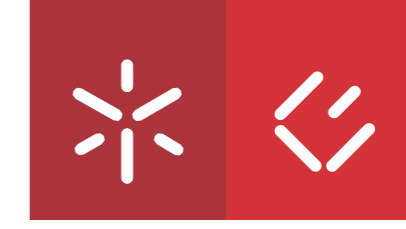


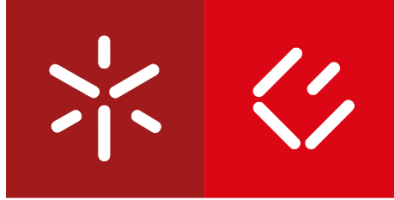


**Project financial evaluation on the
context of Bosch Suppliers Club
initiative**

Pedro Martins Francisco

Universidade do Minho
Escola de Economia e Gestão





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**Project financial evaluation on the
context of Bosch Suppliers Club
initiative**

Master's Project
Master in Finance

Work supervised by
**Professor Benilde Maria do Nascimento Oliveira,
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To my colleagues, for being a part of my daily life and for, they to, teaching me.

And finally, to my family, for all the support, in everything, since always.

Statement of Integrity

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

Universidade do Minho, 31st of October, 2020

Pedro Martins Francisco

Signature:

A handwritten signature in black ink that reads "Pedro Martins Francisco". The signature is written in a cursive style with a horizontal line above the first few letters of the first name.

Título Avaliação Financeira de um projeto no contexto da iniciativa da Bosch “Clube de Fornecedores”

Resumo

O presente trabalho tem como objetivo responder a um problema identificado pela Bosch Car Multimedia. As empresas parceiras na iniciativa “Clube de Fornecedores”, apesar de revelarem boas capacidades técnicas e científicas, revelam poucos conhecimentos sobre análise financeira de projetos de investimento. Desse modo, fez-se uma análise financeira de um projeto entre a Bosch e uma empresa fornecedora hipotética, com o objetivo de criar um quadro de referência que qualquer empresa possa aplicar, de forma a avaliar os próprios projetos.

Para isso, foi realizada uma análise à literatura sobre métodos de avaliação de projetos, tendo-se chegado à conclusão de que o método mais apropriado, tendo em conta a tipologia do projeto em avaliação, seria o Expected Net Present Value (ENPV). Prosseguiu-se fazendo uma análise à metodologia para estimar os inputs necessários ao ENPV. De seguida, fez-se a avaliação financeira do projeto, tendo o ENPV sido estimado em 349 177,10€, pelo que o projeto deve ser aceite. Para finalizar e a título complementar, realizou-se uma análise de risco, tendo os resultados apontado para a viabilidade financeira do projeto.

Palavras chave Análise de risco, avaliação de projeto de investimento, Clube de Fornecedores, ENPV

Title Project financial evaluation on the context of Bosch Suppliers Club initiative

Abstract

The present work aims to answer a problem identified by Bosch Car Multimedia. The partner companies in the “Clube de Fornecedores” initiative, despite showing good technical and scientific skills, reveal little knowledge about financial analysis of investment projects. Thus, a financial analysis of a project was carried out between Bosch and a hypothetical supplier company, with the objective of creating a framework that any company can apply, to evaluate its own projects.

For this, an analysis of the literature on project evaluation methods was carried out, and the conclusion reached was that the most appropriate method, considering the type of project being evaluated, would be the Expected Net Present Value (ENPV). We proceeded with an analysis of the methodology to estimate the necessary inputs of the ENPV. Then, the financial evaluation of the project was made, which returned an ENPV of 349 177,10€, which means that the project should be accepted. Finally and complementary, a risk analysis was carried out, with the results suggesting the financial viability of the project.

Keywords Clube de Fornecedores, ENPV, investment project valuation, risk analysis

Index

Direitos de autor e condições de utilização do trabalho por terceiros	i
Acknowledgements	ii
Statement of Integrity	iii
Resumo	iv
Abstract	v
1. Introduction	1
1.1 Problem Presentation	1
1.1.1 Objective	1
1.1.2 Bosch	1
1.1.3 Suppliers Club	2
1.1.4 The supplier	3
1.1.5 The project	3
2. Thesis Structure	3
3. Framework for project evaluation	4
3.1 Discounted Cash Flow Model	9
3.1.1 Cash flow Estimation	10
3.1.2 Discount Rate	11
4. Methodology	15
4.1 The DCF Model	15
4.1.1 Cost of capital	15
4.1.1.1 Cost of debt	16
4.1.1.2 Cost of equity	16
4.1.1.2.1 The risk-free rate	17
4.1.1.2.2 Beta	17
4.1.1.2.3 Risk Premium	20
4.1.2 Risk Analysis	22
5. Project Valuation	25
5.1 Cost of capital	25
5.1.1 Cost of debt	25
5.1.2 Cost of equity	25
5.1.2.1 Risk-free rate	26
5.1.2.2 Beta	27
5.1.2.3 Risk premium	30
5.2 Estimating the Cost of Capital	33
5.3 Estimating cash flows	34
5.4 Risk Analysis	40

6. Conclusion/Limitations	50
7. References	52

Table Index

Table 1	31
Table 2	31
Table 3.....	32
Table 4.....	32
Table 5.....	33
Table 6.....	33
Table 7.....	34
Table 8.....	35
Table 9.....	37
Table 10.....	38
Table 11.....	39
Table 12.....	39
Table 13.....	40
Table 14.....	40
Table 15.....	49
Table 16.....	49

Figure Index

Figure 1.....	44
Figure 2.....	44
Figure 3	45
Figure 4.....	45
Figure 5	46
Figure 6.....	47
Figure 7.....	48
Figure 8	48

Graph Index

Graph 1	41
---------------	----

Diagram Index

Diagram 1	5
Diagram 2	25

1. Introduction

In this work, we will build a framework that companies can use to financially evaluate their investment decisions. This framework is especially useful for small and medium companies, where capital budgeting practices are very basic or non-existent. Danielson & Scott (2006) performed a survey, in the U.S., to assess what were the most common project evaluation methods. The results were that the most common response, selected by 26 percent of the sample firms, was “gut feel”. The most theoretically correct method, discounted cash flow analysis, was only used by 12 percent of the firms.

While smaller firms may suffer constraints that do not affect larger firms, an investment decision should always undergo rigorous financial analysis. The firm, by not using proper financial tools, will be potentially accepting projects that should be rejected and will reject projects that should have been accepted.

1.1 Problem Presentation

1.1.1 Objective

This project arises from Bosch’s initiative “*Clube de Fornecedores*” (Suppliers Club). The main objective of this initiative is to increase Bosch’s number of Portuguese suppliers. To achieve that, Bosch flagged several companies that have the potential of becoming Bosch’s business partners. Even though these companies meet the technical and scientific criteria, Bosch realized that these companies have a severe lack of financial knowledge.

Therefore, the objective of this project is to contribute to endow Bosch’s suppliers, by building a theoretical framework, that will enable these firms to make informed financial decisions and therefore enhancing the quality of those decisions.

1.1.2 Bosch

Bosch started its activity as a small electrical workshop. The ability to innovate and constantly strive for improvement marks the company's history from its beginnings. The inevitable

difficulties have been used as catalysts for change and improvement, of which the introduction of new forms of production and new products, in the most varied areas, are an example.

Today, the Bosch Group is a leading provider of technology and services. It has around 410 000 employees and generated, in 2018, a revenue of 77.9 billion euros. The Bosch Group has about 440 subsidiaries and regional companies, present in 60 countries.

One such unit is the Braga unit, which started its activity in 1990 as Blaupunkt. With the evolution of the car market, this unit went through a reorganization and became, in 2009, Bosch Car Multimedia Portugal. It currently has about 3200 employees and generated, in 2018, a revenue of over 1.1 billion euros.

1.1.3 Suppliers Club

Bosch was a pioneer in the introduction of a suppliers club in Portugal. The *Clube de Fornecedores* (Suppliers Club) is an initiative that aims to increase the participation of Portuguese SME in the supplying of specialization hubs installed in Portugal, around Nuclear Companies, oriented towards global value chains, through customer and suppliers networks, consequently increasing the national added value and stimulating clustering dynamics with a structural impact on the territory (IAPMEI, 2020).

Nuclear Companies assume a role in positioning their suppliers in clubs of international suppliers, interacting more intensively with the rest of the economy, through positive spill-overs in SMEs and in the regions where they are implemented (IAPMEI, 2020).

The strategic objectives of Bosch's suppliers club are: to empower national companies, so they can follow the growth of Bosch in Portugal and the world, allowing the positioning of these companies as suppliers of the Bosch Group globally and other reference customers worldwide; to decrease Bosch imports, by increasing domestic supplying; to encourage qualified employment in all organizations involved in the Suppliers Club; to foment innovation and qualified entrepreneurship (IAPMEI, 2020).

1.1.4 The supplier

For the purpose of this work, the supplier will be a fictional company, that we will name Company A. This company is a Portuguese SME that operates in the industry with code “293 - Manufacture of parts and accessories for motor vehicles” and represent the average of 1389 European SMEs that operate in this industry.

1.1.5 The project

Under the “*Clube de Fornecedores*” initiative, Bosch and Company A agreed to develop an R&D project, starting in 2020 and ending in 2024. Even though the R&D project ends in 2024, it is expected that after that date, as a direct result of the investigation carried, if successful, a product will be ready for commercialization. Therefore, the project will be divided into two stages. The first is the R&D stage, that will span from 2020 to 2024. The second stage is a direct consequence of the first and will consist in the manufacturing and commercialization of a product for the next 8 years (starting in 2025 and ending in 2032).

2. Thesis Structure

The remaining of this work will have the following structure: In chapter 3 we will build the framework for the project evaluation. In that chapter, we will review and discuss the most widely used methods in capital budgeting and we will build an argument in favour of one of them. In chapter 4 we will address the methodology, that is, we will go through the necessary steps to build the framework we discussed in the previous chapter. Chapter 5 will be where we put into practice what we reviewed up to this chapter, by performing the project valuation. The conclusions will be gathered in the last chapter, where we will also discuss some of the limitations of our work.

3. Framework for project evaluation

We will start building the framework by first ponder about a fundamental issue – what is the goal of a financial manager? According to Ross, Westerfield, Jaffe & Jordan (2015), the answer can be formulated in several different ways, for example, we could say that the ultimate goal of a company is to survive. We could be more specific and say that what the company should strive for is to minimize costs and maximize profits. However, the authors raise a few problems with these formulations.

For example, it is easy to survive/avoid bankruptcy by avoiding borrowing any money or taking risks. Cost minimization can be achieved by cutting on areas such as research and development. It is, therefore, obvious that setting a goal is not as straight forward as one could think. There is, nevertheless, something important that should be noticed. The goals mentioned early can be divided into two classes. The first is related to profitability, by increasing sales and market share, and by decreasing costs. The goals in the second group involve avoiding bankruptcy, safety and stability and are related to controlling risk. We can say, therefore, that these two classes are somewhat contradictory. The pursuit of profit normally involves taking risks, so it is not possible to maximize both safety and profit.

Given this fact, the next step is to re-formulate the company's goal. Ross, Westerfield, Jaffe, & Jordan (2015) proceed with their argument by changing the point of view. Instead of examining this problem from the financial manager perspective, they instead question what would be a good financial decision from the stockholders' point of view. Assuming that stockholders buy stock because they seek financial gains, the answer becomes clear: A good financial decision increases the value of the stock, and poor decisions decrease its value. From this, it follows that "the goal of financial management is to maximize the current value per share of the existing stock". The goal statement can be slightly adjusted for the case of companies that do not have traded stock. In those cases, the objective becomes the maximization of the value of the existing owners' equity.

Whatever the case is, the objective of maximization of value is the same. Because of that, it becomes fundamental to have tools and methodologies that allow to identify investment opportunities that favourably affect the value of the company.

Diagram 1, presented next, summarises the most commonly used valuation methods.

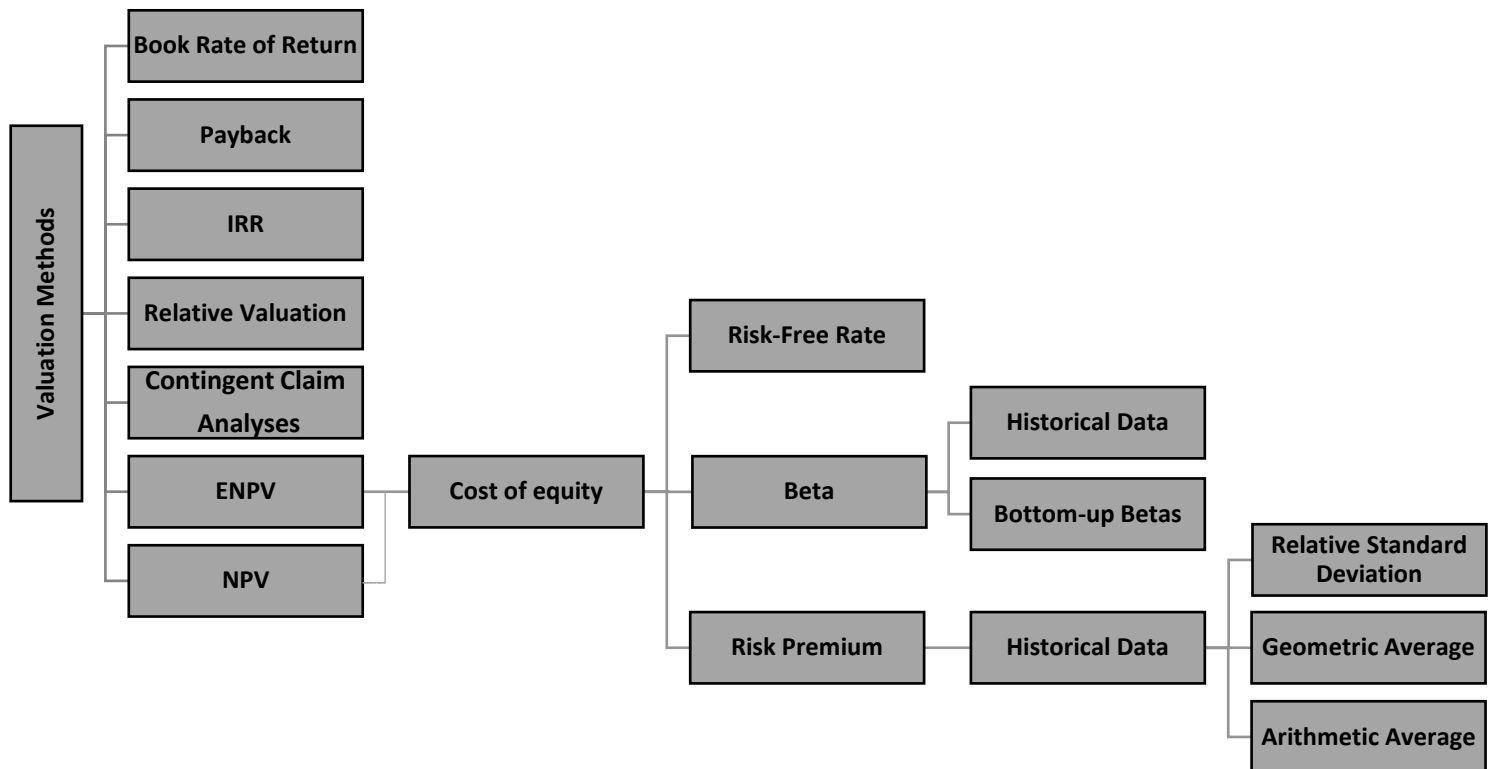


Diagram 1 – Theoretical framework for project valuation

Brealey, Myers & Allen (2011) describe the tools and techniques for project evaluation most widely used by financial managers – the Net Present Value (NPV), book rate of return, payback and the Internal Rate of Return (IRR).

When the **NPV** method is used, the value of a project is computed as the discounted value of the free cash flows estimated for a given time horizon, plus the present value of a forecasted terminal value for the project. The free cash flow (FCF) is the amount of cash that a firm can pay-out to investors after paying for all investments necessary for growth. The terminal value of the project is a forecast of the continuation value of the project beyond the period used in the model. According to the NPV rule, a project should only be accepted if its NPV is positive.

There are two key features in the NPV method. The first is that the NPV recognizes the time value of money. That is, a euro today is worth more than a euro tomorrow, because the euro today can be invested immediately. Second, the NPV depends solely on the forecasted cash flows and the opportunity cost of capital, which means that the decision will not be influenced by manager's tastes, the company's choice of accounting methods or any other subjective criteria.

The **book (or accounting) rate of return** is calculated by dividing the estimated book income by the book value of the asset. The downside of using book values is that they are dependent on how the accountant treats these values. The fact that they can be arbitrarily classified means that they are prone to manipulation.

A project's **payback period** is calculated by counting the number of years it takes for the cumulative cash flow to equal the initial investment. When a company uses the payback rule the projects are accepted if the payback period is less than the specified cut-off period. If, for a certain project, the initial investment would take 4 years to recover, but the firm's cut-off period is 3 years, the project would be rejected. The problems with the payback method are that it ignores all cash flows after the arbitrarily set cut-off date, and it dismisses the time value of money.

There is an alternative to the payback period, called the **discounted payback period**. Under this approach, the cash flows are first discounted and only then the payback period is calculated. Even though this might seem a better method than the payback period, the truth is that it has the same problems as the previous method – the cut-off date is set arbitrarily and the cash flows are ignored after that date. In addition to that, both methods have a more fundamental problem. As we discussed earlier, the role of the financial manager is to maximize the current value of the firm's stock. We then said that there are tools and methods that can be used to answer the question of whether a project will increase the value of the company. However, neither the payback nor the discounted payback period offers an answer to that question. Instead, they only provide information on the amount of time it will take to recover the initial investment.

The **internal rate of return (IRR)** rule is to accept an investment project if the opportunity cost of capital is less than the internal rate of return. Because the IRR is the rate for which the project has a zero NPV, an opportunity cost of capital lower/higher than the IRR means that the project has a positive/negative NPV and, therefore, should be accepted/rejected. Even though this method sounds straight-forward, there are a few considerations to make.

We will start by distinguishing between independent and mutually exclusive projects. An independent project is one whose acceptance or rejection does not depend on accepting or rejecting other projects. When two projects are mutually exclusive only one of them can be accepted, or both rejected.

There are three problems that are common to both types of project. First, it is necessary to assess if the project is borrowing or lending in nature. If the first cash flow is negative (such as

the investment projects) it is a lending project. If the cash flow is positive it is a borrowing project. The implication is that for lending projects a high rate of return is desirable, while for a borrowing project the lower the rate the better.

Second, the project might have multiple rates of return. In fact, there can be as many internal rates of return as there are changes in the sign of the cash flows. The sign changes when, besides the initial investment, it is expected that the company will have to make additional investments during the length of the project. Moreover, there are also cases in which no IRR exists – in such projects, every rate of return will yield a positive/negative NPV.

Lastly, the IRR is hard to use when there are several different opportunity costs. If a project has multiples stages and there are different levels of risk associated with each stage, it is reasonable to discount the riskier cash flows at a higher rate. However, an immediate question comes up. To which of these rates should the IRR be compared with? The fact that there is no simple answer to this question illustrates the shortcomings of this rule.

In addition to these three problems, there is one – a scale problem - that is specific to mutually exclusive projects. As an illustration, let us assume that there are two mutually exclusive projects, project A and B. We will say that project A has an IRR of 50% and an NPV of 5000€, while project B has an IRR of 100% but an NPV of 2500€. According to the IRR rule, project B should be selected. However, project A would be the one to maximize the company's value, because of its higher NPV and should, therefore, be accepted.

These four methods (NPV, book rate of return, payback and IRR) are used to help the decision-maker on deciding on whether a project should be undertaken. The answer they give is a binomial yes/no. If, however, the decision-maker needs quantitative data, only the NPV meets that demand. Damodaran (2012) proposes three possible approaches to asset valuation – the previously discussed NPV, relative valuation and contingent claim analysis. Note that when these methods are applied the result is an absolute quantitative value.

When the **Relative valuation** is used, the value of an asset is estimated by comparing that asset to a similar one, relative to a common variable such as earnings, cash flow, book value or revenues. One example of this approach is the use of an industry-average price-earnings ratio to value a firm, following the assumptions that the other firms are comparable to the firm being valued and that the market, on average, prices these firms correctly. Unlike discounted cash flows

valuation methods, such as the NPV, which search for the intrinsic value, relative valuation depends on the market being right.

Despite its appeal, there are a few considerations to make about relative valuation. This method works better when a large number of comparable firms are traded on financial markets, and the market is, on average, pricing these firms correctly. However, it is more difficult to use when firms have no obvious comparables, little or no revenues, and negative earnings. One other shortcoming of this method is that it builds on the assumption that the market is valuing the comparable firms correctly, but that is not always the case. In contrast, discounted cash flow valuation is based on firm-specific growth rates and cash flows, so it is independent of market errors in valuation.

Contingent claim analysis use option pricing models to compute the value of options that share characteristics with the asset being valued. A patent, for instance, can be analysed as a call option on a product, with the investment being the strike price and the patent life becoming the time to expiration of the option. The main premise behind the use of option pricing models is that discounted cash flow models underestimate the value of assets that are dependent on future events, because they do not value the rights of expanding, abandoning or delaying an investment.

There are, however, limitations in using option pricing models to value long-term options on nontraded assets. When the underlying asset is not traded, the inputs for the value of the underlying asset and the variance in that value cannot be extracted from financial markets and must be estimated. Also, some assumptions hold for the short-term, such as constant variance and dividend yields, but do not hold for the long-term. For both reasons, the values obtained from option pricing models have a great estimation error associated.

While real options are not going to be used, it is true that one of the most consensual methods to value R&D projects is the Black-Scholes formula (Black & Scholes, 1973). Nonetheless, some authors argue that this technique is too complex for most of the managers to implement. Not only the formula is opaque to most, but also some of the assumptions, such as the lognormality of the volatility of stock prices, may not always be appropriate for describing R&D activities (Faulkner, 1996).

An alternative method - the **Expected Net Present Value (ENPV)** - is used by several authors (Borissiouk & Peli, 2001); (Faulkner, 1996); (Kellogg & John, 2000). The ENPV is a discounted cash flow model, which means that for each period, it is necessary to estimate a cash

flow, that will be discounted by an appropriate rate. What differentiates the ENPV from the NPV is that, with this technique, the problem is modelled as a decision tree, where in each node the possible outcomes and their probabilities are defined. This approach has two advantages over Black-Scholes. First, the analysis is more visible and understandable, and therefore easier and more prone to implementation. Second, this methodology eliminates the need to use the log-normal distribution to describe uncertainty. In fact, uncertainty can be modelled most appropriately, depending on the case being analysed (Faulkner, 1996). Also, Faulkner (1996) demonstrated that decision tree valuation can yield the same valuation and results as the Black-Scholes formula.

There are, however, a few aspects to take into consideration about the ENPV. The first is that it uses a constant discount rate. The risk associated with R&D projects is typically higher than the remaining activities carried out by the company. The riskiness of an R&D project is project-specific, which means that a discount rate cannot be replicated using market proxies. In addition to that, different stages of the research project have different levels of risk. Using a unique rate for the entirety of the project not only ignores the fact that the project is different from the rest of the company but also different between its several stages (Borissiouk & Peli, 2001). Second, the ENPV assumes that if a stage is successful the company will automatically invest in the subsequent phase of the project. However, the reality is that such a decision is not automatic because there are factors that might make the company ponder, such as unfavourable economic evolutions. The firm can choose to delay, to contract or even to abandon the project (Borissiouk & Peli, 2001). Lastly, the decision trees can become too big if the project has many options and uncertainties, which defeats the purpose of clarity (Faulkner, 1996).

To value Company A's investment project, the ENPV is going to be used. The reason is that it combines the positive aspects of the NPV with the ability to model the problem considering uncertainty.

3.1 Discounted Cash Flow Model

As we said earlier, the ENPV is a discounted cash flow model. In this section, we will explore the two key aspects of discounted cash flow models: the cash flows and the discount rate.

3.1.1 Cash flow Estimation

When the accounting measure of income in a project is used, the returns are measured using accounting principles and standards, while the cash flow generated by a project is measured as the difference between the cash inflows and the cash outflows. According to Damodaran (2014), cash flows are superior to accounting earnings to measure true return on investment. Three arguments lead to this conclusion.

The first factor is how accounting distinguishes between **operating expenses** and **capital expenses**. The difference between the two is that operating expenses, such as labour and materials costs, yield benefits only in the immediate period, while capital expenditure, such as land and buildings, have their benefits spread over multiple periods. Under accounting rules, operating expenses are subtracted from revenues when computing the accounting income, whereas capital expenses are spread over multiple periods and deducted, in each period, as an expense, called depreciation or amortization.

This distinction leads to the second argument in favour of cash flows. Depreciations and amortizations are not a cash expense but, despite that, reduce the accounting income. In fact, due to their impact on the income, they have a positive impact on cash flows. This is because depreciations and amortizations reduce the taxable income, and, consequently, the taxes paid by the company, which are a cash outflow.

The third and final factor is how and when revenue and expenses are recognized. The accrual system of accounting means that revenues and expenses are recognized when the sale/payment is made, rather than when the cash is received/paid. Consequently, accrual revenues/expenses can be very different from cash inflows/outflows. These differences between accrual earnings and cash earnings can be captured by changes in the non-cash working capital. A decrease in non-cash working capital will increase cash flows, whereas an increase will decrease cash flows.

These three factors can lead to significant deviations between accounting earnings and cash flows. We can, however, calculate the cash flows using the after-tax operating earnings. To do this, all non-cash charges, such as depreciations, are added back to the operating earnings. Then, all cash outflows that represent capital expenditure are subtracted out. Last, we must net out the effect of changes in non-cash working capital, that is changes in accounts receivable, inventory, and accounts payable. Therefore, we have that:

$$\begin{aligned}
\text{Cash flow to firm (FCFF)} &= \\
&= EBIT \times (1 - t) + \text{Depreciation and amortization} \\
&\quad - \text{Change in noncash working capital} - \text{Capital expenditure}
\end{aligned}
\tag{1}$$

The bottom-line argument for the use of cash flows is very straightforward. A project with positive earnings and negative cash flows will drain the business out of cash. Conversely, a project with negative earning but positive cash flows will generate cash for the business.

According to Ross, Westerfield, Jaffe, & Jordan (2015), there are a few important considerations to bear in mind. When analysing a project, the most important question is if that project will make the entire firm more valuable. In that sense, only the incremental cash flows, that is, the cash flows that occur as a direct consequence of accepting the project, matter. Therefore, the cash flows generated by the firm, whether the investment is accepted or rejected, should be ignored.

There are, however, a few pitfalls that must be avoided, when estimating incremental cash flows. A sunk cost is a cost that occurred before accepting or rejecting the project and, for that reason, cannot be changed by that decision. Also, there may exist opportunity costs, that is, it is possible that the company, by accepting the project, will be forgoing opportunities of using assets that would generate revenues. Because the lost revenues are a direct consequence of accepting the project, they can be viewed as a cost. In addition to these costs, there are side effects to consider. They can be divided into two groups – synergy or erosion. Synergy occurs when a new project increases the cash flows of existing projects, while erosion has the opposite effect. Therefore, when building the model, sunk costs should be ignored, but opportunity costs, synergies and erosion must be considered.

3.1.2 Discount Rate

According to Ross, Westerfield, Jaffe, & Jordan (2015), when the firm has extra cash it has two alternatives. It can pay out the cash directly to its investors or the firm can invest in a project, paying out the future cash flows that the project will generate. From the investors' point of view, which of the alternatives is preferable? If the investor can reinvest the cash in a financial asset with the same risk as that of the project, the most desirable alternative is the one with the higher

expected return. For the firm, this means that the project should only be undertaken if its expected return is greater than that of a financial asset of comparable risk. In other words, the discount rate of a project should be the expected return on a financial asset of comparable risk.

Note that this is only true when the firm is financed exclusively with equity. However, the discount rate for a firm with a capital structure that includes both equity and debt can be easily computed if we can calculate the cost of the firm's equity.

As we said earlier, the cost of equity is equal to the highest expected return for an asset with a risk similar to the project. However, a problem arises – what is the required rate of return for a certain level of risk? Fortunately, the Capital Asset Pricing Model (CAPM) can be used to estimate that rate. According to DeMarzo & Berk (2017), under the CAPM, investments have a similar risk if they have the same sensitivity to market risk, as measured by their beta with the market portfolio. The market portfolio is a well-diversified, efficient portfolio representing the non-diversifiable risk in the economy. Therefore, the cost of equity of any investment opportunity equals the expected return of available investments with the same beta. This can be translated to the following formula:

$$R_E = R_f + \beta \times (R_m - R_f) \quad (2)$$

Where R_E is the cost of equity, R_f is the risk-free rate, β is the beta of the project and $(R_m - R_f)$ is the market risk premium.

We will now discuss the case of when the companies are financed with both debt and equity. When that is the case, the total cost of capital is given by the Weighted Average Cost of Capital (WACC):

$$WACC = r_D \times \frac{D}{V} + r_E \times \frac{E}{V} \quad (3)$$

Where r_D is the cost of debt, D is the amount of debt in the firm's balance sheet, E is the value of equity, V is the sum of debt and equity and r_E is the cost of equity. What the formula means is that the firm's total cost of capital is given by a weighted average between the cost of

debt and the cost of equity. The weights are given by the percentage that both debt and equity represent in the total capital structure of the company. Note that if the firm has no debt then the cost of capital will be equal to the cost of equity. The same is true for the cost of equity – if the company has so much debt that the equity becomes worthless, the cost of capital will be equal to the cost of debt (Ross, Westerfield, Jaffe, & Jordan, 2015).

This should make us ponder about what is the optimal capital structure, that is, how much debt should a company have. According to the trade-off theory, as presented by DeMarzo & Berk (2017), the total value of a levered firm (V^L) equals the value of the firm without leverage (V^U) plus the present value of the tax saving from debt, less the present value of financial distress costs:

$$V^L = V^U + PV(\text{Interest Tax Shield}) - PV(\text{Financial Distress Cost}) \quad (4)$$

It is said that debt has a tax shield effect because corporations must pay taxes on the income they earn. Because they pay taxes on their profits after interest payments are deducted, interest expenses reduce the amount of corporate tax firms must pay. Even though with high debt its earnings will be lower, the value of the company will be higher because its value is equal to the total amount it can raise from all investors, not just equity holders.

On the other hand, the debt level will influence the financial distress costs. Three factors determine the present value of financial distress costs: the probability of financial distress, the magnitude of the costs if the firm is in distress and the appropriate discount rate for the distress costs.

The **probability of financial distress** depends on the amount of a firm's liabilities relative to its assets – the higher this ratio the higher the likelihood that the firm will not be able to meet its debt commitments and therefore default. Note, however, that different companies can afford to maintain different levels of debt. For example, a firm with steady cash flows can have higher debt levels when compared to firms with very volatile cash flows.

The **magnitude of the costs if the firm is in distress** will, again, change depending on the firm and on what industry that firm operates in. For instance, firms whose value comes largely from human capital are likely to incur high costs when they risk financial distress, due to the need to retain key personnel and the lack of tangible assets that can easily be sold.

Finally, the **discount rate for the distress costs** will depend on the firm's market risk. Because distress costs are high when the firm does poorly, the beta of distress costs will have an opposite sign to that of the firm. Also, the higher the firm's beta, the more likely it will be in distress in an economic downturn, and thus the more negative the beta of its distress costs will be. Because a more negative beta leads to a lower cost of capital (below the risk-free rate), *ceteris paribus* the present value of distress costs will be higher for high beta firms.

We can now reach a conclusion about the optimal capital structure of a company. According to the trade-off theory, debt has two opposite effects on the company's value – in one hand it creates a tax shield, but in the other, it also creates financial distress costs. Therefore, according to the trade-off theory, the firm should increase their leverage until it reaches a level where the tax savings are just offset by the increased probability of incurring the costs of financial distress (DeMarzo & Berk, 2017).

4. Methodology

In this section, we will take the theoretical framework one step further, by discussing how we will estimate all the necessary inputs.

4.1 The DCF Model

The ENPV is, in its essence, a DCF model. The discounted cash flow models calculate the value of any asset by estimating the present value of its cash flows (Brealey, Myers, & Allen, 2011).

That is:

$$Value = \sum_{t=0}^{t=n} \frac{CF_t}{(1+r)^t} + \frac{PV_H}{(1+r)^n} \quad (5)$$

Where n is the lifetime of the asset, CF_t is the cash flow in period t , PV_H is the terminal value, r represents the discount rate and n is the time horizon of the project.

Therefore, to calculate the value of the project, it is going to be necessary to estimate a proper discount rate and the cash flows that the project will generate.

4.1.1 Cost of capital

As we discussed earlier, the discount rate is the firm's cost of capital. We also said that the cost of capital is a blend of the cost of equity and the cost of debt, which can be calculated using the weighted average cost of capital (WACC). Because the values of debt and equity add up to overall firm value, the after-tax WACC is

$$WACC = r_D \times \frac{D}{V} \times (1 - t_c) + r_E \times \frac{E}{V} \quad (6)$$

Where D represents the debt value, E is the equity value, V stands for the sum of equity and debt values, r_D denotes the cost of debt, r_E corresponds to the cost of equity and t_c is the corporate tax rate.

It is important to note that because interest is a tax-deductible expense, the cost of debt is not r_D but $r_D \times (1 - t_c)$.

4.1.1.1 Cost of debt

The cost of debt measures the current cost to the firm of borrowing funds to finance projects (Damodaran, 2014).

Ideally, the cost of debt should be obtained directly from the firm. It corresponds to the rate that the company would have to pay for financing with a start and end date similar to the investment project.

Alternatively, the cost of debt can be extracted from data made available by authors such as Damodaran (2020a).

4.1.1.2 Cost of equity

The cost of equity will be estimated using the methodology suggested by Damodaran (2014), which follows the CAPM. The cost of equity (R_E) can be expressed as a function of a riskless rate (R_f), a beta (β), and a market risk premium ($R_m - R_f$), as such:

$$R_E = R_f + \beta \times (R_m - R_f) \quad (7)$$

According to this function, to calculate the cost of a risky asset, one should start by calculating the required return on a risk-free asset. The required return for an asset that is risky is the risk-free rate, plus a premium, as to compensate for the risk. That compensation depends on the market risk premium, which is how much the market compensates risk, multiplied by a coefficient. That coefficient is the beta, that measures the level of risk of an asset, relative to the market. A stock with a beta greater than one tends to intensify market moves, while a stock with a

beta between zero and one moves more moderately than the market (Brealey, Myers, & Allen, 2011).

4.1.1.2.1 The risk-free rate

According to Damodaran (2014), for an asset to be considered risk-free it must meet two conditions. First, there can be no default risk. That means that only certain government-issued securities can be considered free of risk. In practice, any government-issued security classified as Aaa or equivalent is default-free. Second, there can be no uncertainty about reinvestment rates. This implies that there are no intermediate cash flows. Therefore, the risk-free rate for a five-year period is a government-issued, five-year zero-coupon bond. It is also important to notice that to avoid exchange risk the risk-free security should be traded in the same currency as the project being valued.

4.1.1.2.2 Beta

According to Damodaran (2014), the conventional approach for estimating betas is the historical market betas approach.

Under the **historical market betas approach**, the beta is calculated by comparing the returns of investing in an equity with the returns of an equity market index. To understand how this comparison is made, let us first recall that, under CAPM, the expected return on a risky asset (R_i) is a function of the beta of the investment (β_i), risk-free rate (R_f) and the expected return on the market portfolio (R_m):

$$R_i = R_f + \beta_i \times (R_m - R_f) \quad (8)$$

This equation can be rearranged in terms of excess returns:

$$R_i - R_f = \beta_i \times (R_m - R_f) \quad (9)$$

The procedures for estimating the beta for the excess returns is to first calculate the returns earned by an investment and a specified market index over a past period, in excess of the risk-free rate in each of the periods. Then, a regression between the excess returns on the investment and the excess returns on the market must be computed. The slope of that regression is the beta. Using the excess returns gives a slightly more precise estimates, when compared to the raw returns approach, because it allows for the variation of the risk-free rate from period to period.

One important aspect to consider is the choice of the market index. In theory, a market portfolio should include all traded assets in the market, held in proportion to their market values. In practice, however, such a portfolio may not exist. That means that whichever portfolio is chosen, it will be only an approximation of the theoretical market portfolio. Because of that, the closer the chosen index comes to the market portfolio the more meaningful the beta estimate will be. To guarantee that the selected market index is a good proxy, there are a few aspects to consider. First, it should contain a high number of companies, so that their individual risk is diversified away. Second, it should contain companies of the same geographical area, so that the market risk is comparable. Also, it should be value-weighted. As an example, for the US market, the most widely used market index is the S&P 500.

Despite its widespread use, there is one key aspect about this approach. The fact that it uses historical market data, more specifically price information, means that this method can only be applied to publicly traded firms. Therefore, if the objective is to find the beta of a private firm, such as Company A, the historical market betas approach cannot be applied. Fortunately, Damodaran (2012) proposes an additional approach to calculate a beta for a private firm - **bottom-up betas**.

This method is applied by comparing the private firm being evaluated with an average publicly-traded company. Under this method, it is assumed that the average unlevered beta for the industry is similar for all the companies that operate in that market. Therefore, the beta of a company can be calculated by adjusting the unlevered average beta to the company's operating and financial leverage.

There are three significant advantages of using this method. First, it can be applied to private firms because no price history of that firm is required. Second, because the beta is obtained by averaging across a large number of betas, it will be more precise than any individual firm's beta estimate. This is true because the standard error of the average beta is given by:

$$\text{Standard error}_{\text{bottom-up beta}} = \frac{\text{Average standard error}_{\text{comparable firm}}}{\sqrt{\text{Number of firms}}} \quad (10)$$

Therefore, the larger the sample, the smaller the standard error of the average beta. Third, the bottom-up beta can reflect recent and even future changes to a firm's business mix and financial leverage, because the weight of each business and the degree of financial leverage can be changed and adjusted to better fit the firm's reality.

There are two additional aspects to consider, that are transversal to the previously described methods. The first is the period for which the data will be downloaded and the second is the return intervals.

The choice of the time period is important because since past data is used to calculate the beta, which will be used to calculate a discount rate for future cash flows, it is implied that the future conditions, both market and firm-specific, are expected to be similar to those of the selected past period. With a small time period, there might be a bias, depending on whether that period was exceptionally good or bad. Even if the sample was not unusual, the future time, when the discount rate will be used, might be, which renders that beta useless. Going back further in time has the advantage of averaging out the outliers but may cause another problem. If the firm changed its characteristics, in terms of business mix and leverage, over that period, the beta will be suitable for that firm in the past, but not for the time period we are interested in – the future (Damodaran, 2014). Even though that is a problem for individual firms, because we are using a large sample of different companies that possible drawback will be, once again, averaged out.

The final choice that can affect beta estimates is the return interval. The use of shorter return intervals, such as daily frequency, increases the number of observations, which offers a more robust statistical outcome. However, for illiquid assets, the sample may contain non-trading days, which can reduce the measured covariance with the market index, and consequently the beta estimate. Using weekly or monthly returns can reduce nontrading bias significantly (Damodaran, 2014).

4.1.1.2.3 Risk Premium

According to the CAPM, the risk premium measures the additional return demanded by investors for shifting their money from a riskless investment to the market portfolio of risky investments. The risk premium is, in other words, how much the investors “charge” for bearing the additional risk.

Damodaran (2014) proposes three different methodologies to estimate the risk premium: one can survey large investors about their expectations about the future, historical data can be used, and the implied premium can be extracted from current market data.

The most common approach to estimate risk premiums is to use historical data and it is the one we will be using. This approach is based on the CAPM, because the risk premium is estimated by calculating the difference between the average returns of a risky security, usually a stock index, and the average returns of a risk-free asset over an extended period of history. Note that by doing this we assume that the risk aversion of investors and the average riskiness of the risky portfolio has not changed in a systematic way across time (Damodaran, 2014).

Albeit historical data is widely used to calculate the risk premium, in practice there can be large differences between the estimations made by banks, consultants and corporations. This is surprising because they use the same historical data. The explanation for these differences lays on three arbitrary variables.

The first is the period to be used. In theory, there are almost limitless possibilities. Should we use one year, ten years, all the available data? According to Damodaran (2014), there are two opposing arguments to this question. The first says that short time periods should be used because the risk aversion of the average investor is likely to change over time. Also, using a recent time period provides a more updated estimate. The contrary argument states that using short periods comes with the cost of having large standard errors, sometimes as large or larger than the actual risk premium estimated. According to Damodaran, this cost overwhelms any advantages associated with using a more updated premium.

Second, the risk-free rate used also impacts the premium estimations. The same aspects we mentioned earlier (section 4.1.1.2.1) are the ones relevant in choosing a risk-free rate to estimate a risk premium – the security should have no default risk, no reinvestment risk and no currency risk.

Finally, there are two different methods to average the returns over time. An arithmetic average return measures the simple mean of the series of annual returns, whereas a geometric average accounts for the compounded returns (Damodaran, 2014). According to Damodaran (2014), there are strong arguments that can be made for the use of geometric averages. First, empirical studies seem to indicate that the returns on stocks are negatively correlated over time. Therefore, the arithmetic average return is likely to overstate the premium. Second, the fact that CAPM will be used to estimate rates for the long period makes the argument for using the geometric average even stronger. To calculate the returns, the following formula is used:

$$Returns = \frac{Value_N + Dividend_N - Value_{N-1}}{Value_{N-1}} \quad (11)$$

Where $Value_N$ and $Value_{N-1}$ corresponds to the stock value in period N and N - 1, respectively and $Dividend_N$ is the dividend value, paid in period N.

The geometric average returns are computed by:

$$Geometric\ Average\ Return = \left[\prod_{i=1}^n (1 + x_i) \right]^{\frac{1}{n}} \quad (12)$$

Where n corresponds to the number of periods and x_i is the return in period i .

The arithmetic average returns are given by the following formula:

$$Arithmetic\ Return = \frac{1}{n} \sum_{i=1}^n a_i = \frac{a_1 + a_2 + \dots + a_n}{n} \quad (13)$$

Where a_i are the returns in period i and n is the number of periods.

There is one condition in using historical data to estimate risk premiums. That condition is that the data must be available and accessible. Countries with well-developed financial markets, such as the US, do not face this problem, but in some foreign markets, it is hard to estimate the risk premium using the historical data approach. For that reason, Damodaran (2014) proposes three alternative methods to estimate the risk premium - relative standard deviation, country bond default spreads, and default spread + relative standard deviation. Despite this, we will only use the

relative standard deviation methodology. The other two require the use of a country sovereign bond, however, as we will see in chapter 5, the market index we chose covers several European countries and there is no bond issued by this set of countries. For that reason, there are no bonds that suit the needs of these two methodologies.

The **relative standard deviation** rationale is that the equity risk premiums of markets should reflect the differences in equity risk, as measured by the volatility of the stock prices. If the standard deviation of two different markets is compared, we get a measure of relative risk (Damodaran, 2014).

$$Relative\ Standard\ Deviation_{Country\ X} = \frac{Standard\ deviation_{Country\ X}}{Standard\ deviation_{Country\ Y}} \quad (14)$$

The relative standard deviation multiplied by the premium of a base country (country Y) should yield a measure of equity risk premium (ERP) for any market.

$$ERP_{Country\ X} = Risk\ Premium_{Country\ Y} \times Relative\ Standard\ Deviation_{Country\ X} \quad (15)$$

Even though this approach has an intuitive appeal, it should be used with caution when the markets are widely different. For instance, there are very risky emerging markets that have low standard deviations for their equity markets because the markets are illiquid. Thus, this approach would understate the equity risk premiums in those markets (Damodaran, 2014).

4.1.2 Risk Analysis

Up until this point, we have made an argument in favour of discounted cash flow models. We said that their superiority came from the fact that they use cash flows instead of profits and they discount these cash flows properly. One could think, therefore, that a high positive expected net present value is a sufficient condition to accept the project. In reality, it would be reckless to assume that that is true. Because these models are dependent on projections, when the project starts, it may become evident that many of those forecasts were wrong. Depending on how far apart from reality they are, the expected net present value may be significantly different from the projections. For this reason, it is fundamental to perform a risk analysis. By using different risk

analysis methodologies, one can get a more realistic perspective on the possible outcomes of the project. We will, therefore, proceed by going through several of these methodologies, as described by Ross, Westerfield, Jaffe, & Jordan (2015).

The first method we will explore is **sensitivity analysis**. Sensitivity analysis breaks the NPV calculation into several variables and shows how the NPV varies as the underlying assumptions change. This analysis reveals the critical variables, that is, which of the assumptions have a major impact on the NPV. By identifying the critical variables, we can invest further resources to refine the projections of these variables, which will reduce the estimation risk.

To calculate the NPV, the company must make estimations about variables such as quantities to be sold, price levels and both variable and fixed costs. To perform the sensitivity analysis, the firm's analysts would make a forecast, for each of these variables, based on a pessimistic, an expected/most likely, and an optimist scenario. Then, the NPV would be calculated for all three possibilities of a single variable, along with the expected forecast for all other variables. This means that the company would calculate an NPV using the pessimist scenario for the sales quantities while maintaining the expected scenario for all other variables. After that, the NPV would be calculated using the pessimist scenario for the price and the expected scenario for all other variables. This process should be repeated until there is an NPV for each of the variables for every scenario.

This analysis allows the managers to understand the behaviour of the NPV when each of the variables change. For instance, if, after conducting the analysis, the NPV values on the pessimistic scenario were highly negative and all the values in the optimist scenario were highly positive, it could be concluded that the project is very sensitive to changes on the forecasted variables. If, however, the sensitivity analysis shows that only a few variables are critical, it gives useful information to the managers. For instance, if the sensitivity analysis shows that the NPV is highly sensitive to selling price changes, but not so much to costs changes, more information about the factors that determine price changes might be needed. The reason is that the effect of an incorrect estimate for the selling price will be much greater than the effect of incorrect estimates on costs. This information is useful because it allows the managers to focus on the critical variables and to consequently reduce the estimation errors.

There are, however, a few drawbacks to keep in mind. For example, sensitivity analysis may increase the false sense of security among managers. If the NPV values in the pessimist

scenario are positive one could be led to think that the project is a sure money-maker. Of course, the truth is that the scenarios are also forecasts, so, in that case, the forecasters were probably not pessimist enough. An additional drawback is how the analysis treats each variable in isolation when, in reality, the different variables are related. For example, if the market is not as receptive to a product as expected both the quantities and the price will be affected simultaneously.

The second method we will be using is **Monte Carlo simulations**. When we reviewed the sensitivity analysis method, we considered the effect of changing one variable at a time. That means that we could only analyse a limited number of possible outcomes. Monte Carlo simulations, however, allow studying the impact of changing multiple variables at a time, while considering the relations between these variables (Brealey, Myers, & Allen, 2011). This is achieved by assigning distribution probabilities to each of the variables that underlie the cash flows. Then, the simulations are run thousands of times. In each simulation, an outcome from each distribution is drawn and the present value is estimated based on those draws. The result is a distribution of the expected value of the project (Damodaran, 2012). What this means is that, while sensitivity analysis answered the question “What if?”, the Monte Carlo simulation, calculates, instead, the probability of a specific scenario to happen.

As Damodaran (2012) states, even though Monte Carlo simulations are very informative there are a few key issues that should be considered when performing simulations. The first one is that the distributions chosen for the inputs should be based on analysis and data. The outputs of the simulation will only be as good as the inputs. A second problem is that real-world data does not always fit a probability distribution. In those cases, using a probability distribution that has little resemblance to the true distribution of an input variable will yield misleading results. Lastly, even when the data fits a statistical distribution there is no guarantee that a future shift in the market will also shift the statistical distributions. Ideally, the probability distributions should be forward-looking, but, due to the difficulty in estimating them, that is rarely done.

Diagram 2 represents a summary of the framework we have been discussing and that we will be using to calculate the ENPV.

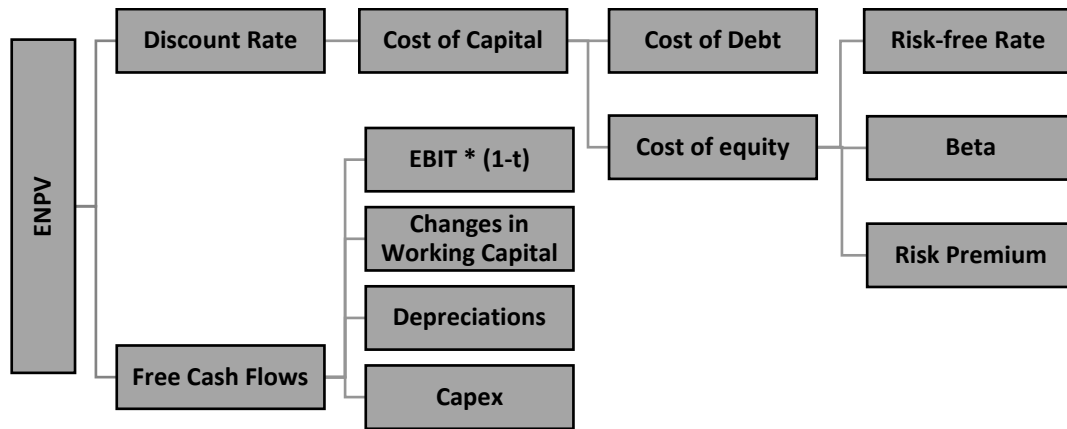


Diagram 2 – Framework Structure

5. Project Valuation

In this section, we will apply the previously reviewed methods to Company A's project. First, the cost of capital will be calculated, which will be preceded by the cash flows estimation. We will then calculate the value of the ENPV. The section will be concluded with a risk analysis.

5.1 Cost of capital

As we previously mentioned, to calculate the cost of capital we need to estimate the cost of debt and the cost of equity. The mixture of the two, weighted by the capital structure of the firm will return the opportunity cost of capital.

5.1.1 Cost of debt

Ideally, the cost of debt is obtained directly from the company, by looking at the most recent borrowing history. Because that was not possible, because we are not using a real company, we will use the cost of debt Damodaran (2020b) estimated for auto & parts European companies: 3.96%.

5.1.2 Cost of equity

As we stated before, to estimate the cost of equity three variables are needed – the risk-free rate, the beta and the risk premium.

5.1.2.1 Risk-free rate

Under periods of high and unstable inflation, government-issued bonds might be risk-free in nominal terms, but not in real terms. A standard approach to estimate the real risk-free rate is to subtract the inflation rate from the nominal riskless rate (Damodaran, 2014). Nevertheless, in the period under analysis, we expect the inflation rate to be low and stable. In addition to that, all values used will be in nominal terms, so the nominal risk-free rate is going to be used.

The risk-free rate that is going to be used is the Euro-area Aaa rated bonds, issued in the 1st of November 2019 (the day the model is being built), with twelve-years to maturity. The rate is, therefore, -0,2444% (European Central Bank, 2020). The scenario of having long term negative risk-free rates is still a novelty and there is no consensus on its meaning and long-term impacts.

Damodaran (2020c) discussed the use of negative rates in the context of valuation and corporate finance. According to the author, there are three ways of dealing with negative rates: we can switch currencies, we can normalize the rate, by calculating average rates across long periods of time or we can leave the rates negative. **Switching currencies** has the downside that, at some point in time, the alternative currency will possibly also have negative rates. By **normalizing rate**, three issues arise. The first is the period to choose to calculate the average and the second is that it is fundamental to be rigorous with how the normalized rate is estimated, as it influences the investment decisions. The third is that using a high normalized risk-free rate with high equity risk premiums, that are prevalent today, will lead to too high a hurdle rate.

According to Damodaran, the more reasonable solution is to **leave the risk-free rate negative**. The fact that this rate is rarely used alone, but only in conjunction with a risk premium means that if we can update the risk premium it may offset the impact of using a negative risk-free rate. Note that small negative rates (-0,25% to -0,50%) also have small mathematical consequences.

5.1.2.2 Beta

The conventional approach for estimating betas is using historical market data. In this method, the correlation between the market excess returns and the company's excess returns is calculated. The slope of the regression is the beta of the company, which measures the riskiness of the stock.

For private companies such as Company A, however, this approach is not possible, because the company is not publicly traded, which means that there is no stock price information. Thus, the bottom-up betas approach, as suggested by Damodaran (2014), will be used.

The first step is to identify a group of publicly traded comparable firms. To do this, first, we had to identify the business area where Company A operates. According to Amadeus, the industry codes where the firm operates are "Primary code: 22292 - Manufacture of other plastic products, n. e. c." and the "Secondary code(s): 29320 - Manufacture of other parts and accessories for motor vehicles." Using Amadeus, we identified a group of ten companies that operate in the same industry as Company A, are publicly traded and operate on the Euro-28 area. To increase the number of comparable firms, a different database was also used. Using Thomson Reuters DataStream, and filtering by companies in the auto & parts industry, the final number of comparable firms was increased to forty-four.

The next step is to estimate the levered betas for each of the identified companies. To do so, using Thomson Reuters DataStream, we downloaded the price information (total return index) and calculated the returns. The selected period was the earliest available in the database, which was the 29th, December 2000 and the frequency was daily. Afterwards, we followed the same procedure with the market index. The index chosen was the STOXX Europe 600. The index covers the 600 largest companies in Europe and is weighted according to free-float market capitalization (STOXX Index Methodology Guide (Portfolio Based Indices), 2019). After that, we downloaded the historical yield to maturities of three-month German bonds, which will be used as the risk-free asset. The period was the same used for the risky assets - between the 1st of January 2001 and the 1st of November 2019. Because the yields are in annual terms, but the data is daily, we must transform the annual rates in daily rates. To do that we used the following formula:

$$\text{Daily rate} = (1 + r_i)^{(1/365)} - 1 \quad (16)$$

Where r_i is the annual rate, in period i .

We proceeded by estimating the excess returns for each period. To do that, for each period, we subtract the risk-free to the daily return rates of both the risky assets, which gives us the excess returns of the market and the excess returns of the firms.

With the excess returns of both the index and the companies calculated it was possible to compute the levered betas for each of the companies, by performing a regression between the market index excess returns and the firms' excess returns. The results were that the average beta is 0.7923 and the median beta is 0.7789. This regression produced an average R^2 of 16.28% and a median R^2 of 12.74 %, which means that market risk, on average, explains only 12.74% of the variance in auto & parts companies' returns.

Even though we now know the levered betas, what we need is the unlevered betas. The difference is that the first measures both the market risk and the firm-specific risk, while the second only measures the market risk. We will follow the methodology proposed by Damodaran (2014). To calculate the unlevered beta for the sector, we started with the median levered beta and we corrected it for the median debt-to-equity industry ratio and for the median cash balance. To be able to do that, the total debt, common equity, cash and enterprise values for each of the companies was downloaded from DataStream and Amadeus. Due to the tax shield effect of debt, the tax rates for each of the origin countries of each of the companies are also needed. This data was retrieved from Damodaran website (Damodaran, 2020a).

The unlevered beta, corrected for the debt-equity ratio is given by:

$$\begin{aligned} \text{Unlevered beta (D/E ratio)} &= \\ &= \frac{\text{median levered beta}}{(1 + (1 - \text{median tax rate})(\text{median D/E ratio}))} \end{aligned} \quad (17)$$

$$\text{Unlevered beta (D/E ratio)} = \frac{0,7789}{(1 + (1 - 30\%)(0,8734))} = 0,4834 \quad (18)$$

The unlevered beta, corrected for cash is given by:

$$\text{Unlevered beta (cash)} = \frac{\text{Unlevered beta (D/E ratio)}}{(1 - \text{median cash balance})} \quad (19)$$

$$\text{Unlevered beta (cash)} = \frac{0,4834}{(1 - 13,41\%)} = 0,5582 \quad (20)$$

Finally, Company A's levered beta is calculated by levering the unlevered beta corrected for cash. This is achieved by using Company A's debt/equity ratio and tax rate. For the cash balance, it was assumed that it was equal to the market's. Company A's levered beta is, therefore:

$$\text{Company A's Levered beta} = 0,5582[1 + (1 - 0,21)(2,4529)] = 1,63986 \quad (21)$$

There is, however, a final consideration. Under CAPM, it is assumed that risk in an investment is risk as perceived by a well-diversified investor. Also, risk has to be measured from the perspective of a marginal investor. Thus, under CAPM, only the risk that an investment adds on to a well-diversified portfolio should be compensated. Risk can, therefore, be broken down into two components: a market component, that is common to all companies that operate on that market and a firm-specific component that only affects that investment. Because only the market component is non-diversifiable, only that component should be rewarded (Damodaran, 2014).

For the owner of a private firm, however, this assumption is not very reasonable, because generally, the company represent a major part of his/her wealth. Therefore, the analysis must be done not with the perspective of an average investor, but from the perspective of the company owner. Consequently, what we must calculate is a beta for the total risk of the business rather than just the market risk.

According to Damodaran (2014), the total risk beta is calculated by dividing the market beta by the square root of the average R^2 , because the R^2 of the regression measures the proportion of the variance that is market risk. That is:

$$\text{Total Beta} = \text{Market Beta} / \text{Correlation with the market} \quad (22)$$

This means that the total beta of Company A is 4.02821.

$$Total\ Beta = Market\ Beta / \sqrt{Average\ R^2} \quad (23)$$

$$Total\ Beta = 1.63986 / \sqrt{16.28\%} = 4.06409 \quad (24)$$

5.1.2.3 Risk premium

To calculate the risk premium, three different approaches are going to be used – geometric average returns, arithmetic average returns, and relative standard deviation.

The first step to estimate the risk premium was to download the yearly prices and dividend yields for both the S&P 500 index and the STOXX 600 index. The earliest dates available on DataStream were used. Regarding the prices, for the S&P 500, there are fifty-five years available, from 1963 to 2018, while for the STOXX 600 there are thirty-two years available, from 1986 to 2018. However, the dividend yield information is scarcer. For the S&P 500, the dividend yields were obtained from Damodaran website (2020d) for the period between 1963 and 2018. For the STOXX 600, however, DataStream only has information on the dividend yields for the period between 2000 and 2018. Therefore, the returns will only be calculated for that period. To calculate them we used the following formula:

$$Returns_N = \frac{Value_N + Dividend_N - Value_{N-1}}{Value_{N-1}} \quad (25)$$

Where $Value_N$ and $Value_{N-1}$ corresponds to the stock value in period N and N - 1, respectively and $Dividend_N$ is the dividend value, paid in period N. The dividend value for each period was calculated by multiplying the price by the dividend yield.

Afterwards, the average arithmetic yearly returns for the STOXX 600 index were calculated using the formula:

$$Arithmetic\ Return = \frac{1}{n} \sum_{i=1}^n a_i = \frac{a_1 + a_2 + \dots + a_n}{n} \quad (26)$$

Where a_i are the returns in period i and n is the number of periods.

The same procedure was followed to compute the geometric average returns, but the formula used was:

$$\text{Geometric Average Return} = \left[\prod_{i=1}^n (1 + x_i) \right]^{\frac{1}{n}} \quad (27)$$

Where n corresponds to the number of periods and x_i is the return in period i .

With the returns of the risky asset calculated, we proceeded by calculating the returns of the risk-free asset. To do so, we started by downloading the yields to redemption of 10-year to maturity German and US government bonds, with a yearly frequency. To calculate the returns, we applied the formula:

$$R_N = \left(Y_N \times \left(\frac{1 - (1 + Y_{N+1})^{-M}}{Y_{N+1}} \right) + \frac{1}{(1 + Y_{N+1})^M} - 1 \right) + Y_N \quad (28)$$

Where Y_N is the yield to redemption on period N , Y_{N+1} is the yield to redemption on period $N+1$, and M is the maturity of the bond. According to Damodaran (2020d), the return on a constant maturity bond is computed by adding two components - the promised coupon at the start of the year and the price change due to interest rate changes.

After computing the returns for each period, the arithmetic and geometric average returns are calculated the same way as we did for the market indexes. The results are presented in tables 1 and 2.

Geometric Average Returns		
S&P 500	Index	9,76%
	US 10-year bond	6,36%
STOXX 600	Index	2,12%
	German 10-year bond	5,78%

Table 1 – Geometric Average Returns, for the American and European markets.

Arithmetic Average Returns		
S&P 500	Index	11,07%
	US 10-year bond	6,75%
STOXX 600	Index	4,19%
	German 10-year bond	5,98%

Table 2 - Arithmetic Average Returns, for the American and European markets.

With the average arithmetic and geometric returns for both the market index and the risk-free assets determined, it was possible to estimate the risk premium for the American and

European markets. To do that, we subtracted the average risk-free returns from the average returns of the market indexes. The results are presented in tables 3 and 4.

Geometric Risk Premium	
S&P 500	STOXX 600
3,4026%	-3,6618%
Standard Error	Standard Error
0,23%	1,29%

Table 3 – Geometric Risk Premiums for the US and European Market and their standard errors

Arithmetic Risk Premium	
S&P 500	STOXX 600
4,2302%	-1,7917%
Standard Error	Standard Error
0,26%	1,42%

Table 4 – Arithmetic Risk Premiums for the US and European Market and their standard errors

There is one obvious problem with these values. The risk premiums for the STOXX 600 are negative, which does not make any sense – the returns on a risky asset cannot be smaller than the returns on a riskless asset. These values are explained by the short timeframe used to calculate them. Damodaran (2014) alerted that using a 10 or 20 year period to calculate risk premium is unreliable, prone to error and returns large standard errors. We can observe that by comparing standard errors of the S&P 500 risk premiums with the STOXX 600. In fact, for the arithmetic risk premium, the standard error of the STOXX 600 is almost as large as the estimate itself. In reality, we knew beforehand that a 20-year period was short and whatever the values we estimated would have to be rejected.

Alternatively, we will use the **relative standard deviation** method to estimate a risk premium value for the European market. We know that the risk premium for the US market is 3,4%, so we proceeded by computing the standard deviation of the returns of both indexes – the S&P 500 and the STOXX 600. We were then able to estimate the relative market returns for the European market, using the formula:

$$\begin{aligned}
 \text{Relative market return}_{\text{Europe}} &= \\
 &= \text{Geometric risk premium of S\&P 500} \times \frac{SD_{\text{STOXX 600}}}{SD_{\text{S\&P 500}}} \quad (29)
 \end{aligned}$$

$$\text{Relative market return}_{\text{Europe}} = 3,4026\% \times \frac{19,171\%}{16,243\%} = 4,0159\% \quad (30)$$

Relative Standard Deviation (%)	
S&P 500 geometric risk premium	3,4026
Standard deviation S&P 500	16,243
Standard deviation STOXX 600	19,171
Equivalent risk premium	4,0159

Table 5 – Equivalent risk premium, calculated by comparing the standard deviation of the European index to the standard deviation of the US index.

The risk premium for the European market is, according to the Relative Standard Deviation, 4,0159% (table 5). This is the value we will use in the cost of capital estimation.

5.2 Estimating the Cost of Capital

With all the variables estimated, it is now possible to calculate the Cost of Capital. To do so, we will start by computing the cost of equity. We will need a risk-free rate, a beta, and a risk premium. As we mentioned earlier, we will use a 13-year to maturity German bond, and the beta and risk premium values we previously calculated. We estimated that the cost of equity is 16,076% (table 6).

Risk-free rate	-0.244%
Beta	4.064
Risk Premium	4,0159%
Cost of Equity	16,076%

Table 6 – Calculating the cost of equity, using the previously estimated variables. Different methods return very different values for the cost of equity.

The final step is to estimate the Weighted Average Cost of Capital (WACC). To do that, we first calculate the weights of debt and equity on the total value of the company (debt + equity). As we discussed earlier, the capital structure is fundamental to minimize the cost of capital. We are assuming that the current capital structure is optimal. Then, based on those weights, we calculate

a weighted average of the cost of equity and the after-tax cost of debt. The WACC values are shown in table 7.

Cost of Debt	3,96%
D/V	57,71%
Tax Rate	21,00%
Cost of Equity	16,08%
E/V	42,29%
WACC	8,60%

Table 7 – The Weighted Average Cost of Capital (WACC).

5.3 Estimating cash flows

Now that we have a discount rate, we will proceed by estimating the cash flows. For that, we will estimate the different variables needed to estimate the Free cash flows to the firm (FCFF). Note, however, that the following values were arbitrarily chosen.

Let's first recall that the project will last thirteen years – the first five will be dedicated to R&D, and, if this stage is successful, during the following eight, a product will be manufactured and sold. If, on the other hand, no viable product results from the R&D stage, the project will end after those five years. The project started in 2020, which means that the R&D phase will end by 2024. In 2025 the production will start, and this project will be finished by 2032.

We started by setting a few assumptions. We assumed that the receivables and payables period would be 60 days and the stock period would be 30 days. We proceed by estimating that the company would spend 80 850€ on salaries in the first year and 400 853€ in 2031 (table 9). The company is expected to have 24 000€ per year of other operational expenses. These two costs are added together and classified as Selling, General and Administrative Expenses (SG&A), as seen on table 10.

An additional investment in fixed assets of 20 000€ in 2020 will be made. After that, we predicted that the company would have to invest 750 000€ fixed assets. The reason the production phase of the project lasts for eight years is that after that period this asset will be completely depreciated. The decision of reinvesting in fixed assets is an investment decision and is, therefore, a different project. The sales would be 500 000€ in the first year, growing to 5 445 000€ at the

end of the project, which means that the sales will increase by 50% each year, except in the last, where they will remain constant. The sales values and yearly growth rate are presented in table 10. Next, based on the industry average, we assumed a gross margin of 50%, which means that the Cost of Goods Sold (COGS) will be half of the value of sales. After predicting all the needed input, it was possible to calculate the expected free cash flow. Note that all values are in nominal terms, that is, they were calculated considering the expected inflation rate for the period. To calculate the expected inflation rate, we used estimates from Banco de Portugal and past data. Banco de Portugal only releases projections until the year of 2022 (Banco de Portugal, 2020), so for the remaining of the period we used a 20-year average Portuguese inflation rate, which we calculated to be 1,92%.

Harmonized Consumer Price Index (%)												
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
0,1	0,8	1,1	1,92	1,92	1,92	1,92	1,92	1,92	1,92	1,92	1,92	1,92

Table 8 – Expected Harmonized Consumer Price Index for the period between 2020 and 2032

The final step was to calculate the Expected Net Present Value. First, it was necessary to determine the possible outcomes. We determined that after the R&D phase ends, the company can either proceed to the production phase or to abandon the project, contingent on the R&D phase returning a marketable product. Every year after that, the company, depending on the success of the product, can decide to continue with the commercialization or to abandon the project. If the company decides to abandon the project, the future cash flows will be zero. We estimate that the project has a 50% chance of proceeding to the production phase (Trajtenberg, 2000). After that, we expect that only in the last three years the company will consider terminating the project before the expiration date. Because we assumed the probability of that happening would be residual, we assumed it to be 10% for each of those years. This information is displayed in table 11.

To calculate the ENPV we must compute the accumulated cash flows from period 12 to period 0. The accumulated cash flow for each period is calculated using the following formula.

$$AFCF_N = FCF_N + \frac{(AFCF_{N+1} \times (1 - p) + 0 \times p)}{(1 + r)} \quad (31)$$

Where $AFCF_N$ is the Accumulated cash flow in N, FCF_N corresponds to the Free cash flow in N, p is the Probability of unsuccess, and r represents the discount rate.

Using the previously calculated WACC, we estimate that the ENPV will be of 349 177,10 €. Because the ENPV is positive, we can conclude that the company should accept the project.

Number of employees	2020	2021	2022	2023	2024	2025	2026	202	2028	2029	2030	2031	2032
Administration													
Financial Administration													
Marketing						1	1	1	1	1	1	1	1
Production						20	20	20	20	20	20	20	20
Quality						1	1	1	1	1	1	1	1
Maintenance						1	1	1	1	1	1	1	1
R&D	2	2	2	2	2								
Base monthly salaries (€)													
Administration													
Financial Administration													
Marketing	2 000	2 020	2 040	2 061	2 081	2 102	2 123	2 144	2 166	2 187	2 209	2 231	2 254
Production	700	707	714	721	728	736	743	750	758	766	773	781	789
Quality	900	909	918	927	937	946	955	965	975	984	994	1 004	1 014
Maintenance	700	707	714	721	728	736	743	750	758	766	773	781	789
R&D	2 000	2 020	2 040	2 061	2 081	2 102	2 123	2 144	2 166	2 187	2 209	2 231	2 254
Total Salaries expenses (Tax included) (€)	80 850	81 659	82 475	83 300	84 133	373 883	377 623	381 399	385 211	389 064	392 956	396 884	400 853

Table 9 – The total salaries expenses are calculated by multiplying the salary by the number of employees, for each department.

	2020	2021	2022	2023	2024	2025	2026	202	2028	2029	2030	2031	2032
Salaries Expenses	80 850	81 659	82 475	83 300	84 133	373 883	377 623	381 399	385 211	389 064	392 956	396 884	400 853
Other Operational Expenses	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000	24 000
SG&A (€)	104 850	105 659	106 475	107 300	108 133	397 883	401 623	405 399	409 211	413 064	416 956	420 884	424 853

Table 10 – Selling General and Administrative Costs calculation.

Free Cash Flow (Values in €)													
Period	2020	2021	2022	2023	2024	2025	2026	202	2028	2029	2030	2031	2032
Sales	0	0	0	0	0	500 000	750 000	1 125 000	1 687 500	2 531 250	3 796 875	5 695 313	5 695 313
Growth Rate							50,00%	50,00%	50,00%	50,00%	50,00%	50,00%	0,00%
COGS	0	0	0	0	0	250 000	375 000	562 500	843 750	1 265 625	1 898 438	2 847 656	2 847 656
SG&A	104 850	105 659	106 475	107 300	108 133	397 883	401 623	405 399	409 211	413 064	416 956	420 884	424 853
Inv./Desinv. In Working Capital	5 172	1 173	23	24	24	-92 513	14 378	-43 173	-64 812	-97 272	-145 962	-218 999	114
Depreciations & Amortizations	2 500	2 500	2 500	2 500	2 500	96 250	96 250	96 250	93 750	93 750	93 750	93 750	93 750
EBIT * (1 – Tax Rate)	-84 807	-85 445	-86 090	-86 742	-87 400	-192 865	-97 070	48 072	269 223	599 461	1 096 308	1 843 087	1 839 952
Capex	-20 000	0	0	0	0	-750 000	0	0	0	0	0	0	0
Free cash flow	-97 135	-81 772	-83 567	-84 218	-84 876	-939 128	13 558	101 149	298 161	595 939	1 044 096	1 717 839	1 933 816

Table 11 - To calculate the free cash flow we had to first estimate the sales for the first year and a growth rate for the following years. We also estimated the operational margin and the SG&A costs. After that, based on estimated investment in working capital, depreciations and invested capital we were able to compute the free cash flow.

Expected Net Present Value (Values in €)													
Discount Rate	0	1	2	3	4	5	6	7	8	9	10	11	12
8,60%	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Possible Outcomes	-97 135	-81 772	-83 567	-84 218	-84 876	-939 128	13 558	101 149	298 161	595 939	1 044 096	1 717 839	1 933 816
					0	0	0	0	0	0	0	0	0
Probability of Bad Outcome	0%	0%	0%	0%	50%	0%	0%	0%	0%	0%	10%	10%	10%
Cumulative Cash flow	349 177	484 716	615 232	758 929	1 831 395	2 081 161	3 280 176	3 547 701	3 743 118	3 741 386	3 795 671	3 320 379	1 933 816
ENPV	349 177												

Table 12 – Calculation of the Expected Net Present Value (ENPV). The ENPV is computed by considering different possible outcomes, and their probabilities.

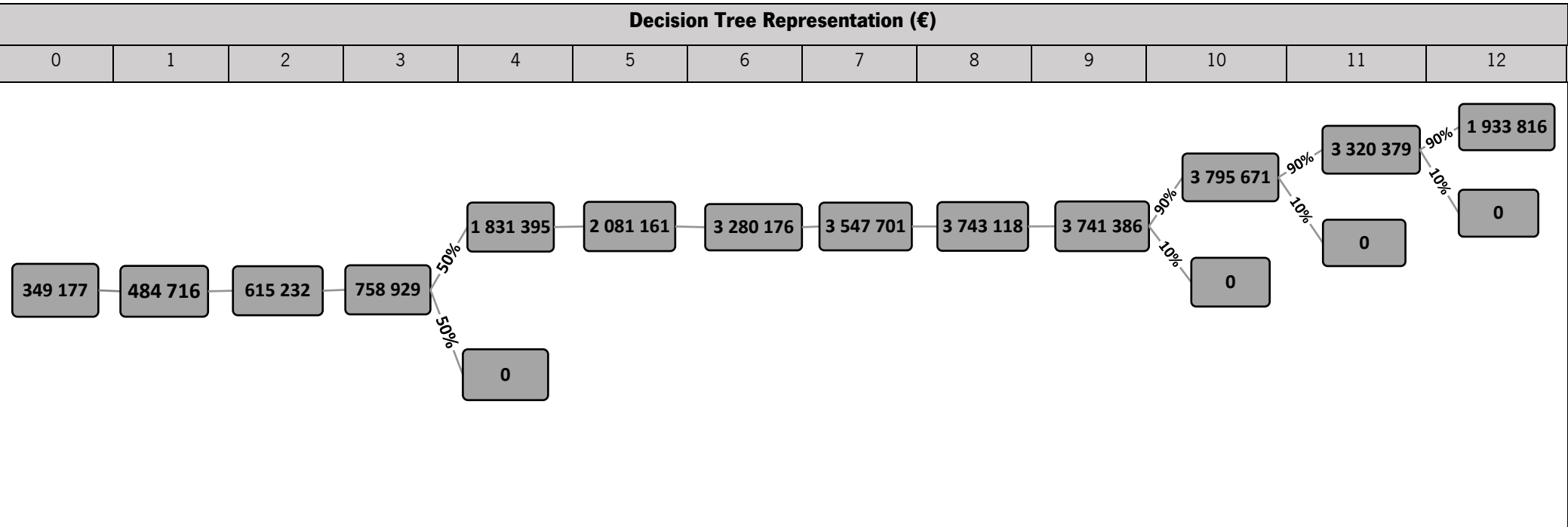


Table 13 – Visual representation of the possible outcomes and their value.

5.4 Risk Analysis

In the previous section, we estimated the cash flow associated with the investment project under analysis. Because they are only, in the best of cases, reasonable estimations, there is great uncertainty that the values used represent the project accurately. Even if this was not the case, the future is always uncertain and, therefore, any estimation invariably carries that uncertainty. Although we cannot make that fact disappear, there are tools that allow measuring how sensible our project is to that uncertainty.

A simple tool we can use is the sensitivity analysis. The objective of doing this analysis is to measure how sensitive the NPV is to changes in underlying assumptions. The usefulness of this analysis is that it allows to better manage the operations and the risks of an investment, after the acceptance phase (Damodaran, 2014).

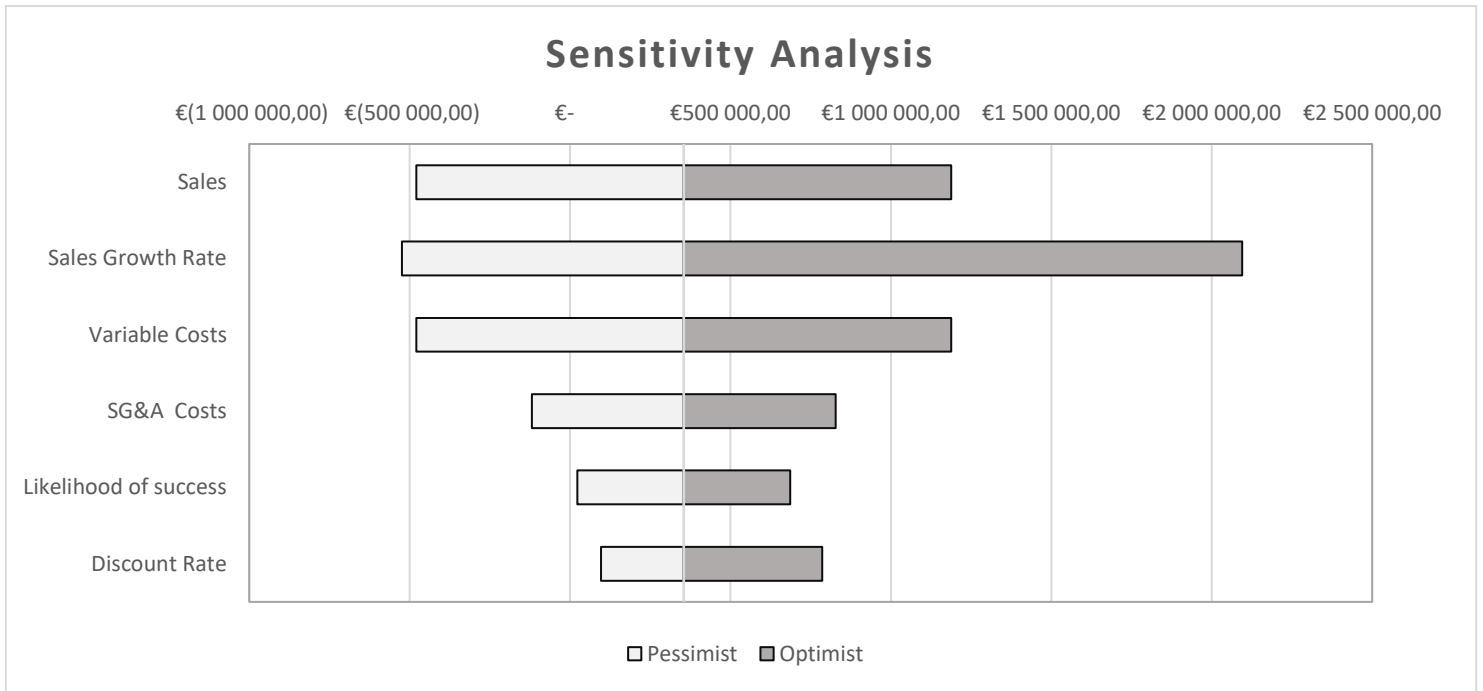
To perform a sensitivity analysis of our project, we started by defining the key variables of the project – Sales, Sales Growth Rate, Variable Costs (Gross Margin), SG&A costs and likelihood of success. After that, we established three scenarios – an expected, an optimistic and a pessimistic. The optimist and the pessimist scenarios were 50% better and worse, respectively, than the base scenario. Then, for each of the scenarios, we changed one variable at a time, while maintaining everything else constant. Note that the fixed costs are set relative to the expected scenario, that is, they are 100% in the base scenario and 50 p.p. higher/lower in the optimist/pessimist scenario. The result of this analysis is presented in tables 14 and 15, and graph 1 offers a visual representation.

Variable	Scenarios		
	Pessimist	Expected	Optimist
Sales	250 000 €	500 000 €	750 000 €
Sales Growth Rate	25%	50%	75%
Variable Costs	75%	50%	25%
SG&A Costs	150%	100%	50%
Likelihood of success	25%	50%	75%

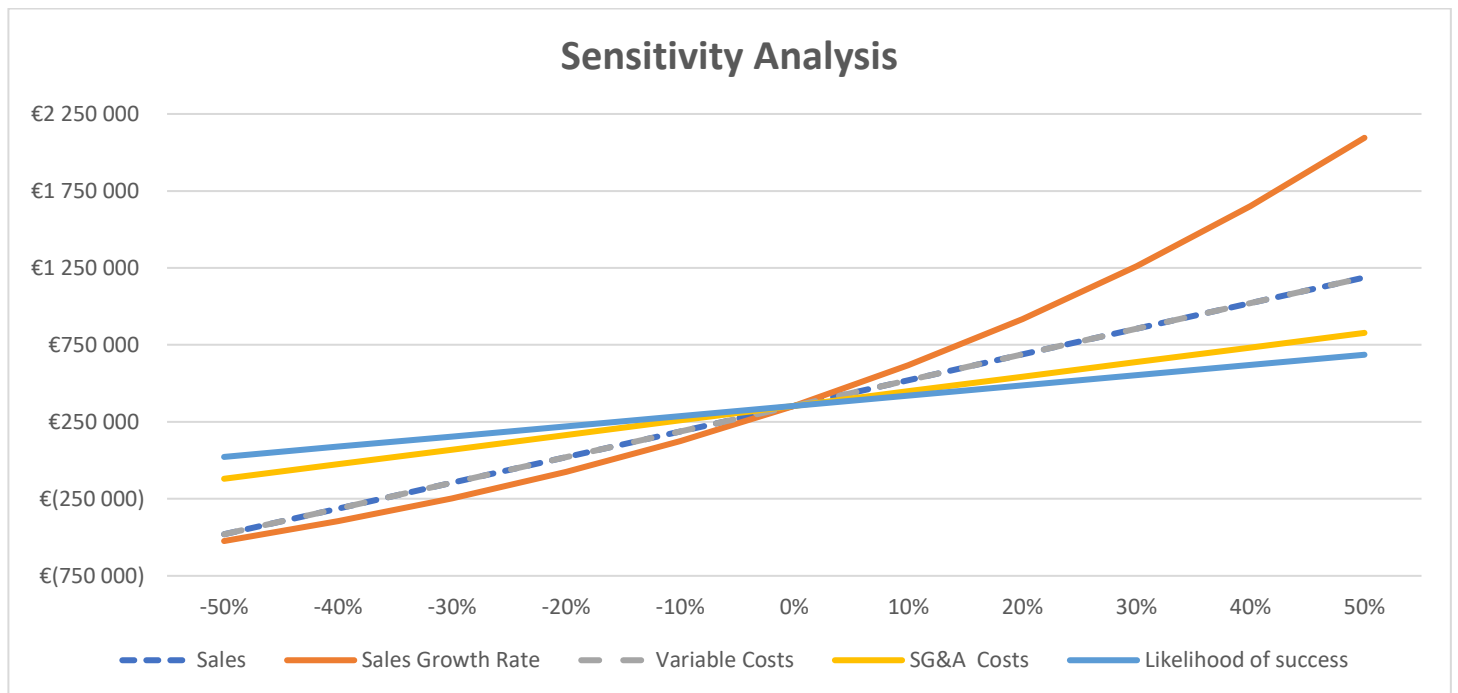
Table 14 – Scenarios and variables used in the sensitivity analysis

Variable	ENPV		
	Pessimist	Expected	Optimist
Sales	- 479 589 €	349 177€	1 187 887 €
Sales Growth Rate	- 523 789 €	349 177€	2 095 001€
Variable Costs	- 479 589 €	349 177€	1 005 240 €
SG&A Costs	- 119 492 €	349 177€	638 569 €
Likelihood of success	22 509,88 €	349 177€	619 725 €

Table 15 – The results of the sensitivity analysis.



Graph 1 – Visual representation of the sensitivity analysis



Graph 2 - Visual representation of how critical the variables are

As we can see, because the ENPV is sensitive to the sales, sales growth rate, variable costs, and SG&A costs these are the critical variables. They are critical because if the pessimist scenario

occurs in any of these variables the ENPV is negative, while the opposite is also true, that is, if the optimist scenario happens the ENPV will be significantly higher than expected. We can also observe that for the likelihood of success variables, independently of the scenario that occurs, the ENPV will be positive. Also, we can see in graph 2 how critical the variables are – the higher the slope the higher the impact of a change on that variable. We can observe that the variable that has the highest impact on the ENPV is sales growth rate, followed by sales and variable costs. SG&A costs are a border case, because in the pessimist scenario it will barely lead to a negative ENPV. We can also observe that in graph 2 – SG&A costs have a rather low slope, which indicates that ENPV is not very reactive to its changes.

What we can conclude from this analysis is that the management team should focus on the critical variables, trying to gather more information on their drivers, to reduce the estimation risk - which means that the projections will have a decreased probability of being significantly different from reality.

This analysis also reinforces the results we got from the ENPV. If the results of the sensitivity analysis were large negative values in the pessimist scenario and large positive number in the optimist scenario, it would mean that a change in a single forecasted variable could greatly alter the ENPV estimate, which would make us doubtful of the ENPV results. In this case, however, we did not observe that.

Even though sensitivity analysis is frequently used in the real world it has one big limitation, that is the fact that it only allows for one variable to change at a time. Monte Carlo simulation, however, is a further attempt to model real-world uncertainty, as it allows to measure the outcome as many variable changes at the same time. This means that, while sensitivity analysis attempted to answer the question “What if this scenario happens?”, the Monte Carlo simulation tries to calculate how likely a certain scenario is to happen (Ross, Westerfield, Jaffe, & Jordan, 2015).

According to Ross, Westerfield, Jaffe, & Jordan (2015), the first step to build a Monte Carlo simulation is to specify the basic model, which, in our case, will be the model we used earlier to calculate the ENPV. The variables that make up the model are: Sales, Sales Growth Rate, Gross Margin, SG&A costs, Probability of the R&D stage to be successful, and the discount factor. The next step is to specify a probability distribution for each variable. This choice should be based on historical data or cross-sectional data, but, in reality, it is always a mixture of real data and reasonable assumptions. The final step is to run the simulation. In each cycle, the computer will, based on the

assigned probabilities, draw one value for each of the variables, which will result in an ENPV value. After this process is repeated thousands of times, the result will be a distribution of all possible ENPV values.

Given this, we can say that simulations provide the most complete assessment of risk since they are based on a probability distribution for each input, rather than a single expected value. This results in the output taking the form of an expected value across a probability distribution. This distribution reinforces the point that valuation models yield estimates of the value of risky asset that are imprecise and can explain why there might be different valuations for the same asset (Damodaran, 2014).

To perform a Monte Carlo simulation of the project under analysis, we started, as mentioned earlier, by defining that the variables that make the model are Sales, Sales Growth Rate, Gross Margin, SG&A costs, probability of the R&D stage to be successful, and the discount factor.

For the sales, we defined that their variation was described by a triangular distribution, with a minimum value of 150 000€, a likely value of 500 000€ and a maximum value of 750 000€. The triangular distribution should be used when the minimum, maximum and the likeliest values are known. We are assuming that Company A knows that they will not sell less than 150 000€ in the first year and that selling more than 750 000€ in the same period is very unlikely. Only the sales value for 2025 was simulated since the subsequent values are calculated using the first year.

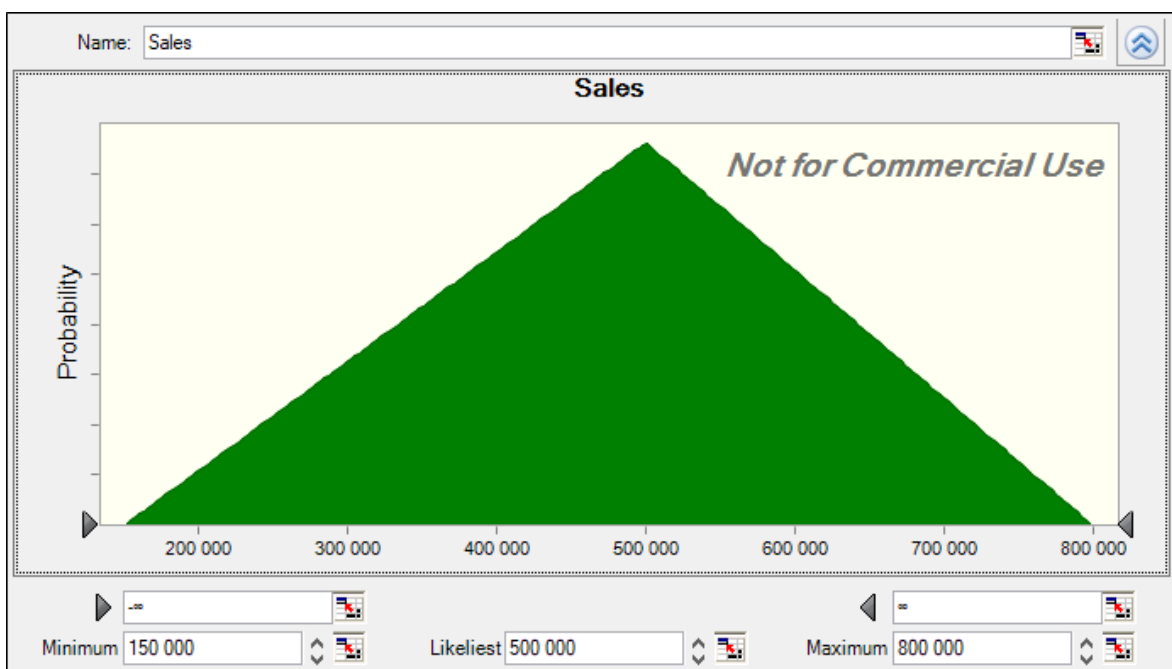


Figure 1 – Probability distribution of the expected sales.

Next, we assigned a normal distribution to the sales growth rate, with a 50% mean and 10% standard deviation. We are assuming that the probability of the rate being larger than expected is the same as being smaller.

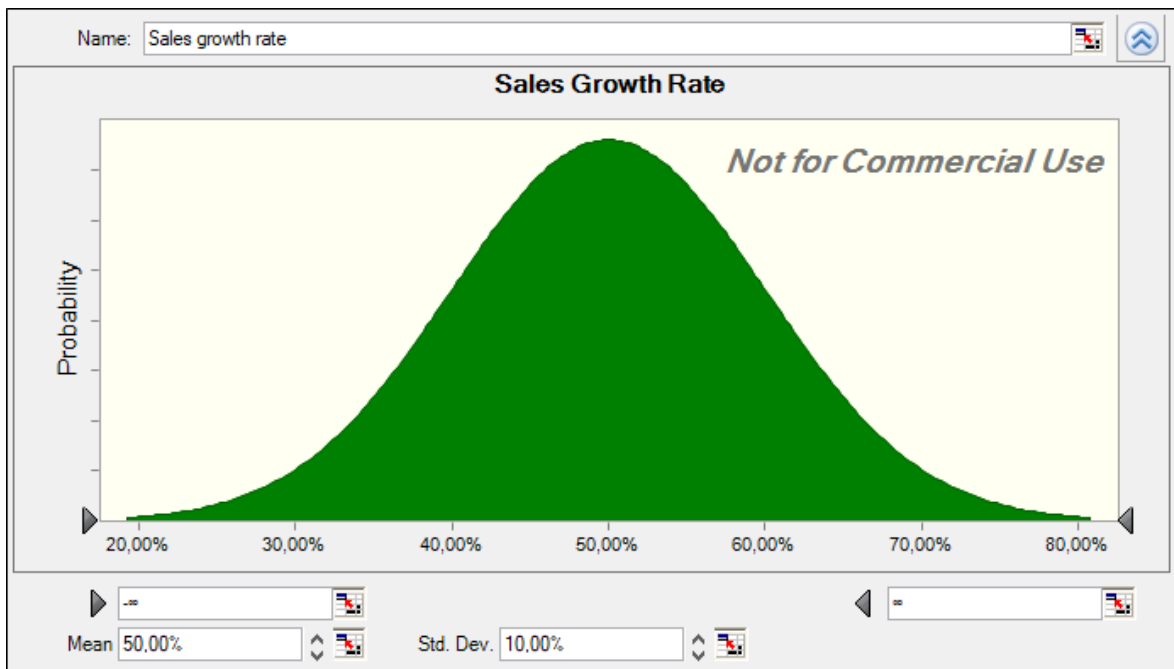


Figure 2 – Probability distribution of the expected sales growth rate.

The gross margin was assigned a BetaPERT, with a 50% likeliest value, a 20% minimum and 80% maximum. The reason was that we think that there is a high probability of the gross margin to not be significantly different from the likeliest value and we also expect that it will never be less than 20% or more than 80%.

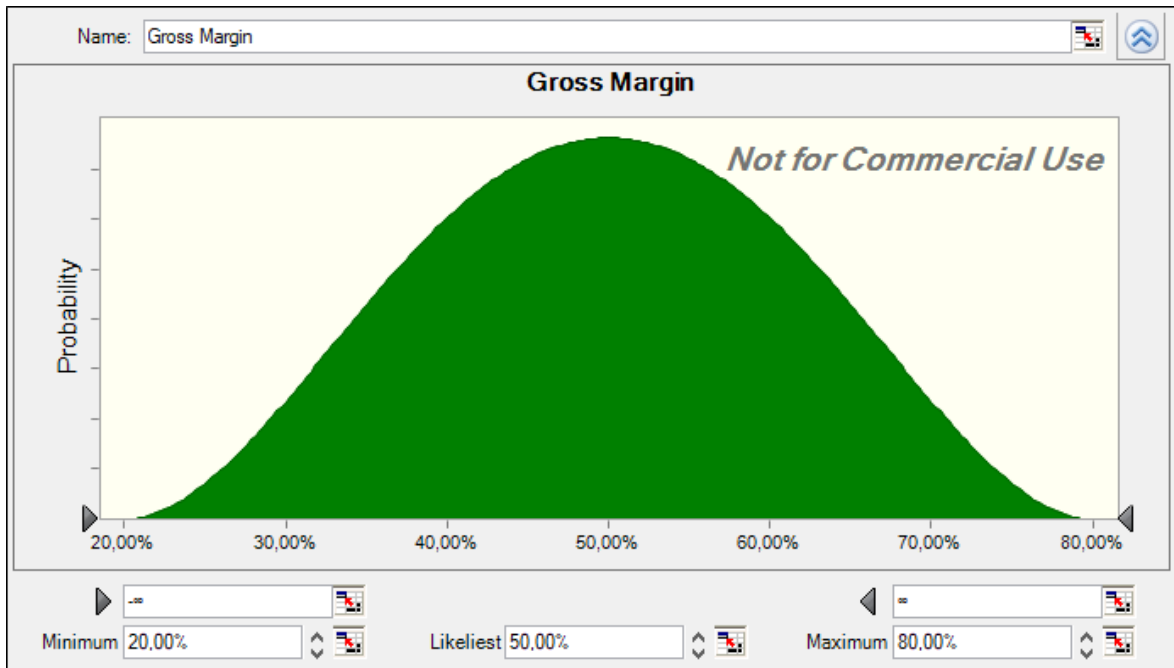


Figure 3 – Probability distribution of the gross margin.

We expect that the SG&A expenses will follow a student's t distribution, with a 100% midpoint, a 15% scale and 30 degrees of freedom. The reason is that we expect the value to be close to 100%, but we know that the actual SG&A expenses value can be significantly different from the midpoint.

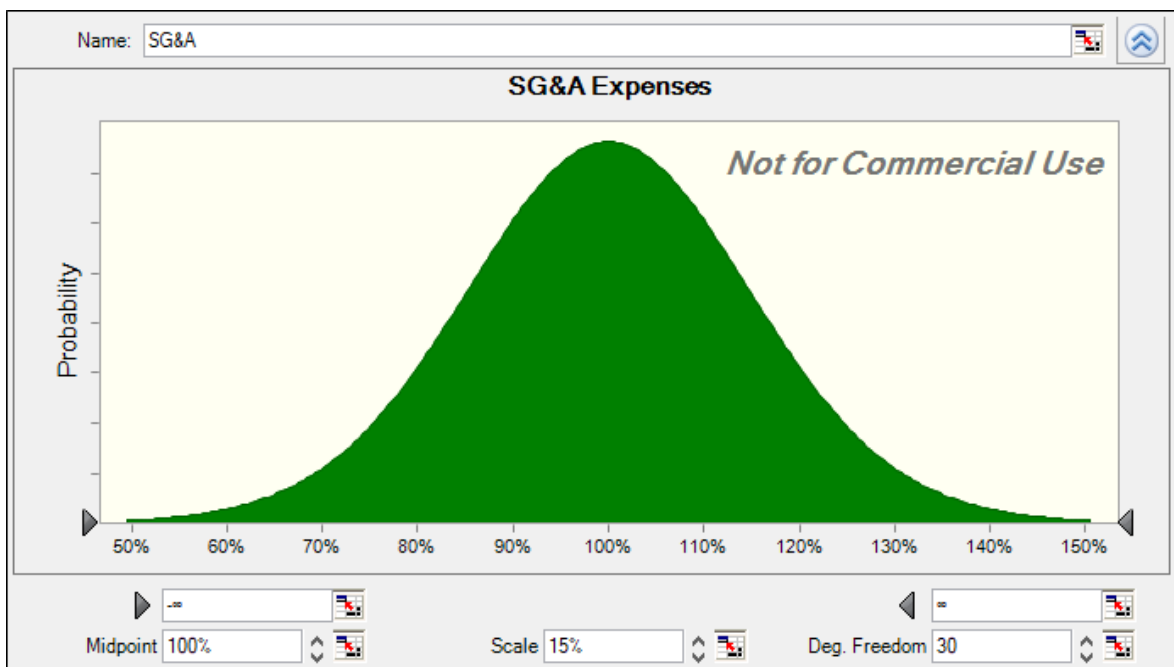


Figure 4 – Probability distribution of the SG&A expenses.

For the probability of success, we assigned a normal distribution, with a 50% mean and 10% standard deviation. The reason is that we know that 50% is the most likely value, we expect that the actual probability could as likely be above or below the mean and also that that probability is more likely to be close to the mean than far away.

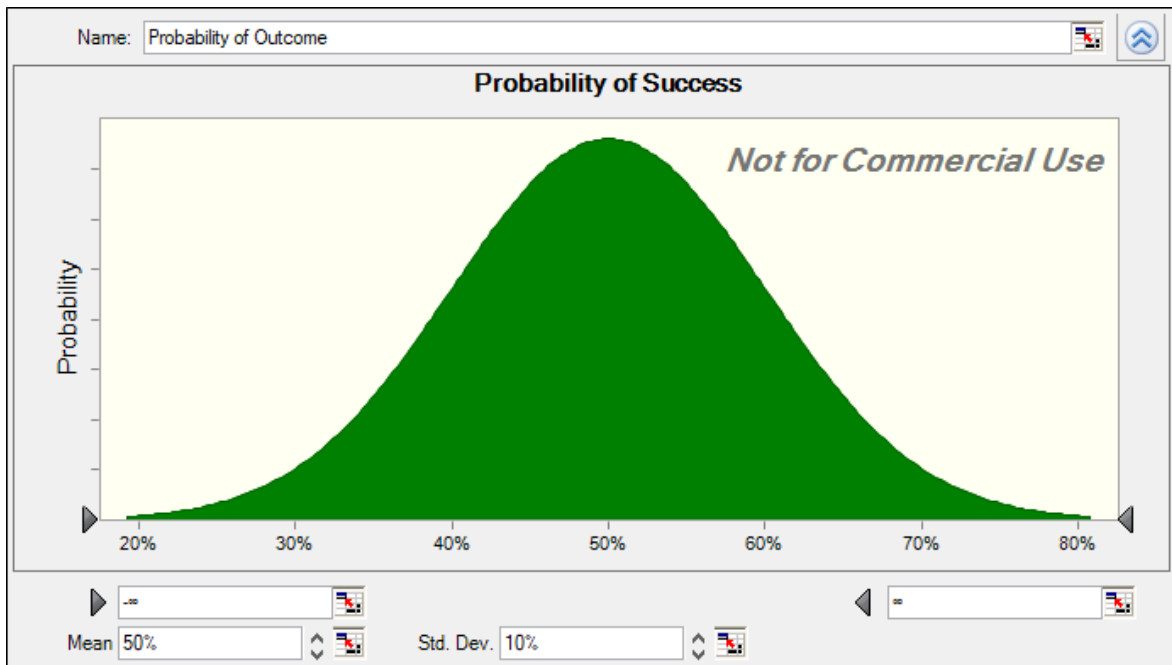


Figure 5 – Probability distribution of the probability of success.

The last variable we simulated was the discount factor. We assigned it a lognormal distribution, with a location of 2%, a mean of 8,60% and a standard deviation of 2%. The reason is that we expect the values to be positively skewed, that is, most of the values will be close to the minimum.

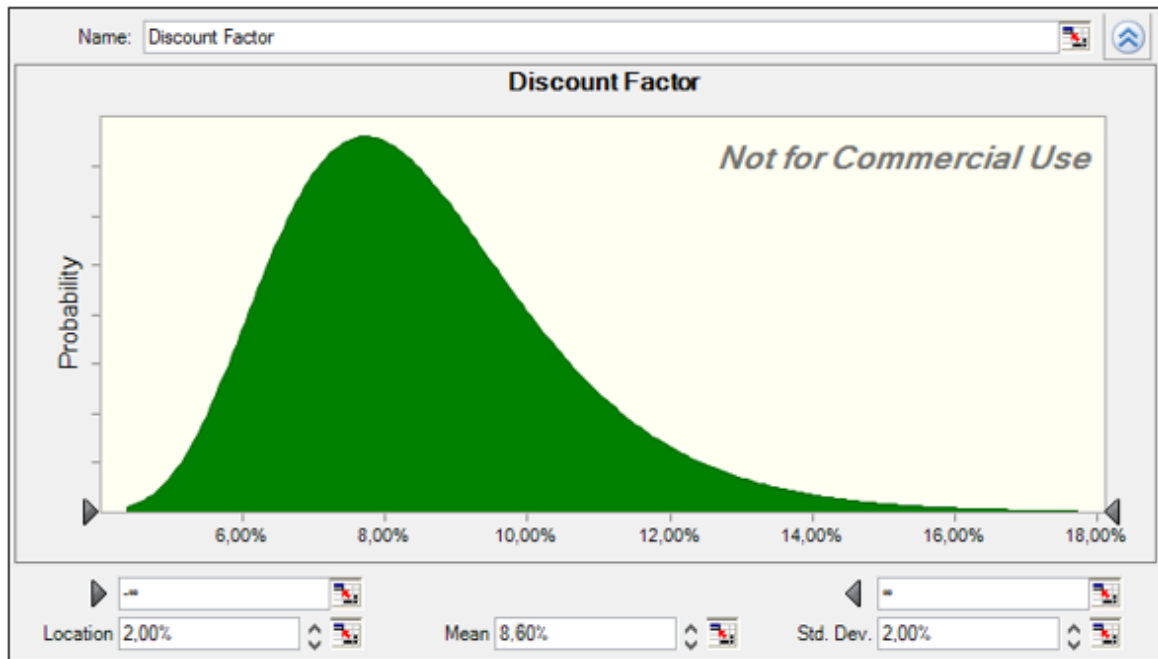


Figure 6 – Probability distribution of the discount factor.

Next, we defined that the SG&A expenses would have a coefficient of correlation of 1 with the sales. This guarantees that when the sales revenues are at their maximum so are the costs.

The final step was to run the simulation. Even though there are rigorous methods to estimate each of these variables, there is no way of guaranteeing that our estimations will fit future contexts. That is the reason why simulating a big number of scenarios is important. For that reason, we used 20 000 trails. The results were that, with a 95% confidence level, the probability of a positive ENPV value is 66.50% (figure 7). Also, ENPV can range from -909 632€ to 6 469 507€, the mean value is 383 300€ and the median value is 228 869€, which are close to the base value of 387 756,68 € (table 16). These results show that it is not expected to observe a large deviation from the base scenario. Also, it is important to notice that even though there is a 33,5% probability of the project having a negative ENPV, there is a 25% chance that the ENPV will be between – 333 352€ and 0€. That is, in case of a negative outcome, the ENPV will be a small negative number (Figure 8).

The results of the Monte Carlo simulation are aligned with the ENPV results and point at the viability of the project. For that reason, the final verdict is that the project should be accepted.

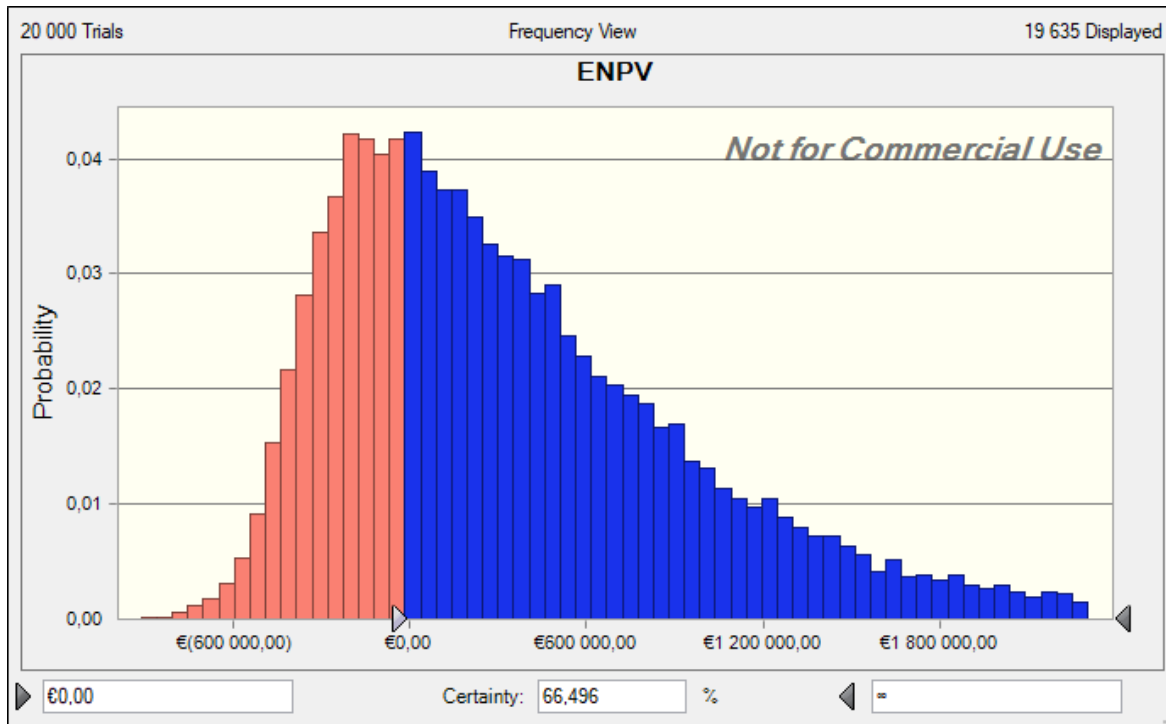


Figure 7 - Probability distribution of the expected net present value.

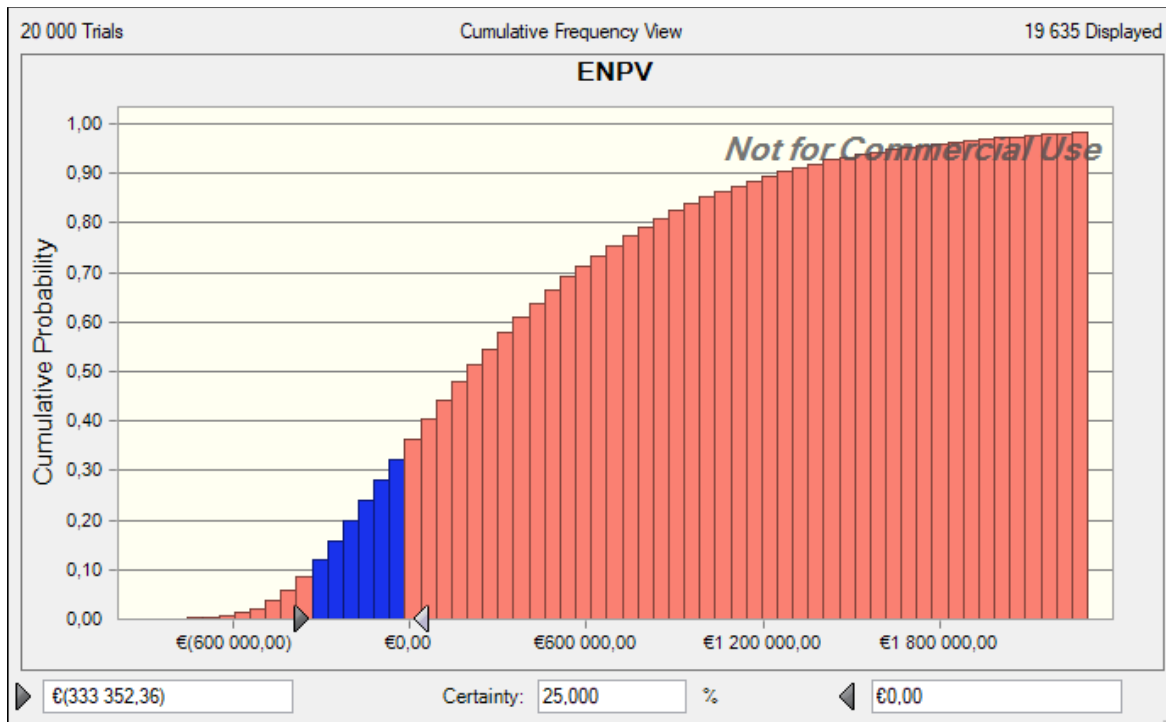


Figure 8 – Cumulative Frequency of the expected net present value.

A set of descriptive data will be presented in the following tables.

Percentiles:	Forecast values (€)
0%	(909 632,39)
10%	(308 639,87)
20%	(171 333,19)
30%	(44 408,06)
40%	85 289,91
50%	228 838,28
60%	390 818,34
70%	585 603,11
80%	848 102,54
90%	1 274 925,87
100%	6 469 507,41

Table 16 – Forecast values for the ENPV, distributed by their percentiles.

Statistics:	Forecast values
Mean	383 300,67 €
Median	228 869,63 €
Standard Deviation	684 571,52 €
Skewness	1,53
Kurtosis	6,91
Minimum	(909 632,39) €
Maximum	6 469 507,41 €

Table 17 – A set of descriptive data.

6. Conclusion/Limitations

We started the thesis by presenting the problem we are trying to solve. We said that, as a result of the initiative “*Clube de Fornecedores*”, Bosch realized that their suppliers had a severe lack of financial knowledge. The objective of this thesis was to endow the suppliers with this kind of knowledge, by doing a financial analysis on a project in which the company and Bosch were cooperating. In practice, we will value a project between Bosch and Company A. This project is an investment project, that can be divided into two stages. During the first stage, Company A will conduct R&D activities, with the expectation that those efforts will result in a sellable product. If that is the case, the project will advance to its second stage, where it will be manufactured and sold.

We started by building a framework, based on a literature review on valuation methods, that the suppliers could use to financially evaluate their decisions. The reasoning is that the decision of working with Bosch is only financially sound if the value of the company increases as a consequence of that decision. We presented a total of seven different valuation methods but argued that, for this project, the ENPV was going to be used. We justified this decision with the fact that ENPV has the advantages of using the NPV while allowing to consider uncertainty.

We proceeded by explaining that because the ENPV is a discounted cash flow model, we needed to estimate the cash flows the project will generate and a discount rate. For the discount rate, the opportunity cost of capital was used. Because Company A is a private firm, the opportunity cost was in the perspective of the firm owner. We started by saying that the weighted average cost of capital (WACC) is a mixture between the after-tax cost of debt and the cost of equity. Next, we explained that the cost of equity is calculated by adding a risk premium to a risk-free rate. Because of that, we exposed several ways of estimating these parameters.

For the risk-free rate, we used Aaa rated European bonds, with 13 years to maturity, which, at the 1st of November 2019 had a rate of -0.244%. The next step was to estimate the beta. After analysing the possible methods, we chose to calculate it by following a bottom-up approach. This required us to calculate the betas of multiple publicly traded comparable firms. After that, based on these betas and the capital structure of Company A we calculated the firm's beta, which is 4.064. The final step to calculate the cost of equity was to estimate a risk premium. To do that, we ended up using the relative standard deviation. We started by calculating the market index returns and the returns of the risk-free asset. After calculating the geometric average of both series of returns, to estimate the risk premium

we subtracted the risk-free returns to the index returns. Using the CAPM formula we estimated that the cost of equity was 16,08%. The final step was to calculate the cost of capital. Given Company A capital structure and assuming a cost of debt of 3.96% we estimated that the WACC was 8.60%.

After that, the cash flows were estimated. We had to make predictions about the sales value and their growth rate, the costs, and the investments to be made. We also estimated, for each period, the probability of the company to abandon the project. With those values estimated, we calculated that the ENPV was 349 177,10€, which means that the project should be accepted.

To finalise, we performed a risk analysis. First, with the sensitivity analysis, it was asserted that the critical variables were the Sales, the Sales Growth Rate, and the Gross Margin. We also performed a Monte Carlo simulation. The results showed that there is a 66.50% probability of the ENPV value to be between 0€ and 6 469 507€ and a 33.5% chance that they will be between -909 632,39 and 0€. A further analysis of these results shows that it is likely that the project will have a positive ENPV and that, in case of a negative ENPV, it is expected that it will be a small negative number.

There are some limitations to our thesis. First, a single discount rate was used for every period. It can be argued that this approach is not corrected because some stages of the project are riskier than others and should, therefore, be discounted at a higher rate. Second, there is a general agreement that real options are the most accurate instrument to value a risky project, such as R&D projects. However, we decided not to use real options based on the target beneficiary of our thesis. The reasoning was that if Bosch's suppliers reveal a lack of financial knowledge and the objective is to present them a framework they can use in the future, it would be unreasonable to expect these companies to use one of the most advanced and complex valuation techniques available. However, as an alternative, we proposed the use of a middle-ground method – the ENPV – which incorporates some of the real options advantages in the NPV method.

However, the main limitation of the thesis is the fact that the estimation for the cash flows was arbitrarily chosen and are, in the best case, an educated guess. Despite that fact, it is our opinion that the objective of the thesis was met. That is, over the thesis we expose and describe several possible methods to value an investment project and describe how to calculate the different parameters these methods require. We also showed how the free cash flow is calculated and how, combining the discount rate with the cash flows, we can calculate the ENPV. Our argument is that, by using the framework we used, but feeding it different numbers, any company can calculate the value of a project, and that was the objective of our thesis.

7. References

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