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An average-based accounting approach to capital asset investments: The case of project finance

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An average-based accounting approach to capital asset investments: The case of project finance

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Abstract. Literature and textbooks on capital budgeting endorse Net Present Value (NPV) and generally treat accounting rates of return as not being reliable tools. This paper shows that accounting numbers can be reconciled with NPV and fruitfully employed in real-life applications. Focusing on project finance transactions, an *Average Return On Investment* (AROI) is drawn from the pro forma financial statements, obtained as the ratio of aggregate income to aggregate book value. It is shown that such a metric correctly captures a project's economic profitability, as long as it is compared with a *comprehensive Weighted Average Cost of Capital* that includes a correction factor which takes account of the capital foregone by the investors. Contrary to the Internal Rate of Return, AROI is unique and we provide an explicit functional relation which links it to the NPV. The approach holds for levered and unlevered projects, constant and non-constant leverage ratios, constant and non-constant WACCs.

Keywords. Return On Investment, capital budgeting, lost capital, average, financial accounting, project finance.

JEL: M4, G31.

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Introduction

While accounting information is widely used for short-run decisions (such as pricing or production planning), the usefulness of accounting information for long-term decisions (such as capital asset investments) is widely questioned due to the short-run focus of financial information[1]. For this reason, accounting textbooks recommend the standard corporate finance approach of discounted cash flow methods for these types of decisions.[2] In particular, the gold standard for long-term decisions is the Net Present Value (NPV), if an *absolute* measure of worth is required, while the internal rate of return (IRR) is the preferred *relative* measure of worth (Brealey, Myers and Allen 2011, Berk and DeMarzo 2011, Frezatti et al. 2013).

The use of financial accounting for corporate investment decision-making is rather common in real-life applications. In many circumstances, cash flows are derived from accounting estimates: To forecast the cash flows of a project, financial managers begin by forecasting earnings (Berk and DeMarzo 2011; Titman and Martin 2011; Finnerty 2013). Among the types of investments that require pro-forma financial statements are start-up firms, build-up leveraged buyout transactions, and project financing transactions. The latter consist of a long-term large-scale investment whereby a project company is incorporated for the only purpose of undertaking the investment.

This paper aims at showing that, whenever pro forma financial statements are available, accounting data can provide a considerable amount of information on economic profitability. The results have both practical and theoretical implications: Practically, it is shown that accounting rates of return can be actually used in capital budgeting for facilitating decisions; theoretically, the role of accounting rates of return as a source of value creation (and, therefore, as economically significant pieces of information) is established. More specifically, we make use of weighted arithmetic means of accounting rates to integrate the Net Present Value (NPV) analysis with useful additional information. In particular, we introduce the *Average Return On Investment* (AROI), expressed as the ratio of average income to average book value, and show that it captures a project's economic profitability, in association with a *comprehensive* WACC which represents the cost of capital. The product of the overall capital invested and the AROI (net of the cost of capital) is equal to the NPV. For this reason, NPV can then be seen as an aggregate residual income depending on the AROI and this reformulation highlights the contributions of both the investment's scale (B) and the project's economic efficiency (AROI, net of cost of capital) to value creation. As a byproduct, this decomposition facilitates the derivation of a quick-and-dirty test for a project's safety level with respect to changes in economic efficiency: The greater the economic efficiency, the greater the resilience of the project to changes in expectations about the AROI. Therefore, AROI is indeed a source of value creation, and, given the unambiguous definition of net investment and net borrowing naturally triggered by it, the AROI helps the evaluator understand whether value is created because the project rate of return is greater than the minimum acceptable rate of return (net investment) or because the borrowing rate is smaller than the maximum acceptable rate (net borrowing), a task which neither NPV nor IRR can accomplish. A detailed analysis is obtained which enables a distinction to be drawn between the investment side of a project and its financing side. In other words, the analysis separately measures the investment efficiency (i.e., economic efficiency resulting from investment of funds at a sufficiently great investment rate of return) and the financing efficiency (i.e., economic efficiency resulting from borrowing funds at a sufficiently small financing rate). The results are general in that they hold for any pattern of time-variant costs of capital.

We also show that, in case where the average book value is equal to the IRR-based project balance, then the AROI is equal to the IRR, so the difference between IRR (=AROI) and comprehensive WACC signals value creation. However, while IRR may not be unique, the AROI is unique. Finally, we show that, while the comprehensive WACC adjusts for scale, a particular kind of "conservative" accounting, which reports profitability in the last period, results in an AROI which can directly be compared with the WACC.

The remainder of the paper is structured as follows. In the first section of the paper, we describe project financing transactions, which represent one of the most compelling settings where the methodology can be used. In the second section, we present the average ROI and the comprehensive WACC, and show that project NPV can be seen as an aggregate residual income depending on these two rates as value drivers. Relations with IRR are sketched, in the case of non-constant ROIs as well as constant ROIs. In the third section, we introduce a *comprehensive* AROI, associated with a well-determined sequence of book values, which can be directly compared with the WACC for capturing economic profitability. Some remarks conclude the paper.

1. Project finance

Many types of investments naturally require pro forma financial statements. For example, private equity investments (investments in start-up firms, build-up leveraged buyout transactions) involve ownership of limited partnership units that are part of a private equity fund. Typically, the partnership has a fixed life of 7 to 10 years. Pro forma financial statements are constructed for the planned interval and the project's free cash flows are derived from them (see Titman and Martin 2011). Particularly relevant is the case of *project finance transactions*. Project finance is a form of no-recourse debt, whereby a legal entity is incorporated, with the intention that such a Special Purpose Vehicle (SPV) or *project company* will be used to undertake a specific project with a limited (usually long-term) life. The funds needed for designing, building and operating the new project are typically supplied by a group of sponsoring firms, which constitute the SPV's equity holders, and a group of banks, which constitute the SPV's debt holders (Gatti 2013). Loans are guaranteed by the SPV's net assets, so project finance transactions enable equity holders to limit their financial exposure to the fund committed in the project: "By segregating risky assets in a project company, managers can prevent a failing project from dragging the parent firm into default. Project finance allows the firm to isolate asset risk in a separate entity where it has limited ability to inflict collateral damage on the sponsoring firm" (Esty 2004, p. 217). At the same time, debt holders impose a large set of covenants aimed at limiting, to some extent, the flexibility of the use of funds by the SPV's shareholders (Smith and Warner, 1979). Project finance originated in the energy generation sector and is now used to fund large-scale projects such as power generation facilities, oil and natural gas pipelines, electric utilities, chemical plants, water and waste water treatment facilities, renewable energy and green technologies, etc. (Scannella 2012) and, recently, Internet and e-commerce projects (Borgonovo, Gatti and Peccati 2010). The creation of a SPV is associated with a careful economic analysis of the capacity of the entity to generate sufficient cash to meet the expectations of the capital providers. For this reason, considerable time and resources are devoted to financial modelling and financial accounting. In particular, extensive negotiations intervene between equity holders and debt holders for estimation of cash flows. The estimation process consists of forecasting revenues and costs in order to get the projected EBITDA and EBIT and, more generally, for constructing pro forma financial statements that collect the forecasts about economic and accounting variables. By constructing a sequence of income statements and a sequence of balance sheets for every period of the project's life, the analysts try to describe the future actual reported statements of the project company; thus, full consideration is given to accounting and fiscal rules in the country or region where the SPV operates. Once the agreement on the estimated data is reached between shareholders and debt holders, the project's free cash flows are derived from the data recorded in the income statements and balance sheets (Gatti 2013).

2. The average ROI and the comprehensive WACC

Consider a project opportunity with a limited life of n periods. Suppose that, after due investigation and a proper estimation process, sponsors and lenders agree on the estimated data and create an SPV for undertaking the project; pro forma financial statements are drawn, which record period-by-period revenues, operating costs, depreciation, interest expenses, taxes, as well as working capital requirements, net property, plant and equipment. Let x_t^{DA} be the Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) and let Dep_t denote the depreciation expense. Then, $x_t := x_t^{DA} - Dep_t$ is the Earnings Before Interest and Taxes (EBIT). Turning to the SPV's projected balance sheets, the book value of net assets, denoted as B_t, consists of two main categories, net fixed assets (NFA) and net working capital (WC), so that the following accounting identity holds:

$$NFA_t + WC_t = B_t. \tag{1}$$

After liquidation of the SPV, $B_n = 0$. Total accruals are equal to the change in book value; it depends on Dep_t and new capital expenditures, as well as on changes in working capital: $\Delta B_t = \Delta NFA_t + \Delta WC_t$, where $\Delta y_t \coloneqq y_t - y_{t-1}$, is the difference operator, $y \coloneqq B$, NFA, WC. Using the data in the SPV's project income statements and balance sheets, date-t free cash flow is computed as Net Operating Profit After Taxes (NOPAT) less change in invested capital:

$$F_t = \overbrace{x_t \cdot (1-\tau)}^{\text{NOPAT}} - (\Delta NFA_t + \Delta WC_t) \qquad F_0 = -B_0 \tag{2}$$

where τ is the project company's tax rate. The prospective Return On Investment (ROI) is the ratio of NOPAT to book value of assets:

$$ROI_t = \frac{x_t^\tau}{B_{t-1}} \tag{3}$$

where $x_t^\tau \coloneqq x_t(1-\tau)$. Let $WACC_t$ be the Weighted Average Cost of Capital, which represents the required rate of return (on a per-period basis) for investments of equal risk, and let $v_{t,0} = \prod_{h=1}^{t}(1 + WACC_h)^{-1}$ be the discount factor. The project's economic value created (i.e. wealth increase) as of time 0 is the net present value (NPV): $NPV = \sum_{t=0}^{n} F_t \cdot v_{t,0}$. We will also make use of the net future value (NFV), which is just the NPV as of time n: $NFV = NPV/v_{n,0}$. The project creates economic value if and only if the NPV (NFV) is positive.

We now derive the average ROI and the corresponding cost of capital. To this end, suppose the investors, rather than undertaking the project, decide to invest B_0 in a market-traded financial asset of equal risk to that of the project, and to periodically withdraw from (or add to) that financial asset a monetary amount equal to the project's free cash flow. The value of such an asset is described, recursively, in equation (4):

$$B'_t = B'_{t-1} \cdot (1 + WACC_t) - F_t \qquad\qquad B'_0 = -F_0. \tag{4}$$

The amount B'_t is called *lost capital*; it has been introduced in Magni (2009, 2010), though it has been previously used by O'Hanlon and Peasnell (2002) as well:[3] The lost capital implicitly contains an annuity-type depreciation charge equal to $B'_{t-1} - B'_t = F_t - WACC_t \cdot B'_{t-1}$. The resulting asset, which acts as a benchmark, generates, by construction, the same vector of cash flows generated by the project from time 0 to time $n-1$. The benchmark's last cash flow is $F_n + B'_n$. Therefore, the benchmark's cash-flow stream is $(F_0, F_1, \dots, F_{n-1}, F_n + B'_n) = (F_0, F_1, \dots, F_n) + (0,0,\dots,0, B'_n)$. From (4), one gets $B'_n = B'_0/v_{n,0} - \sum_{t=1}^{n} F_t \cdot \prod_{h=t+1}^{n}(1 + WACC_h) = -NFV$, so the benchmark can just be viewed as a replica of the project itself, net of the project NFV. Therefore, the terminal lost capital measures the opportunity cost of investing in the project: If $B'_n > 0$, the cost of investing in the project exceeds the benefits, so economic value is destroyed (i.e. investing in the benchmark supplies an additional terminal amount equal to B'_n which is not supplied by the project); if $B'_n < 0$, value is created.

The accounting data found in the pro forma financial statements are particularly relevant as a signal of value creation or destruction: Just note that, if investors invested in the benchmark, they would receive a return equal to $WACC_t \cdot B'_t$. Hence, the difference

$$\xi_t = x^\tau_t - WACC_t \cdot B'_{t-1} \tag{5}$$

is an *excess return*, and $WACC_t \cdot B'_{t-1}$ represents a lost (i.e., foregone) income, and the value B'_t represents the lost capital.[4] Using again (4), one can rewrite (5) as $\xi_t = (B_t - B_{t-1}) - (B'_t - B'_{t-1})$. Summing through t, one gets

$$\sum_{t=1}^{n} \xi_t = -B'_n = NFV. \tag{6}$$

Equation (6) summarises the *lost-capital residual income valuation model*. Denoting as $x^\tau = \sum_{t=1}^{n} x^\tau_t$ the overall NOPAT and as $B = \sum_{t=1}^{n} B_{t-1}$ the overall invested capital, the return on investment over the given interval $[0, n]$ is obtained as the ratio of average NOPAT to average book value (or overall NOPAT to overall book value):

$$\overline{ROI} = \frac{x^\tau/n}{B/n} = \frac{x^\tau}{B}. \tag{7}$$

As x^τ is independent of accruals (i.e., $x^\tau = \sum_{t=0}^{n} F_t$), (7) can also be written as $\overline{ROI} = \sum_{t=0}^{n} F_t / B$ (a formulation we will use later). If capital is nonzero in every period, one can write this *average ROI* (henceforth, AROI) as a capital-weighted average of *ROI*s:

$$\overline{ROI} = \frac{ROI_1 \cdot B_0 + ROI_2 \cdot B_1 + \dots + ROI_n \cdot B_{n-1}}{B_0 + B_1 + \dots + B_{n-1}}. \tag{8}$$

Owing to (5)-(6), $NPV = v_{n,0} \cdot (\sum_{t=1}^{n} ROI_t \cdot B_{t-1} - \sum_{t=1}^{n} WACC_t \cdot B'_{t-1})$, whence, using (7) or (8),

$$NPV = v_{n,0} \cdot B \cdot (\overline{ROI} - \overline{WACC}) \quad \Leftrightarrow \quad NFV = B \cdot (\overline{ROI} - \overline{WACC}) \tag{9}$$

where

$$\overline{WACC} := \alpha_1 \cdot WACC_1 + \alpha_2 \cdot WACC_2 + \cdots + \alpha_n \cdot WACC_n$$

is a linear combination of the period WACCs, with $\alpha_t \coloneqq B'_{t-1}/B$. We call it *comprehensive* WACC, in the sense that it "comprehends" (i.e. encompasses) the capital foregone by the investors (lost capital) as well as the foregone rate of return (WACC). Essentially, in any given period, the investors forego investing B'_{t-1} at the rate $WACC_t$. The comprehensive WACC just expresses the overall lost income as per unit of overall book value: $\overline{WACC} = \sum_{t=1}^{n} WACC_{t-1} \cdot B'_{t-1}/B$, so that $\sum_{t=1}^{n} WACC_t \cdot B'_{t-1} = \overline{WACC} \cdot B$. In other words, to forego an overall income equal to $\sum_{t=1}^{n} WACC_t \cdot B'_{t-1}$ is equivalent to giving up the opportunity of investing B at the return rate $\overline{WACC}$. The latter is then a comprehensive cost of capital, which adjusts for investment scale via the weights $\alpha_t = B'_{t-1}/B$.[5] Therefore, equation (9) enables one to interpret the situation in a most intuitive way: Undertaking the project is like investing the overall amount B at a return rate equal to $\overline{ROI}$, so renouncing the alternative to invest the same amount at the return rate $\overline{WACC}$. Therefore, NPV is just the product of the capital base committed in the project and the excess return rate ($\overline{ROI} - \overline{WACC}$). Economic profitability is then grasped by a direct comparison of the two rates. This also means that the NPV can be framed, intuitively, as an aggregate residual income: A capital base (B) multiplied by a residual rate of return ($\overline{ROI} - \overline{WACC}$) measuring the investment efficiency.

Note that, in such a framework, it is rather natural to ascertain the financial nature of a project (and, correspondingly, of the AROI and the comprehensive WACC). We introduce the following definition.

Definition 1. *A project is a net investment if the average book value is positive; it is a net borrowing if the average book value is negative*.

Armed with Definition 1, equation (9) is effective in supplying another additional feature that the standard NPV cannot supply. If $B > 0$, the free cash flow stream represents a net investment (i.e., an asset) and value is created if and only if $\overline{ROI} > \overline{WACC}$, which means that value is created because the *investment* rate is greater than the minimum acceptable return to capital. If, instead, $B < 0$, then the cash flow stream represents a net borrowing (i.e., a liability). In this case, the economic meaning of the rates is reversed: $\overline{ROI}$ is a borrowing rate and $\overline{WACC}$ is the maximum acceptable borrowing rate. Therefore, value is created if and only if $\overline{ROI} < \overline{WACC}$, which means that value is created because the *financing* rate is smaller than the maximum acceptable borrowing rate. We have then proved the following proposition.

Proposition 1. *Given a set of estimated accounting numbers and the period WACCs, the economic value created is given by* (9)*; therefore, if a project is a net investment (borrowing), value is created if and only if its AROI is greater (smaller) than the comprehensive WACC:*

$$\overline{ROI} > \overline{WACC} \quad (<). \tag{10}$$

A more sophisticated analysis is possible by splitting the project's lifespan in two regions: the investment region T_I, consisting of the periods where book values are positive (i.e., periods where investors inject funds in the project), and the financing region T_B, consisting of the periods where book values are negative (i.e., periods where investors absorb funds from the project). Let $B_I = \sum_{t\in T_I} B_{t-1}$ the overall book value invested in the investment region and let $B_F = \sum_{t\in T_F} B_{t-1}$ be the overall book value "borrowed" in the financing region. One can construct an investment AROI, denoted as $\overline{ROI_I}$, expressing the project's investment rate of return in the investment region, and a financing AROI, denoted as $\overline{ROI_F}$, expressing the project's financing rate of return in the financing region:

$$\overline{ROI_I} = \frac{\sum_{t\in T_I} ROI_t \cdot B_{t-1}}{B_I}, \qquad \overline{ROI_F} = \frac{\sum_{t\in T_F} ROI_t \cdot B_{t-1}}{B_F}.$$

Likewise, an investment comprehensive WACC and a financing comprehensive WACC can be constructed:

$$\overline{WACC_I} = \frac{\sum_{t\in T_I} WACC_t \cdot B'_{t-1}}{B_I}, \qquad \overline{WACC_F} = \frac{\sum_{t\in T_F} WACC_t \cdot B'_{t-1}}{B_F}.$$

In this way, considering that $B = B_I + B_F$, the economic value created (NFV) can be decomposed into an investment NFV and a financing NFV:

$$NFV = \underbrace{B_I \cdot \left(\overline{ROI_I} - \overline{WACC_I}\right)}_{\text{investment NPV}} + \underbrace{|B_F| \cdot \left(\overline{WACC_F} - \overline{ROI_F}\right)}_{\text{financing NPV}}. \tag{11}$$

This accounting-based equality exactly tells us whether value is generated as a result of investment efficiency (i.e., the project's investment rate is greater than the minimum acceptable rate of return: $\overline{ROI_I} > \overline{WACC_I}$) or as a result of financing efficiency (i.e., the project's financing rate is smaller than the maximum acceptable financing rate: $\overline{ROI_F} < \overline{WACC_F}$). It also exactly quantifies the contributions to value creation of the financing region and investment region. These pieces of information cannot be supplied by the traditional NPV and IRR analyses.[6]

If $B = 0$, then $\overline{ROI}$ is not defined. However, $B = 0$ means that net assets are positive in some periods and negative in some other periods, which implies that both B_I

and B_F are nonzero; thus, investment AROI and financing AROI can be computed (as well as the associated costs of capital). Owing to eq. (11), they provide, even in this case, important information on whether and how value is created. Furthermore, while the project's return on the overall capital B cannot be obtained, one can still compute the project's return on the initial investment by replacing B with B_0 in (7): $\overline{ROI}(B_0) = x^\tau/B_0$. This modified AROI captures the project's economic profitability measured as per unit of initial capital (again, a piece of information that IRR cannot provide).[7]

As a result, Equations (9) and (11) show that accounting rates are value drivers and convey economically significant pieces of information.

Corollary 1. *Owing to Proposition 1 and eq. (11), the accounting rates of return are economically significant: They represent a source of value creation (NPV depends on book values and incomes) and convey detailed information as to (i) whether and how much value is created, (ii) whether and how much of the created value is generated as a result of investment or financing.*

Equation (9) decomposes NPV into investment scale (B) and economic efficiency ($\overline{ROI} - \overline{WACC}$): A given NPV can be obtained either as a result of investing a large capital at a small AROI or as a result of investing a small capital at a high AROI. This piece of information cannot be derived from a traditional NPV or IRR analysis. For example, consider project α with an invested capital equal to €100, an AROI equal to 30% and a comprehensive WACC equal to 5%. The NPV is $€100 \cdot (0.3 - 0.05) = €25$. Consider also a project β whose invested capital is €2,500, with an AROI equal to 7% and a comprehensive WACC equal to 6%. The NPV is the same: $€2{,}500 \cdot (0.07 - 0.06) = €25$ but α's investment efficiency (25%) is much greater than β's (1%): The latter achieves a €25 NPV because the investment scale is much larger than α's. This formulation also enables the analyst to draw a quick-and-dirty information on the "safety level" of the project: The greater the economic efficiency, the greater the resilience of the project to a decrease in the expectations on AROI, other things constant. For example, the safety level of α is higher: If β's expected AROI (net of the cost of capital) decreases by just 1.5 percentage point, the NPV reduces by $1.5\% \cdot €2{,}500 = €37.5$. The same reduction for α implies a reduction in NPV of only €10. Most notably, a reduction of 1.5 percentage points turns β to a value-destroying project, whereas the same reduction does not affect acceptance of α. Therefore, (9) discloses, in a fast and intuitive way, the effects of changes in economic efficiency upon the NPV.[8] We can then state the following corollary.

Corollary 2. *Owing to eq. (9), the AROI enables a decomposition of the economic value created into a return component and a capital component, which supplies (ii) information about the role played by investment efficiency as opposed to investment size in creating value and (ii) a quick-and-dirty measure of the project's economic sensitivity to change in the expected economic efficiency.*

As for the informational requirements, it is worth noting that, in the given context, the AROI approach and the NPV approach require the same pieces of information; both are derived using the accounting data available in the pro forma financial statements: AROI makes direct use of accounting rates and capital amounts, while NPV uses them indirectly, to the extent that cash flow estimates are obtained from the pro forma accounting numbers.[9]

Note that, contrary to the IRR, the AROI is not the solution of an equation, so it is not subject to problems of multiplicity (the same holds for $\overline{WACC}$, given that the values B_t' are uniquely determined from the free cash flows). Consider, for example, the following accounting data: $B_0 = 28, B_1 = 2, x_1^\tau = 14, x_2^\tau = -17$ and assume $WACC_1 = WACC_2 = 5\%$. Then, the AROI is $\overline{ROI} = \frac{14-17}{28+2} = -\frac{3}{30} = -10\%$. The firm loses €0.1 per unit of invested capital. Note that the IRR does not exist, for $F_1 = 14 - (-26) = 40, F_2 = -17 - (-2) = -15$ and the equation

$$-28 + \frac{40}{1+x} - \frac{15}{(1+x)^2} = 0$$

has no solution. The lost capital is $B_0' = 28, B_1' = -10.6$ so the comprehensive WACC is $\overline{WACC} = 0.05 \cdot \frac{17.4}{30} = 2.9\% > -10\%$, which signals value destruction.

This sweeps away some of the problems which mar the IRR, namely, the fact that an IRR may not exist or that, in presence of many IRRs, it is not clear which one is economically significant. Another problem of the IRR is that it cannot be applied if WACC is time-variant. This problem can be solved in those situations where IRR is equal to the AROI. If one assumes that the ROI equals IRR in every period: $ROI_t = IRR$ for every $t = 1,2, \dots, n$, then, the comprehensive WACC is indeed the cost of capital that IRR can be compared with when WACC is not constant. This result holds in more general cases where the ROIs are time-variant but are linked to IRR via a well-defined accounting constraint. To this end, let $B_t^{IRR} := \sum_{k=t+1}^{n} F_k \cdot v_{k,t}$ be the project balance (i.e., book value induced by IRR), with $B_0^{IRR} \coloneqq B_0$ and $B_n^{IRR} = 0$. Let $B^{IRR} \coloneqq \sum_{t=1}^{n} B_{t-1}^{IRR}$ be the overall capital induced by the IRR. Assume the ROIs are time-variant but the average book value is equal to the average project balance: $B/n = B^{IRR}/n$. Then, the AROI becomes

$$\overline{ROI} = \frac{x^\tau}{B} = \frac{x^\tau}{B^{IRR}}.$$

But $F_t = B_{t-1}^{IRR}(1 + IRR) - B_t^{IRR}$ for $t = 1,2, \dots, n$, and, as previously seen, $\overline{ROI} = \sum_{t=0}^{n} F_t / B$; hence, the IRR coincides with the average ROI:

$$\overline{ROI} = \frac{\sum_{t=0}^{n} F_t}{B^{IRR}} = \frac{F_0 + \sum_{t=1}^{n}[B_{t-1}^{IRR}(1 + IRR) - B_t^{IRR}]}{B^{IRR}} = \frac{IRR \cdot B^{IRR}}{B^{IRR}} = IRR.$$

We have then proved the following result, which sets a link between IRR, book values and cost of capital.

Proposition 2. *Assume that the average book value is equal to the average project balance. Then, the IRR equals the average ROI, and value creation is determined by the comparison of IRR and comprehensive WACC:* $\overline{ROI} = IRR \gtrless \overline{WACC}$.

(The above mentioned case of constant ROIs is just a particular case of Proposition 2: If $IRR = ROI_t$ for every t, then $B_t = B_t^{IRR}$ and, obviously $B/n = B^{IRR}/n$).

3. Comprehensive AROI

A particular case of AROI is the *comprehensive* AROI. To better appreciate it, let us assume, for simplicity, that the project cost of capital is constant, that is, $WACC_t = WACC$ for every t. In this case, the comprehensive cost of capital becomes $\overline{WACC} = WACC \cdot \left(\frac{B'}{B}\right)$ where $B' := \sum_{t=1}^{n} B'_{t-1}$ is the aggregate lost capital; the acceptance condition becomes $\overline{ROI} > WACC\left(\frac{B'}{B}\right)$. As seen in the previous sections, this just means that, to make the AROI comparable with the cost of capital, one must adjust the latter to get an adjusted (comprehensive) $WACC$ allowing for differences in scale. However, one might wonder whether one could do the reverse: Adjust the $AROI$ to make it directly comparable to the $WACC$. The answer is positive. The project NPV is $NPV = v^n \cdot B(\overline{ROI} - \overline{WACC})$, where $v^n := (1 + WACC)^{-n}$, but it can be reframed as

$$NPV = v^n \cdot B'\left(\frac{x^\tau}{B'} - WACC\right) \tag{12}$$

so the condition for value creation becomes

$$\overline{ROI}' > WACC \tag{13}$$

where $\overline{ROI}' := \frac{x^\tau}{B'}$. The latter is just the AROI that would be obtained if, given the free cash flows $F_t, t = 0,1, \dots, n$, the project company's change in book value were equal to $F_t - WACC \cdot B_{t-1}$. In this case, the depreciation plan mimics the alternative investment:

$B_t = B'_t$ for all $t < n$. We call such an AROI the *comprehensive* AROI. It directly allows for scale by considering the aggregate lost capital B' as the capital base. It is worth noting that, in such a case, the ROI is just equal to the WACC in every period except the last one. This means that residual income is zero between time 0 and time $n-1$ (value is neither created nor destroyed). The final period is the "moment-of-truth" when profitability is reported. NFV equals residual income in the last period. Assuming the project is actually profitable, this kind of reporting might be said to be conservative (but not overly so).

Remark. The results are easily generalized to varying rates: The weights for the $\overline{WACC}$ are $\alpha_t := B'_{t-1}/B'$, so the weights sum to 1 ($\sum_{t=1}^{n} \alpha_t = 1$) and the linear combination $\overline{WACC} = \sum_{t=1}^{n} \alpha_t \cdot WACC_t$ becomes a genuine weighted mean:

$$\overline{WACC} = \frac{WACC_1 \cdot B'_0 + WACC_2 \cdot B'_1 + \cdots + WACC_n \cdot B'_{n-1}}{B'_0 + B'_1 + \cdots + B'_{n-1}}.$$

The project creates value if and only if $\overline{ROI}' > \overline{WACC}$ (or $\overline{ROI}' < \overline{WACC}$ in case of a net borrowing).[10]

To sum up, either the cost of capital is adjusted for scale and then compared with the AROI or, vice versa, the AROI is adjusted and directly compared with the cost of capital. We have seen that, in the latter case, profitability is reported only in the last period, with residual income being equal to zero in the first $n-1$ periods.

Concluding remarks

Companies often use financial modelling to estimate a project's cash flows and the project Net Present Value (NPV). Most notably, project finance transactions are large-scale investments with long-term (but limited) life where financial accounting is important; they rest on a careful, detailed process of negotiations regarding estimated data and the construction of pro forma financial statements on the basis of which the project cash flows are computed and economic performance is assessed. NPV is then derived, which signals anticipated value creation or destruction, but it does not supply information on the sources of the anticipated value creation or destruction For example, it does not distinguish the contribution of economic efficiency to value creation from the contribution of the investment scale, and cannot inform whether (and to what extent) profitability is created as a result of an investment ability or a financing ability (or both). We have presented an average-based framework, where accounting numbers are reconciled with the financial drivers and, in particular, with the NPV. We have introduced unique metrics measuring economic performance and have shown that they can cope with time-variant

WACCs. These costs of capital are aggregated in linear combinations (weighted means if the depreciation plan mimics the alternative investment) which enables to cope with most general situations where the leverage ratio changes. Simple linear relations are obtained which link shareholder value creation, the project NPV, the AROI, the WACC. The approach makes it possible to ascertain whether value is created because funds are invested at a greater rate than the market rate or it is created because funds are borrowed at a smaller cost than the market rate (by using NPV one cannot distinguish between the two different ways of increasing investors' wealth); also, the NPV can be decomposed into an investment NPV (depending on investment AROI) and a financing NPV (depending on a financing AROI). The contributions of economic efficiency and investment scale is captured by reformulating NPV as the product of overall book value and AROI (net of cost of capital). This also makes it possible to derive an intuitive quick-and-dirty test informing about the resilience of the created value to changes in the economic efficiency of the project. The AROI, contrary to the IRR, has no problems of uniqueness; and, even if it cannot be defined when the project's overall book value is zero, the investment and financing AROI can be defined and are still valid tools; in addition, an adjusted AROI can be computed which informs about economic value created as expressed per unit of initial investment (a piece of information which the IRR cannot provide). For these reasons, the average-based accounting approach is a useful tool which supplements and enriches the NPV analysis.

References

Berk, J., DeMarzo, P. 2011. Corporate Finance. Second edition. Harlow, UK: Pearson.

Borgonovo E., Gatti S. Peccati L. 2010. What drives value creation in investment projects? An application of sensitivity analysis to project finance transactions. *European Journal of Operational Research*, 205(1) (August), 227–236.

Brealey, R.A., Myers, S., Allen. F. 2011 *Principles of Corporate Finance*. Global Edition. McGraw-Hill Irwin.

Danielson, M.G., Press, E. 2003. Accounting return revisited: Evidence of their usefulness in estimating economic returns. *Review of Accounting Studies*, 8, 493–530.

Esty, B. 2004. Why study large projects? An introduction to research on project finance. *European Financial Management*, 10(2), 213–224.

Finnerty, J. D. 2013. *Project Financing: Asset-Based Financial Engineering*, third Edition. Hoboken, NJ: John Wiley & Sons.

Fisher, F.M., McGowan, J.J. 1983. On the misuse of accounting rates to infer monopoly profits. *American Economic Review*, 73(1) (March), 82–97.

Frezatti, F., De Souza B., Capuano Da Cruz, A.P., Girão Barroso, M.F. De Camargo Camacho, M.J. 2013. Investment decisions on long-term assets: Integrating strategic and financial perspectives. *European Accounting Review*, 22(2), 297–336.

Gatti, S. 2013. *Project Finance in Theory and Practice*. Second edition. Burlington: Academic Press, Elsevier.

Kay, J.A. 1976. Accountants, too, could be happy in the golden age: The accountants rate of profit and the internal rate of return. *Oxford Economic Papers*, 28(3) (November), 447–460.

Küpper H.-U. 2009. Investment-based cost accounting as a fundamental basis of decision-oriented management accounting. *Abacus*, 45(2), 249–274.

Magni, C.A. 2009. Splitting up value: A critical review of residual income theories. *European Journal of Operational Research*, 198(1) (October), 1–22.

Magni, C.A. 2010. Residual income and value creation: An investigation into the lost-capital paradigm. *European Journal of Operational Research*, 201(2) (May), 505–519.

Nevitt, P.K., Fabozzi, F.J. 2000. *Project Financing.* Seventh Edition. London: Euromoney Books.

O'Hanlon J., Peasnell, K.V. 2002. Residual income and value creation: The 'missing link', *Review of Accounting Studies*, 7(2/3), 229–245.

Peasnell, K.V. 1982a. Some formal connections between economic values and yields and accounting numbers. *Journal of Business Finance & Accounting*, 9(3), 361–381.

Peasnell, K.V. 1982b. Estimating the internal rate of return from accounting profit rates. *The Investment Analyst*, April, 26–31.

Peasnell, K.V. 1996**.** Using accounting data to measure the economic performance of firms. *Journal of Accounting and Public Policy*, 15(4) (Winter), 291–303.

Rajan, M.V., Reichelstein, S., Soliman, M.T. 2007. Conservatism, growth, and return on investment. *Review of Accounting Studies* 12, 325–370.

Scannella E. 2012. Project finance in the energy industry: New debt-based financing models. *International Business Research*, 5(2) (February), 83–93.

Smith Jr., C.W., Warner, J.B., 1979. On financial contracting: an analysis of bond covenants. *Journal of Financial Economics*, 7, 117–161.

Stark, A.W. 2004. Estimating economic performance from accounting data—A review and a synthesis. *The British Accounting Review,* 36(4) (December), 321–343.

Titman, S., Martin, J.D. 2011. *Valuation. The Art and Science of Corporate Investment Decisions*. Second edition. Boston: Prentice Hall.

ENDNOTES

[1] See Küpper (2009), who fruitfully combines an investment-based approach with cost accounting in order to connect long-term with short-term decisions.

[2] The ways in which accounting rates of return might be used in project appraisal and the pitfalls in doing so have been extensively examined in the literature. See Kay (1976), Peasnell (1982a,b; 1996), Fisher and McGowan (1983); Stark (2004), Danielson and Press (2013), Rajan, Reichelstein and Soliman (2007).

[3] O'Hanlon and Peasnell (2002) use a different name: *unrecovered capital*.

[4] This excess return is a comprehensive capital charge for the project income: "comprehensive" in the sense that it takes account of the capital B'_{t-1} given up by the investors. Equation (5) is, as a matter of fact, a "residual" income, which is called *lost-capital residual income* (see Magni, 2009, 2010 for a theoretical investigation).

[5] Note that the comprehensive cost of capital incorporates information on both exogenous factors (market rate) and endogenous ones (book values).

[6] Note that the AROI is just the weighted average of the investment AROI and the financing AROI: $\overline{ROI} = (B_I \cdot \overline{ROI}_I + B_F \cdot \overline{ROI}_F)/B$. Analogously, $\overline{WACC} = (B_I \cdot \overline{WACC}_I + B_F \cdot \overline{WACC}_F)/B$.

[7] It is worth noting that the associated cost of capital is $\overline{WACC}(B_0) = \sum_{t=1}^{n} \alpha_t \cdot WACC_t$ where α_t is redefined as $\alpha_t := B'_{t-1}/B_0$. The difference $\overline{ROI}(B_0) - \overline{WACC}(B_0) = \left(\frac{NFV}{B_0}\right) \cdot (1+r)^n$ is just the (accumulated value of the) well-known profitability index.

[8] For a more reliable account of the robustness of a project to changes in its drivers a serious sensitivity analysis is needed (see Borgonovo, Gatti and Peccati 2010).

[9] A case that is commonly made for cash flows is that they are objectively determinable, whereas accounting profit and book value require judgments and allocations that are vulnerable to manipulation and management. This is clearly a problem in financial reporting. However, the situation in project appraisal is subtly different. Here, cash flows are not objectively determinable; they must be inferred from forecasts of sales and costs, i.e., from accounting magnitudes. Equation (2) represents this inferential process by specifying cash flows as being derived from the accounting estimates. In particular, in project financing transactions, the accuracy of the estimation process is guaranteed by the fact that several parties intervene in the complex task of estimating the key input variables and building up the pro forma financial statements. Owing to the availability of such financial statements to all the parties involved in a project financing transaction (equityholders, creditors, technical advisors, auditors), the same accounting numbers can be used to derive the AROI and the cash flows (and, therefore, the NPV).

[10] Evidently, due to the nature of the reporting, which reports profitability in the last period, the condition $\overline{ROI}' > \overline{WACC}$ can be replaced by a condition on the last period: $ROI_n > WACC_n$.

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