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A Required Debt Service Coverage Ratio Related to the Economic Value of the Asset Involved

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Abstract

This paper aims to associate the Debt Service Coverage Ratio, *DSCR*, with the asset value involved. Usually, a minimum *DSCR* is defined by advisors for debt sizing of projects or as a reference for their risk assessment. Many times, such a definition depends on the investor's industrial sector, such as infrastructure, power, etc. Since each project has its own market and risk features, the usual *DSCR* definition may over or undervalue those features, resulting tight or relaxed financial conditions in view of the project's cash flow and risk. An analytical relation is found for relating a required ratio, *DSCRr*, to the value and risk of the asset involved, which also depends on the cost of debt and corporate tax. The relation is based on the financial criteria that the amount of debt associated to any asset should be smaller than its economic value with a high level of confidence. If the usual *DSCR* is greater than the *DSCRr*, the sponsor is sacrificing part of its profitability. If the usual *DSCR* is smaller than the *DSCRr*, the lenders are assuming a greater risk than the maximum recommended. The research results should not have relevant limitations. The comparison between usual *DSCR* and *DSCRr* could help sponsors and lenders reach an agreement on any financing, especially in project finance. This paper fulfils the need to associate the *DSCR* with the risk of the debtor and not only to the industrial sector where it operates.

Keywords

DSCR, Discounted Cash Flow Valuation, Financial Valuation, Financial Ratios: Valuation and Prediction, Valuation, Free Cash Flow, Debt Sizing

1. Introduction

The sponsors of a project usually look for financing to optimize their wealth and profitability, so that they should take into account the lenders' point of view in order to obtain the suited financing for the project. Many lenders base their financial valuations, among other factors, on the debt service coverage ratio (Borgonovo, Gatti & Peccati, 2010) which is known as *DSCR* and corresponds to the ratio between cash flow available for debt service, known as "*CFADS*" (Moody's Investor Service, 2022; S&P, 2023) and the debt service (amortization and interest of debt).

Also, some lenders, financial advisors and financial courses (for instance (Euromoney Learning, 2024)) recommend sizing the debt according to cash flow projections with a *DSCR* in every period greater than or equal to a required *DSCR*. In this case, the required *DSCR* is defined depending on the industrial sector of the project or firm, such as infrastructure, power, mining, oil & gas, telecoms (Gatti & Caselli, 2011).

The rating agencies used to consider the real *DSCR* in the last years and the *DSCR* resulting from their projections for issuing their risk opinion about a firm or project, among other factors (FitchRatings, 2023, 2020; Moody's Investor Service, 2022; S&P, 2023).

In general terms and in addition to investing in profitable assets, the way to reach the sponsors' goal of increasing its profitability, i_e, is to decrease the interest rate of the financing, increase the duration of the debt and increase the amount of the investment which is financed by debt (Rodriguez, 2023). In this context, since the cost of the debt is usually smaller than the required profitability for the sponsors, one way for the sponsors to increase its profitability it is to increase the risk taken by the lenders.

However, the lenders usually apply some criteria for not assuming too much risk from a project or firm. For instance, lenders want sponsors to provide enough equity or funds to a project in order to ensure their continued interest in the project in case of any problem during construction or operational period (Nevitt, 1995). In this sense, lenders expect that in case of such a problem, the sponsor would pay attention to solving it because of its interest. This means that lenders' willingness is not to provide financing for the total amount of an investment.

In this context, the *DSCR* is one of several tools that sponsors and lenders use to size debt and mitigate the financial risk of a project. Perhaps the *DSCR* is one of the most widely used tools in financial risk assessment, but comparing different levels of *DSCR* with actual default rates or associated credit spreads may not be a direct relationship. In effect, firstly, the *DSCR* to be considered must be the ratio at the beginning of the project, not after the project has started and, secondly, it cannot be ruled out that the calculation of the *DSCR* has not been correct either due to the assumptions or risk assessment. A project is probably carried out because the *DSCR* and other financial indicators appear to be sufficient, for example a *DSCR* between 2x and 3.5x for the A rating (Moody's Investor Service, 2022). In this context, if there is an early termination of the project, the *DSCR* at the debt sizing date was probably within an appropriate range, but perhaps the assumptions were not appropriate or the risk assessment was not complete.

The problem definition and development are performed in section 2 based on a theoretical model, what includes a review of the basic ideas in which the *DSCR* should be based on; and it is found an analytical relation among the *DSCR*, the size of debt and the economic value of the asset. The *DSCR* meeting that relation is named *DSCRr*, and a *DSCR* value equal to *DSCRr* means the sponsors optimize their profitability in the project and the lenders do not assume too much risk to jeopardize the pay back of the funds provided. Section 3.1 presents an example of a typical project for a transmission line and section 3.2 presents an example of a toll road project.

The examples aim to show the way to calculate the *DSCRr* and, in case of using the usual *DSCR* for debt sizing, the reason why the debtor would sacrifice profitability if the usual *DSCR* is greater than *DSCRr* or why the lenders assume more risk if the usual *DSCR* is smaller than *DSCRr*. The effects on the sponsor´s profitability of the usual *DSCR* greater than *DSCRr* is obvious.

The effects on the lender's risk can be assessed by theoretical situations, since the risk from a project can be understood as the probability of happening a problem for the project. In this sense, if such a problem never happens, it does not mean that risk has not been assumed. In this context, an empirical validation of the proposed *DSCRr* expression using a large dataset of projects should consider not only the real facts about the project but the risks involved. For instance, a project could have a bad performance but it continues with its operation because lenders have sacrificed part of their expected profit.

In this context, *DSCRr* aim is to assess a specific financial risk of a project, not only a sector risk as the usual *DSCR*, and to define a threshold that optimize the profitability for the sponsor and to provide a limit for the risk taken by the lenders.

2. Theoretical Model

2.1. Basic Ideas

In order to optimize the sponsor's profitability in a project, i_e, which should be equal or greater than the profitability requested to the funds provided by the sponsors to the project, i_{er}, the sponsors could pose the following model to define the debt amortization schedule of each period k, $Amort_k$, which is the variable of the model. The objective function is:

$$Max\, i_e \tag{1}$$

Subject to

$$E\left(-(Inv - Debt) + \sum_{k}^{n} \frac{CFADS_k - Amort_k - Fexp_k}{(1+i_e)^k}\right) = 0 \tag{2}$$

$$i_e \geq i_{er} \tag{3}$$

$$DSCR_k \geq DSCR_r \quad k = 1, \cdots, n \tag{4}$$

$$\sum_{k}^{n1} Amort_k \leq MD \tag{5}$$

Where Inv is the investment amount; Debt is the amount of the debt provided by the lenders during the investment period (in the previous conceptual model it is assumed as period 0); *CFADS* is the operational cash flow available for debt service (capital and financial expenses), taxes included; $Amort_k$, is the amortization amount in period k, the variable of the conceptual model; $Fexp_k$ is the financial expense in every period k, which depends on the variables $Amort_k$; n is the number of periods of the cash flow projections and n1 is the number of periods of the amortization period (n1< n) which is usually not defined by the investor but by the lenders.

Relation (1) considers the sponsor's profitability as objective function. Maybe the optimization problem could be posed with the expected net present value of the cash flow to equity with a defined discounted rate. The idea is not to review the best way for the sponsor to make decisions on its investment but making it clear that there are some constraints related to the lenders, expressions (4) and (5), in its optimization problem that should be considered, as it will reviewed in the next paragraphs.

The sponsor's profitability is defined by (2), since the expected net present value discounted at i_e, should be zero. $CFADS_k$ is an estimated value for every period k of a feasible future scenario, what it means there is some level of risk because of the different scenarios involved. The first term, Inv – Debt, is the sponsor's contribution and the sum in (2) corresponds to the expected cash flow to equity during operation phase at discount rate i_e.

Relation (3) sets that this rate should be greater than the profitability requested to the funds provided by the sponsors to the project, i_{er}, which could be defined as Capital Asset Pricing Model (CAPM) or similar (Brealey et al., 2008).

DSCR in (4) is the ratio between *CFADS*, either the expected value for the period k or other specific scenario considered as a worse case, and the sum of the amortization and financial expense, $Fexp_k$, to be paid in each period k.

The solution to the optimization problem will be to increase the duration and the size of the debt according to the relation between the sponsor's profitability, the asset's profitability and the cost of debt (Rodriguez, 2023). Because of this, since the lenders usually pose a limit to the size of debt that they are able to assume for a firm or Project, it is necessary for them to define a maximum debt value (MD) in the relation (5), which may become an active constraint. In case of project finance, it is usual that the lenders define MD as a percentage of the total investment amount or in relation to the amount of equity provided by the sponsors (Pierru & Babusiaux, 2011; Nevitt, 1995).

Of course, from Debtor's viewpoint, any active constraint on debt amount or maximum percentage of the assets financed with debt is a limitation on its net present value and profitability.

However, sometimes the sponsors and lenders may agree on a MD to meet the required conditions to get a specific rating risk (FitchRatings 2023, Moody's Investor Service, 2022, S&P, 2023).

Since the *CFADS* depends on the amount of taxes which, at its turn, depends on the amount of debt and its amortization schedule, the problem should be solved in a recursive process if a solver software is not being used. For instance, first, assuming an initial amount of debt, the period to pay the debt, and *DSCRr*. Second, given this information and *CFADS*, the amortization and interest for each period can be calculated since relation (4) is an active constraint because the solution to the optimization problem is to increase the duration of the debt. If relation (5) turns out to be a non active constraint, the size of debt can be adjusted and then the process can start again with a greater amount of debt.

A different required *DSCR* could be defined for different periods in (4). It is clear that the optimal solution will include the same *DSCR* as *DSCRr* (the restriction will be active for each period). The solution of the problem (1) should be simple for any solver. In case of a unique *DSCRr* in (4) for all the periods, the set of constraints (4) will be used to find an expression for *DSCRr*.

Although the process just described could provide acceptable results for sponsors and lenders, it could be convenient for them to associate the required *DSCRr* to the risk involved to the specific project or firm (not only to the industrial sector where the Project could be assigned), in order to complement the experience of each lender. In this context, if the defined *DSCR* for the industrial sector of the Project or firm is greater than the *DSCRr* of the Project, the sponsors would not be harnessing the Project in the best way in relation to their profitability. And, if it were less than the *DSCRr*, the lenders would be assuming more risk than the one they are willing to accept.

The main basic idea behind the relation (4) is to ask the project for enough liquidity for paying the debt. So, in case of an operational cash flow in the current situation was less than the estimated value that was considered at the moment of debt sizing, the debtor could still be able to pay the installment of the debt. This is a reasonable criterion but in some cases it could not be enough.

After defining the size and conditions of the debt, the possibility of changes in the market (demand, prices, size of debt, level of competence, etc) is always present. Since these future changes in the market may be negative in terms of the risk taken by the lenders, it is convenient for the lenders and the debtor to have an upper limit for the debt, although the limit may be implicit and not necessarily recognized for everyone.

In case of a project developed by the sponsors under a special purpose vehicle (project finance case) it is usual that the assets of the project (facilities and properties) or, in case of a concession, the right to operate the asset built by the special purpose vehicle, are the main collateral (Nevitt, 1995; Gatti, 2024) behind a syndicated debt. Also, the project could be affected by an early termination of the operation of the project (which triggers the acceleration of the debt) because of a fail in the economics or because the project does not meet its obligations with the grantor institution, for instance in case of a concession granted by the State.

So, in the worst case scenario if there is an early termination of the project, due to the collateral, the assets (the assets by themselves or the right to operate them) could be sold to a third party to pay back the debt. This means that the project should have value to third parties and, in case of collection of guarantees, the collected income should be greater than the debt amount.

In this context, either the case of corporate debt, where some models define default depending on the comparison between the total value of the firm's assets and its liabilities (Blanc-Brude & Hasan, 2016) or the case of projects, it seems to be convenient to define the economic value of the asset, maybe with a safety coefficient, as a possible maximum debt value. In this way, in case of a default of the debtor that causes the acceleration of the debt and the asset selling, the risk of not recovering the debt would be mitigated since there would be someone interested in buying the assets, paying the debt, and then it will continue the operation of the firm or project. Specifically in project finance cases, where the lenders used to look to the collateral value of the assets securing the loan as the last back-up source of funds to repay the debt (Nevitt, 1995), the asset value as the maximum debt value is a direct conclusion. Similar concept is considered in traditional models of credit risk (Blanc-Brude & Hasan, 2016).

It should be noted that the default for corporations and projects or their feasible maximum debt amount have had several versions (some of them (Dias & Ioannou, 1995; Zhang, 2005)). From one of these versions, for corporations, the default is expected to occur when the value of the firm's asset falls below a threshold and, in case of projects, when the cash flow is not able to repay the debt service in a given period (Gatti et al, 2007). In this last case maybe the project could get provisional funds to repay the debt service in that period and repay those borrowed additional funds in a future period.

Although not repaying the debt on time is not acceptable for lenders, eventual liquidity problems could be solved if the debt amount is less than the asset value (Blanc-Brude & Hasan, 2016) in the context that the early termination of a financial agreement could be less convenient for all parties than the illiquidity solution. For this reason is justified to consider as a maximum debt value an amount based on the economic value of the asset.

If the economic value of the asset is not considered and the default is for instance a *DSCR* below certain threshold, in case of debt acceleration, the debt amount of the defaulted firm is not necessarily less than the economic value of the firm's asset, in the context that the asset selling is the last opportunity for the lenders to recover the amount of debt. This risk could increase in a period with a low level of interest rate at the time of the debt sizing, because the usual *DSCR* as one of the main criteria could tend to increase the size of the debt in comparison to a normal interest rate level (Barry et al., 2008). Indeed, if the cost of debt diminishes, the financial expense diminishes and if the *DSCR* is constant in the debt sizing process, the amount of amortization each period could increase. Therefore, the total amount of debt could increase.

In this way, if MD is limited to the economic value of the involved asset, in a subsequent default situation of the firm, the risk for the lenders of not recovering the debt would be mitigated for the lenders in such a situation.

It should be noted that the criteria of having an amount of debt less than the economic value of the asset does not only mean that in case of default it is more likely that the debt will be paid in full than if not, but it should also be understood in the sense of game theory. The result in case of a default will affect the behavior of interacting decision-makers in the previous decisions to the default situation. In this context, if the debt amount is greater than the economic value, the problem from a defaulted project is a problem for the debtor and lenders. If it is less than the economic value, the problem is first for the debtor and then, for the lenders.

If the real *DSCR* is smaller than the required *DSCRr*, it does not mean necessarily that the debt will not be paid if the project operates normally, but rather the risk assumed by the lenders is greater than if not, because, in case of the asset selling, it is not sure that the debt will be paid in full.

2.2. Novel Approach for Debt Service Coverage

The relation (4) can be written as an active constraint in the following way, where it is assumed that the operational flow is $CFADS_k^*$. The symbol "*" indicates that *CFADS* corresponds to a specific scenario, for instance, to the expected value of $CFADS_k$.

$$\frac{CFADS_k^*}{Amort_k + Fexp_k} = DSCR_r \quad k = 1, \cdots, n1 \tag{6}$$

It is usual that a base case scenario is established from the expected performance in a normal economic environment (FitchRatings, 2023; S&P, 2023). So, the cash flow projections are based on the most likely financial and operating parameters and sensitivities (Moody's Investor Service, 2022) and the *DSCR* referenced by these agencies would be calculated excluding extraordinary outliers (FitchRatings, 2020). In this context, the expected values of $CFADS_k$ could be the suited scenario to compare to the references from the rating agencies. Some rating agencies also apply a series of stresses to key parameters identified in the analysis, for instance in a toll road, the lower traffic or revenue or higher interest rates. The combination of the base case and the selected performance stresses will result in a rating case (FitchRatings, 2020).

In (6) the denominator on the left side can be moved to the right side and right side is moved to the left side. In addition, in each relation (6) is subtracted in both sides the financial expense in the corresponding period, $Fexp_k$, times the tax rate t and it is divided by $(1 + d*(1 - t))^k$, where d is the cost of the debt. Then, all the relations for the n1 period are added. Lastly, it is included the economic value of the asset, EV, with a safety coefficient, δ, as an upper bound for the debt, what corresponds to MD in (5).

The EV to be considered can be defined according to the one which is exceeded with a high percentage of reliability, for instance, α in case of the asset selling. So, it can be solved for the required *DSCRr* calculated at period "0", for periods 1 to n1.

$$\begin{aligned}&\frac{1}{DSCR_r}*\sum_k^{n1}\frac{CFADS_k^*-Fexp_k*t*DSCR_r}{\left(1+d*(1-t)\right)^k}\\&=\sum_k^{n1}\frac{Amort_k+Fexp_k*(1-t)}{\left(1+d*(1-t)\right)^k}=Debt\le\frac{EV_\alpha}{\delta}=MD\end{aligned} \tag{7}$$

The first term in the numerator of the left side in (7) can be replaced by $Fexp_k \, times \, t$ plus the Free Cash Flow to Firm (Brealey et al., 2008; Damodaran, 2012; Fernández, 2012), $FCFF_k^*$, which also contains taxes, as *CFADSk*, but they are calculated as if there were no debt and everything was financed with an equity contribution. So, the required *DSCRr* calculated at period "0" for period 1 to n1 can be solved from (7):

$$\delta*\frac{\sum_k^{n1}\frac{FCFF_k^*+Fexp_k*t*\left(1-DSCR_r\right)}{\left(1+d*(1-t)\right)^k}}{EV_\alpha}\le DSCR_r \tag{8}$$

The term $DSCR_r$ is at the left and right side in (8), but it can be calculated by iteration. In effect, first it is assumed that the second term at the left side is zero for calculating $DSCR_r$. Then it is calculated again $DSCR_r$ according to expression (8) and by using the previous value for $DSCR_r$. The iteration will converge to the final value for $DSCR_r$ because the value for the iteration n + 1 is smaller than the one for the iteration n.

In the numerator, the sum ends at n1, the amount of periods of the debt, and it can be added and subtracted the last terms up to the end of the considered horizon, n. In the denominator, the economic value of the asset could be calculated with *FCFFk*, with the same scenario * of the numerator but assuming that the economic value of the asset is exceeded in a percentage α respect to the universe of potential cases, as it is shown the following **Figure 1**.

In this context the *DSCRr* coefficient would explain the difference between the capacity of paying back the debt in full in n1 periods in scenario * and the economic value with α confidence interval in scenario *.

In case of the scenario * corresponds to the expected value, the discount rate to value the asset with the expected values $E\left(FCFF_k\right)$ is i_a, the weighted average cost of capital, including the duration of debt and the free cash flow of the firm or project (Rodriguez, 2023). In this context, the discount rate to value the asset, i_a, depends on the expected free cash flow of the asset, *FFCFk*, the profitability of the equity, i_e, the amount of debt, *D*, its cost, *d*, the duration *DMDt*, and corporate taxes, *t*, that a potential investor would have in case of buying the asset. In this context, the assumption about *D* is not necessarily the amount of debt of the current situation but the amount of debt that a potential buyer could borrow in case of it proposes to buy the assets. Also, it should be noted that the discount rate of the asset does not depend on directly the amortization schedule of the debt, but it depends on the duration and on the cost of debt at the moment of the early termination of the project what could be worse than the current situation.

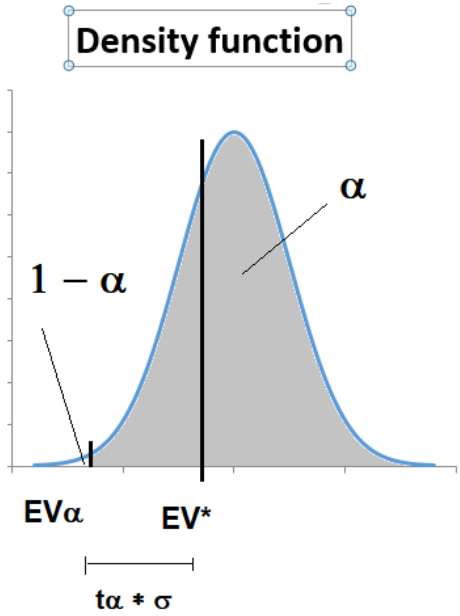

Figure 1. Typical density function.

The cost of capital i_a can be calculated with an iterative process according to the following relation:

$$i_a = \frac{SDFF - DMDt * D}{SDFF} * i_e + \frac{DMDt * D}{SDFF} * d * (1-t) \tag{9}$$

Where:

$$SDFF = \frac{1}{(1+i_a)} * E\left(\sum_k^n \frac{FCFF_k * k}{(1+i_a)^k} \right)$$

$$DMDt = \frac{1}{(1+d*(1-t))} * \frac{E\left(\sum_k^n \frac{(Amort_k + Fexp_k * (1-t)) * k}{(1+d*(1-t))^k} \right)}{E\left(\sum_k^n \frac{Amort_k + Fexp_k * (1-t)}{(1+d*(1-t))^k} \right)}$$

After calculating the suited rate to the economic value of the asset, the expression for $DSCRr$ in (8) becomes:

$$\delta * \frac{\sum_k^n \frac{E(FCFF_k) * (1-\beta) + Fexp_k * t * (1 - DSCR_r)}{(1+d*(1-t))^k}}{EV_\alpha} \le DSCR_r \tag{10}$$

Where:

$$\beta = \frac{\sum_{k=n1+1}^n \frac{E(FCFF_k)}{(1+d*(1-t))^k}}{\sum_k^n \frac{E(FCFF_k)}{(1+d*(1-t))^k}} \tag{11}$$

The economic value of the asset, EV_α could be calculated with simulation by looking for its value from the resulting density function. Another alternative is through its parameters expected value, the factor t_α and the variation coefficient of the economic value, ρ_{EV}.

$$EV_\alpha = E\left(\sum_k^n \frac{FCFF_k}{(1+i_a)^k}\right) * (1 - t_\alpha * \rho_{EV}) \tag{12}$$

For defining EV_α, first, it is calculated the expected value for $FCFF_k$ of each period k, and then the discount rate i_a is calculated with the mentioned process. Then it can be calculated the density function for EV, the specific value EV_α, or ρ_{EV} and t_α.

An alternative for obtaining an approximation to EV_α is to estimate t_α by using the Central Limit Theorem in the sense that the density function of the difference between expected EV of the sample and its mean would tend to a normal distribution for an amount of simulation steps enough large.

It is clear that similar relations to (10), (11), and (12) can be found based on *CFADS* instead of *FCFF*, in the following way.

$$\delta * \frac{\sum_k^n \frac{E(CFADS)}{(1+d)^k} * (1-\beta_2)}{EV_{\alpha 2}} \le DSCR_r \tag{13}$$

Where:

$$\beta_2 = \frac{\sum_{k=n1+1}^n \frac{E(CFADS_k)}{(1+d)^k}}{\sum_k^n \frac{E(CFADS_k)}{(1+d)^k}} \tag{14}$$

$$EV_{\alpha 2} = E\left(\sum_k^n \frac{CFADS_k}{(1+i_a)^k}\right) * (1 - t_\alpha * \rho_{EV}) \tag{15}$$

In (15) the discount rate to value the asset with the expected values $E(CFADS_k)$, i_a, the weighted average cost of capital, is defined according to the following relations (Rodriguez, 2023).

$$i_a = (1-\gamma) * i_e + \gamma * d \tag{16}$$

Where:

$$\gamma = \frac{DMD * D}{SCFADS} \tag{17}$$

$$SCFADS = \frac{1}{(1+i_a)} * E\left(\sum_k^n \frac{CFADS_k * k}{(1+i_a)^k}\right) \tag{18}$$

$$DMD = \frac{1}{(1+d)} * \frac{E\left(\sum_k^n \frac{(Amort_k + Fexp_k) * k}{(1+d)^k}\right)}{E\left(\sum_k^n \frac{Amort_k + Fexp_k}{(1+d)^k}\right)} \tag{19}$$

2.3. Preliminary Analysis for the Required *DSCRr*

The relation (10) confirms that the level of the *DSCRr* to be required to a firm or project depends on the free cash flow of the specific firm or project and on the level of risk that the lenders are able to take. In effect, if the project is riskier (variance increases), the factors t_α and ρ_{EV} increase, so that EV_α diminishes and *DSCRr* increases.

If the cost of debt were less than a previous $DSCR_r$ calculation in the current situation (scenario*) and in the scenario for calculating the economic value, on the one hand, the discount rate of the asset diminishes and the denominator of (10), EV_α, increases. On the other hand, the numerator of (10) increases too. Due to the increase in the numerator is greater than the increase in the denominator, because the decrease in the discount rate of the denominator is probably smaller than the decrease in the numerator (the discount rate is an average between the equity profitability and the cost of debt), the *DSCRr* increases. This is a relevant difference with the usual application of the *DSCR*. In effect, many times in the practice, a lower interest rate entails a greater amount of debt but the required *DSCRr* is not adjusted in the process. The problem of this is the possibility to overvalue the asset because there is not a limit for increasing the asset value in relation to the economic value.

The idea of the safety factor, δ, is to deal other risk factors, such as not payment from a relevant client of the debtor or other similar risk that affects liquidity of debtor and it is not treated by a reserve account or an equivalent mitigating scheme. But it also represents the asset selling cost, bankruptcy cost for instance, in the range from 4% to 20% (Dias & Ioannou, 1995).

It should be noted that the use of relations (9) and (10) assumes a fixed interest rate on the debt. Otherwise, the corresponding interest rate risk must be reviewed. In practice, most projects have a fixed interest rate to avoid the associated risk. Some projects might justify having a variable interest rate because an increase in the interest rate can occur at the same time as there is an increase in revenue. Furthermore, in the case of a variable interest rate, some mitigating factors can be considered so as not to affect the project's ability to pay its debt, for example reserve accounts.

From (6) it is clear that the *DSCR* is a necessary slack to ensure that, in a scenario worse than the expected situation, the project can still pay its debt. In the case of a fixed interest rate, the worst case scenario means that the *CFADS* amount is less than the expected value. In the case of a variable interest rate, in addition to the *CFADS* risk, an increase in the interest rate will deteriorate the slack considered for the *CFADS* risk. In this context, an increase in the variable interest rate could be offset by an increase in the *DSCR* so as not to affect the slack considered for *CFADS* risk.

It is known that a constant installment (principal and financial expense of debt) can be calculated according to (20).

$$\text{Constant installment} = \frac{D*(1+i)^n*i}{\left((1+i)^n-1\right)} \tag{20}$$

Where D is the amount of the debt, i the interest rate and n the amortization period. In the event that the *CFADS* risk and the interest rate risk were independent of each other (not correlated), according to the compensation criteria in the previous paragraph, an increase of 1% in the interest rate (for example, 3.5% instead of 2.5% in one semester) would mean an increase between 9% and 21% on the constant installment, depending on the extension of the amortization period (for 20 and 40 semesters, respectively). Thus, in the case of a variable interest rate and a constant installment, the *DSCR* reference should increase in the range of the mentioned percentage. In this context, the best way to mitigate the risk of a variable interest rate should be reviewed on a case-by-case basis, considering reserve account alternatives or increasing the required *DSCR* or a combination of them, among other alternatives.

Lastly, if there is a slack between the cash flow of the debt and the cash flow of the firm or project ($n1 < n$ and β is greater than zero), the required *DSCR* diminishes what means the risk decreases because of the mentioned slack.

The DSCRr determined according to (8) is the minimum value for an economic value greater than the debt amount. Perhaps in some period k the expression (8) for that *DSCR* is not met but, as was explained in section 2.1, eventual liquidity problems could be solved since debt amount is less than the asset value.

Only as an example to see the effect in *DSCRr* due to the involved parameters, in the Table 1 is shown the *DSCRr* in case of d = 5% per year, t = 27%, i_a = 8%, t_α = 2.33 (equivalent to a normal distribution for the economic value and α . = 99%) and $FCFF_k = FCFF$.

Table 1. Example of a $DSCR_r$, $FCFF_k$ = *FCFF*.

ρ_{EV}			0.05					0.10		
n	8	10	12	14	16	8	10	12	14	16
n1	6	8	10	12	14	6	8	10	12	14
DSCRr	1.04	1.15	1.24	1.32	1.38	1.20	1.33	1.43	1.51	1.59

In this context, it can be concluded that the *DSCRr* could be defined according to every firm or project situation. In a specific situation it should increase to the extent the risk involved increases, the amortization period of the debt increases, and, in case the maximum amount of debt is equal (or greater) to the economic value of the asset, if the cost of debt decreases as it was explained in the second paragraph in this section.

It should be noted that many times the loan life coverage ratio (LLCR) is used to complement the results of the usual *DSCR* application (Gatti & Stefano, 2011; Borgonovo, Gatti, & Peccati, 2010). However, since LLCR does not represent the debt, its use does not have the same meaning of using the *DSCRr* approach.

In case of defining different *DSCRr* for every period k, $DSCRr_k$, the flat *DSCRr* in (6) is the weighted average of the set of $DSCRr_k$ that could be defined for each period k, according to the following relation.

$$\frac{\sum_{k}^{n1}\frac{1}{DSCRr_k}*\frac{FCFF_k^{*}*Fexp_k*t\left(1-DSCRr_k\right)}{\left(1+d*\left(1-t\right)\right)^{k}}}{\sum_{k}^{n1}\frac{FCFF_k^{*}*Fexp_k*t*\left(1-DSCR_k\right)}{\left(1+d*\left(1-t\right)\right)^{k}}}=\frac{1}{DSCR_r} \tag{21}$$

The relation (21) can be set from (7) and (8) and a similar conclusion could be applied in case of considering a set of *DSCR* for a period k that does not meet (21). If the considered *DSCR* for the period k is greater than the *DSCRr* for the period k, $DSCRr_k$, which meets (21), in that period k the sponsor would not be harnessing the project in the best way in relation to its profitability. If it were less than the *DSCRr* for the period k, $DSCRr_k$, which meets (21), the lenders would be assuming more risk than the one can be recommended according to provide a debt smaller than the economic value of the assets.

3. Case Studies

Some cases are presented to show how to calculate the *DSCRr*. Any estimate of economic value depends on assumptions about future cash flows that include risk factors that affect them. The appropriate discount rate for calculating the economic value corresponds to the one proposed by Rodríguez, 2023. Although the assumptions considered for the cash flow projections could be classified from simple to complex, the idea of calculating a *DSCRr* that optimizes the profitability of the sponsor and suggests a limit for the risk assumed by lenders should not be affected by a potential inaccuracy on *CFADS* more seriously than the usual calculation for *DSCR*.

In case of a *DSCR* according to the specific industrial sector, the principal and the financial expense of the debt are calculated from (6) also considering the potential inaccuracy of the *CFADS*. In this sense, the potential inaccuracy of the assumptions for the preparation of the cash flow can affect the usual calculation of the *DSCR* and also the *DSCRr*, but in the latter case, given that the inaccuracy would be in the numerator and denominator of (8), the final effect may be faded. The *DSCR* process requires explicitly comparing the scenario considered in the numerator of (8), whether conservative, optimistic or adequate, with a reliable economic value in the denominator. This comparison could help prepare the scenarios for the numerator. In this context, the development of feasible scenarios requires in-depth knowledge of the project (market, competitiveness, O&M cost, etc.) and the use of appropriate tools for evaluation and the risks involved (financial modeling, Monte Carlo or similar, etc.).

3.1. Case Study 1, Power Transmission Line

It deals a transmission line and an electric substation project in the north of Chile. The investment amount is 275 million dollars and the asset life is 40 years. In a preliminary stage, an investor estimates to gather funds from equity, 42 million dollars, and debt, 233 million dollars. This capital structure should be checked with the capital market conditions because the lenders could be willing to provide funds only by a part of the total investment and only if the asset value is greater than the debt amount, as it is usual under a project finance scheme.

The bid documents and the corresponding regulation establish a fixed amount for the incomes for the first 20 years of operation, adjusted by inflation. The annual income to be paid by the users of the transmission line is defined by the bidder and the lowest amount of the different bidders determines the winner of the bid process. After 20 years of operation, the incomes are set according to a tariff process, every 4 years, which depends on a new asset valuation calculated by the authority, and its discount rate, which is set by the corresponding regulation. The result of this process is considered in the cash flow as a residual value.

The risk involved in the example can be appreciated as a very low level because the income is fixed for the first 20 years of operation, the O&M cost are statistically in a very specific range and in a very much lower scale than the income.

In **Table 2**, after a Monte Carlo process, the expected FFCF is shown for each semester in thousands of nominal dollar.

Table 2. $FFCF_k$ transmission line.

k	E(FFCFk)	E(FFCFk)*k	k	E(FFCFk)	E(FFCFk)*k
1	9.710	9.710	21	13.147	276.087
2	9.860	19.719	22	10.435	229.559
3	10.019	30.058	23	13.531	311.216
4	10.029	40.118	24	10.452	250.842
5	10.313	51.563	25	13.976	349.402
6	10.066	60.395	26	10.484	272.597
7	10.661	74.628	27	14.412	389.122
8	10.127	81.015	28	10.500	293.991
9	10.975	98.772	29	14.881	431.535
10	10.177	101.770	30	10.516	315.467
11	11.336	124.697	31	15.328	475.161
12	10.242	122.900	32	10.506	336.196
13	11.645	151.379	33	15.853	523.142
14	10.274	143.837	34	10.516	357.536
15	11.991	179.861	35	16.284	569.943
16	10.315	165.043	36	10.464	376.716
17	12.365	210.203	37	16.862	623.907
18	10.360	186.480	38	10.461	397.524
19	12.729	241.843	39	17.385	677.998
20	10.390	207.800	40	88.938	3.557.522

In Table 3, in order to calculate the discount rate of the asset, i_a, it is assumed the profitability that a potential buyer would ask for the project, i_e, the expected cost of debt, d, the assumed debt duration, *DMDt*, the debt amount, D (thousands of dollar), and tax rate, t. The i_e estimate (nominal rate) is based on the long term treasury rate of 2.5%, a levered β_e of 1.53 and a market premium risk of 6.0% according to the usual expression for the expected return (Damodaran, 2012). The levered β_e is based on an unlevered β_a of 0.39 (NYU Stern, 2024), a debt to equity ratio of 4 and tax rate of 0.27, according to the expression for the levered beta for equity (Damodaran, 2012).

Table 3. i_e, debt features and taxes for a potential buyer.

i_e	12.0%
DMDt	17.2
Debt	233.000
d (annual)	7.5%
d (semester)	3.75%
t	27%

The duration of debt is initially calculated from an amortizing schedule based on constant installments over 40 semesters.

Table 4 shows the iterative process to calculate the asset discount rate. Gamma is the factor for the cost of debt in Relation (9).

Table 4. Iterative process for calculating i_a.

Iteration	i_e	d	Gamma	i_a	*SDFF*
				2.74%	5.879.457
1	6.00%	2.74%	0.681	3.78%	4.423.000
2	6.00%	2.74%	0.906	3.05%	5.395.716
3	6.00%	2.74%	0.742	3.58%	4.665.628
4	6.00%	2.74%	0.858	3.20%	5.172.078
5	6.00%	2.74%	0.774	3.47%	4.799.463
6	6.00%	2.74%	0.835	3.28%	5.062.590
7	6.00%	2.74%	0.791	3.42%	4.871.101
8	6.00%	2.74%	0.822	3.32%	5.007.518
9	6.00%	2.74%	0.800	3.39%	4.908.817
10	6.00%	2.74%	0.816	3.34%	4.979.445
11	6.00%	2.74%	0.804	3.38%	4.928.501
12	6.00%	2.74%	0.813	3.35%	4.965.038
13	6.00%	2.74%	0.807	3.37%	4.938.725
14	6.00%	2.74%	0.811	3.35%	4.957.618

In **Figure 2**, after calculating the discount rate and its application to $FCFF_k$, the density function for the economic value, EV, is shown for a simulation with 1000 runs where income is fixed during the first 20 years (10.8% of the investment cost of the asset) and the O&M cost can be randomly between 1.21% and 2.3% of the investment cost. The coefficient of variation turns out to be 0.66%, relatively low as it was expected. The EV for α = 99% is obtained from the density function, 264 million dollar. The net present value of the numerator of relation (10) is 301 million dollars. So, for a debt in 20 years (n1 = 40 semesters, β = 0) the final value for the required *DSCRr*, is 1.12 according to relation (10) before applying the factor δ.

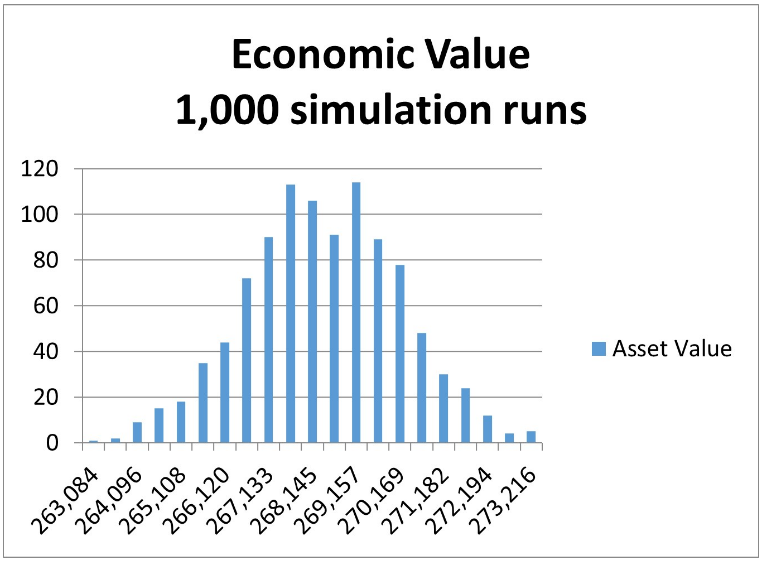

Figure 2. Density function Economic Value 1000 runs.

The usual *DSCR* application to size a debt, considers as an upper limit for the debt, a percentage of the amount of the total investment (273 million US dollars in the previous example), for instance 80% to 90% according to real cases in Chile (equivalent to a maximum relation debt to equity ratio in the range of 80/20 to 90/10). In this context, given a *DSCRr*, the cost of debt and *n*1 periods of time for the amortization, the usual process to size the debt determines the maximum amortization and interest to be paid according to relation (6) for each period of time $k = 1, \cdots, n1$. From these *n*1 relations can be found the amortization for each period of time, limited to the maximum debt previously defined and maximizing the duration of the debt.

In case of the current example, by assuming a *DSCR* = 1.25 (equivalent to the value seen from some real cases to subscribe new debt), a MD equal to the 85% of the total investment (232 million US dollar), and the assumption for the amortizing schedule with constant installments, certain *CFADS* is determined, and according to (6) that means a debt amount of 214 in the same amortizing period and a new amortizing schedule. This new debt amount and new schedule are considered in the model to define new uses and sources and projections for a new expected *CFADS*. According to (6) the new iteration defines a new amount of debt, 212 and a new amortizing schedule. The final iteration confirms a debt amount of 212 million US dollar and the new amortizing schedule. The final amount of debt is smaller than the assumed MD because the assumed *DSCR* did not permit to reach a greater value.

The main difference between the usual approach to debt sizing with the *DSCR* process and the *DSCRr* process is the MD definition. In the first case, the amount of the MD is defined by some general criteria, for example, a percentage of the total investment or similar. In the second case, MD is defined based on the economic value that the project would have in the event of a potential sale of the asset, regardless of the reason that caused the sale (financial, technical or legal).

The problem with defining the *DSCR* according to a ratio depending on the industrial sector to which the project could be assigned and not relating it to the corresponding cash flow is that it could undervalue the debt capacity of the project, as in the previous example, or could overvalue it, as would be the case in the event that the result of said definition of MD is greater than the definition of MD according to economic value. One way to relate the MD to the cash flow and the risk involved is through the proposed *DSCRr* process.

In other words, in addition to the threshold of the usual *DSCR* criteria for defining the maximum debt, the proposed approach considers the economic value of the asset and its risk as a reference to define the required *DSCRr* for the specific project or firm. So, the *DSCR* is not defined in relation to the industrial sector of the firm or project, but in consideration of the cash flow of the specific project or firm, in order to the debt not to be greater than the economic value. In this way, it is avoided the risk of overvaluing the asset in case of relatively low interest rate at the moment of structuring the debt. This criterion may be crucial in case of project finance where the assets of the project are the main collateral of the debt. So, in case of default, the recovery of the debt depends on the amount collected from the assets selling.

In some real cases of transmission lines in Chile the required *DSCR*, backward-looking, for making restricted payment has been 1.15x and for allowing to subscribe additional debt has been 1.25x.

It should be noted that in case of the cost of debt diminishes to 5.2% instead of 7.5%, the required *DSCRr* increases to 1.22 and 1.20 as final result according to (8) instead of 1.12 as it was explained in the second paragraph in section 2.3 (further details in Appendix A). This means that if the project had been structured with a *DSCR* of 1.12x and the cost of debt was 5.2%, the amount of debt would have been greater than the economic value of the project (275 versus 233 million US dollar), if the profitability required by a buyer for the assets were 12%. But it could correspond to the economic value if the required equity profitability were some percentages less than 12%.

In this context, the suited *DSCR* for debt sizing or other application should consider the economic asset value to be an efficient risk mitigant in case of an asset selling or collection of guarantees. In the example of the previous paragraph the risk assumed by the lenders in case of a debt sizing with *DSCR* equal to 1.12 would be higher in case of a cost of debt of 5.2% at the time of the debt sizing in comparison to the case with a cost of debt of 7.5%. In other words, the required full payment of the debt would be an interesting opportunity for the sponsors asking profitability of 12% or higher if the cost of debt were 7.5%.

3.2. Case Study 2, Toll Road

It deals with an interurban toll road project in the center of Chile, between Santiago and Valparaíso cities. It is a concession to be granted by the State. The investment amount is 29.1 million UF (1 UF is approximately 38 US dollar, in March, 2024), including interest and other financing costs during the construction period, until year 2030. The asset life is more than 25 years, but the concession period lasts until a defined net present value of the income is reached (44.1 million UF in the example). In a preliminary stage, an investor estimates to gather funds from equity, 5.8 million UF, and debt, 16.9 million UF. Other funds come from operation of the pre-existing assets during construction period. This capital structure should be checked with the capital market conditions because the lenders could be willing to provide funds only by a part of the total investment and only if the asset value is greater than the debt amount, as it is usual under a project finance scheme.

The bid documents and the corresponding regulation establish fixed tariffs for tolls for the concession period, adjusted by inflation every year. According to bid documents, each bidder asks for a specific net present value of the income (the discount rate for this effect is defined in bid documents) and the lowest amount of the different bidders determines the winner of the bid process. The concession period ends at the moment the proposed net present value of the income has been reached.

The risk involved in the example can be appreciated as a low level because the net present value of income is fixed whatever the traffic is, and the O&M costs are not too much relevant in comparison to the income.

In **Table 6**, after a Monte Carlo process, it is shown the expected FFCF for every semester period in thousands of UF after the construction period.

Table 6. $FFCF_k$ tollroad.

k	E($FFCF_k$)	E($FFCF_k$)*k
1	439	439
2	1.676	3.352
3	493	1.480
4	1.732	6.928
5	547	2.734
6	1.787	10.724

Continued

7	622	4.355
8	1.865	14.917
9	1.912	17.210
10	1.975	19.748
11	2.421	26.634
12	3.016	36.195
13	3.485	45.301
14	1.664	23.294
15	1.169	17.535
16	82	1.318
17	97	1.657
18	-18	-318
19	0	0

In Table 7, in order to calculate the discount rate of the asset, i_a, it is assumed the profitability that a potential buyer would ask for the project, i_e, in case of asset selling due an early termination of the project, the expected cost of debt, d, the assumed debt duration, *DMDt*, the amount of debt, D (thousands of dollar), and tax rate, t. The i_e estimate (real rate) is based on long term Chilean treasury rate of 2.4%, a levered β_e of 1.20 and a market premium risk of 5.5% and according to the usual expression for the expected return (Damodaran, 2012).

Table 7. i_e, debt features and taxes for a potential buyer of the toll road project.

i_e =	9.0%
DMDt	7.3
Debt =	16,901
d (annual) =	4.7%
d (semester)=	2.35%
t=	27%

The duration of debt is initially calculated from an amortizing schedule based on principal growing 3% each semester of a total of 14.

In Table 8 it is shown the iterative process for calculating the discount rate for the asset. Gamma is the factor for the cost of debt in Relation (9).

Table 8. Iterative process for calculating i_a, tollroad project.

Iteration	ie	d	Gamma	ia	*SDFF*
				1.72%	190.656
1	4.50%	1.72%	0.645	2.70%	170.127

Continued

2	4.50%	1.72%	0.723	2.49%	174.404
3	4.50%	1.72%	0.705	2.54%	173.419
4	4.50%	1.72%	0.709	2.52%	173.641
5	4.50%	1.72%	0.708	2.53%	173.591
6	4.50%	1.72%	0.709	2.53%	173.602

In **Figure 3**, after calculating the discount rate and its application to $FCFF_k$, it is shown the density function for the economic value, EV, for a simulation with 1,000 runs. The income depends on the GDP growth and on the elasticity traffic to GDP of each vehicle type (car, bus, light truck, truck); while the O&M cost can be randomly between some defined values and according to a specific defined density function. The coefficient of variation turns out to be 3.67%, greater than the transmission line but relatively low as it was expected. The EV for α =99% is obtained from the density function, 17,965 thousands of UF. The net present value of the numerator of relation (10) is 21,341 thousands of UF. So, for an amortizing debt in 7 years ($n1$ = 14 semesters, β =0) the required final $DSCRr$, is 1.18 according to relation (10), before applying factor δ.

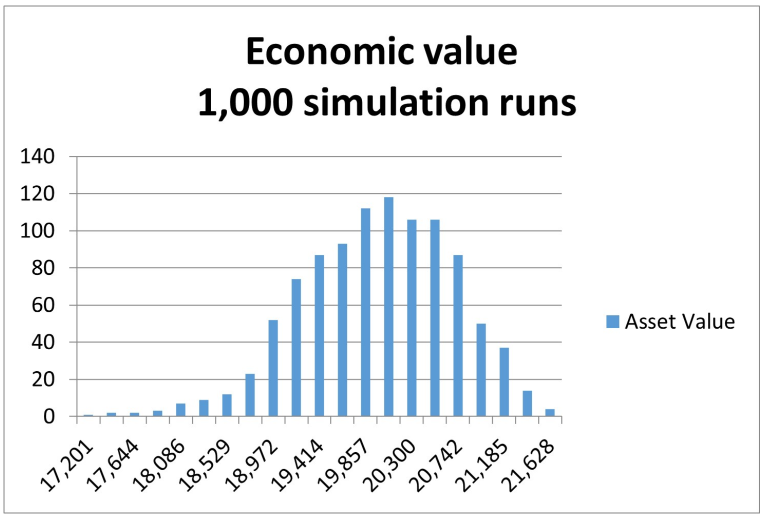

Figure 3. Density function Economic Value 1000 runs, Tollroad.

In case of the current example, by assuming a $DSCR$ = 1.25 (corresponding to the value seen from some real cases to subscribe new debt), a MD equal to a ratio debt/equity of 80/20 (23.2 million UF), and an amortizing schedule with principal growing 3% per semester, certain $CFADS$ is determined, and according to (6) that means a debt amount of 16.0 million UF in the same amortizing period and a new amortizing schedule. This new debt amount and new schedule are considered in the model to define new uses and sources and projections for a new expected $CFADS$. According to (6) the new iteration defines a new amount of debt, 16.1 million UF and a new amortizing schedule. The final iteration confirms a debt amount of 16.1 million UF and the new amortizing schedule. The final amount of debt is smaller than the assumed MD because the assumed *DSCR* for the industrial sector did not permit to reach a greater value.

There is an important difference in the risk involved between the example and the other cases where the sectorial *DSCR* equal to 1.25 is based on. In the example, the concession period ends at the moment the proposed net present value of the income has been reached what diminishes the traffic risk in a very relevant way. Because of this maybe the sectorial *DSCR* could be related to that kind of risk (traffic) while $DSCR_r$ is related to the specific risk of the project after the traffic risk is mitigated with the net present value of the income.

It calls the attention that in the transmission line and toll road projects the *DSCR* assigned to each project is the same (1.25) but the risk from both, the amortizing period and the financing structure are different, what strengthens the idea of relating the required *DSCR* to each project.

In case of other brownfield interurban projects the required *DSCRr* for allowing additional debt has been 1.25 times looking backward and 1.15 times for restricted payment and the size of debt has been 1.25 times looking forward (Prospecto Legal Segunda Emisión de Bonos por Línea de Títulos de Deuda Ruta del Maipo Sociedad Concesionaria S.A., 2019).

In case of other greenfield projects, the required *DSCRr* for 20 years loan term has been 1.35 times for keeping the same collateral conditions in some of them, and 1.30 times for allowing Restricted Payments in other ones (Nuñez & Palacios, 2003).

4. Conclusion

The definition of a required *DSCR* has been broadly used, among other factors, to define a debt size limit for projects or firms or as a reference for their risk assessment. Sometimes, such a definition depends on the industrial sector where the project or firm operates, such as infrastructure, power, mining, oil & gas, telecoms. However, since each project or firm has its own market and risk features, the referred *DSCR* usual definition by industrial sector may over or undervalue those features, resulting tight or relaxed conditions in view of the cash flow of the firm or project and the risk involved.

It is assumed a worst case scenario for lenders where the firm or project defaults and, as consequence, the recovery of the debt depends on the income collected from the assets selling. This situation can be easily understood in case of project finance where the assets (or the right to operate them) are the main collateral for the loan term, but a similar concept can be applied to corporate loans. According to that situation, it is proposed to define the required *DSCRr* in order to limit the amount of debt, not only by debt to equity or debt to total investment ratios according to the industrial sector involved, but including the economic value of the assets of the specific situation.

It is found that the economic asset value (for instance, a value that is exceeded with a confidence interval of 99%) and the net present value of the free cash flow to firm, at debt cost, are related to the required *DSCRr*. This relation permits to define a required *DSCRr* for the specific firm or project, not only to the industrial sector where they operate.

The required *DSCR* calculated in that way, *DSCRr*, not only meets the liquidity conditions but also means that if *DSCR* considered for debt sizing were less than *DSCRr* the financing amount according to the usual *DSCR* process could be greater than the economic value of the asset (it depends on a MD considered in the process greater than the reliable economic value) what can be crucial in any loan term financing.

Also, the use of *DSCRr* would allow avoiding over debt sizing of assets in periods with low cost of debt as it could be seen with the usual application of *DSCR*.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix A. Power Transmission Line with Cost of Debt 5.2%

Table A1. FFCFk.

k	E(FFCFk)	E(FFCFk)*k	k	E(FFCFk)	E(FFCFk)*k
1	10.500	10.500	21	13.737	288.478
2	9.151	18.302	22	9.802	215.650
3	10.787	32.360	23	14.082	323.882
4	9.218	36.871	24	9.850	236.406
5	11.069	55.345	25	14.482	362.053
6	9.279	55.672	26	9.918	257.862
7	11.393	79.751	27	14.873	401.560
8	9.355	74.841	28	9.975	279.286
9	11.698	105.280	29	15.279	443.098
10	9.419	94.187	30	10.032	300.962
11	12.035	132.383	31	15.719	487.275
12	9.493	113.917	32	10.098	323.126
13	12.331	160.301	33	16.132	532.342
14	9.544	133.619	34	10.144	344.893
15	12.689	190.337	35	16.574	580.080
16	9.619	153.910	36	10.196	367.048
17	13.013	221.213	37	16.997	628.881
18	9.674	174.125	38	10.231	388.769
19	13.367	253.972	39	17.486	681.956
20	9.737	194.740	40	88.751	3.550.056

Table A2. I_e, debt features and taxes for a potential buyer.

i_{e} =	12.0%
DMDt =	18.3
Debt =	227,785
d (annual) =	5.2%
d (semester)=	2.60%
t=	27%

Table A3. Iterative process for calculating i_a,

Iteration	ie	d	Gamma	ia	SDFF
				1.90%	7.459.006
1	6.00%	1.90%	0.558	3.71%	4.491.336
2	6.00%	1.90%	0.927	2.20%	6.835.628
3	6.00%	1.90%	0.609	3.50%	4.750.664
4	6.00%	1.90%	0.876	2.41%	6.441.167
5	6.00%	1.90%	0.646	3.35%	4.952.004
6	6.00%	1.90%	0.840	2.55%	6.179.263
7	6.00%	1.90%	0.673	3.24%	5.106.327
8	6.00%	1.90%	0.815	2.66%	6.000.075
9	6.00%	1.90%	0.694	3.15%	5.223.295
10	6.00%	1.90%	0.797	2.73%	5.875.060
11	6.00%	1.90%	0.708	3.09%	5.311.137
12	6.00%	1.90%	0.784	2.79%	5.786.687
13	6.00%	1.90%	0.719	3.05%	5.376.627
14	6.00%	1.90%	0.774	2.82%	5.723.652

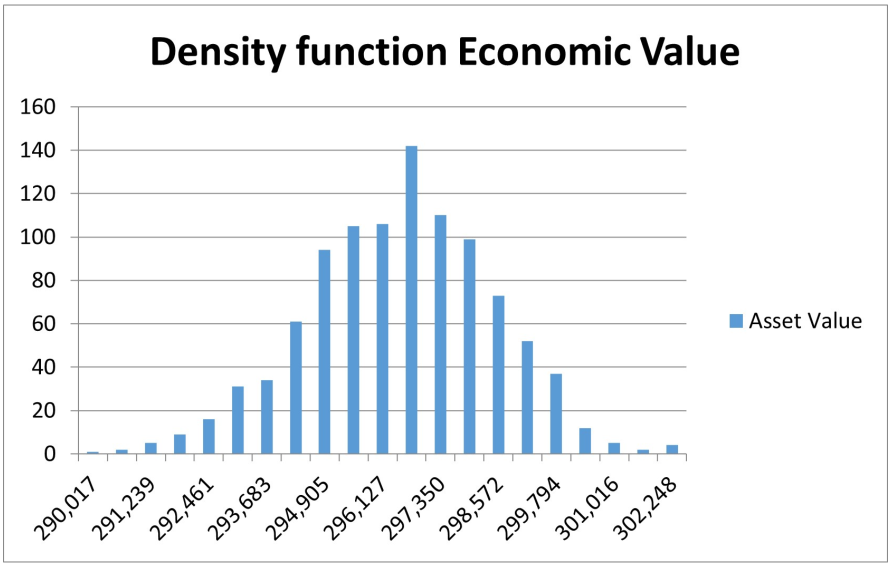

Figure A1. Density function economic value 1000 runs.

$$DSCR_r = \frac{356884}{291552} = 1.22 \text{ as first result}$$