Governance of PPP Infrastructure Projects:
A Variable Capital Structure Valuation Approach

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Abstract

Over the next decade, governments around the world will invest massively in new projects, aiming at closing the long-identified infrastructure gap, in order to sustain economic and social development, and recover from recent adverse shocks. This paper examines this topic from two perspectives: (*i*) how should these projects be valued and selected? and (*ii*) how should these projects be financed? We discuss conceptual, methodological and governance issues raised in the context of infrastructure investment project valuation with variable capital structures. The commonly used free cash flow (FCF) valuation approach may prove inappropriate, or even imprudent, for valuing, namely, very long-term infrastructure projects financed with variable capital structure arrangements. Under this framework, the literature recommends using the Capital Cash Flow (CCF) or the Adjusted Present Value models to mitigate some of the biases of the standard FCF approach. We show that despite dealing with tax benefits differently, FCF and CCF models are algebraically equivalent, the latter being a way to value future cash flows using the same assumptions made in the context of the FCF methodology, while overcoming some of its shortcomings.

Keywords: Governance; PPP; Infrastructure investments; Valuation; Variable capital structures.
JEL classification: G31; G32; G38; H43.

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Abstract

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I. Introduction

According to Schwartz et al. (2020), typically, «infrastructure needs far exceed the resources that countries can hope to raise in a fiscally responsible and macroeconomically sustainable way». Therefore, to increase infrastructure development, governments ought to either increase borrowing, or mobilize private sector funding. In addition, Doumbia and Lauridsen (2019) argue that in emerging markets this lack of infrastructure is even greater, making the need to rely on private capital more relevant, especially taking into consideration the pursuit of the 2030 Sustainable Development Goals (SDGs).

It is widely accepted that increasing public infrastructure investment spending, albeit necessary, is not a sufficient condition for improving economic and social welfare. Indeed, achieving expected welfare gains requires compliance with the good governance practices of the projects, namely, to improve public resources allocative efficiency, and eventually loosen financing and budgetary constraints (e.g., OECD, 2022; Andonov et al., 2021; Lucas and Montesinos, 2020; Maskin and Tirole 2008; Annez, 2006).[1]

Due to financing limitations, budgetary constraints, efficiency concerns, and infrastructure deficits, governments have been resorting to various forms of asset-backed structured financing, namely, limited recourse project financing, more specifically public-private partnerships (PPPs, P3, henceforth), for the provision of public infrastructure development (e.g., Engel *et al*., 2021; Buso *et al*., 2017; Levin and Tadelis, 2010; Välilä, 2005).[2] Furthermore, prior research indicates that good governance of PPP structures,

[1] According to South et al. (2019), «the growing gap between a global infrastructure deficit and the availability of public funding sources suggests private participation in the provisioning of public infrastructure will persist .and even expand in the coming decades».
[2] As articulated in Maskin and Tirole (2008, p. 412), «although the variety of risk-sharing arrangements and governance structures makes a precise characterization difficult, a PPP is usually defined as a long-term development and service contract between government and a private partner».

everything else constant, provides incentives for bringing in private sector's funding and management expertise to infrastructure projects (e.g., Fouad *et al*., 2021; Raquel and Andrade, 2010; Tirole, 2006). In addition, PPPs reduce government's borrowing needs, provide better, timely delivery and project innovation, promote allocative efficiency, and project management effectiveness (Pinto, 2017; Klompjan and Wouters, 2002).[3]

PPP infrastructure projects - from design, construction to operation - are prone to contracting incompleteness, therefore, they are complex to structure, procure, finance, and execute. Such features, typically, become ubiquitous and non-negligible sources of governance problems in P3 implementation (e.g., South *et al*., 2019; Casady *et al*., 2020, 2017; Kokkaew *et al*., 2015; Hart, 2003, 1995). In this framework, good governance of infrastructure is key to promote economic and social welfare, and to ensure efficient usage of public resources (e.g., OECD, 2022; Prats Cabrera, 2019).

In the aftermath of the 2008 financial and the sovereign debt crises, and the governmental responses to the COVID-19 pandemic, most countries around the world experienced a significant rise in their debt levels, and an increase in their debt overhang risks (e.g., Bulow *et al*., 2020; Kalemli-Özcan *et al*., 2019; Cuerpo *et al*., 2015; Buttiglione *et al*., 2014; European Commission, 2013). This indebtedness buildup may, on the one hand, constrain governments from allocating fiscal income to infrastructure investment or, on the other hand, favor the use of P3 to circumvent potential fiscal resource shortages, rather than to reap efficiency gains. However, because «of limited fiscal space and financing constraints, many countries will turn to the private sector to complement public investment» (Fouad *et al*.,

[3] See, e.g., Bertelli *et al.* (2020), Hodge and Greve (2017) and Willems and Van Dooren (2016), among others, for mixed evidence regarding the benefits of PPPs.

2021, p.1). More recently, various governments around the world announced plans for investing in new projects, aiming at closing the long-identified infrastructure gap, in order to sustain economic and social development, and recover from recent adverse shocks. Lucas and Montesinos (2020, p.369), predict that «governments worldwide will invest tens of trillions of dollars in new infrastructure investments over the next decade».[4]

For example, in Europe, the European Commission and the European Investment Bank launched the 'Europe 2020 Project Bond Initiative' in 2012, designed to (*i*) mobilize the necessary funding for project financing of large European Union infrastructure projects, which exceeded EUR 2 trillion between 2012 and 2020; and (*ii*) attract additional private finance from institutional investors such as insurance companies and pension funds (Scannella, 2012).

In addition, the COVID-19 pandemic may have endangered the progress of several SDGs, therefore increasing the instrumental importance of private capital and P3 for pursuing these goals (Macht *et al.*, 2020).

This prediction raises, at least, two governance related questions. First, how should the projects to be undertaken be selected? And how should these projects be financed? In this work, we describe and discuss conceptual, methodological and governance issues raised in the context of infrastructure investment project valuation with variable target capital structures.

The remainder of the chapter is organized as follows: In Section 2, we parsimoniously discuss the theoretical and empirical background of our generic research question. The

[4] See also Prats Cabrera (2019). Sarmento and Renneboog (2016) posit that the provision of infrastructure development has often been associated with 'failures' in fulfilling its promises in terms of economic, social, and welfare goals.

following section describes the research design, methodological approach, and model specification. The final section summarizes and offers concluding remarks.

II. BACKGROUND

Public infrastructure investment projects, due to their scale and complexity, more often require significant amounts of resources, namely, financial capital. This financial capital typically exceeds project sponsors' funding capability. To try to overcome such a potential debility, projects tend to be structured under increasingly more complex contracting designs.

It is widely acknowledged that writing incomplete contracts is an inefficient governance mechanism for economic relationships contingent on the future states of nature, which may become a source for potential opportunistic behavior, and costly agency problems (e.g., Bolton and Scharfstein, 1998; Williamson, 1996).[5]

Over the last decades, the concept of governance gathered significant notoriety as a key institutional factor for the well-functioning activity of market economies (Tricker, 2019; Mallin, 2018). Therefore, good governance is deemed beneficial, namely, to improve the allocation of suboptimal property rights, and promote the enforcement of contracts, and ultimately allocative efficiency (Aghion and Holden, 2011; Dixit, 2009; Williamson, 2005; Whinston, 2003).[6] Under this framework, the structure of ownership rights becomes an important governance factor within contractual relationships, playing a similar role in mitigating agency conflicts.[7] From another perspective, Larcker and Tayan (2013) present

[5] Among other types, opportunistic behavior may assume the form of ex post opportunism in the form of hold-up problems whenever there are relationship-specific investments (e.g., Bolton and Scharfstein, 1998; Hart and Moore, 1988). Agency problems associated with the imperfect observability of agent's actions, include the cost of writing, executing, and enforcing contracts.

[6] According to Zingales (1998), corporate governance encompasses «the complex set of constraints that shape the ex-post bargaining over the quasi-rents generated by a firm».

[7] According to Hart, (1995), the «governance structure can be seen as a mechanism for making decisions that have not been specified in the initial contract. More precisely, governance structure allocates residual rights of control over the firm's nonhuman assets».

"trust" as an unwritten contract in corporate governance, as it replaces the need for a written contract (and is a substitute for rigorous controls) because both principal and agents commit in advance, implicitly or explicitly, to implement a set of actions that benefit the organization as a whole.

From a theoretical perspective, the allocation of ownership rights of control among inside and outside residual claimants is an important determinant of corporate governance effectiveness. However, when ownership becomes increasingly separated from control rights, the ineffectiveness of corporate governance structure may increase the likelihood of agency problems emerging.[8]

Assuming the observability and contractability of actions, the ability to renegotiate, the nature of information, imperfect monitoring, and the risk preferences of parties, extant contract theoretical modeling contribute to resolving conflicts of interest, and informational problems between contracting parties. Under the unobservability of an agent — say, a private P3 contractor – level of effort, an uninformed risk-neutral principal – say, a P3 financier — can only audit ex post the reported project's realized returns at a cost. In this framework, the optimal incentive contract makes agent's compensation dependent upon the costly verification of the project's return realizations (e.g., Dewatripont and Legros, 2005; Holmström, 1979; Townsend, 1979).

The dominant conceptual perspective of corporate governance of mainstream economists and legal scholars, articulates corporate governance, at large, in terms of the defense of residual claimants' interests (e.g., Williamson, 2008; Becht *et al*., 2007; Tirole, 2001; Shleifer and Vishny, 1997). This view, well-articulated in Tirole (2006, p.16),

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[8] As noted in Williamson (1988), agency theory focuses primarily on ex ante incentive-alignment contractual arrangements, whereas transaction cost economics is more concerned with ex post governance structures.

postulates corporate governance in terms of the «ways in which the suppliers of finance to corporations assure themselves of getting a return on their investment» (see also, Hart and Zingales, 2017; Jensen, 2010, 2000; Friedman, 1970). Enunciated differently, corporate governance refers to «the ways in which a corporation's insiders can credibly commit to return funds to outside investors and can thereby attract external financing» (Tirole, 2006, p. 16). In this framework, equity, and debt claims, besides their financial idiosyncratic nature, also play a critical governance role (Williamson 1996).[9] In addition, as the environmental, social and governance (ESG) issues have made their way to the top of the agenda of mainstream private investors in new infrastructure projects, sustainability, environmental, social, and governance factors have become central topics of the P3's risk-reward equation (e.g., Gabor, 2019; Weber *et al*., 2016).

By allowing the segregation of the sponsors' assets from those of the project, project non-recourse structured finance, either under the project finance or P3 format, allows the project's credit risk to be disentangled from that of its sponsors, (Pinto, 2017; Hainz & Kleimeier, 2011; John & John, 1991).

According to Esty (2004, 2003), project finance deals can be conceptualized as an asset governance mechanism as it allows the mitigation of the deadweight costs of market imperfections and frictions, namely agency and asymmetric information problems. Project finance can be used to mitigate costly agency conflicts inside project companies and among capital providers.

[9] The quality of the institutional governance architecture, namely incentives deployment, regulatory framework, quality of the institutions in terms of transparency, accountability, and enforcement of property rights legal protection are important determinants of governance quality (e.g., Percoco, 2014; Himmelberg *et al*., 2002; La Porta et al., 2000).

Therefore, the incorporation of legally independent companies — SPEs —, creates new asset-specific governance structures to mitigate potential conflicts between management and ownership (Finnerty 1996, Kensinger and Martin 1988; Williamson 1988). Additionally, as articulated in John and John (1991) and Flannery et al. (1993), SPEs' joint ownership and high leverage are useful mechanisms to minimize costly agency conflicts among project parties. Moreover, because P3/project finance arrangements are structured as extensive and detailed networks of contracts, they contribute to lowering informational problems (e.g., Gatti et al., 2013; John and John, 1991).

Due to the size and scope of their features, public infrastructure projects are usually exposed to wide repercussions and scrutiny, at both the social and the institutional level. Therefore, we should expect that their impact on the environmental, social, and governance dimensions to be discernibly incorporated across the projects' entire lifecycle decision-making process.

As they are usually highly levered funded projects, lenders play a crucial part in contributing to the materialization of the growing ESG consciousness, lending, for example, through sustainable syndicated loans or green project finance bonds (Barber *et al.*, 2021; Flammer, 2021; Zerbib, 2019; Schoenmaker and Schramade, 2018; Dhaliwal *et al.*, 2014; Goss and Roberts, 2011.

Regarding sustainable debt financing instruments, one of the biggest developments came in the form of initiatives promoting sustainable projects. One of the most prominent examples is the Equator Principles (EP).[10] These principles aim at being a common baseline

[10] For further developments on EP see https://equator-principles.com/about-the-equator-principles, and Macve and Chen (2010), Wright (2012) and Chen *et al*. (2018).

framework for financial institutions to identify, assess and manage environmental and social risks when financing projects. Adopted by 126 financial institutions in 38 countries, the EP apply, among others, to project finance and, therefore, to P3 transactions. As these types of projects are typically associated with capital-intensive, large infrastructure and industrial projects with a significant impact on the environment, the EP allow the identification, assessment and management of environmental and social risks and impacts in a structured way, for a sustainable environmental and social performance and improved financial, environmental, and social outcomes during the projects' lifecycle (Weber et al., 2016; Inderst, 2020). From this vantage point, to appraise the governance quality of a P3 infrastructure project, we need a framework for answering the general question of which project-specific risk adjusted discount rate should be used for project valuation.[11] To set out such a framework, we assume that it is the rate of return project financiers forego in alternative investments of equivalent risk. One of the central tenets of the modern financial economics theory is that the discount rate in a fair value model should reflect the risk profile of expected net benefits generated by the project.

The standard textbook fair value method, widely used to value public infrastructure investment projects, measures the net present value of a project's expected benefit stream.[12] Under that framework, the economic (and social, if externalities are included in the analysis) merit of a risky public investment project is gauged by discounting the flow of the project's net benefits at a project-specific risk adjusted opportunity cost of capital (e.g., Gollier 2021; Lucas and Montesinos, 2021; Kruger *et al*., 2015).

[11] For further details on governance of PPPs see Prats Cabrera (2019).
[12] We use interchangeably "fair value approach" and "free cash flow approach".

Governmental spending in an infrastructure project is financed, directly or indirectly, through taxation, which implies, among other effects, a loss in society's intertemporal consumption. In this framework, the relative magnitude of the social welfare loss associated with funding the project is the aggregate measure of the public sector's marginal cost of capital. Therefore, for risk-averse taxpayers — residual claimants of the net benefits of the project — the discount rate quantifies the degree of collective willingness to postpone consumption (e.g., Dahlby, 2008).

However, the choice of discount rate parameter, an aggregated measure of the market price of a project's risk portfolio, has been a controversial governance issue, both at the general and the P3 level (e.g., Engel *et al*., 2021; Gollier, 2021; Dietz et al., 2018; Gollier and Cherbonnier, 2018; Greenstone *et al*., 2013). As postulated by Greenstone et al. (2013), «the choice of a discount rate to be used over very long periods of time raises highly contested and exceedingly challenging scientific, economic, philosophical, and legal issues».

For example, there are some arguments that the public sector is a risk-neutral investor because it optimizes the diversification benefits associated with its portfolio of infrastructure projects. Consequently, the appropriate discount rate to use to value these projects should be the risk-free rate.[13]

Furthermore, it also argued that the government may borrow at a lower cost than private sector P3 contractors, therefore the discount rate to use should be the public sector cost of debt. However, it is widely acknowledged that both public and private sectors borrow in the same competitive capital markets, which price financial claims according to the riskiness

[13] See, e.g., Gollier (2021), Dietz *et al*. (2018), Gollier and Cherbonnier (2018), and Lucas (2014) for discussions on Arrow and Lind's (1970) proposition to discount public sector risky investments at the risk-free rate, which seems at odds with the modern asset pricing theory.

of the borrower, not its institutional nature. Therefore, «the cost of capital for a given project is essentially the same for governments and private investors» (Lucas and Montesinos, 2021, p. 370). Thus, the concern that private contractors use a higher discount rate to make an abnormal profit, may be misplaced. Additionally, there is no reason for potential arbitrage between PPP's potential efficiency gains and private sector's 'higher required rate of return', if «the contracting process is sufficiently competitive to ensure that private partners earn a return that is commensurate with the risk they assume» (Lucas and Montesinos, 2021).

III. VALUATION

Infrastructure project valuation under variable capital structure

The appraisal of the economic merit of resource allocation, the expected benefits of which are spread into the future, should be conducted under the discounted cash flow approach, and can be performed under different methods. Namely, when focusing on the value of all claims on the project, the free cash flow (FFC), the capital cash flow (CCF), or the adjusted present value (APV) models. The differences between those methods relate to relevant cash flow and capital cost measurement (Koller et al., 2021). See appendix A on the calculation of the various cash flow types.

However, the discounted free cash flow (FCF) approach has been the dominant investment project valuation method, either in standard corporate finance textbooks, MBA classrooms and in practitioners' suites (e.g., Graham and Harvey, 2002; Pike, 1996; Bierman, 1993). The FCF valuation model estimates a project's expected value creation by discounting the cash flow stream over its useful life, at an after-tax risk-adjusted weighted average cost of capital rate (WACC). The model is anchored on the central assumption of a constant discount rate over the project's useful life, carrying the strong implications of invariant levels of both business and financial risk. Consequently, it should be specifically used for valuing projects funded with relatively low and stable target leverage, and investment grade debt.

As the FCF model is not an unbiased estimator of the expected economic value of an investment project, its use is prone to non-negligible misvaluation bias, and may prove inappropriate, or even imprudent, for valuing, namely, very long-term infrastructure projects financed with variable capital structure arrangements, and/or intensively financed with non-investment grade debt (e.g., Fernandez, 2020, 2007; Koller *et al*., 2021; Antill and Lee, 2008; Arzac, 2008; Ruback, 2002, 1995; Kaplan and Ruback, 1996, 1995). As mentioned by Esty (1999), «failure to incorporate the effects of changing leverage or to measure leverage correctly can result in serious valuation errors».

Since the late 1980s, an increasing volume of public infrastructure projects, such as road and rail networks, ports, airports, and energy production and distribution infrastructure, have been contracted upon under different variations of design, build, finance, operate and maintain (DBFOM) arrangements. These projects have been mostly financed under non-stationary capital structures, and intensely leveraged structures, in the form of (non-recourse) project finance or public-private-partnerships (PPP). Admittedly, long maturity is one of the idiosyncratic characteristics of these investment projects contracted-out on a concession basis.

Whenever the invariability of the discount rate assumption is violated, as is most often the case of long-term infrastructure investment projects, the literature recommends using the CCF or the APV models to mitigate some of the biases of the standard FCF approach to value such large-scale infrastructure projects, financed with variable target capital structures. CCF and APV models, in contrast to the FCF methodology, require the computation of actual taxes (and not hypothetical taxes as in the FCF model) and, therefore, effective tax benefits (Ruback, 1995, 2002). However, the APV model assumes that future interest tax shields are discounted at the risk-free interest rate, which is manifestly lower than the expected return on assets, leading to an overestimation of the debt tax benefits associated with debt (Koller et al., 2021). Therefore, the CCF comes out as the most robust model for valuing investment projects with variable capital structures. See Appendix B for comparison between FCF and CCF models regarding how they treat debt interest tax shields.

Under the CCF approach, the project's cash flows are estimated considering interests on debt as a cash outflow, and the expected debt tax savings. In contrast to the FCF approach, in the CCF method, the project's cash flows, which do not include the periodic borrowing expenses, but incorporate the associated income tax savings, are discounted at a pre-tax WACC, the expected return on the project's assets. Thus, and contrary to the FCF model, in which any tax benefits are reflected in the weighted average cost of capital, in the capital cash flow model this adjustment is periodically made by re-estimating the cash flow, thereby incorporating the tax effect induced by changes in the capital structure over time, if any. Despite treating tax benefits differently, both models are algebraically equivalent; that is, the capital cash flow methodology is just another way to value future cash flows using the same assumptions made in the context of the FCF methodology, while overcoming its limitations.

The APV model also allows the referred limitations to be overcome, namely when using the expected return on assets to discount the future free cash flows. Appendix C shows that the NPV is the same when FCF, CCF and APV methodologies are used in the context of investment project valuation with constant capital structures (Table 1). In other words, if a specific project manages its capital structure to a target debt-to-value level of 40 percent, the FCF-based valuation leads to the same value for NPV as CCF and APV methodologies. In the case of variable capital structures, and due to the different treatment given to the interest tax benefits, the NPV is different when using the FCF methodology compared to CCF- and APV-based valuations (Table 2).

According to the CCF model, the discount rate is the pre-tax weighted average cost of capital, which is equivalent to the expected rate of return on the assets (r_A):

$$r_A = r_F + \beta_A(r_M - r_F) \tag{1}$$

where, r_A denotes expected return on assets; r_F, the risk-free interest rate; r_M, the expect return on well-diversified market portfolio; and β_A, the systematic risk of assets.[14]

Expected return on assets is appropriate for discounting capital cash flows (CCFs), as it is a pre-tax rate, the tax effects associated with interest expenses are reflected in the cash flows. Furthermore, the expected rate of return on assets, as a function of the temporal dimension of the value of money, the market risk premium and systematic risk coefficient of assets, is not influenced by variations in the capital structure, which allows the temporal variability of project's capital structure to be accommodated:

$$\text{pre-taxWACC} = \frac{D}{V} \times k_D + \frac{E}{V} \times k_E \tag{2}$$

where, *WACC* denotes *Weighted Average Cost of Capital*; *D*, outstanding debt; k_D, debtholders expected return; *E*, equity; k_E, equityholders expected return; and $V = D + E$.

Specifying k_D and k_E based on Sharpe, Mossin and Lintner's Capital Asset Pricing Model (CAPM):

$$k_D = r_F + \beta_D(r_M - r_F) \tag{3}$$

$$k_E = r_F + \beta_E(r_M - r_F) \tag{4}$$

[14] In equilibrium, the expected rate of return on a risky asset is a linear combination of the rate of return on a risk-free financial asset and a premium for non-diversifiable risk.

where, β_D, debt systematic risk; β_E, equity systematic risk; r_M, expected rate of return on a well-diversified market portfolio, and r_F, risk-free interest rate.

Replacing (3) and (4) in (2):

$$\text{pre-taxWACC} = \frac{D}{V}[r_F + \beta_D(r_M - r_F)] + \frac{E}{V}[r_F + \beta_E(r_M - r_F)] \quad (5)$$

simplifying,

$$\text{pre-taxWACC} = r_F + \left(\frac{D}{V}\beta_D + \frac{E}{V}\beta_E\right)(r_M - r_F) \quad (6)$$

Equation (6) shows that the systematic risk of assets, $ß_A$, is a weighted average of the systematic risk of debt and equity:

$$\beta_A = \frac{D}{V} \times \beta_D + \frac{E}{V} \times \beta_E \quad (7)$$

Replacing (7) in (6):

$$r_A = \text{pretaxWACC} = r_F + \beta_A(r_M - r_F) \quad (8)$$

where r_A denotes the expected return on assets.

An interesting feature of this approach is the fact that it does not require the estimation of the project's target capital structure, a task that is generally highly complex and uncertain, especially in projects with a long useful life and funded with levered variable capital structure.

IV. SUMMARY AND CONCLUDING REMARKS

PPPs have emerged as an alternative to traditional public procurement in financing and providing infrastructure services. These are typically large-scale projects with relatively transparent cash flows, using relatively leveraged capital structures and long-term financing. More recently, with the increasing need for the development of projects to achieve ESG goals such as the United Nation's Sustainable Development Goals, alongside the financing constraints companies may face when raising capital for the financing of ESG projects, there is more room for project finance, and more specifically PPPs, to be incorporated into this whole process of promoting ESG projects.

The most common technique for valuing cash flows is the FCF method, which excludes debt tax benefits from the FCFs and the tax deductibility of interest is treated as a decrease in the cost of capital using the after-tax WACC. As the WACC is affected by changes in debt levels, this method poses several problems when valuing highly leveraged transactions, such as project finance transactions and more specifically PPPs.

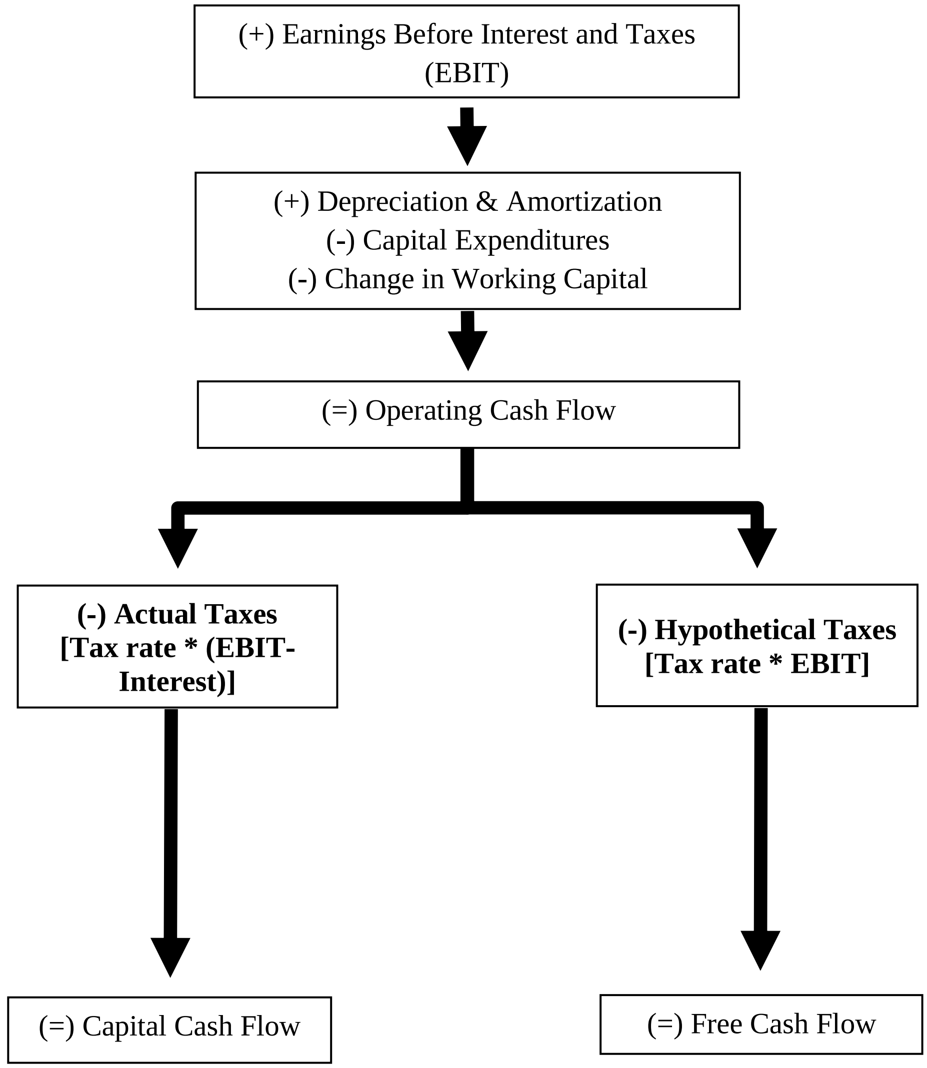
The CCF method is presented as an alternative method for valuing large-scale projects with risky cash flows. CCF measure the cash flows available to both equity and debtholders. Contrary to FCF, the interest debt tax benefits are included in the cash flows. In this case, the appropriate discount rate for CCF is the expected return on assets, corresponding to the riskiness of the assets of the project. The riskiness of the project's assets is relevant because CCF include all the cash flow generated by the assets and available to all capital providers. We show that the expected return on assets is equivalent to the after-tax WACC; i.e., the FCF and CCF methods are algebraically equivalent. An asset beta is required to compute the expected return on assets under the assumption that the risk of the debt tax benefits matches the risk of the project's assets.

Appendix A - Estimating free cash flow and capital cash flow categories

The following table presents how different cash flows can be calculated. The free cash flow (FCF) is a cash flow that remunerates the invested capital, but remains independent from the way the investment is financed; capital is invested by equityholders and debtholders. Therefore, cash flows considered are cash flows from assets, prior to any debt payments, but after the firm has reinvested to create growth assets. When a company actively manages its capital structure to a target debt-to-value level, both FCF and the interest tax shield are discounted based on the same rate (Koller et al., 2021). Therefore, Ruback (2002) combines the two flows and named the resulting cash flow (FCF plus interest tax shields) Capital Cash Flow (CCF).

(+)	Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA)
(-)	Depreciation and Amortization (D&A)
(=)	Earnings Before Interests and Taxes (EBIT)
(-)	Estimate of Corporate Tax
(=)	Earnings Before Interests and After Taxes (EBIAT)
(+)	D&A
(-)	Change in Working Capital
(-)	Capital Expenditures
(=)	**Free Cash Flow (FCF)**
(+)	Interest Tax Shields
(=)	**Capital Cash Flow (CCF)**

Appendix B – A summary of how cash flow valuation techniques treat debt tax benefits



Source: adapted from Ruback (1995).

Appendix C – Calculation of NPV in constant *versus* variable capital structures

Table 1: Infrastructure investment project with a constant capital structure

	Year 0	Year 1	Year 2	Year 3
Cost of capital				
Weight of debt	40.00%	40.00%	40.00%	40.00%
Cost of debt	4.00%	4.00%	4.00%	4.00%
Weight of equity	60.00%	60.00%	60.00%	60.00%
Unlevered beta	0.70	0.70	0.70	0.70
Levered beta	1.07	1.07	1.07	1.07
Debt to equity ratio	0.67	0.67	0.67	0.67
Corporate tax rate	20.00%	20.00%	20.00%	20.00%
Equity risk premium	7.00%	7.00%	7.00%	7.00%
Risk-free rate	2.00%	2.00%	2.00%	2.00%
Cost of equity	9.51%	9.51%	9.51%	9.51%
WACC	6.99%	6.99%	6.99%	6.99%
Pre-tax WACC	7.31%	7.31%	7.31%	7.31%
Free cash flow valuation				
Free cash flow	-100.00	30.00	30.00	130.00
WACC	6.99%	6.99%	6.99%	6.99%
Discount factor	1.00	0.93	0.87	0.82
Present value of free cash flow	-100.00	28.04	26.21	106.15
Net present value (NPV)	**60.5**			
Capital cash flow valuation				
Present value of future cash flows	160	142	122	0
Debt	64	57	49	0
Interest tax shields	0.51	0.45	0.39	0.00
Free cash flow	-100.00	30.00	30.00	130.00
Capital cash flow	-99.49	30.45	30.39	130.00
Expected return on assets	7.31%	7.31%	7.31%	7.31%
Discount factor	1.00	0.93	0.87	0.81
Present value of capital cash flow	-99.49	28.38	26.39	105.21
Net present value (NPV)	**60.5**			
Adjusted present value				
Debt	64.16	56.65	48.60	0.00
Interest tax shields	0.51	0.45	0.39	0.00
Cost of debt	4.00%	4.00%	4.00%	4.00%
Discount factor	1.00	0.96	0.92	0.89
Present value of interest tax shields	0.51	0.44	0.36	0.00
Free cash flow	-100	30	30	130
Pre-tax WACC	7.31%	7.31%	7.31%	7.31%
Discount factor	1.00	0.93	0.87	0.81
Present value of free cash flow	-100.00	27.96	26.05	105.21
Net present value (NPV)	**60.5**			

Table 2: Infrastructure investment project with a variable capital structure

	Year 0	Year 1	Year 2	Year 3
Cost of capital				
Weight of debt	40.00%	30.00%	20.00%	10.00%
Cost of debt	4.00%	3.00%	2.00%	1.50%
Weight of equity	60.00%	70.00%	80.00%	90.00%
Unlevered beta	0.70	0.70	0.70	0.70
Levered beta	1.07	0.94	0.84	0.76
Debt to equity ratio	0.67	0.43	0.25	0.11
Corporate tax rate	20.00%	20.00%	20.00%	20.00%
Equity risk premium	7.00%	7.00%	7.00%	7.00%
Risk-free rate	2.00%	2.00%	2.00%	2.00%
Cost of equity	9.51%	8.58%	7.88%	7.34%
WACC	6.99%	6.73%	6.62%	6.72%
Pre-tax WACC	7.31%	6.91%	6.70%	6.75%
Free cash flow valuation				
Free cash flow	-100.00	30.00	30.00	130.00
WACC	6.99%	6.73%	6.62%	6.72%
Discount factor	1.00	0.94	0.88	0.82
Present value of free cash flow	-100.00	28.11	26.39	106.95
Net present value (NPV)	**61.4**			
Capital cash flow valuation				
Present value of future cash flows	161	142	122	0
Debt	65	43	24	0
Interest tax shields	0.52	0.26	0.10	0.00
Free cash flow	-100.00	30.00	30.00	130.00
Capital cash flow	-99.48	30.26	30.10	130.00
Expected return on assets	7.31%	6.91%	6.70%	6.75%
Discount factor	1.00	0.94	0.88	0.82
Present value of capital cash flow	-99.48	28.30	26.43	106.86
Net present value (NPV)	**62.1**			
Adjusted present value				
Debt	64.58	42.74	24.36	0.00
Interest tax shields	0.52	0.26	0.10	0.00
Cost of debt	4.00%	3.00%	2.00%	1.50%
Discount factor	1.00	0.97	0.96	0.96
Present value of interest tax shields	0.52	0.25	0.09	0.00
Free cash flow	-100	30	30	130
Pre-tax WACC	7.31%	6.91%	6.70%	6.75%
Discount factor	1.00	0.94	0.88	0.82
Present value of free cash flow	-100.00	28.06	26.35	106.86
Net present value (NPV)	**62.1**			

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