but the net income remains unchanged (x_t).[3] Analytically:

$$\partial bv_t \,/\, \partial d_t = -1 \tag{2.3a}$$

$$\partial x_t \,/\, \partial d_t = 0 \tag{2.3b}$$

$\partial x_t \,/\, \partial d_t$ is not obtained directly from (Eq. 2.3a), but is consistent with the same because $\frac{\partial \mathrm{bv}_{t-1}}{\partial d_t} = \frac{\partial \mathrm{bv}_t}{\partial d_t} + \frac{\partial d_t}{\partial d_t} - \frac{\partial x_t}{\partial d_t} = -1 + 1 - 0 = 0$ (Ohlson 1995: 667). Introducing the abnormal variable, defined as:

$$x_t^a = x_t - (R_\mathrm{f} - 1)\mathrm{bv}_{t-1} \tag{2.4}$$

where x_t^a measures the excess returns that the company receives.

Because the results exceed the cost of capital, Ohlson (1995) expressed the present value of expected dividends (PVED), based on the net income and the value of equity. Hence, the PVED is[4]:

$$P_t = \sum_{\tau=1}^{\infty} R_\mathrm{f}^{-\tau} E_t(x_{t+\tau}^a - \mathrm{bv}_{t+\tau} + R_\mathrm{f}\mathrm{bv}_{t-1+\tau}) \tag{2.5}$$

(Footnote 2 continued)

information arising from the equilibrium forces and provides the mapping of accounting information into price shares.

[3]This assumption is in line with the principle of perfect capital markets, so it excludes any signal effect associated with the variable "income".

[4]Expressing dividends according to the current results, through the CSR principle and replacing x_t, the expression obtained for the abnormal results, we obtain $d_t = x_t^a - \mathrm{bv}_t + R_\mathrm{f}\mathrm{bv}_{t-1}$.

This expression, after some algebraic transformations, allows us to redefine the PVED model as follows[5]:

$$P_t = \mathrm{bv}_t + \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t(x_{t+\tau}^a) \tag{2.6}$$

This model is well known and reported in the literature as the residual income valuation *model* (RIV) or Edwards and Bell (1961) model (White et al. 1997: 1062).

As shown by Lo and Lys (2001), the Gordon's model and RIV are analytically equivalent, so to reject the RIV means ignoring that financial assets are a function of the present value of expected future cash flows.

The innovation of Ohlson (1995) against the RIV model or the Gordon model lies in the treatment that gives the structure of the time series of abnormal results (x_t^a). To define the stochastic process that follows the variable x_t^a, Ohlson (1995) introduces the variable v_t—other information, i.e. a variable that captures relevant events in terms of information that affects prices, but are not yet reflected in the financial statements. This time lag of the occurrence of certain events that are relevant to the formulation of economic agents' beliefs on the growth of abnormal results of the company, is one of the limitations ascribed to the financial statements, or rather to its ability to disclose all relevant information timely, i.e. *lack of timeliness* (Rayn 1995; Beaver 2002). To fill this gap, Ohlson (1995) supports his model in a dynamic information, which he defines as an autoregressive process of first order, and which features the dynamics of abnormal results. Analytically, the dynamic information is defined as:

$$\begin{cases} x_{t+1}^a = w x_t^a + v_t + \varepsilon_{1,t+1} \\ v_{t+1} = \gamma v_t + \varepsilon_{2,t+1} \end{cases} \tag{2.7}$$

where the parameters w and γ are fixed and known and assume values between]0, 1[.[6] In a broad sense, these exogenous parameters to the model are determined by the environment that characterizes the company. The random terms $\varepsilon_{1\tau},\ \varepsilon_{2\tau}$ have $E_t(\varepsilon_{k,t+\tau}) = 0$ with k = 1.2 and $\tau \geq 1$. The model imposes the independence of v_t in relation to x_t^a because $E_t[v_{t+\tau}]$ depends only on v_t, with v_t reflecting all (not just financial) information relevant to the estimation of abnormal returns, regardless of their past values. However, its effect is reflected in x_t^a, which is incorporated in the

[5]Note that $R_{\mathrm{f}}^{-\tau} E_t(\mathrm{bv}_{t+\tau}) \to 0$ *com* $\tau \to \infty$, i.e. the present value of capital converges to zero as the time horizon tends to infinity. The model assumes that the equity grows at a rate less than r_{f}.

[6]The parameters w and γ assume values greater than zero for economic conditions and values less than 1 in order to ensure stability/stationarity of the model. This condition implies that the $E_t(x_{t+\tau}^a) \to 0$ and $E_t(v_{t+\tau}) \to 0$ with $\tau \to \infty$. Indeed if w = 1, this means that growth opportunities persist indefinitely, which is not consistent with the empirical evidence.

variable bv_t, by the property of CSR.[7] This dynamic information enables the company to earn abnormal returns over a period of time, and this effect is captured by the parameter w. However, due to the competition effect the abnormal process, i.e. firms' profitability trend, tends to converge to the average of the economy—*mean reverting*.

Combining Eqs. 2.3a and 2.3b, the Eqs. 2.1 (PVED), 2.2 (Principle CSR) and 2.7 (dynamic information), Ohlson (1995: 669) defines the evaluation function based on the calculation of the expected value for the abnormal results. Hence, the enterprise value is defined as[8]:

$$P_t = \mathrm{bv}_t + \alpha_1 x_t^a + \alpha_2 v_t \tag{2.8}$$

where

$$\alpha_1 = \frac{w}{R_\mathrm{f} - w} \geq 0 \text{ and}$$
$$\alpha_2 = \frac{R_\mathrm{f}}{(R_\mathrm{f} - w)(R_\mathrm{f} - \gamma)} > 0.$$

According to the OM, the market value of the company (MVE or P_t) is a linear function of the level of capital invested in the company (bv_t), the abnormal results (x_t^a) generated by the company and the variable (v_t)—other than the financial information. Ohlson (2000) suggests the analysts' forecasts for future one-year results could be a good *proxy* for the variable v_t. The market value of the company's equity is much more sensitive to the variables x_t^a and v_t, the greater the persistence of the parameters w and γ, exogenous to the model, and therefore $\alpha_1(w)$ and $\alpha_2(\gamma)$ are increasing in their determinants.

Equation 2.8 can be reformulated in terms of net profit (adjusted for dividends) and the value of equity (bv_t), where φ corresponds to the multiple of results—price earnings ratio (PER):

$$P_t = \kappa[\varphi x_t - d_t] + (1 - \kappa)\mathrm{bv}_t + \alpha_2 v_t \tag{2.9}$$

with

$$\begin{cases} \varphi = \frac{R_\mathrm{f}}{R_\mathrm{f} - 1} \\ \kappa = (R_\mathrm{f} - 1)\alpha_1 = \frac{(R_\mathrm{f} - 1)w}{R_\mathrm{f} - w}. \end{cases}$$

[7]The CSR defines $\mathrm{bv}_t = \mathrm{bv}_{t-1} + x_t - d_t$ being $x_t^a = x_t - (R_\mathrm{f} - 1)\mathrm{bv}_{t-1}$; replacing x_t in the CSR expression we obtain $\mathrm{bv}_t = x_t^a + R_\mathrm{f}\mathrm{bv}_{t-1} - d_t$, an expression that shows that any relevant events from the point of view of information are contained in the value of equity (bv_t) through the "dynamic information".

[8]The analytical deduction of the Eqs. 2.8 and 2.9 appear in the Appendix 2.1.

The previous expression can be interpreted as a weighted average of the evaluation model based on the updated income flows—the discounted profits (*earnings model*) and the assessment model from stock of assets required for generated the income flows—the model on equity (*book value model*).[9]

Ohlson (1995) also shows that in the medium- and long-term, the variable (bv_t) is an unbiased estimator of the market value of the company (MVE), i.e. there is an *unbiased accounting* property. In the short term, Ohlson (1995) admits the existence of *goodwill*, which defines as the flow of abnormal results that the company expects to receive, and which are derived from trademarks, patents, location, customer loyalty, investment in R&D, advertising and specificity of the organizational model—intangible assets, which are potential sources of value creation. Analytically:

$$P_t - \mathrm{bv}_t = \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau}\left(x_{t+\tau}^a\right). \tag{2.10}$$

Indeed, using the evaluation function defined (Eq. 2.8), it is shown that:

$$E_t[P_{t+\tau} - \mathrm{bv}_{t+\tau}] = \alpha_1 E_t\left(x_{t+\tau}^a\right) + \alpha_2 E_t(v_{t+\tau}) \rightarrow 0 \; com \; \tau \rightarrow \infty. \tag{2.11}$$

i.e. in the medium and long term *goodwill* is null; *in this context* the book value of equity (bv_t) is an unbiased estimator of MVE.

2.2 The Extent of the Ohlson Model: The Feltham Ohlson Model (FOM)

In the work of Feltham and Ohlson (1995) (FOM), the authors introduce two new effects: (i) the understatement of operating assets, *accounting conservatism*; and (ii) growth in the operational assets. The effect *conservatism accounting* reflects the persistence of the difference between the market value of equity (MVE) and book value (BVE), which is the source of the *unrecorded goodwill*. This *unrecorded goodwill* may result due to an understatement of existing and/or an overestimation of expected abnormal results.

To demonstrate these two effects, the authors continue to assume the neoclassical model of discounted dividends (PVED) and in accordance with Miller and Modigliani (1961), Modigliani and Miller (1958) the irrelevance of dividend policy

[9]In theory, Ferreira and Sarmento (2004) argue that the equity valuation and evaluation on the basis of updated income streams should give the same value. However, empirically, and given the existence of *goodwill* associated with the presence of intangible assets and the relevance or lack of relevance of financial statements, which derives from their (in)capacity in terms of timely reporting of all relevant and reliable information, the two approaches tend to have marked differences.

and the separation between operating and non-operating activities. The separation of such activities will have different effects on the evaluation function.

The non-operating activities include assets and liabilities traded in perfectly individualized markets, whereby the value of this class of asset tends to match its market value, generating investment with zero net present value (NPV). Therefore, the evaluation of such assets does not imply any specification, contrary to operating assets. The difficulties in the assessment of the value of operating assets are related in that they are not evaluated in a perfect, liquid market.

Assuming the separation between operating and non-operating activities and including the dividend policy, Feltham and Ohlson (1995) began by defining a set of accounting and financial variables, from which the evaluation function is specified.

Thus, considering a multiperiod context, where in each period [$t = 0, 1, 2 \ldots$], the company discloses all the information about its operating and non-operating activities; this information is described by Zhang (2000: 128) as follows:

> These data are random prior to their disclosure and the probabilistic structure governing their stochastic behaviour is exogenous.

In this context the variables considered are:

- bv_t value of the company's equity at date t;
- x_t net profit generated in the period [$t - 1$, t];
- d_t dividends at date t;
- fa_t net non-operating assets (non-operating assets minus liabilities) at time t[10];
- i_t result from non-operating activities in the period [$t - 1$, t];
- oa_t net operating assets, i.e. operating assets minus operating liabilities, on the date t;
- ox_t operating result for the period [$t - 1$, t];
- c_t operating cash flow, i.e. the cash flow generated by operating activities net of investments;
- P_t market value of the company (MVE) on date t.

The relations established between these variables are:

(i) in line with the OM, the principle CSR:

   (a) The book value of equity results from the aggregation of operating (oa_t) and non-operating assets (fa_t). Analytically: $\mathrm{bv}_t = \mathrm{oa}_t + \mathrm{fa}_t$;
   (b) Similarly, the results generated by the two types of activities (operational —ox_t, and not operational activities—i_t), i.e. $x_t = \mathrm{ox}_t + i_t$;
   (c) Consistent with the OM model, the principle that defines CSR:

[10]This variable can take a negative value when the non-operating liabilities exceed the non-operating assets. For convenience of analysis, and similarly to the d_t variable, it is considered $\mathrm{fa}_t > 0$.

$$\mathrm{bv}_t = \mathrm{bv}_{t-1} + x_t - d_t;$$

(ii) Net interest relation (NIR)—Income generated from non-operating activities:

$$i_t = (R_\mathrm{f} - 1)\ \mathrm{fa}_{t-1} \text{ where } R_\mathrm{f} = 1 + r_\mathrm{f}. \tag{2.12}$$

The rate considered is the free-risk rate (r_f), which is independent of the financial situation of the company (i.e. fa_t is >0 or fa_t <0).[11] As it is assumed that the non-operating assets and liabilities are paid at the free-risk rate, this type of activity generates a net present value (NPV) of zero. The basic intuition of this reasoning is based on the principle that non-operating assets and liabilities are traded in perfect markets, which resemble a cash account (*numeraire asset*) measured without any risk (Morgenstern 1963).

(iii) Financial asset relation (FAR)—Relationship between net non-operating assets:

$$\mathrm{fa}_t = \mathrm{fa}_{t-1} + i_t - [d_t - c_t]. \tag{2.13}$$

At the beginning of the period, the company begins its activity with a volume of non-operating assets—fa_{t-1}. During the period t, these assets generate an income i_t, as dividends paid only at the end of the year t. The cash flow generated by operating activities (*cash flow to the firm*—c_t) is also determined at the end of the period. Note that the amount $[c_t - d_t]$ affects the level of non-operating assets at the end of the year, but not the level of income generated in the period (i_t). The variable c_t gains particular relevance in the FOM model, compared to the OM model.

(iv) O*perating asset relation* (OAR)—Relationship between net operating assets:

$$\mathrm{oa}_t = \mathrm{oa}_{t-1} + \mathrm{ox}_t - c_t. \tag{2.14}$$

The reasoning behind this relationship is similar to the CSR principle. The company starts its activity with a certain level of operational assets (oa_{t-1}), which generate an outcome in the period—operational results (ox_t); the cash flow (c_t) generated by operating activities is transferred to non-operating activities.[12] Given the FAR relation, the transference of c_t for financial

[11]In a context of perfect markets, the company cannot change interest rates. Moreover, given the *homemade* concept, individual investors cannot mimic the decisions of indebtedness of the company, since, at a higher or lower level of debt, the company is not a creative source of value Miller and Modigliani (1961), Modigliani and Miller (1958). To emphasize that, Feltham and Ohlson in 1999 incorporated risk aversion and the existence of heterogeneous preferences of investors in their article.

[12]If negative, c_t corresponds to net investments in operating assets (oa_t).

activities does not generate any gain or loss, because such transference is taken at market value, thus the c_t variable is objectively measured independently of any accounting principles underlying the valuation of operating assets (oa_t) (Feltham and Ohlson1995).

Since the criterion for decision-making by managers should be creating wealth, the aim of Feltham and Ohlson (1995) is to determine the value of the company and not the value that is distributed to shareholders (e.g. dividend model). Thus, with reference to the Gordon's model (PVED), in which the value is determined by the level of expected wealth transfer to shareholders $(d_{t+\tau})$, and considering the relationships between various financial accounting-defined variables (i.e. CSR, NIR, FAR and OAR), Feltham and Ohlson (1995) demonstrate the equivalence of the neoclassical model (PVED) with the following three expressions (Proposition 1)[13]:

$$P_t = \mathrm{fa}_t + \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t(c_{t+\tau}); \tag{2.15a}$$

$$P_t = \mathrm{bv}_t + \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t\left(x_{t+\tau}^{a}\right); \tag{2.15b}$$

$$P_t = \mathrm{bv}_t + \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t\left(\mathrm{ox}_{t+\tau}^{a}\right); \tag{2.15c}$$

Equation 2.15a, and according to Miller and Modigliani (1961), shows that the key factor to generating value for a company is the net present value of cash flow flows from operating activities and the risk that is inherent them. Equation 2.15b is equivalent to the PVED model (Eq. 2.6). Equation 2.15c specifies that, given the principle of separation between operating and non-operating activities, abnormal results derive from operating activities. Only the investments in real assets that have the capacity to create value, given the existence of economic agents in the markets with expertise in specific business and with inside information and skills that enable them to track innovation, thus sustaining their competitive advantages in the face of competition.

Therefore, in the terminology of Feltham and Ohlson (1995), and in line with Miller and Modigliani (1961), Modigliani and Miller (1958), the value of the company is $\mathrm{MVE}_t = \mathrm{fa}_t + (\mathrm{oa}_t + g_t)$. From this equation, it follows that *goodwill* is a function only of the expected results from abnormal operational results, i.e. it depends only on the operational activities.

[13]The analytical deduction of these formulas and their equivalence with the PVED model are reported in Appendix 2.2.

The demonstration is sustained by the CSR principle, and the NIR and FAR relations. Therefore:

$$\begin{aligned} P_t &= g_t + \mathrm{fa}_t + \mathrm{oa}_t \Leftrightarrow \\ P_t - \mathrm{fa}_t &= \mathrm{oa}_t + g_t \end{aligned} \tag{2.16}$$

using Eq. 2.15a, we obtain

$$\mathrm{ao}_t + g_t = \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(c_{t+\tau}) \tag{2.17}$$

By Eq. 2.15c:

$$\begin{aligned} \mathrm{ao}_t + g_t &= \mathrm{oa}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(\mathrm{ox}^a_{t+\tau}\right) \Leftrightarrow \\ g_t &= \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(\mathrm{ox}^a_{t+\tau}\right) \end{aligned} \tag{2.18}$$

This expression has two implications: (i) *goodwill* (g_t) can be different from zero, i.e. the value of the operating assets (oa_t) differs from its current expected cash flows; and (ii) the bias from the difference between market value (MVE) and book value (BVE) does not differ just in the short term, as it tends to persist in the medium and long term. It is from the persistence of this differential that the problem of *unbiased accounting* versus *conservative accounting* arises.[14]

In this context, Feltham and Ohlson (1995) define the property *unbiased accounting* as occurring when the $E_t(g_{t+\tau}) \to 0$ *com* $\tau \to \infty$. As a negation of this property, there is *conservative accounting*, whereby the $E_t(g_{t+\tau}) \succ 0$ *com* $\tau \to \infty$. Thus the property *unbiased accounting* (Proposition 2) implies:

$$E_t(\mathrm{oa}_{t+T}) = E_t\left[\sum_{\tau=1}^{\infty} R_f^{-\tau} E_{t+T}(c_{t+T+\tau})\right] \to 0 \; com \; T \to \infty,$$

[14]For Ohlson (1995) *unbiased accounting* is characterized by a self-corrective process, in which the medium- and long-term abnormal results tend to zero and the return on equity ratio (ROE) converges to r (the cost of capital). Kothari (2001) highlights this autocorrective effect of the OM model, which makes the OM "immune" to the manipulation of policies and/or accounting principles. For example, any strategy to increase the results in t, will increase the bv_t. In the following period, this effect tends to be offset by a reduction of the abnormal results because the cost of capital $[(R_f - 1) * \mathrm{bv}_{t-1}]$ increases.

or equivalently,

$$E_t\left[\sum_{\tau=1}^{\infty} R_f^{-\tau} E_{t+T}\left(\mathrm{ox}_{t+T+\tau}^{a}\right)\right] \rightarrow 0 \; com \; T \rightarrow \infty. \tag{2.19}$$

Replacing (→0) by (>0) occurs the *conservative accounting* effect. In other words, *unbiased accounting* occurs if the average value of operating assets (oa_t) equals the present value of future cash flows, or the abnormal operating results value is zero with τ → ∞. Hence, the proposition 2 suggests that *conservatism accounting* understates the book value of operating assets and/or overstates the present value of the abnormal of expected operating results.[15]

With the aim of considering the effect of the persistence of abnormal results, the effect of *conservatism accounting*, the growth in operating assets (oa_t), and operational results (ox_t), Feltham and Ohlson (1995) redefine the dynamics of information initially specified by the OM model. Thus, the dynamic information (*linear information model—LIM*) becomes defined as:

$$\begin{cases} \mathrm{ox}_{t+1}^{a} = w_{11}\mathrm{ox}_t^{a} + w_{12}\mathrm{ao}_t + v_{1t} + \varepsilon_{1,t+1} \\ \mathrm{oa}_{t+1} = \; + w_{22}\mathrm{oa}_t + v_{2t} + \varepsilon_{2,t+1} \\ v_{1,t+1} = \gamma_1 v_{1t} + \varepsilon_{3,t+1} \\ v_{2,t+1} = \gamma_2 v_{2t} + \varepsilon_{4,t+1} \end{cases} \tag{2.20}$$

where $E_t\left(\varepsilon_{j,t+\tau}\right) = 0$ with j = 1, 2, 3 and 4 and $\tau > 0$.

The dynamic of information depends now not only on the persistence of abnormal results, the effect captured by the parameter w_{11}, as well as the growth of investments in operating assets (reflected in the parameter w_{22}), but also on the effect of *conservatism accounting* at the level of operational assets via parameter w_{12}. The v_{1t} and v_{2t} variables, and in line with the OM model, aim to capture all available information that may change investors' expectations about the persistence of abnormal and growth resulting from new investments. Thus, the vector ($\underline{v}$—other information) can be interpreted, assuming the semi-strong principle of efficiency, i.e. the prices tend instantaneously to reflect all publicly available information $\left(\phi_t^m\right)$ (Fama 1976). If we subdivide $\left(\phi_t^m\right)$ into two, i.e. economic and financial information ($\left(F\phi_t^m\right)$ and other information $\left(NF\phi_t^m\right)$), then the vector $\underline{v}$ is identified with the latter subset of information, i.e. other non-financial information not yet incorporated in the financial statements. However, the FOM model emphasizes, that the

[15]This effect is most easily seen in the expression: $\sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(c_{t+\tau}) = \mathrm{oa}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(\mathrm{ox}_{t+\tau}^{a}\right)$ deduced from the Eq. (2.15c). Given the objectivity in how the variable c_t (*cash flow to the firm*) is measured (which is independent of any criteria or accounting policy), an understatement of operating assets (oa_t) must be compensated by an overestimation of abnormal results $\left(\mathrm{ox}_t^{a}\right)$; thus the value of the variable c_t remains unchanged.

effect of these parameters is limited to the short term. In this context, the dynamic evolution of cash flows is characterized by:

$$c_{t+1} = w_{11} ox_t^a + \left[\left(R_f - w_{22}\right) + w_{12}\right] oa_t + \left[v_{1t} - v_{2t}\right] + \left[\varepsilon_{1,t+1} - \varepsilon_{2,t+1}\right] \quad (2.21)$$

The dynamics of cash flows depend on the current abnormal results of the w_{11}, w_{12} parameters that measure the understatement of operating assets (*conservatism accounting*), the increase in operating assets (w_{22}), and even the information that is being made available to the market (vector—$\underline{v}$).

Restrictions that can be imposed on the parameters of the LIM are:

(i) $|\gamma_h| \prec 1$ with h = 1.2.
The purpose of this restriction is to ensure that random events, whose effect is captured by v_{1t} and v_{2t} variables, and not reflected in the financial statements, have no impact on the medium and long term, i.e. $E_t\left[v_{h,t+\tau}\right] \to 0,\ com\ h = 1,2\ e\ \tau \to \infty$.

(ii) w_{11}, the parameter that measures the persistence of abnormal results assumes values ε]0, 1[. With this condition, the objective is to introduce restrictions to the persistence of abnormal results. Thus, $w_{11} \succ 0$ eliminates potential oscillations that would not be economically acceptable and $w_{11} \prec 1$, permits abnormal results that persist for some time, but its effect declines over time because the competition within the medium term tends to eliminate abnormal returns.

(iii) The parameter w_{22}, which reflects the effect of the increase in operating assets assumes values within the range]1, R_f[with R_f = (1 + r). This restriction imposes limitations on the growth of operating assets in the long term to ensure convergence when calculating the present value of operating abnormal results $\left(\mathrm{ox}_t^a\right)$ and the expected cash flows (c_t).

(iv) The parameter w_{12} enables us to introduce the dichotomy *unbiased accounting* $(w_{12} = 0)$ versus *conservatism accounting* $(w_{12} \succ 0)$, i.e. the problem of underestimation of operating assets.[16]

Given the reformulation of the LIM of the FOM, and continuing to take the neoclassical framework of PVED and relationships previously established between the variables (i.e. CSR, NIR, FAR and OAR), the evaluation function is now defined as:

[16]To impose $w_{12} \succ 0$ the model eliminates the effect of *aggressive accounting*, i.e. the MVE is less than BVE. This restriction simplifies the analysis, and is in accordance with the empirical evidence. Indeed, Feltham and Ohlson (1995: 701) find, and taking as reference the data from the Compustat database, that the MVE of companies tends to be greater than 2/3 of their BVE. Stober (1999) found the opposite (*aggressive accounting*), but only for the period 1973–1979, and justified as a consequence of the oil shock.

$$P_t = \mathrm{bv}_t + \alpha_1 \mathrm{ox}_t^a + \alpha_2 \mathrm{oa}_t + \beta \cdot v_t \tag{2.22}$$

with

$$\alpha_1 = \frac{w_{11}}{R_\mathrm{f} - w_{11}}$$
$$\alpha_2 = \frac{w_{12} R_\mathrm{f}}{(R_\mathrm{f} - w_{22})(R_\mathrm{f} - w_{11})}$$
$$\beta = (\beta_1, \beta_2) = \left[\frac{R_\mathrm{f}}{(R_\mathrm{f} - w_{11})(R_\mathrm{f} - \gamma_1)}, \frac{\alpha_2}{R_\mathrm{f} - \gamma_2}\right].$$

In this context, *goodwill* (g_t) corresponds to:

$$P_t - \mathrm{bv}_t = g_t = \alpha_1 \mathrm{ox}_t^a + \alpha_2 \mathrm{oa}_t + \beta \cdot v_t \tag{2.23}$$

that is *goodwill* is an increasing function of operating abnormal results, whose persistence is measured by the parameter w_{11} (the higher w_{11}, the higher is α_1), operating assets (oa_t) only when they are undervalued because the necessary condition for $\alpha_2 > 0$ is that $w_{12} > 0$ and, the variable v_t ($\underline{v}$). We should also notice that in both models (OM and FOM) the tax effect is ignored. However, given that both models assume a perfect capital market (i.e. the models do not admit the existence of costs derived from asymmetric information, agency costs and transaction costs), then the tax effect will not have a material effect on the evaluation function.[17]

2.3 The Effect of Conservatism Accounting

According to Richardson and Tinaikar (2004), the *accounting conservatism* effect can occur in a company as a result of investments in *items* such as R&D and advertising. In accordance with GAAP, this type of investment should be recorded as historical costs and recognized immediately as expenses (*ex ante conservatism)* which underestimate the present value of cash flows from these investments.

Given the company profile examined in this research namely, new economy companies[18] and companies with an Initial Public Offering (IPO) date that is contemporary with net firms—*non-net firms* (see Sect. 5.4.2), also which are firms that operate mainly in high-tech sectors (*high-tech firms*), we will focus our analysis on the first kind of *conservatism accounting* (*ex ante*) identified by Richardson and Tinaikar (2004)—the impact of immediate accounting as costs of investment in

[17]The deduction of this model (Eq. 2.22) is in Appendix 2.3.

[18]The concept of the new economy company is defined in Sect. 5.4.1.

intangibles such as R&D and advertising on the variables “MVE”, “BVE” and “net income”, the main determinants of value according to the OM and FOM.

Feltham and Ohlson (1995) show that growth companies, particularly technology companies in the early stages of their life cycle (*start-up* companies), where investments in intangible assets (e.g. R&D and advertising) predominate, have generally poor results or even negative results, since only a portion of their investments are capitalized, while the investments such as R&D and advertising are immediately recognized as an expense in the income statement. Consequently, and because these investments tend to persist over time, in addition to the understatement of the variable “results”, the variables “assets” (*unrecognized assets*) and “equity” (BVE) are undervalued (McCrae and Nilsson 2001).

So consider the time $t = 0$, where the initial investment made by shareholders is ($-d_0$), and is applied in non-operating assets (fa_0), so $-d_0 = \mathrm{fa}_0$ and $\mathrm{bv}_0 => 0$. Then, if $P_0 = d_o$ at this time, the *goodwill* (g_0) is null. The company continues to invest in operating assets (oa_t), and, by the OAR, the variable cash flow is negative, i.e. $c_1 < 0$, as consequences of these investments. Considering the Proposition 2 (Eq. 2.19), which defines the property *unbiased accounting* as:

$$E_t(\mathrm{oa}_{t+T}) = E_t\left[\sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_{t+T}(c_{t+T+\tau})\right] \text{ with T} \rightarrow \infty,$$

or equivalently,

$$E_t\left[\sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_{t+T}(\mathrm{ox}^a_{t+T+\tau})\right] \rightarrow 0 \text{ with T} \rightarrow \infty,$$

it is possible for a period of time $T\ \varepsilon\ [0, \infty[$, that the $\sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_0(\mathrm{ox}^a_\tau) < 0$, implying that the company can expect to get negative results in the first years of its life, as the result of pursuing high-growth opportunities, particularly if they are associated with investments in R&D and advertising (counted as costs). However, this situation tends to be reversed, because in the future the company will only continue to undertake new investment projects if their expectations are associated with abnormal returns; otherwise we are looking at the effect of *free cash flow* (Jensen 1986). However, this phenomenon is more typical in companies in the maturity phase.

To better clarify the analysis, the authors define the Proposition 9, which uses on date 0 a null *goodwill*:

$$P_0 = -d_0 = \mathrm{fa}_0 \text{ with } \mathrm{oa}_0 = \mathrm{ox}_0 = 0 \text{ but the } E_0(\mathrm{oa}_1) > 0. \tag{2.24}$$

Thus, assuming *conservative accounting*, i.e. the understatement of operating assets:

$$E_0(\mathrm{ox}_1^a) = E_0(\mathrm{ox}_1) < 0. \quad (2.25)$$

In the context of *unbiased accounting*, we obtain equality.

Indeed, at the time $t = 0$, the evaluation function becomes: $P_0 = \mathrm{fa}_0 + \beta_1 v_{10} + \beta_2 v_{20}$, or $P_0 + d_0 = g_0 = \beta_1 v_{10} + \beta_2 v_{20}$; so expectations about new growth opportunities at time $t = 0$ depend only on v_{10} and v_{20}. The relevance of this reasoning is relevant in emerging sectors, such as the Internet. It is a new sector in which expectations about high future abnormal returns are sustained in non-financial variables (v_t), whose proxies are associated with web-traffic variables, such as "number of visitors per website", "average time spent on website", "percentage of the Internet user population", etc. (Copeland et al. 2000; Damodaran 2001; Tockic 2004, 2005, among others).

Thus, in a scenario of *unbiased accounting* and according to LIM:

$$\begin{aligned} E_0(\mathrm{ox}_1^a) &= E_0(\mathrm{ox}_1) = v_{10} = 0 \text{ (given Proposition 9)};\\ E_0(\mathrm{oa}_1) &= v_{20} > 0 \text{ (given Proposition 9)};\\ E_0(c_1) &= v_{10} - v_{20} = -v_{20} \text{ (see Eq. 2.20)}. \end{aligned} \quad (2.26)$$

The value of investing is v_{20} (negative values for the variable c_t represent investments in operating assets), which is fully capitalized.

In a scenario of *conservatism accounting*, and also taking into account Proposition 9, we obtain:

$$\begin{aligned} E_0(\mathrm{ox}_1^a) &= E_0(\mathrm{ox}_1) = v_{10} < 0;\\ E_0(\mathrm{oa}_1) &= v_{20} > 0;\\ E_0(c_1) &= v_{10} - v_{20}. \end{aligned} \quad (2.27)$$

In this context, part of the cash flow is absorbed by losses because the value invested corresponds to v_{20}, but only the portion $(v_{20} - v_{10})/v_{20} < 1$ is capitalized, and the value ($v_{10} < 0$) is recognized as (negative) results in the net income statement ($v_{10} < 0$).

Feltham and Ohlson (1995) demonstrated, and considering the dynamic of information at the time of its initialization, i.e. at $t = 0$, and assuming that at this time the *goodwill* is null, the *conservatism accounting* effect explains how the first years of a company's life can register negative results. However, this situation begins to reverse itself as the company continues to invest. Based on the principle of rationality, the company only continues investing if the investments (growth opportunities) are generating abnormal returns, i.e. $E_t(\mathrm{ox}_t^a) > 0$, because the objective of managers is to maximize the value of the company or equivalently maximize the selection of projects with positive NPV.

With reference to business *start-ups*, particularly companies in technology industries, the net results are not a good *proxy* for future results, as they tend to incorporate high amounts allocated on investments in intangible assets, recorded as costs, as imposed by GAAP. Core et al. (2003) claim that IPO companies still report losses, because those companies are holding in their "portfolio" high-growth opportunities, so investors' attention focuses on the expectations of future growth. Myers (1977) has associated the persistence of losses with the existence of a high-growth opportunities portfolio.

Thus, using the RIV model, it is easy to explain why the multiples of price-to book value (P/B) and the (PER) tend to be high for those companies due the high expectations of future growth. Thus, defining the net profit (x_t) as x_t = ROE$_t$ * bv$_{t-1}$ (return on equity—ROE) and rewriting the RIV model (Eq. 2.6), where r identifies the cost of capital, we obtain[19]:

$$\mathrm{MVE}_t = \mathrm{bv}_t + \sum_{\tau=1}^{\infty} \frac{E_t(\mathrm{ROE}_{t+\tau}\mathrm{bv}_{t+\tau-1} - r\mathrm{bv}_{t+\tau-1})}{(1+r)^{\tau}}.$$

Dividing the above expression by the bv$_t$ variable, we obtain the multiple of book value (P/B):

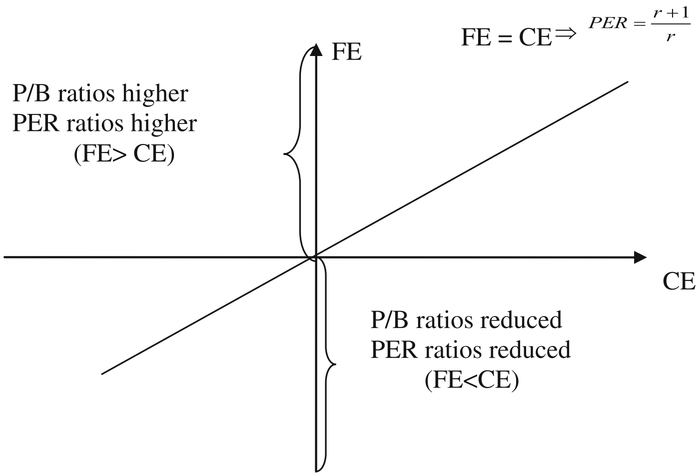
$$\frac{\mathrm{MVE}_t}{\mathrm{bv}_t} = 1 + \sum_{\tau=1}^{\infty} \frac{E_t[(\mathrm{ROE}_{t+\tau} - r)\mathrm{bv}_{t+\tau-1}]}{(1+r)^{\tau}\mathrm{bv}_t}. \tag{2.28}$$

Equation 2.28 shows that the P/B ratio is a function of the expected abnormal results $\left(\frac{E_t(\mathrm{ROE}_{t+\tau}-r)}{(1+r)^{\tau}}\right)$ and the growth of "stock" needed to generate results in the future $(\mathrm{bv}_{t+\tau-1} / \mathrm{bv}_t)$. In the absence of abnormal returns the value of this multiple is the unit.

Calculating now the PER, we add the dividends (d_t) to the RIV model, i.e. $P_t + d_t = (\mathrm{bv}_t + d_t) + \sum_{\tau=1}^{\infty} \frac{E_t(x^a_{t+\tau})}{(1+r)^{\tau}}$. Given the CSR property, we can define bv$_t$ + d_t = bv$_{t-1}$ + x_{t-1}, and replacing this expression in the expression above, we obtain $P_t + d_t = (\mathrm{bv}_{t-1} + x_t) + \sum_{\tau=1}^{\infty} \frac{E_t(x^a_{t+\tau})}{(1+r)^{\tau}}$, now calculating the PER we get:

$$\frac{P_t + d_t}{x_t} = \left(\frac{1+r}{r}\right) + \frac{1}{x_t}\left[\sum_{\tau=1}^{\infty} \frac{E_t(x^a_{t+\tau})}{(1+r)^{\tau}} - \frac{x^a_t}{r}\right]. \tag{2.29}$$

[19]Recall that the RIV model is equivalent to the PVED model, which assumes as a theoretical framework an economy, where the preferences of agents are homogeneous and they are risk neutral.



Source: White et al. (1997: 1071) adapted.

Fig. 2.1 The relationship between the multiples P/B and PER and future abnormal earnings (*FE*) and current earnings (*CE*)

The PER summarizes the determinant of the magnitude of this ratio, i.e. the difference between future abnormal earnings $\left(\sum_{\tau=1}^{\infty} \frac{E_t(x_{t+\tau}^a)}{(1+r)^\tau} - \mathrm{FE}\right)$ and current abnormal earnings $\left(\frac{x_t^a}{r} - \mathrm{CE}\right)$. Graphically this is expressed in Fig. 2.1.

Along the 45° line, the expected abnormal earnings (FE) equals current earnings (CE). In this context, the current results are a good indicator of future performance. Above this line, growth affects PER ratios and future abnormal earnings (FE) exceed the current earnings (CE). Note that, even when the net results are negative, the PER ratios can take high values. In this context, the negative results are seen as transitory, e.g. the result of large investments in intangibles, recorded as costs, particularly in technology-based companies in the *start-up* phase (*accounting conservatism*).

Below the 45° line, because the future earnings (FE) are lower than the current earnings (CE), low PERs appear because the high values of CE are due to the presence of transitory *items,* which are not expected to persist in the future.

In summary, *goodwill,* measured by the difference between the market value (MVE) and the book value of equity (BVE) of the company, is the result of a dual effect: (i) the undervaluation of assets (*conservatism accounting*); and (ii) overestimation of the expected abnormal results. These effects are more pronounced in technology-based companies, especially in the *start-up* phase. Therefore, in accordance with LIM, the FOM at the time of the establishment of the company and taking into account Proposition 9 as the same model, show that only part of the investment is capitalized, with the remainder recognized as cost. However, assuming the principle of rationality, it is expected that managers invest in new growth opportunities if they are associated to abnormal returns. Hence, the *net firms* and companies with contemporaneous initial purchase offer (IPO) dates (including *non-net firms and* very young companies during the *start-up phase*), often propose a new untested business idea), "moving" to the market with high losses valued positively by the market and sustain the phenomenon of *negative pricing of losses,* i.e. the positive valuation of losses. The evaluation of this type of company is particularly difficult, given the difficulty of estimating future cash flows. The volatility of their prices reflects this phenomenon.

Appendix 2.1: Deduction of the OM Model (Eqs. 2.8 and 2.9)

1. **Deduction of the Ohlson (OM) (1995) model—Eq.** 2.8:

Ohlson (1995) defines the valuation function as:

$$P_t = \mathrm{bv}_t + \alpha_1 x_t^a + \alpha_2 v_t.$$

with the parameters assuming the values:

$$\alpha_1 = \frac{w}{R_\mathrm{f} - w} \geq 0 \text{ and}$$
$$\alpha_2 = \frac{R_\mathrm{f}}{(R_\mathrm{f} - w)(R_\mathrm{f} - \gamma)} \succ 0.$$

To obtain this function we first assume:

(i) The matrix $P = R_\mathrm{f}^{-1}\begin{bmatrix} w & 1 \\ 0 & \gamma \end{bmatrix}$;
(ii) The dynamic of information is defined as: $\left[x_{t+1}^a, v_{t+1}\right] = R_\mathrm{f} P[x_t^{a,}, v_t] + \left[\varepsilon_{1,t+1}, \varepsilon_{2,t+1}\right]$ and,
(iii) Assuming that the supranormal results are defined as:

$$R_\mathrm{f}^{-\tau} E_t\left(x_{t+\tau}^a\right) = [1, 0] P^\tau \left[x_t^a, v_t\right].$$

Based on the *Residual Income Valuation Model* (RIV), the expression assumes:

$$P_t - \mathrm{bv}_t = \sum_{\tau=1}^{\infty} R_\mathrm{f}^{-\tau} E_t\left(x_{t+\tau}^a\right) = [1, 0] \left[P + P^2 + \ldots\right] \left[x_t^a, v_t\right].$$

A series of matrices P + P^2 + … are convergent, given the square root of the characteristic of the matrix is less than unit. Thus, we could conclude that:

$$[1,0]P[I-P]^{-1} = [\alpha_1, \alpha_2], \text{ i.e.:}$$

$$[1,0]\left[R_f^{-1}\begin{bmatrix} w & 1 \\ 0 & \gamma \end{bmatrix}\right]\left[\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - R_f^{-1}\begin{bmatrix} w & 1 \\ 0 & \gamma \end{bmatrix}\right]^{-1} = [\alpha_1, \alpha_2]$$

$$\begin{bmatrix} R_f^{-1}w & R_f^{-1} \end{bmatrix}\begin{bmatrix} 1 - R_f^{-1}w & -R_f^{-1} \\ 0 & 1 - R_f^{-1}\gamma \end{bmatrix}^{-1} = [\alpha_1, \alpha_2]$$

$$\begin{bmatrix} R_f^{-1}w & R_f^{-1} \end{bmatrix}\begin{bmatrix} \frac{1}{1-R_f^{-1}w} & \frac{R_f^{-1}}{\left(1-R_f^{-1}w\right)\left(1-R_f^{-1}\gamma\right)} \\ 0 & \frac{1}{1-R_f^{-1}\gamma} \end{bmatrix} = [\alpha_1, \alpha_2]$$

$$\begin{bmatrix} \frac{R_f^{-1}w}{1-R_f^{-1}w} & \frac{R_f^{-1}wR_f^{-1}}{\left(1-R_f^{-1}w\right)\left(1-R_f^{-1}\gamma\right)} + \frac{R_f^{-1}}{1-R_f^{-1}\gamma} \end{bmatrix} = [\alpha_1, \alpha_2]$$

$$\begin{cases} \alpha_1 = \frac{R_f^{-1}w}{1-R_f^{-1}w} = \frac{R_f^{-1}w}{R_f^{-1}(R_f-w)} = \frac{w}{R_f-w} \\ \alpha_2 = \frac{R_f^{-1}wR_f^{-1}}{\left(1-R_f^{-1}w\right)\left(1-R_f^{-1}\gamma\right)} + \frac{R_f^{-1}}{1-R_f^{-1}\gamma} = \frac{R_f^{-1}wR_f^{-1}}{R_f^{-1}(R_f-w)R_f^{-1}(R_f-\gamma)} + \frac{R_f^{-1}}{R_f^{-1}(R_f-\gamma)} \end{cases}$$

$$\begin{cases} \alpha_1 = \frac{w}{R_f-w} \\ \alpha_2 = \frac{w}{(R_f-w)(R_f-\gamma)} + \frac{R_f-w}{(R_f-w)(R_f-\gamma)} = \frac{R_f}{(R_f-w)(R_f-\gamma)} \end{cases}.$$

2. **Deduction of the Eq. 2.9 of the OM Model**

Assuming the Eq. 2.8:

$$P_t = \text{bv}_t + \alpha_1 x_t^a + \alpha_2 v_t,$$

and substituting x_t^a, we obtain,

$$P_t = y_t + \alpha_1[x_t - (R_f - 1)y_{t-1}] + \alpha_2 v_t.$$

Due the CSR principle:

$$P_t = \text{bv}_t + \alpha_1 x_t - \alpha_1(R_f - 1)(\text{bv}_t - x_t + d_t) + \alpha_2 v_t \Leftrightarrow$$
$$P_t = \text{bv}_t + \alpha_1 x_t - \alpha_1(R_f - 1)\text{bv}_t + \alpha_1(R_f - 1)x_t - \alpha_1(R_f - 1)d_t + \alpha_2 v_t \Leftrightarrow,$$

$P_t = \text{bv}_t[1 - \alpha_1(R_f - 1)] + \alpha_2 v_t + \alpha_1 x_t + \alpha_1(R_f - 1)x_t - \alpha_1(R_f - 1)d_t$ and $\kappa = \alpha_1(R_f - 1)$ thus,
$P_t = \text{bv}_t(1 - k) + \alpha_2 v_t + \alpha_1[x_t + (R_f - 1)x_t - (R_f - 1)d_t]$,
$P_t = (1 - k)\text{bv}_t + \alpha_2 v_t + \alpha_1 R_f x_t - \alpha_1(R_f - 1)d_t$, and $\varphi = \frac{R_f}{R_f - 1}$, we obtain:

$$P_t = \kappa(\varphi x_t - d_t) + (1 - \kappa)\text{bv}_t + \alpha_2 v_t.$$

Appendix 2.2: Deduction of the Equivalence of the Preposition Number 1 of Feltham and Ohlson (FOM) (1995) Model and Eqs. 2.15a, 2.15b and 2.15c

(i) Equation 2.15a: $P_t = \text{fa}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(c_{t+\tau})$
Assuming the FAR [$\text{fa}_t = \text{fa}_{t-1} + i_t - (d_t - c_t)$] and the definition of i_t [$i_t = (R_f - 1)\text{fa}_{t-1}$], the dividends could be expressed as:

$$\begin{aligned} d_t &= \text{fa}_{t-1} + i_t + c_t - \text{fa}_t = \text{fa}_{t-1} + (R_f - 1)\text{fa}_{t-1} + c_t - \text{fa}_t \\ &= R_f \text{fa}_{t-1} + c_t - \text{fa}_{t.} \end{aligned}$$

Hence for any sequence of the variables $c_t e$ fa_t ($\{c_{t+\tau}, \text{fa}_{t+\tau}\}_{\tau \geq 1}$), valuation function is:

$$\begin{aligned} P_t &= \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(d_{t+\tau}) = \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t[R_f \text{fa}_{t+1-\tau} + c_{t+\tau} - \text{fa}_{t+\tau}] \\ &= \text{fa}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(c_{t+\tau}), \end{aligned}$$

because $R_f^{-\tau} E_t(\text{fa}_{t+\tau}) \to 0 \; com \; \tau \to \infty$.

(ii) Equation 2.15b: $P_t = \text{bv}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(x_{t+\tau}^a\right)$
This equations corresponds to the Residual Income valuation Model defines in Eq. 2.6.

(iii) Equation 2.15c: $P_t = \text{bv}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(ox_{t+\tau}^a\right)$
Assuming operational and non-operational activities, the following expression corresponds to the operational abnormal results: $\text{ox}_t^a = \text{ox}_t - (R_f - 1)$ oa_{t-1}, applying the OAR we obtain:

$$\begin{aligned} \text{oa}_t &= \text{oa}_{t-1} + \text{ox}_t - c_t, \text{substituting the variable ox}_t \\ c_t &= \text{oa}_{t-1} + \left[\text{ox}_t^a + (R_f - 1)\text{oa}_{t-1}\right] - \text{oa}_t \Leftrightarrow \\ c_t &= \text{ox}_t^a + R_f \text{oa}_{t-1} - \text{oa}_t. \end{aligned}$$

For any sequences of the variables $\left(\left\{\text{ox}_{t+\tau}^a, \text{oa}_{t+\tau-1}\right\}_{\tau \geq 1}\right)$, we obtain:

$$\sum_{\tau=1}^{\infty} R_f^{-\tau} E_t(c_{t+\tau}) = \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(\text{ox}_{t+\tau}^a + R_f \text{oa}_{t-1+\tau} - \text{oa}_{t+\tau}\right) = \text{oa}_t + \sum_{\tau=1}^{\infty} R_f^{-\tau} E_t\left(\text{ox}_{t+\tau}^a\right),$$

thus, $R_f^{-\tau} E_t(\text{oa}_{t+\tau}) \to 0 \; com \; \tau \to \infty$.

If we add fa_t to the above expression, and due the Eq. 2.15a, the valuation function is:

$$P_t = \sum_{\tau=1}^{\infty} R_{\mathrm{f}}^{-\tau} E_t(d_{t+\tau}) = (\mathrm{oa}_t + \mathrm{fa}_t) + \sum_{\tau=1}^{\infty} \mathrm{ox}_{t+\tau}^{a} = \mathrm{bv}_t + \sum_{\tau=1}^{\infty} \mathrm{ox}_{t+\tau}^{a}.$$

Appendix 2.3: Deduction of the Feltham and Ohlson (1995) —Eq. 2.22

Assuming the definition of goodwill:

$$g_t = P_t - \mathrm{bv}_t$$

Multiplying the above expression by R_{f} and according Ohlson (2000):

$$R_{\mathrm{f}} g_t = E_t\left[g_{t+1} + \mathrm{ox}_{t+1}^{a}\right].$$

g_t could be defined as a linear function, such as:

$$P_t - \mathrm{bv}_t = g_t = \alpha_1 \mathrm{ox}_t^{a} + \alpha_2 \mathrm{oa}_t + \beta \cdot v_t$$

with

$$R_{\mathrm{f}} g_t = R_{\mathrm{f}}\left[\alpha_1 \mathrm{ox}_t^{a} + \alpha_2 \mathrm{oa}_t + \beta \cdot v_t\right] = E_t\left[\alpha_1 \mathrm{ox}_{t+1}^{a} + \alpha_2 \mathrm{oa}_t + \beta \cdot v_t + \mathrm{ox}_{t+1}^{a}\right] \Leftrightarrow$$
$$R_{\mathrm{f}} \alpha_1 \mathrm{ox}_t^{a} + R_{\mathrm{f}} \alpha_2 \mathrm{oa}_t + R_{\mathrm{f}} \beta \cdot v_t = E_t\left[(\alpha_1 + 1)\mathrm{ox}_{t+1}^{a} + \alpha_2 \mathrm{oa}_{t+1} + \beta v_{t+1}\right].$$

Due the structure of Linear Information Model (LIM):

$$R_{\mathrm{f}} \alpha_1 \mathrm{ox}_t^{a} + R_{\mathrm{f}} \alpha_2 \mathrm{oa}_t + R_{\mathrm{f}} \beta_1 v_{1t} + R_{\mathrm{f}} \beta_2 v_{2t} = (\alpha_1 + 1) E_t(\mathrm{ox}_{t+1}^{a}) + \alpha_2 E_t(\mathrm{oa}_{t+1}) + \beta E_t(v_{t+1})$$

Substituting the expected values according the dynamic information:

$$R_{\mathrm{f}} \alpha_1 \mathrm{ox}_t^{a} + R_{\mathrm{f}} \alpha_2 \mathrm{oa}_t + R_{\mathrm{f}} \beta_1 v_{1t} + R_{\mathrm{f}} \beta_2 v_{2t} = (\alpha_1 + 1)(w_{11} \mathrm{ox}_t^{a} + w_{12} \mathrm{oa}_t + v_{1t})$$
$$+ \alpha_2 (w_{22} \mathrm{oa}_t + v_{2t}) + \beta_1 \gamma_1 v_{1t} + \beta_2 \gamma_2 v_{2t}$$

Solving the equation based on that the probability should be one, thus:

$$\begin{cases} R_f\alpha_1 = (\alpha_1+1)w_{11} \\ R_f\alpha_2 = (\alpha_1+1)w_{12}+\alpha_2 w_{22} \\ R_f\beta_1 = (\alpha_1+1)+\beta_1\gamma_1 \\ R_f\beta_2 = \alpha_2+\beta_2\gamma_2 \end{cases} \Leftrightarrow \begin{cases} R_f\alpha_1 = \alpha_1 w_{11}+w_{11} \\ R_f\alpha_2 - \alpha_2 w_{22} = (\alpha_1+1)w_{12} \\ R_f\beta_1 - \beta_1\gamma_1 = (\alpha_1+1) \\ R_f\beta_2 - \beta_2\gamma_2 = \alpha_2 \end{cases} \Leftrightarrow \begin{cases} \alpha_1(R_f - w_{11}) = w_{11} \\ \alpha_2(R_f - w_{22}) = (\alpha_1+1)w_{12} \\ \beta_1(R_f-\gamma_1) = (\alpha_1+1) \\ \beta_2(R_f-\gamma_2) = \alpha_2 \end{cases}$$

$$\Leftrightarrow \begin{cases} \alpha_1 = \frac{w_{11}}{R_f - w_{11}} \\ \alpha_2(R_f - w_{22}) = (\frac{w_{11}}{R_f - w_{11}}+1)w_{12} \\ \beta_1(R_f-\gamma_1) = \frac{w_{11}}{R_f - w_{11}}+1 \\ \beta_2(R_f-\gamma_2) = \alpha_2 \end{cases} \Leftrightarrow \begin{cases} \alpha_1 = \frac{w_{11}}{R_f - w_{11}} \\ \alpha_2(R_f - w_{22}) = (\frac{w_{11}+R_f-w_{11}}{R_f - w_{11}})w_{12} \\ \beta_1(R_f-\gamma_1) = \frac{w_{11}+R_f-w_{11}}{R_f - w_{11}} \\ \beta_2 = \frac{\alpha_2}{R_f-\gamma_2} \end{cases}$$

$$\Leftrightarrow \begin{cases} \alpha_1 = \frac{w_{11}}{R_f - w_{11}} \\ \alpha_2 = \frac{R_f w_{12}}{(R_f-w_{11})(R_f-w_{22})} \\ \beta_1 = \frac{R_f}{(R_f-w_{11})(R_f-\gamma_1)} \\ \beta_2 = \frac{\alpha_2}{R_f-\gamma_2} \end{cases}.$$

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