Universidade do Minho
Escola de Economia e Gestão

Mário Jorge Oliveira Brás

Investment decisions of a Bosch suppliers club member: a case study

julho de 2020

Universidade do Minho
Escola de Economia e Gestão

Mário Jorge Oliveira Brás

Investment decisions of a Bosch suppliers club member: a case study

Projeto de Mestrado

Mestrado em Finanças

Trabalho efetuado sob a orientação do

Professor Doutor Artur Jorge Pereira Rodrigues

julho de 2020

Acknowledgements

The completion of this thesis has been possible thanks to several people. First, I would like to acknowledge my gratitude to Professor Artur Rodrigues, who has invested a lot of time and effort in supporting me throughout the work. His suggestions and ideas were crucial for me to solve emerging problems.

I would also like to thank Carla Pereira from Hardware Development, who despite all responsibilities that her function in the company has, when always possible provided great comments and project related information. Her availability and contribution were fundamental, so I could understand what the project was about.

Finally, my colleague Pedro Francisco was also a great support as we helped each other when in doubt. Sometimes we felt lost about how things should be made, and together was easier to provide solutions.

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.

Resumo

Este projeto investiga a participação da empresa Hardware Development Inc. na iniciativa "Clube de Fornecedores". Esta empresa é uma das maiores em Portugal, tem crescido durante a última década e é esperado que continue a crescer no futuro. A firma não usa o Valor Atual Líquido para tomar as suas decisões financeiras. Consequentemente, as Opções Reais foram um assunto mencionado e comparado, mas não teve aplicação prática. Neste projeto, eu desempenhei uma análise de Fluxos de Caixa Descontados do projeto TSIM. Este é um projeto I&D, começado em 2019, proveniente da iniciativa "Clube de Fornecedores" da Bosch e é esperado que produza vendas até 2024. O custo de capital estimado para o projeto foi de 8.64%. O Valor Atual Líquido do projeto é cerca de 400 mil euros, mas é mais pequeno do que o fundo não reembolsável de 996 mil euros. O projeto é, portanto, aceitável apenas devido ao subsídio recebido. Talvez também seja preferível aceitar o projeto devido a outros efeitos não considerados neste projeto, nomeadamente futuras oportunidades que surgiriam caso as Opções Reais fossem utilizadas. A análise de risco foi feita através de uma simulação de Monte Carlo, e estimou 20% de probabilidade de o projeto produzir um Valor Atual Líquido negativo, o que é reduzido e confirma a recomendação de aceitar o projeto. A análise de sensibilidade permitiu a identificação das vendas e dos custos operacionais como as variáveis de maior impacto no projeto.

Palavras chave: Valor Atual Líquido, Fluxos de Caixa Descontados, Simulação Monte Carlo

Abstract

This project investigates the case of Hardware Development Inc. participation in the initiative “Clube de Fornecedores”. The company is one of the largest companies in Portugal, has been growing for the past decade and it is expected to keep growing in the future. The firm does not seem to use Net Present Value for its financial decisions. Therefore, Real Options was a subject matter mentioned and compared but it was not applied. In this project I conduct a DCF analysis of the project TSIM, that is an R&D project, started in 2019 and it is expected to produce sales until 2024, and that was submitted to the initiative “Clube de Fornecedores” of Bosch. The estimated cost of capital is 8.64%. The base-case scenario NPV is around 400 thousand euros, but it is smaller than the non-refundable subsidy of around 996 thousand euros. The project is therefore acceptable only because of the subsidy. It may also be worthwhile to accept because of other effects not considered in this project, namely future growth opportunities that could be valued using Real Options Analysis. The risk analysis done using Monte Carlo simulation estimated a 20% probability of the project producing a negative NPV, which is low and confirms the recommendation of accepting the project. The sensitivity analysis allows the identification of sales and operating expenses as the variables responsible for the success of the project.

Key Words: Net Present Value, Discounted Cash Flow, Monte Carlo Simulation

Table of Contents

List of Tables

List of Figures

1. Introduction

This project follows the initiative "Clube de Fornecedores" (Suppliers Club) which involves promoting and integrating the participation of Portuguese small medium enterprises (SME's), in international value chains, through cooperation with influent and relevant companies. These influent and relevant companies will ensure the SME's better conditions and access to markets and technologies.

More specifically to this project, the nuclear company here is BOSCH – Car Multimédia Portugal, SA and the potential supplier which I will be evaluating is Hardware Development Inc.

BOSCH wants to increase its number of Portuguese suppliers. To make this possible to accomplish, BOSCH identified an ecosystem of companies that have the potential to meet the requirements of a proper supplier. Although these companies have the scientific and technical knowledge, their decisions are not very well sustained financially.

Several financial analysis methods will be applied and the goal here is to use the best "state of art" that finance can provide, in order to give the best solution to the problem. However, the financial methods that might be implemented and used to achieve informed financial decisions will depend on Hardware Development's willingness to change their methods and the level of complexity they will be able to reach.

One of the main goals here is to contribute and to improve the financial knowledge and awareness of Hardware Development. Also, personally, my goal is to correctly apply what I have studied and add value to the company.

After meetings with Bosch's Project Innovation department, the goal was not to assess the value of Hardware Development but assess the incremental value that participating in this project will give to the supplier. Therefore, it was necessary to access Hardware Development's application to "Clube de Fornecedores" to obtain the financial information needed to value the project.

From BOSCH's perspective, the main goal is to decrease importations to have a more solid supply and work with Portuguese products.

This project has also a global objective which is to contribute to a change in the ecosystem of this sector. It has the potential to change the market. The expected contributions are:

- Encourage these suppliers to go along BOSCH's growth worldwide, allowing these companies to be positioned not only as BOSCH's suppliers but also to other clients.

- Decrease importations with the increase on Portuguese supply and value added.
- Increase qualified employment in the ecosystem.
- Promote innovation and entrepreneurship to attract foreign investment in our country.

Last, but not least, it is important to say that these innovation projects will certainly promote a more sustainable and healthy national economy.

2. Company's Recent Performance and the Market Context

Founded in 1995, Hardware Development has been growing and developing its business in a balanced and sustainable way. The company's main activity is dedicated to hardware and software development for industry in general, with high vocation to car industry and great know-how in industrial automation. Currently, Hardware Development is one of the biggest companies in the Portuguese ecosystem of small medium enterprises.

Palepu & Healy (2012) state that "in analyzing a firm's profit potential, an analyst has to first assess the profit potential of each of the industries in which the firm is competing". Therefore, in order to have a better comprehension of the company's current situation, I performed a market study specific to the sector with the same economic activity code as Hardware Development in Portugal. This economic activity code is noted as: Manufacture of instruments and appliances for measuring, testing and navigation. This brief analysis goes through market and company past income statements, structure ratios, dimension, and capital structure.

After gathering information and meetings with the company, it was possible to state that Hardware Development expects to enter aerospace and aeronautic markets in the future. These markets have a great level of technology integration and can add significant value to the company. In relation to the customers, the company is currently trying to diversify and not depend in one customer as it happened in the past with the case of Bosch. Currently they have Bosch, Visteon, Delphi, Preh and Continental as their main customers.

Because of the recent public international scandals related to manipulation of CO_2, those in the industry are concerned. This is an opportunity for Hardware Development since their main activity is to develop software and hardware systems for testing equipment and making sure everything is under control and legal.

2.1. Sales and Net Income

Concerning the main indicators of corporate performance such as sales and net income, the company is positioned as one of the leaders in the Portuguese industry. In relation to historical sales, the table below shows how the company is compared to the average Portuguese industry.

Sales have been growing a lot in the past few years, with a small decrease in the last year. The number of relevant companies that make up the Portuguese industry is around 33.

	2013	2014	2015	2016	2017	2018
Industry Average Sales	1 552,88 €	1 951,69 €	2 148,61 €	2 533,52 €	2 696,26 €	2 068,80 €
Hardware Development's Sales	3 867,85 €	5 523,45 €	8 275,06 €	12 018,88€	21 071,34€	14 282,06 €
Annual Growth rate		42,80%	49,82%	45,24%	75,32%	-32,22%
5-year Growth rate	*269,25%*					

Table 1 - Historical Sales
Source: Amadeus
Values in thousands of Euros

This growth is reflected in the 5-year growth rate of 269,25%. This means that the company had an exponential growth in recent years and the decrease in sales growth might indicate that the company is starting to reach maturity. The graphic below illustrates sales evolution.

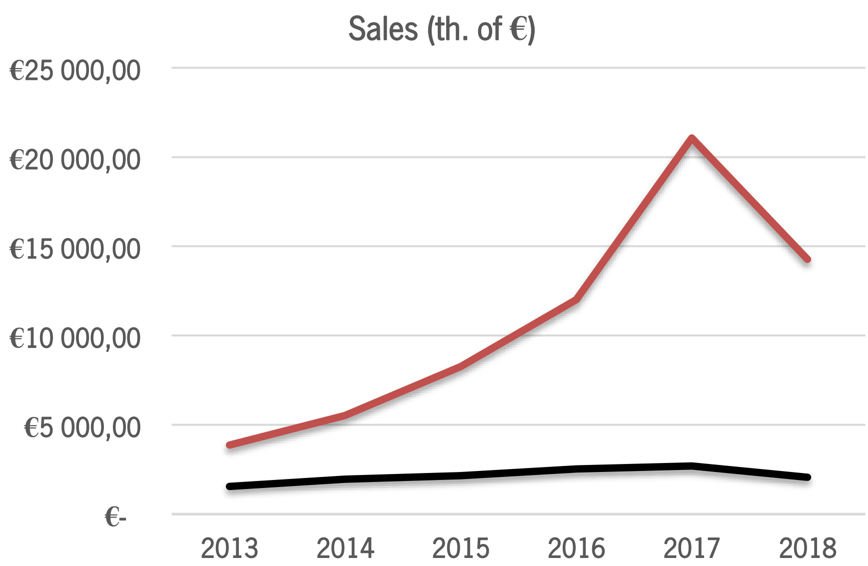


Figure 1 - Sales Evolution (Amadeus)

In relation to net income, the behavior has been even more positive than sales. The company has grown 1209,19% in the last 5 years, according to net income. It also had a small decrease in the last year but not as high as it happened with sales.

Table 2 marks the facts explained. Values in thousands of Euros.

	2013	2014	2015	2016	2017	2018
Industry Average Net Income	90,38 €	120,15 €	96,99 €	150,82 €	216,75 €	278,36 €
Hardware Development's Net Income	214,38 €	584,60 €	562,26€	1 299,95€	2 947,68€	2 806,71 €
Annual Growth rate		172,69%	-3,82%	131,20%	126,75%	-4,78%
5-year Growth rate	1209,19%					

Table 2 - Historical Net Income
Source: Amadeus
Values in thousands of Euros

When comparing company and market behavior in the plot below, it is possible to notice that net income has a much higher variation from 2013 to 2017, and this is where we can state that the company is really one of the biggest in the Portuguese sector. Results way above industry average.

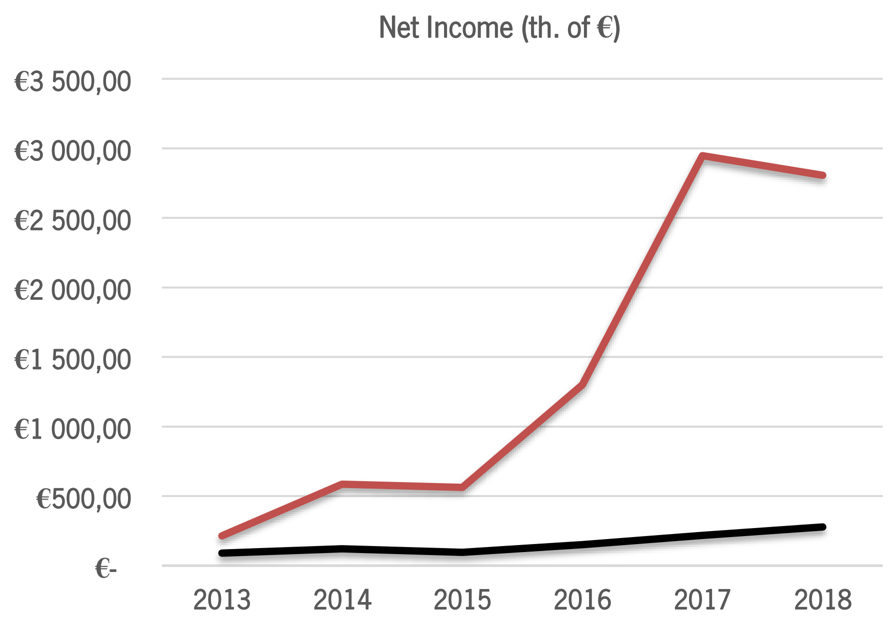


Figure 2 - Net Income Evolution (Amadeus)

2.2. Capital Structure and Company Size

Next is presented a capital structure analysis with the complement of comparing company's net working capital and number of employees with the Portuguese sector. This is important to perceive Hardware Development's dimension, in terms of actual capital and amount of people contributing to higher results.

	Hardware Development	Industry Average
Total Assets	13 811 712,00 €	2 837 689,00 €
Equity	7 751 994,00 €	1 474 298,00 €
Long-term Debt	2 969 951,00 €	930 404,00 €
Short-term Debt	3 089 767,00 €	912 578,00 €
Equity + Debt	13 811 712,00 €	2 837 690,00 €
Working capital Last avail. yr	3 089 766,85 €	1 079 990,00 €
Number of employees Last avail. yr	96	22

Table 3 – Size Comparison - Balance Sheet 2018
Source: Amadeus
Values in Euros

Concerning the table above, it is possible to conclude that the company is clearly one of the largest of the sector. There is only one company in the Portuguese industry that has a higher number of employees which is "Janz – Contagem e Gestão de Fluídos, S.A.", with 234 employees. This probably is the main competitor of Hardware Development in Portugal. These two companies are well above industry in terms of dimension and results. Despite Janz having higher number of employees, both companies' capital structure and dimension is very similar. Industry's data as well as Hardware Development's is available in appendix. Hardware

Development's balance sheet is available in appendix 1.

2.3 Financial Ratios

Financial ratios are very important for a company to study its financial analysis. Managers use financial ratios to understand a company's short-term and long-term health, as well as analyzing competitor's policy and checking on costumer availability to extend debt. It is necessary a benchmark for assessing a company's financial position. It is useful to compare the company's current financial ratios with the correspondent industry average. (Brealey, Myers, & Allen, 2011)

The following table shows financial ratios for 2018, comparing the company's ratios to the industry average.

	Hardware Development	Industry Average Ratios
Liquidity ratio	1,61	2,95
Solvency ratio %	56,13	45,87
ROE %	36,21	19,37
ROCE %	26,37	12,71
ROA %	20,32	5,18
Profit margin %	20,28	10,11
EBITDA Margin %	22,11	15,62
EBIT Margin %	20,42	10,65

Table 4 - Financial Ratios Comparison
Source: Amadeus

Analyzing Table 4, it is possible to perceive that the company is financially healthy. The company presents better capability of honoring their obligations in the long-term than industry, and in general, it has more return and profits than the average of industry. The only downside of financial ratios for Hardware Development is liquidity ratio. This ratio is below industry average which means that the company might have difficulty to honor obligations in the short run. A solution to this problem probably should be reducing its average term receivables.

In general, the company is financially healthy, it is one of the largest companies in Portugal at this business, it is profitable and has growth prospects.

3. Problem Presentation

The main objective of this project is to help Hardware Development Inc. to have a better financial perspective in R&D projects, as well as assess these projects. The company is currently involved in three projects related to “Clube de Fornecedores”. I will evaluate TSIM project because it involves a product development, and the company was willing to provide information.

3.1. TSIM

TSIM is a R&D project with the objective of conception and development of modular test systems, interactive manuals, and a remote assistance system, using augmented reality.

TSIM is structured in three components that divide into the principal R&D lines:

- R&D of a new automatic modular test system focused on the development of coupling modules that allow the test of different types of products in the same platform.
- R&D of a new self-diagnosed automatic test system developed for quality and reliability assessment of the product.
- R&D of a new interactive after sales assistance application for maintenance, with the objective of developing a system that allows visualization of equipment’s information and after sales assistance utilizing augmented reality techniques.

This project started in 01/05/2019 and it is expected to end in 30/04/2022. Relatively to this project, the company received an incentive in the value of 996.463,95€. However, the total cost for this project is 1.541.716,56€. Similar to the previous project, the remaining investment will be through the company’s own equity. All financial supports are not refundable, and the project has no other costs different.

The purpose of this project will be mainly focused on financially evaluating the TSIM project. It is important to mention that some assumptions had to be made.

Hardware Development has been developing specific solutions for each customer needs. It is difficult to produce a table with unit costs of a specific product and which sale price to apply because each product is different from deal to deal. TSIM is about developing a new, innovative, and high technology test machine that the company didn’t have until now. Therefore, the predicted sales are very empiric. This means that the company will definitely be more efficient in their production from now on, derived from the new machine and technology, but because the machine produces different solutions for each customer, there is not a specific product that is constant. Also, the values of sales predicted from the project are not only estimated through each solution developed. It also incorporates an increase in knowledge and improvement in other solutions that come from that knowledge.

The company assumes that this R&D project has huge impact on the company's growth and development of other solutions.

4. Literature Review

Capital budgeting is a process to evaluate potential profitable projects before they are approved or rejected. These capital budgeting problems can be solved through discounted cash flow (DCF) analysis. DCF consists in predicting future cash flows from determined project, discount them back at a given discount rate, subtract the initial investment and then we obtain the Net Present Value (NPV) of that project. Another capital budgeting method is the Internal Rate of Return (IRR) analysis. The IRR is the rate of a determined project which is equivalent to a null NPV. Then, if the cost of capital is lower than the IRR the project will be profitable. (Brealey, Myers, & Allen, 2014)

In conclusion, risk takes part of economic efficiency when evaluating capital budgeting projects. The more complex and uncertain a project is, the greater the importance of having this dynamic approach and having respect for risk. Literature says that risk is the most important factor in investment projects. Which is why I will have it very much in consideration.

4.1. Investment Definition

When earnings and revenues exceed the value of the costs, a firm can either choose to keep the excess as saving and have no growth in the future, or it can give up the immediate possession and reinvest the money in order to get a larger amount after a certain period. Investment is then defined by Reilly and Brown (2012) as the current commitment of dollars for a period to get future payments that will compensate the investor for the time value of the funds or the opportunity cost, the expected rate of inflation and the uncertainty or risk of future payments. This type of compensation, in which the investor is rewarded for the risk that is exposing himself in the investment, is described as return on initial dollar amount invested, or investor's required rate of return. This is the minimum rate of return an investor accepts as a compensation for deferring consumption. (Reilly & Brown, 2012)

4.2. Discounted Cash Flow (DCF) Analysis

Discounted cash flow (DCF) analysis is a project or asset valuation method used to estimate the present value of the future expected cash flows associated to the project or asset. Damodaran (2014), states that the process by which future cash flows are adjusted to reflect these factors is called discounting, and the magnitude of these factors is reflected in the discount rate which is the cost of capital. DCF is considered by big company's managers as the "most accurate and flexible method for valuing projects." (Goedgart, Koller, & Wessels, 2005)

4.2.1. Net Present Value (NPV)

A very important variable that is considered, as Firer, Ross, Westerfield & Jordan (2012) state, is time value of money, because a dollar today is worth more than a dollar tomorrow. Hence, the net present value (NPV) of the future cash flows $(\mathrm{CF_t})$ at a given point in time t, discounted back at a risk-adjusted discount rate r, can be written as:

$$\mathrm{NPV} = -\ \mathrm{Initial\ Investment} + \sum_{t=1}^{N} \frac{\mathrm{CF_t}}{(1+r)^t}$$

Where:

CF_t = Cash flow in period t

r = Discount rate (WACC)

N = Life of the project

After NPV is calculated, it is very simple to decide if the project must be accepted or not, because the hurdle rate is already factored in the present value. (Damodaran, 2014)

$$\mathrm{If\ NPV} > 0 \rightarrow \mathrm{Accept\ the\ project}$$

$$\mathrm{If\ NPV} < 0 \rightarrow \mathrm{Reject\ the\ project}$$

4.2.2. Internal Rate of Return (IRR)

The IRR is very close relatively to NPV. If used correctly both are supposed to produce the same answer. Brealey, Myers & Allen (2011) state that IRR rule stands as the following: "Accept investment opportunities offering rates of return in excess of their opportunity costs of capital." This statement when properly interpreted, is absolutely correct. The challenge is to interpret it in long-lived investment projects.

Concerning IRR definition, it can be defined as the discount rate that makes NPV = 0. IRR is illustrated in the following formula:

$$\mathrm{NPV} = -\ \mathrm{Initial\ Investment} + \sum_{t=1}^{N} \frac{\mathrm{CF_t}}{(1+\mathrm{IRR})^t} = 0$$

CF_t = Cash flow in period t.

IRR = Internal Rate of Return

N = Life of the project.

Hence, to find IRR for an investment project lasting t years, it is necessary to solve the previous equation for IRR. (Brealey, Myers, & Allen, 2011)

4.3. The Argument for Incremental Cash Flows

A project valuation depends on earnings and cash flows. So, we must examine which one provides a more reliable measure of performance. There are two arguments stated by Damodaran (2014) for us to use incremental cash flows and not accounting earnings (such as net income). The first one is that earnings can be manipulated by accountants for individual periods using elaborated accounting techniques. The author states that the second argument is much more direct. The author says business accepts other payoff but cash. Hence, a project that generates positive earnings and negative cash flows, provides a cash outflow despite earnings. Conversely, projects with negative earnings and positive cash flows, might not be accepted whilst providing a cash inflow to the company. (Damodaran, 2014)

As this is a project valuation and I want to calculate the project value, and not the company's overall value, the incremental cash flows will take place in the estimation. The incremental cash flows that the project will add to the company's business that we should focus on. (Damodaran, 2014)

The book looks to different inputs before estimating cash flows. To calculate cash flows, we need to pass through revenues, operating expenses, operating income, and net income. After estimating net income, we need to add back the depreciation charges and subtract the working capital requirements (annual variations in working capital) and capital expenditures (CAPEX). In the last year of the project, the salvage value of the entire working capital will be added. (Damodaran, 2014)

To get from after-tax operating earnings, which measures de earnings to the firm, to cash flows to the firm's investors, Damodaran (2014) states that we must take into consideration the three factors outlined:

- Add back depreciations and amortizations to the operating earnings (noncash charges).
- Subtract capital expenditures (cash outflows).
- Net the effect of changes in working capital, if noncash working capital increased, the cash flows will be reduced by the change and vice-versa.

Depreciations and amortizations are very important because they not only reduce taxable and net income, but also add back its value after net income to calculate cashflows, producing a tax benefit of having depreciations. With this procedure, the company is having a tax benefit associated to noncash expenses before net income but is also being compensated when adding the total value of depreciations to after-tax net income. (Damodaran, 2014)

In the case of projects with large depreciations charges, it is produced a large tax-benefit from depreciations, which can be written as follows:

$$\text{Tax benefit of depreciation} = \text{Depreciation} * \text{Marginal tax rate}$$

The following table gives an intuitive explanation of what was explained before:

Cash Flows	Year (t)
+Revenues	1
Operating expenses	
-Exploration costs	2
-Labor	3
-Depreciations	4
EBIT	5 = 1 – 2 – 3 – 4
Taxes	6
Net Income	7 = 5 – 6
+Depreciations	4
-/+Change in working capital	8
-Capital Expenditures (CAPEX)	9
Free Cash-Flow	10 = 7 + 4 – 8 – 9

Table 5 - Cash Flow Calculation (Damodaran, 2014)

4.4. Capital Asset Pricing Model (CAPM) and the Cost of Equity (Ke)

This section is the first of those explaining the methods applied to obtain the discount rate at which cash flow will be discounted.

The Capital Asset Pricing Model (CAPM) describes the relationship between expected return and systematic risk of assets. CAPM is widely used throughout companies that use finance to sustain their investment decisions. It is one of the most used methods in finance, despite having some limitations and assumptions that deviate from how things happen in reality.

Damodaran (2014), states that CAPM assumes that there are no transactions costs, all assets are traded, and investments are infinitely divisible. It also assumes that markets are efficient, with investors not finding under or overvalued assets and not having access to private information. Another limitation of CAPM is that, because the model is based on a linear relationship between returns and systematic risk (beta), it assumes that beta is constant over time.

As said before, CAPM is based on the relationship between an asset's beta, the risk-free rate, and the market risk premium. The model is now illustrated in the following equation:

$$\text{Expected return} = \text{Risk free rate } + \text{Beta} * \text{Equity Risk Premium}$$

In summary, CAPM is an economic model for valuing any type of assets by relating systematic risk and expected return. Overall, the general idea behind CAPM is that an investment has to compensate the investor by two different sources: time value of money which is reflected through the risk-free rate, and the risk premium that is "the additional expected return per unit of risk borne". (Sharpe, 1964)

In relation to publicly traded firms, it is possible to calculate the cost of equity through capital asset pricing model (CAPM). The betas in the CAPM and multifactor models that measures risk, are usually estimated using historical stock prices. Because there are no stock prices in private firms, as well as many private firm owners fail to diversify, it is very difficult to estimate accurate betas for these firms. (Damodaran, 2012)

Following Damodaran (2012), in the absence of such information, as is the case with private firms, there are three ways in which we can estimate betas: fundamental betas, accounting betas and bottom-up betas.

Due to some limitations from fundamental betas and accounting betas, referred in the book, bottom-up betas seem to be the most accurate method to quantify this variable. For example, a limitation in fundamental betas is that the R-squared of the regressions are very low, providing large standard errors in the predictions. In relation to accounting betas, because it considers changes in the company's earnings to regress against changes in S&P500 earnings, the limitation urges when private firms usually measure earnings once a year. This leads to regressions with very few observations and limited statistical significance. Another counterpart of accounting betas is that earnings are often smoothed out by private firms which leads to mismeasurement. (Damodaran, 2012)

4.4.1. Bottom-Up Betas

Bottom-Up betas can be estimated for private firms, and the reason that I chose this method to calculate the company's beta is because it has the same advantages that it does for publicly traded firms. Hence, the beta for Hardware Development, can be estimated by looking at the average betas of the industry's publicly traded companies. The differences in financial leverage and capital structure are adjusted to Hardware Development's situation for the final estimate.

Damodaran (2014), suggests the following to adjust unlevered betas for financial leverage and capital structure of the private firm:

- First, we assume that the private firm's market debt-to-equity ratio will be equivalent to the industry's average. Also, comparable firms stand for publicly traded companies in Europe with the same economic activity code as Hardware Development. Hence, we first need to find the levered beta of the publicly traded companies that generate income from similar operations as the private firm. Then, it is necessary to un-lever these comparable companies' beta using their debt-to-equity ratio. This is done by solving the following equation for $\beta_{U\ C.Company}$, where C. Company stands for "comparable company".

$$\beta_{L\ C.Company} = \beta_{U\ C.Company}[1 + (1 - \text{Tax rate})\left(\text{C. Company}\frac{\text{Debt}}{\text{Equity}}\right)]$$

Following Reilly and Brown (2012), the $\beta_{L\ C.Company}$ is calculated by running a simple linear regression of a security's returns against the market returns in a certain period of time, calculating their daily variations, and then use the following formula:

$$\beta_{L\ C.Company} = \frac{\text{Cov}\ (R_I, R_M)}{\text{Var}\ (R_M)} = \frac{\sigma_{im}}{\sigma_m^2}$$

Where:

$\text{Cov}\ (R_I, R_M)$ = Covariance of returns of a security and the market

$\text{Var}\ (R_M)$ = Variance of returns of the market

Applying to this project development, the market returns will be a European stock index and the security's returns will be the stock price returns of the comparable companies with same economic activity code in Europe. The data used will be further explained.

- The book states that if there is only a small number of comparable companies, it is necessary to widen the industry for a better sample. Also, the book provides two options of un-levering betas. One is to average levered betas, debt-to-equity ratio and tax rate for the sector and un-lever using the averages. The other is to un-lever beta for each the comparable firms and use each of their own inputs to un-lever the beta. And hence, average this value for the final industry's un-levered beta. I will follow the second option for better estimates of un-levered betas. Also, the final un-levered beta of the industry will be a simple average and not a weighted average (using market capitalization for the weights) because Damodaran (2014) states that "the savings in standard error are larger if a simple averaging process is used".

- Before adjusting the previous value for the firm's capital structure, the book says we need to do an adjustment for cash. Because the beta that we obtain might be affected by the cash holdings of the comparable firms, and because investments in cash and market securities have almost null betas, it is necessary to adjust it for cash. For cash adjustment we use the following formula:

$$\text{Unlevered beta corrected for cash} = \frac{\text{Unlevered beta}}{\left(1 - \frac{\text{Cash}}{\text{Firm Value}}\right)}$$

- After I get an un-levered industry beta, finally it is necessary to use the private firm's target or optimal debt-to-equity ratio. So, we re-lever beta, using the private firm's capital structure, as presented in the following formula:

$$\beta_{\text{L private firm}} = \beta_{\text{U industry}} \left[1 + (1 - \text{Tax rate}) \left(\text{Optimal} \frac{\text{Debt}}{\text{Equity}}\right)\right]$$

There are three advantages when using bottom-up betas, following Damodaran (2014):

- Possibility to estimate accurate betas for private firms.
- Because we use a large number of betas from the business, it will be more precise than any individual firm's regression beta estimate.
- "The bottom-up beta can reflect recent and even forthcoming changes to a firm's business".

4.5. Modified Historical Risk Premium

Damodaran (2012), defines market risk premium as "the premium demanded by investors for investing in the market portfolio, which includes all risky assets in the market, instead of investing in a riskless asset". The book considers different approaches to calculate market risk premiums such as Historical Average Risk Premiums and Country Risk Premiums. I will use the country risk premium so the estimation is adjusted to the market of my company so it can better reflect Portuguese conditions.

This methodology starts with a basic assumption given by Damodaran (2014) that the risk premium in any equity market can be written as:

$$\text{Equity risk premium} = \text{Base premium for mature equity market} + \text{Country premium (if any for a specific market)}$$

The base premium is made from the argument that the United States equity market is mature and that there is enough historical data to make a reasonable estimate of the risk premium. The easiest way to make a judgement on the default risk of a government is to assume that any sovereign that is Aaa rated is mature and default-free. The ratings assigned will be obtained from a major rating agency that is Moody's. (Damodaran, 2014)

The estimation of the final equity risk premium goes through 5 steps, following Damodaran's methodology:

1. <u>Estimating mature market risk premium.</u>

The first step consists in using a mature market risk premium as a basis such as the United States market. Following the steps of Damodaran, he firstly computes the implied equity risk premium (ERP) for the S&P500. Data on implied ERP is available on the authors website.

2. <u>Estimate the default spread for the country in question.</u>

The second step is to define the rating assigned for Portugal in order to get a default spread. For this, Damodaran states that the estimation should be based upon the local currency sovereign rating for the country from Moody's website.

3. <u>Convert the default spread into a country risk premium.</u>

Country default spreads that come with country ratings provide important information, but still only reflects default risk. Damodaran (2014), states that it is expected that country equity risk premium to be larger than the country default risk spread since equities are riskier than bonds. To address the issue of volatility, here we are adjusting the country default spread for the additional volatility of the equity market to get a country premium. Therefore, to scale the default spread up to reflect the higher risk of equity in the market, relative to the default spread, we use relative ratios for individual countries. These ratios are calculated by dividing the volatility of the equity market for that country (σ_{Equity}) relative to the volatility in bonds for the same country

$(\sigma_{Country\ Bond})$ used to estimate the default spread. In my case of course I will use the ratio calculated for Portugal.

This equation is given by Damodaran (2014) as follows:

$$\text{Country risk premium} = \text{Country default spread} * \left(\frac{\sigma_{Equity}}{\sigma_{Country\ Bond}}\right)$$

4. Compute a total equity risk premium.

In this step we simply add the mature market premium from step 1 to the country risk premium from step 3 to get a total equity risk premium, illustrated in the following equation:

$$\text{Equity risk premium} = \text{Country risk premium} + \text{Base premium for mature market}$$

The author says that this is the most realistic approach for the immediate future. However, this type of risk premium approach works using the country risk premium for only one country because the company only operates in Portugal. Otherwise it would be necessary to produce a weighted average of risk premiums depending in how many countries the company would operate. (Damodaran, 2014)

4.6. Risk-Free Rate

The final input necessary to calculate cost of equity through CAPM is the risk-free rate. To calculate the required return on a risky asset, Damodaran (2014) states that generally we begin with an asset that is defined as risk-free. Using its expected return as the risk-free rate, the expected return on a risky asset will always be measured relative to the risk-free rate.

Also, for an investment to be risk-free, the investor has to have the certainty that a determined income is guaranteed. Risk-free rate is one of the fundamental inputs to define the required return to equity on an investment. However, instead of what most people think, the concept of risk-free rate can be difficult and tricky to apply. Damodaran (2014), states that there are two conditions for an asset to be considered risk-free. The first one is that there has to be no default risk, which implies that the security has to be issued by a government. This happens because it is very difficult for a government to go to bankruptcy. However, some fewer stable countries can cause problems and not being default-free. The second condition is that there can be no uncertainty about reinvestment rates. For this to happen, for a 5-year investment, the risk-free rate for this time horizon must be the expected return on a default-free (government) five-year zero-coupon bond. (Damodaran, 2014)

4.7. Cost of Debt (Kd)

Concerning publicly traded firms, the cost of debt is typically calculated using yields on bonds issued by these firms. With private firms not being rated and not having bonds outstanding, different approaches are used. (Damodaran, 2012)

Damodaran (2012), presents different alternatives to calculate de cost of debt. One is to calculate the cost of debt using the interest rate on the borrowing from the last weeks or months. But it also states that interest rates on debt issued in the past are not current, so it is not a good measure. The second one is to consider the cost of debt will resemble the industry's cost of debt, assuming that the firm's capital structure will adjust to comparable firms.

Considering the project "Clube de Fornecedores" and my company, the information provided was about the average of recent borrowings and that is the cost of debt I will use.

4.8. Weighted Average Cost of Capital (WACC)

Concerning Damodaran (2012), if we consider all of the financing that the firm takes on, the composite discount rate (or cost of financing) will be a weighted average of the costs of equity and debt, and this weighted cost is the cost of capital (WACC). It also states that, the value of a private firm is the present value of expected cash flows, discounted back at an appropriate discount rate. Applying this methodology to project valuation, it is necessary to estimate future cash flows of this project, and for that we need the information explained before, discounting them at a discount rate which is the cost of capital.

As WACC is a weighted average of two different inputs, such as a cost, represented by K_d that is the cost of debt, and a required return K_e that is called cost of equity, Damodaran (2012) states that "the WACC is neither a cost nor a required return, but a weighted average of a cost and required return". The following equation presents WACC:

$$\mathrm{WACC} = \frac{D}{D+E} * K_d * (1-T) + \frac{E}{D+E} * K_e$$

Where,

K_d = Cost of debt.

K_e = Required return to equity (Cost of equity).

T = Marginal tax rate.

D = Market value of debt.

E = Market value of equity.

Because Hardware Development is a private firm, I cannot estimate cost of capital's inputs similar to publicly traded firms. Damodaran (2012) states that the fundamental definitions of these costs have not changed through public to private firms, but the process of estimating them needs to be changed given the special circumstances surrounding private firms.

Associated to the WACC are the tax benefits of having debt (more concretely, in the use of the after-tax cost of debt in the cost of capital) and the expected additional risk that derive from this issuance of debt (in the form of higher costs of equity and debt at higher debt ratios). (Damodaran, 2012)

4.9. Simulations

When evaluating economic efficiency in project valuation, there are several approaches to consider risk and uncertainty. As we all know, traditional approaches of valuation are based on a single-scenario result, not considering other scenarios and possibilities. Basing our valuation in NPV, it is a step forward when comparing to many companies, because many others use static criteria not respecting risk such as only considering average profitability and the payback period of the project. Although NPV already integrates dynamic criteria such as present value, internal rate of return, and including a risk premium in respect for risk (which forms a part of the discount rate), that is not enough to give us a very well sustained decision. The limitations of the methods mentioned before, can be mitigated using a simulation with a probabilistic approach of evaluation. This approach is based on a large number of trials and scenarios, consistently considering uncertainty and risk associated to a project. To increase the quality and level of my evaluation, I will use the Monte Carlo Simulation method for this approach. This simulation also has the advantage of providing probabilities to NPV, using determined distributions for inputs. (Damodaran, 2014)

4.9.1 Monte Carlo Simulation

This type of simulation is used when there is uncertainty and lots of risk factors that can influence results. Brealey, Myers & Allen (2011), state that Monte Carlo simulation is a tool for considering all possible combinations. The model is based in hundreds or thousands of scenarios and then calculating criteria values for each scenario. Also, the objectivity of using different interpretations of the simulation will depend mainly on the purpose of each work. In my case, the objective is to analyse the impact of changing probabilistic variables in the Excel model on the NPV of the project.

In relation to the Monte Carlo Simulation, Damodaran (2014) states that it can be performed in four steps:

1. **Determination of "probabilistic" variables**

The creation model phase consists in the practical model that I will build on the Excel sheet. This model includes calculation of cash flows and net present value of the project, using all necessary inputs for its estimation. It is important at the creation of the financial model to have in mind that the output and answers from the simulation will depend on the connection of the financial model. With that being said, it is very important to perceive the influence of each input in results. These inputs can be identified as "probabilistic" variables as they are inputs with high uncertainties associated. The advantage of Monte Carlo is that there are no constraints in the number of trials and variables to change, unlike scenario analysis and decision trees. Therefore, the impact of these inputs will be tested on NPV of the project. (Damodaran, 2014)

2. **Definition of probability distributions**

The determination of probability distribution function for risk factors is problematic. Or we have historical data about inputs and use it to rely on the probability distribution function, or it is necessary to rely on experience and knowledge of experts from the sector, that concern the individual risk factors to fit distributions.

Fitting distributions can be a very difficult task in simulations. Features such as whether inputs are symmetric or asymmetric, if data has discrete values or continuous values, upper or lower limits on the data and the likelihood of observing extreme values, is subject to the assumptions of the person producing the simulation. A study of probabilistic approaches from Damodaran, states that these four questions mentioned previously are crucial to help in characterization of the distribution.

The author says that inputs like revenues, market size, market share and profit margins, for instance, represent a continuous value and an example of discrete values is whether some product or software is approved or not. Starting from these inputs, Damodaran provides an illustrated scheme with the steps to better fit a distribution, which is in attachment 2. This scheme will be followed during the simulation process to fit distributions. As this is a capital budgeting project, and I want to calculate NPV through similar inputs to the ones mentioned, continuous distributions are the choice to go.

Concerning Damodaran studies, there is impossible to specify all possible outcomes from continuous data. So, there are two alternatives to compensate this. Firstly, the author suggests converting continuous data into discrete form, for instance define an interval of revenues variation and go through the process of discrete distributions from there. The second is to find a continuous distribution that best fits the data and specify the parameters of the distribution. (Damodaran, 2014)

Giving examples of distributions that might be useful to our case, I can start with the normal distribution which is the most symmetric of all. Damodaran in his probabilistic approach paper says that this distribution is best suited for data that meets these 3 requirements:

- There is a strong tendency for the data to take on a central value.
- Positive and negative deviations from this central value are equally likely.
- The frequency of the deviations falls off rapidly as we move further away from the central value.

In his research, Damodaran (2007) suggests that people should have perception that sometimes may be more realistic to use distributions different from normal distribution. However, he says that despite other distributions better fit the data, the benefits of such distributions are weighted off against the easy way normal distribution work with only few parameters.

Another valid alternative of distribution to apply to my case is lognormal distribution. Damodaran in his paper states that if the data is positively skewed, one common choice is the lognormal distribution, characterized by three parameters: a shape (σ), a scale ($\mu\ or$ median) and a shift parameter (θ).

When data is constrained, the topics that need answer for fitting distributions rely on whether constrains happen in one side of the distribution or both. Once it is known, there are two choices. One is to use a continuous distribution that fits the requirements. For this alternative, Damodaran (2007) states that "lognormal distribution can be used to model data, such as revenues that are constrained to be never less than zero". The second alternative is to use a uniform distribution if the probabilities of the outcomes are even, or triangular distribution if the data is clustered around an expected value. (Damodaran, 2007)

Speaking of triangular distributions, this is another option when it comes to fitting continuous distributions to my inputs. This distribution consists in assuming lower and upper limits on the values and have a central value that is most likely to happen, for instance the most likely scenario.

3. **Check for correlation across variables**

Despite being tempting to start the simulation after defining distributions, it is important firstly to check for correlation across the inputs selected as variables. Damodaran gives the example of inputs like inflation and interest rates, saying that despite these variables can impact the final NPV, their behaviour also depends on each other, as high inflation is usually accompanied by high interest rates.

4. **Run the simulation**

It is time to practically produce the simulation in the program. Damodaran says that the more the number of inputs and different distributions of inputs selected, the higher needs to be the number of trials of the simulation.

Damodaran, in is probabilistic approach study, states that simulations yield better estimates of expected value than conventional risk adjusted value models and also, simulations by providing better estimates of the expected value and the distribution in that value, lead to better decisions. Therefore, final decisions related to the project will be much more sustained, leading to quality improvement about its acceptance or rejection.

4.10. The case of Real Options

Although DCF analysis is still a good method for cash-flow valuation, it has its limitations. Today's investments are full of high risks and uncertainties, and DCF analysis is inadequate to deal with this type of issues. With DCF analysis only having in consideration one scenario, assuming constant risk and reversibility of investments, in other words, an investment can be undone, and the expenditures recovered, Dixit and Pindyck, (1994) claim that only techniques that can appropriately address the problem of uncertainty should be applied, which is the case of Real Options. Relating to financial options, a call option gives the investor the opportunity to invest at a given moment or not. (Dixit & Pindyck, 1994) Therefore, option-pricing theory has applications for all kind of investments, whether they are financial or not. (Black & Scholes, 1973)

An investor should always have the ability to delay an investment because if he intends to do so, it's because he knows he'll have more valuable information in the future, and therefore reducing uncertainty. This happens because the investor is turning the uncertainties of the future into certainties of the present. In the case of real options, it gives the investor an option to take an action, whether it is to delay, expand, contract or abandon, at a predetermined cost, which is the exercise price, for a predetermined time to maturity. (Copeland & Antikarov, 2003)

Also, just as an example, a firm must have the options of not undertaking a project now, abandon if the project's going wrong, expand if going well, and DCF analysis assumes that if an investment doesn't proceed now, it will never proceed.

So, DCF analysis and Real Options defer in the obvious, options. With options, two sources of value arise. Firstly, all else being equal, it is always preferred to pay later than sooner, arising time value of money. Secondly, having more options for decision making reduces uncertainty. Real Options take part on these uncertainties by assessing probabilities to different outcomes to a project's future. This means that the variance of returns will be a percentage of profit or loss. Therefore, associated to the sentence "higher risks, higher returns", the higher is the variance the riskier a project is, with its return being either much higher or lower than less risky projects.

Despite all advantages Real Options present when comparing to DCF, it still has a great limitation. Sometimes is very difficult to measure the uncertainties associated and it still takes a lot of time and complexity. Maybe developing a "user friendly" software that would allow companies to quickly produce simulations and select their data in a very intuitive way would be a step for this methodology being more used in real markets by real companies. The usage of this methodology by most of companies would represent a great development in decision making because not only would reduce risk for companies, but also it would be used in a large variety of sectors.

5. Methodology

Getting to the practical phase went through meetings with Sr. José Oliveira from Bosch and with financial department from Hardware Development. From initial meetings I could already tell that the problem would be about capital budgeting and project valuation and that Hardware Development only uses their experience in the Portuguese market to sustain their financial decisions. They are aware of the existence of Discounted Cash Flow method but yet not using it. With such information, I could tell that Real Options is going too far when a company does not even constantly use DCF for their decisions. When using discounted cash flow (DCF) to value a project, implicitly assumes that a firm will hold the project passively. In other words, it is called ignoring the real options attached to the project - options that sophisticated managers can take advantage of. Managers who hold real options do not have to be passive; they can make decisions to capitalize on good fortune or to mitigate loss. The opportunity to make such decisions clearly adds value whenever project outcomes are uncertain. Having real options in consideration, managers can estimate the opportunity cost of continuing or abandoning a project after acquiring new information. Including real options when valuing a project, increases its value and will give much more accurate results to act accordingly. This is a methodology that the company should try to look forward to getting in touch in the future. (Brealey, Myers, & Allen, 2014)

The risk-free rate was extracted from European Central Bank website and refers to the 5-year German Government Bonds. I chose this maturity because, as stated in literature review, the risk-free rate must resemble the maturity of the project. The project started on May 2019, so I used the 5-year German government bond from May 2019, with the project ending in 2024.

The Equity risk premium was obtained through the modified historical premium method suggested by Damodaran (2014). I used the tool provided by Damodaran that calculated country risk premiums and added it to a mature market risk premium such as the U.S. market. Ratings and default spreads were obtained from Moody's website and standard deviations of equities and bonds for Portugal used consisted in the authors website data.

In relation to the additional data for the calculation of the cost of capital, firstly I went to Datastream and downloaded STOXX EUROPE 600 Price Index monthly data for the last 25 years. Then I calculated Industry's Levered Beta through returns from 20 publicly traded companies from the same sector and economic activity code as Hardware Development in Europe (2651 - Manufacture of instruments and appliances for measuring, testing and navigation). Using only this data was not enough because it would lead to a small sample of firms. Therefore, as stated in the literature review, it was necessary to broad my research to other industries to collect data. Hence, I used data from an identical industry which is Manufacture of electronic components and boards (261). As Damodaran (2014) suggests, I calculated the monthly returns of the prices and then calculated the levered beta allocated to each company. Also, I used market values to calculate each publicly traded company's capital structure. Hence, I could calculate an unlevered beta for each of the companies through adjusting it from each company's Debt-to-Equity ratio. Another thing important to mention is that I used the specific country tax rate for each of the companies' beta adjustments. A company allocated in Sweden was adjusted using the tax rate of Sweden and so on. Country tax rates from Damodaran's website are available in appendix 4. Using Damodaran (2014) cash adjustment formula ($\frac{\text{Unlevered beta}}{\left(1-\frac{\text{Cash}}{\text{Firm Value}}\right)}$), I adjusted the unlevered beta for each company's cash holdings. Then as stated in Damodaran (2014), I calculated the median unlevered beta for this set of companies and re-levered it adjusting to Hardware Development's capital structure.

Concerning cost of equity, I calculated it through CAPM provided by Sharpe (1964). Then, used the company's recent average interest rate on borrowing for the cost of debt as stated in Damodaran (2012). After these processes, was time to calculate the company's Weighted Average Cost of Capital (WACC).

In relation to project data, meetings, and conversations with Hardware Development's financial department helped me a lot to understand how these types of projects work. They recommended me to check their website because there is the overall information about the projects they are involved in "Clube de Fornecedores".

Consulting the guide for application to these types of R&D projects in Compete 2020, it helped me a lot to understand which variables would be important to know related to each project. In the formulary provided from Compete 2020, each company must specify some variables such as forecasted sales from the project, project related costs, financing and incentives associated, etc. This detailed data is not publicly available which forced me to kindly ask to the company's administration to provide it to me for dissertation purposes. The permission to use such information had to pass through a confidentiality agreement, which obliged me and Professor Artur Rodrigues to sign it if we wanted the information.

To calculate cash-flows I used the structure from Damodaran (2014) that computed the after-tax operating income and therefore the after-tax cash-flows. However, because gathering this amount of information needs a very well mounted structure, I followed the calculation of the inputs for cash-flows provided by IAPMEI (2016). This helped me to structure costs associated to the project since labour, services, materials and equipment from capital expenditures, depreciations, etc.

The company gave me a lot of project related information that was crucial to start the valuation. Sales were projected since 2021 to 2024 because the company expects to start operations in 2021 and therefore obtain profit from there. As this is an R&D project and will have great impact in the knowledge and methodology of the company, makes sense to understand that despite forecasts being until 2024, the knowledge and development acquired from the project will prevail in the future. After projecting sales, I started to interpret and separate the costs per group to perform correctly the income statement related to the project.

Because there is not a specific product and this is more like a services provision that the company produces different solutions for each client with a new machine, a fixed cost of production isn't possible to determine and use for gross profit purposes.

In relation to capital expenditures, there were acquired equipment and computer programs that are subject to depreciations. These expenses work as investment in property, plant, and equipment so they are part of CAPEX. Calculating depreciations from straight line method, I used the annual depreciation rates provided in the Compete 2020 form.

Concerning employee remuneration costs, from 2019 to 2024, the information is that the company hired two Junior Technicians, one for Software and other for electronics. Monthly and annual remunerations already included the social contribution of 23,75% for the company. All costs are presented in the problem resolution section. With the intention of calculating working capital needs afterwards, I had to calculate the personal income tax and social contributions from employee remunerations. Very important to this variable is to perceive the incremental costs of human capital for the project. This is because the company provided a table listed with employee remunerations, but as stated in literature review, I could only consider incremental costs. So, I asked the company if all those employees were hired purposely for the project or in other words, if the project did not exist these employees would be fired. The answer was that only two of those employees were there because of the project, as they are mentioned above.

Also, the company had exploration costs associated to the project such as other services, travel expenses, specialized services, direct services, materials, and indirect costs. All costs detailed in Excel sheet and problem resolution.

Changes in working capital are also another variable that have to be considered and in the end of the project they will be added back through a variable named salvage value of the project. This is no more than the investment in working capital for each year of the project. Working capital needs are composed by three parameters: clients, inventory, and taxes/government. Inventory for this case has a value of zero as this is a project that has not cost of goods sold associated. Clients come from multiplying the sales from a determined year by the average term receivables and divide it by 12. In relation to the taxes/government variable, whether there are positive personal income tax, social contributions, and VAT values, they are discounted or added depending if we are calculating working capital needs or resources. Excel sheet describes in detail this methodology. Working capital resources are composed by suppliers and taxes/government. Suppliers are obtained through exploration costs in each ear + VAT in that specific year. (IAPMEI, 2016)

Concerning NPV and IRR, once I had all information needed, it was just to practically calculate them in the Excel tool, using the structure provided by Damodaran (2014). Next step is to produce a Monte Carlo simulation.

Concerning Monte Carlo simulation, firstly I used the software of Crystal Ball to produce it. I chose this tool because is one of the most user friendly on the market and it is free.

Conform it was mentioned in the literature review, firstly I needed to identify the variables to change as well as their distributions. After defining distributions, the process was very simple, it was just defined NPV as a prevision variable and check for correlation between inputs. The problem resolution section will contain the analysis of the simulation's results providing probabilities to answer different important questions. Also, justifications for each input distribution and correlation will also be explained.

Finally, it was time to present results and discuss them. An important subject matter is that results will be confronted with the theory and conclusions will take place considering that.

6. Problem

6.1. Weighted Average Cost of Capital

6.1.1. Cost of Equity

For beta calculation purposes, I use the monthly returns of public traded comparable companies, with the same economic activity code as Hardware Development and from an identical sector as well, from the last 25 years. Using these historical stock prices, I calculate the levered beta for each company and obtain the values presented in appendix 5.

Also, I got the capital structure of these companies and unlevered each of these company's betas. Hence, I obtained the unlevered beta, correcting for cash so the final betas are not affected by cash holdings of the company. Values of unlevered betas are shown in appendix 6.

The final value for the industry unlevered beta is an average of each company's unlevered beta corrected for cash. The value obtained is 0,75. In general, this is an industry with high liquidity, well-structured and well diversified in terms of risk.

In order to re-lever the beta, I adjusted $\beta_{\text{L private firm}}$ for the capital structure of Hardware Development, with the company's debt-to-equity ratio being 0,78. The tax rate is the current Portuguese corporate tax rate of 21%. Then I finally obtained the value of 1,38 for the company's levered beta.

The cost of equity was calculated through CAPM that is represented by $\text{Expected return} = \text{Risk free rate} + \text{Beta} * \text{Equity Risk Premium}$. For risk-free rate I am using the 5-year German government bond from the European Central Bank which is -0,4116% and the methodology is suggested by Damodaran (2014) that calculates the equity risk premium through adjusting default spreads for the country in question (Portugal) and then add it back to a mature market risk premium such as the U.S. market.

The Moody's rating for Portugal is Baa3 which leads to a rating-based default spread of 1,84%. Inputs for Equity risk premium calculation are presented in the following table:

Equity Risk Premium	
Country	Portugal
Moody's rating	Baa3
Rating based default spread	1,84%
Mature market risk premium (US)	5,20%
$\boldsymbol{\sigma_{Equity}}$	22,96%
$\boldsymbol{\sigma_{Country\ Bond}}$	7,14%
$\boldsymbol{\sigma_{Equity}/\sigma_{Country\ Bond}}$	3,22
Country Risk Premium	5,92%
Total Equity Risk Premium	11,12%

Table 6 - Equity Risk Premium (Damodaran, 2014)

Applying the formula presented above, the final cost of equity for the company is 14,72%.

Damodaran (2014) states that if we are discounting cash-flows to the firm, they must be discounted at the weighted average cost of capital (WACC). Before proceeding to calculation of WACC, the company has provided information about the cost of debt. As stated in the literature, an alternative is using the interest rate from the recent loans of the company. In this case, pre-tax cost of debt is 0,85%.

WACC is given by $\mathrm{WACC} = \frac{\mathrm{D}}{\mathrm{D+E}} * \mathrm{K_d} * (1 - \mathrm{T}) + \frac{\mathrm{E}}{\mathrm{D+E}} * \mathrm{K_e}$ as explained before. Therefore, and using the company's capital structure, the final value for the WACC is 8,64%.

In summary, the input values are presented in the following table:

German Government Bond - European Central Bank Data	
Maturity	2 May 2019
5 years	-0,4116%
Relever Beta to Hardware Development's Capital Structure	
Hardware Development's Debt-to-Equity	0,781697973
Company's Levered Beta	1,375242921
Cost of Equity	
Ke	14,88%
Cost of Debt	
Pre-tax Kd	0,85%
After-tax Kd	0,67%
Weighted Average Cost of Capital	
Total Debt	6 059 718,00 €
Total Equity	7 751 994,00 €
WACC	8,6444%

Table 7 - Weighted Average Cost of Capital Inputs (Damodaran, 2014)

6.2. Discounted Cash-Flow Analysis

Currently, as stated in the company's contextualization, Hardware Development is a company that when comparing to rest of the Portuguese industry, has a larger dimension. They expect to have around 500 000€ in sales from the project until 2024, but this is a relatively small number when comparing to a company that produced around 15 million € in sales in 2018. However, as this is an R&D project, in the long term it will have great impact.

As stated in Damodaran (2014), the first step is to calculate the income statement and, therefore, net income of the project for each year.

The company received a subsidy related to this project, in a total value of 1 046 790,28 €, distributed by different years. The subsidy is taxable and is part of the income statement.

6.2.1. Revenues

The expected sales turnover is illustrated in in Table 8:

	Sales & Services from project	Subsidy
2019	0,00 €	517 028,96 €
2020	0,00 €	220 966,66 €
2021	125 000,00 €	212 774,43 €
2022	250 000,00 €	96 020,23 €
2023	350 000,00 €	0,00 €
2024	500 000,00 €	0,00 €

Table 8 - Revenues from the project (TSIM)

Value Added Tax (VAT) in Portugal is 23% and is needed to estimate the impact of taxes/government contributions from sales, operating costs, labor, etc., in changes in working capital.

Concerning the cost of sales, as explained before, there is not a specific product to be sold. The company produces specific solutions that are different from deal to deal. For that reason, there is no cost of goods sold but there are exploration costs and services associated to the solution development.

In their application to Compete 2020, the company reported each of the initial cash outlays such as capital expenditures and costs of materials and services. These investments are presented in appendix 7 and 9, respectively. The investments are grouped by accounting descriptions such as computer programs, basic equipment, materials, specialized services, travel expenses, indirect costs, etc. Hardware Development reported that some investments were subject to depreciations. This helped to understand which of the purchases should be considered as capital expenditures, not being part of the cash flow calculation as exploration costs, and which should be considered as exploration costs. However, materials have a big impact on these costs and the company is accounting them as being the depreciable assets. Damodaran (2014), states that “If we define capital expenditures as expenses designed to generate benefits over many years, research and development (R&D) expenses are really capital expenditures”.

6.2.2. Capital Expenditures

The depreciation method is the straight-line method and I assume depreciations start in 2019. The company provided information about the annual depreciation rates for each of the capital expenditures

The next two tables present the initial capital expenditures (CAPEX) related to the project, including all property, plant, and equipment investments, as well as annual depreciations. Detailed depreciations are illustrated in appendix 8. As we can see, all assets are fully depreciated at the end date of the project.

	Investment
	2019
Basic Equipment	88 700,00 €
Computer Software	58 350,00 €
Total	147 050,00 €
VAT	33 821,50 €
Total + VAT	180 871,50 €

Table 9 - CAPEX

	Annual Depreciations
2019	46 081,61 €
2020	36 931,61 €
2021	36 931,61 €
2022	19 700,00 €
2023	7 400,00 €
2024	0,00 €

Table 10 - Annual Depreciations

6.2.3. Exploration Costs

Next, I present exploration costs associated to the project. These were provided by the company and they are constituted by other services, travel expenses, specialized services, direct services, materials, and indirect costs. All these costs contributed to the direct development of the product. There are no other exploration costs different.

	2019	2020	2021	2022	2023	2024
Other Services	12 650,00 €	21 500,00 €	100,00 €	0,00 €	0,00 €	0,00 €
Travel Expenses	5 500,00 €	4 930,00 €	1 330,00 €	0,00 €	0,00 €	0,00 €
Specialized Services	6 320,00 €	4 800,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Direct Services	1 500,00 €	10 000,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Materials (Hardware)	450 500,00 €	6 100,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Indirect Costs	217 127,16 €	112 651,84 €	112 899,56 €	43 102,79 €	0,00 €	0,00 €
Total	**693 597,16 €**	**159 981,84 €**	**114 329,56 €**	**43 102,79 €**	**0,00 €**	**0,00 €**

Table 11 - Exploration Costs

6.2.4. Human Capital Costs

In relation to the costs with human capital for the project, as stated in the methodology, the company purposely hired two junior technicians, whose annual remuneration is considered as a cost of the project. These are the only incremental human capital costs of the project, and are constant over the years:

	Monthly Remuneration	**Annual Remuneration**
Junior Tech. - Software	1 890,00 €	20 790,00 €
Junior Tech. - Electronics	1 890,00 €	20 790,00 €
Total	3 780,00 €	41 580,00 €
Personal Income Tax	567,00 €	6 237,00 €
Social Contributions	415,80 €	4 573,80 €
Total Retentions	982,80 €	10 810,80 €

Table 12 - Human Capital Costs

6.2.5. Working Capital

Concerning changes in working capital, the annual investment needed was calculated simply subtracting current assets for current liabilities. Here also enter taxes/government costs considering the annual VAT contributions, social contributions, and the Portuguese personal income tax. We must include also the government account related to taxes that are paid quarterly/monthly. To be more intuitive, next are presented the taxes/government contributions for working capital investment:

Government	2019	2020	2021	2022	2023	2024
Social Contributions	415,80 €	415,80 €	415,80 €	415,80 €	415,80 €	415,80 €
Personal Income Tax	567,00 €	567,00 €	567,00 €	567,00 €	567,00 €	567,00 €
VAT	-18 608,05 €	3 506,63 €	12 848,08 €	17 417,75 €	20 125,00 €	28 750,00 €

Table 13 - Working Capital (Government/Taxes)

The balance of clients and suppliers account is calculated by assuming that the company has 143 days of average term receivables and 145 days of average term payables. The tax payable term is assumed to be every 4 months.

In relation to changes in working capital, as we can see in table 14, working capital for the first year is negative due to a large cash outlay as a result of a large purchase of products and services from the company in the beginning of the project.

Current Assets	2019	2020	2021	2022	2023	2024
Customers	252 611,73 €	107 960,63 €	165 030,96 €	169 059,72 €	171 004,17 €	244 291,67 €
Inventory	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Taxes/Government	18 608,05 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Total	271 219,78 €	107 960,63 €	165 030,96 €	169 059,72 €	171 004,17 €	244 291,67 €
Current Liabilities	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Suppliers	343 619,59 €	79 257,67 €	56 640,77 €	21 353,84 €	0,00 €	0,00 €
Taxes/Government	982,80 €	4 489,43 €	13 830,88 €	18 400,55 €	21 107,80 €	29 732,80 €
Total	344 602,39 €	83 747,10 €	70 471,65 €	39 754,39 €	21 107,80 €	29 732,80 €
Working Capital	-73 382,61 €	24 213,53 €	94 559,31 €	129 305,32 €	149 896,37 €	0,00 €
Changes in Working Capital	-73 382,61 €	97 596,14 €	70 345,78 €	34 746,02 €	20 591,04 €	-149 896,37 €

Table 14 - Changes in Working Capital

6.2.6. Net Present Value (NPV)

During capital budgeting valuation, a project's attractiveness is evaluated based on the cash flows and income that it will generate in the future. Initially, projects have the investment phase which will generate large negative cash flows hoping that one time in the future will be compensated with positive results. As experienced by Damodaran (2014), my experiments confirm that this behavior is represented in the income statement generated from the project, as in the first two years we have negative results. Since sales start to show up in 2021, the project starts to be profitable and compensating the initial investment.

Through Discounted Cash-Flow Analysis, I estimated the cash flows and the after-tax operating income. I add back depreciation charges to the net income, providing the company a depreciation tax benefit, added changes in working capital for the year in question and estimated capital expenditures if occurred. After-tax cash flows calculation is illustrated next:

	2019	2020	2021	2022	2023	2024
Revenues						
Sales & Services	0,00 €	0,00 €	125 000,00 €	250 000,00 €	350 000,00 €	500 000,00 €
Incentive	517 028,96 €	220 966,66 €	212 774,43 €	96 020,23 €	0,00 €	0,00 €
Total Revenues	**517 028,96 €**	**220 966,66 €**	**337 774,43 €**	**346 020,23 €**	**350 000,00 €**	**500 000,00 €**
Operating Expenses						
Labor	41 580,00 €	41 580,00 €	41 580,00 €	41 580,00 €	41 580,00 €	41 580,00 €
Depreciations	46 081,61 €	36 931,61 €	36 931,61 €	19 700,00 €	7 400,00 €	0,00 €
Exploration Costs						
Other Services	12 650,00 €	21 500,00 €	100,00 €	0,00 €	0,00 €	0,00 €
Travel Expenses	5 500,00 €	4 930,00 €	1 330,00 €	0,00 €	0,00 €	0,00 €
Specialized Services	6 320,00 €	4 800,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Direct Services	1 500,00 €	10 000,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Materials	450 500,00 €	6 100,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Indirect Costs	217 127,16 €	112 651,84 €	112 899,56 €	43 102,79 €	0,00 €	0,00 €
EBIT	**-264 229,81 €**	**-17 526,79 €**	**144 933,26 €**	**241 637,44 €**	**301 020,00 €**	**458 420,00 €**
Taxes	-55 488,26 €	-3 680,63 €	30 435,98 €	50 743,86 €	63 214,20 €	96 268,20 €
After-tax Operating Income	**-208 741,55 €**	**-13 846,16 €**	**114 497,28 €**	**190 893,58 €**	**237 805,80 €**	**362 151,80 €**
Depreciations	46 081,61 €	36 931,61 €	36 931,61 €	19 700,00 €	7 400,00 €	0,00 €
Changes in working capital	73 382,61 €	-97 596,14 €	-70 345,78 €	-34 746,02 €	-20 591,04 €	149 896,37 €
Capital Expenditures	147 050,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
After-tax Cash-Flows	**-236 327,33 €**	**-74 510,70 €**	**81 083,11 €**	**175 847,56 €**	**224 614,76 €**	**512 048,17 €**

Table 15 - Incremental Cash Flow Calculation

Analyzing the cash flows the project, in the first years they are negative due to high initial expenses and only the subsidy from the European fund as revenues. Beginning in 2022, the only costs that remain as operating expenses are labor, depreciations and indirect costs. This is a great difference of costs when comparing to the first years, and for that reason the operating income is larger.

Table 16 presents the present value of cash flows and the NPV of the project:

t	Present Value	NPV
0	-236 327,33 €	**400 403,11 €**
1	-68 582,19 €	
2	68 693,52 €	
3	137 124,31 €	
4	161 216,35 €	
5	338 278,44 €	

Table 16 - Net Present Value

The NPV is higher than zero and therefore, the project should be accepted.

In relation to the cost of capital that would cause the NPV to be zero, the Internal Rate of Return (IRR), the estimate is not possible to obtain because there is more than one year with cash outflow.

Please notice that this project has a positive NPV only because of the subsidy received. The revenues generated by the project itself, clearly are not enough to produce a profitable deal for the company. Clearly this project is worth accepting only because of the money that enters as not refundable.

This conclusion can change depending in which scenario we are discussing results. If I run a simulation with determined assumptions relative to revenues, it is possible that in an optimal scenario, this project might be profitable enough without the European fund. Out of curiosity, not considering the European fund in valuation, the NPV for the project would be -370 182,10€, which coming from the NPV rule gives the decision to reject the project.

6.3. Risk Analysis

6.3.1. Monte Carlo Simulation

Monte Carlo simulation is a powerful tool that allows managers to better analyze risk and consider uncertainty in their decisions. The tool used to run the simulation was Crystal Ball.

Following the steps explained in the literature review, firstly I have to determine which inputs/assumptions have impact in the project's NPV. Considering that this is an R&D project which has a more product development and services type of costs, rather than individual unit price of a constant product, variables like price and units sold were not target of variation. Here all inputs are changing at the same time in 100000 trials. Also, the impact of each one in NPV will be measured.

In relation to sales, I chose to change the total sales in the project, as this is a number forecasted by the company and as any forecast it has his potential risks and high levels of uncertainty. These forecasted values are considered as the base case and the most likely scenario.

For sales, I used a lognormal distribution. The reason for this distribution to be used is because the literature stated, "lognormal distribution can be used to model data, such as revenues that are constrained to be never less than zero". Following the scheme presented in appendix 3, because this is a continuous and asymmetric variable with mostly positive values, it also recommends using the lognormal distribution. Also, as sales is a very volatile variable, the standard deviation assumed was 30%. I made a sum of the total expected sales for the project (1 225 000,00 €), just for simulation purposes. Each year has a fixed percentage of the total. Here I am assuming that growth rates between years never changes. The next figure illustrates the assumption.

Assumption: Total Revenues

Lognormal distribution with parameters:

Local	0,00 €
Mean	1 225 000,00 €
Standard Deviation	367 500,00 €

Selected interval between 0,00 € to ∞

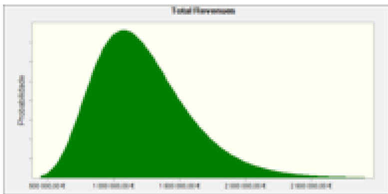


Figure 3 - Assumption: Total Revenues (Crystal Ball)

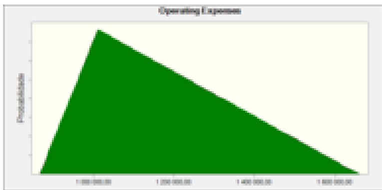
Many types of initial costs have substantial uncertainty, such as capital expenditures and exploration costs, and a proper capital budgeting analysis should incorporate the additional risk that is due to an uncertain initial cash outlay. Therefore, I am considering capital expenditures in my simulation. Also, because the more capital expenditures we have, the more assets will need treatment and have exploration costs, I assumed a correlation coefficient between these 2 variables of 0.4. As there are neither product price nor quantities sold, no other variables are directly correlated with these. Here I am assuming that correlations between values are constant over time.

In relation to exploration costs, the company expects a total value of 1 011 011,35 € during the project. This is a continuous variable, rounded by a central value and with no outliers, and therefore, I assumed a triangular distribution. Because there is more chance of these costs being higher than the base case, rather than being lower, this distribution has a 5% percentile close to the expected value and a 95% percentile of 1 500 000,00 €. Hence, the parameters and distribution are next illustrated:

Assumption: Operating Expenses

Triangular distributions with parameters:

5%	941 881,20
Expected value	1 011 011,35
95%	1 500 000,00



Correlated with:	Coefficient
CAPEX	0,40

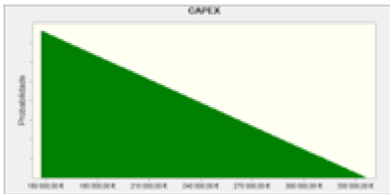
Figure 4 - Assumption: Operating Expenses (Crystal Ball)

Capital expenditures have a certain value declared by the company in their application. In order to consider risk, I assumed a triangular distribution with minimum value of 147 050,00 €. This is the minimum and also expected value of the distribution. To reflect the chance of increasing CAPEX, I assumed a 95% percentile of in the worst case double these costs during the project. Figure 5 presents all assumptions concerning CAPEX.

Assumption: CAPEX

Triangular distribution with parameters:

Minimum	147 050,00 €
Expected value	147 050,00 €
95%	294 100,00 €



Correlated with:	Coefficient
Operating Expenses	0,40

Figure 5 - Assumption: CAPEX (Crystal Ball)

Because there are some differences in WACC depending on the methods we use to calculation of cost of equity and also depending on the assumptions of cost of debt, this is another variable considered in the simulation. I assumed a normal distribution with mean 8,5541% which is the value calculated for the expected scenario, and standard deviaton 2%. Being this a continuous variable, I assumed an equally likelihood of the change in this value is higher or lower than the expected value, next illustrated:

Assumption: WACC

Normal distribution with parameters:

Mean	8,5541%
Standard deviation	2,0000%

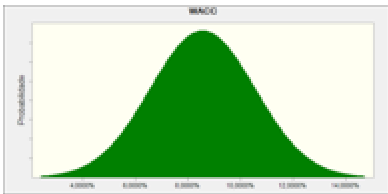


Figure 6 - Assumption: WACC (Crystal Ball)

Running the smiluation for 100000 trials, the first conclusion I obtained is that the NPV has a range between -657 288,83 € and 2 256 043,55 €.

There are 3 questions we need to answer in every simulation:

- What is the likelihood that NPV will be greater than 400 403,11 € (expected value)?
- What is the likelihood of a negative NPV? Is there a chance of a negative return on this project?
- Of all of the inputs, which one is the most important? Which one contributes the most to the risk in this project?

Answering the first question, the probability of a negative return is 20,38% as illustrated in Figure 7.

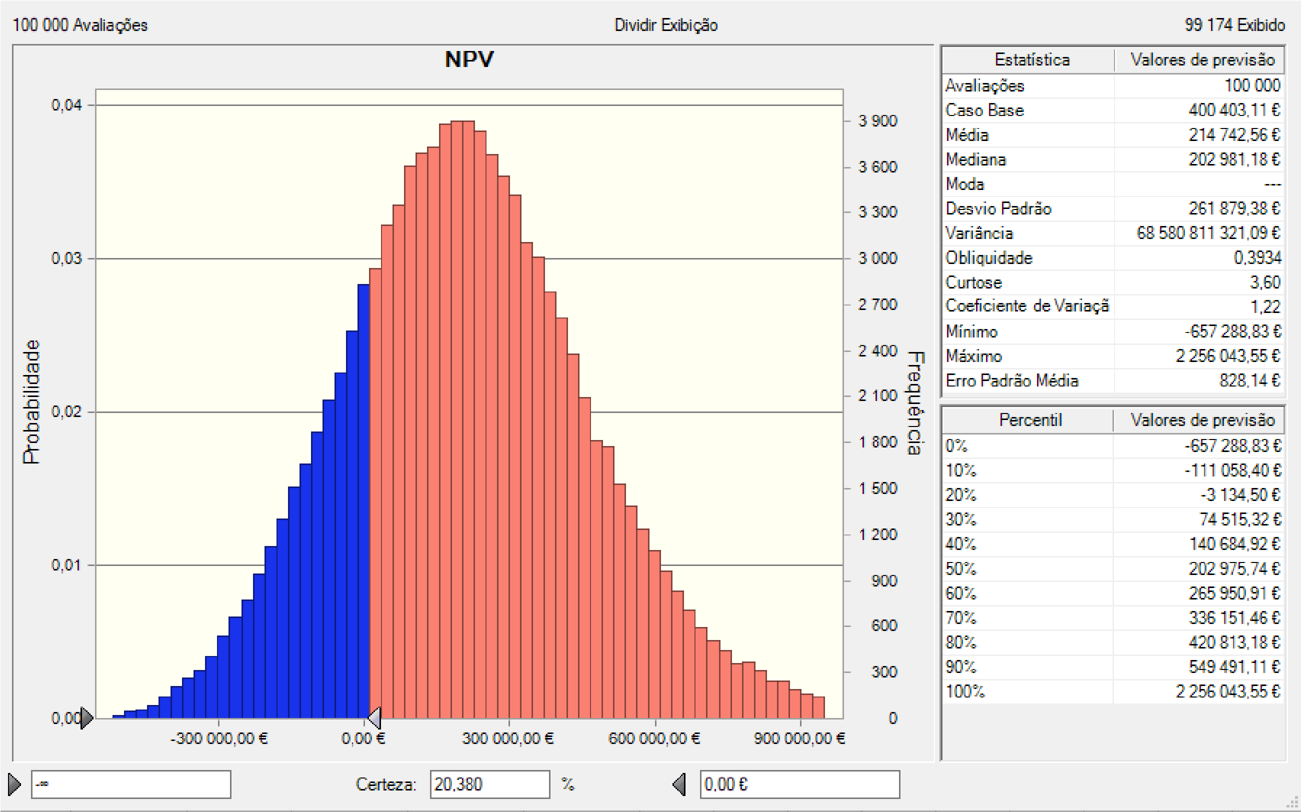


Figure 7 - NPV < 0 (Crystal Ball)

The conclusion of this value is that there is a chance of a negative NPV but there is only a relatively small probability. However, it is something that the company should take attention. Avoiding any additional costs is crucial to the return on the project.

Next questions answer can be obtained through obtaining a probability of a higher NPV than the expected base case. The value obtained for the probability is 22,203%, which means that there is a higher chance of NPV being larger than the base case than having a negative return on the project. This result is represented in Figure 8:

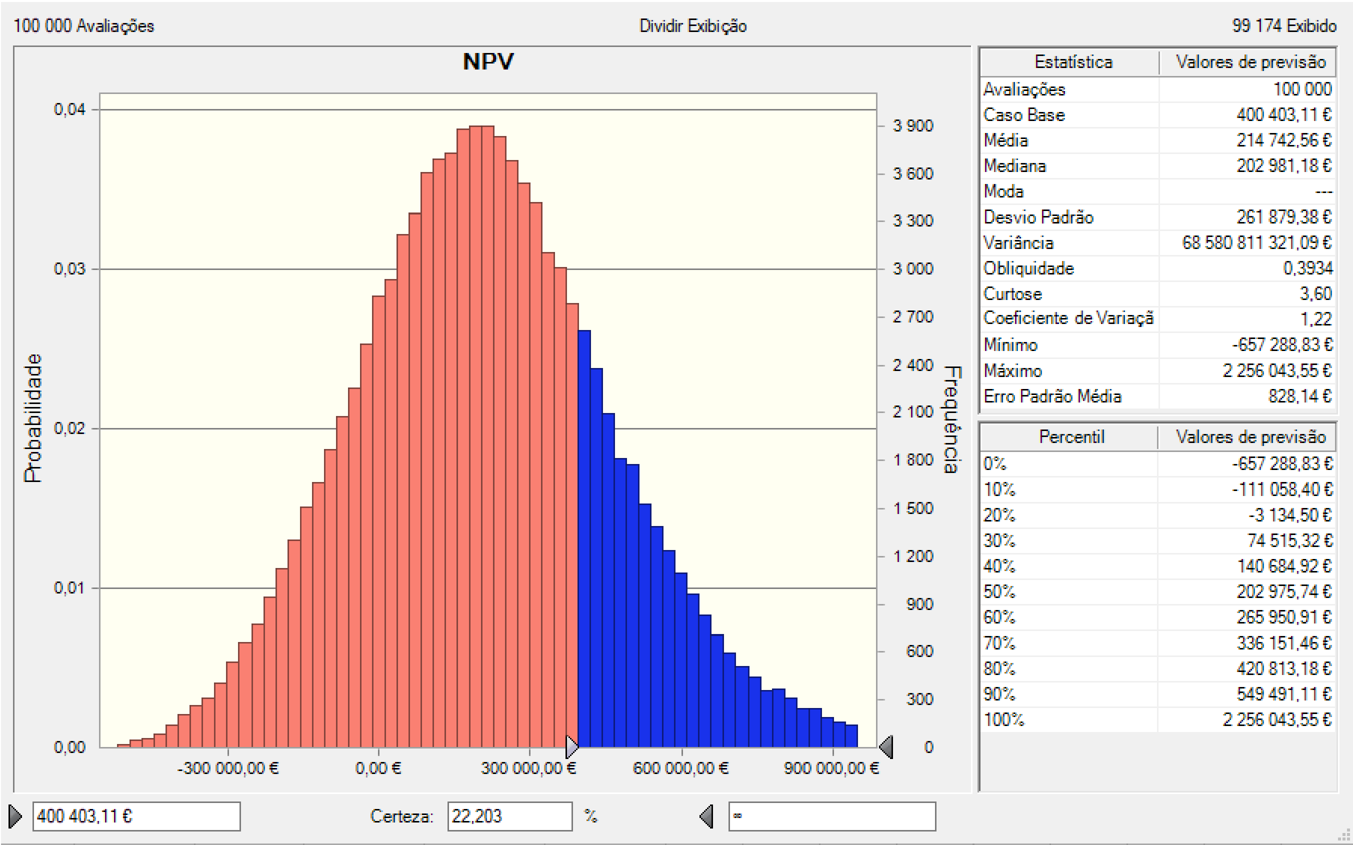


Figure 8 - NPV > 400 403,11 € (Crystal Ball)

The third question is very important to answer so the company can focus on which variables need more attention and the ones that is not necessary to expend much time trying to improve.

The next figure illustrates the NPV variation impact in percentage, of each of my assumption variables:

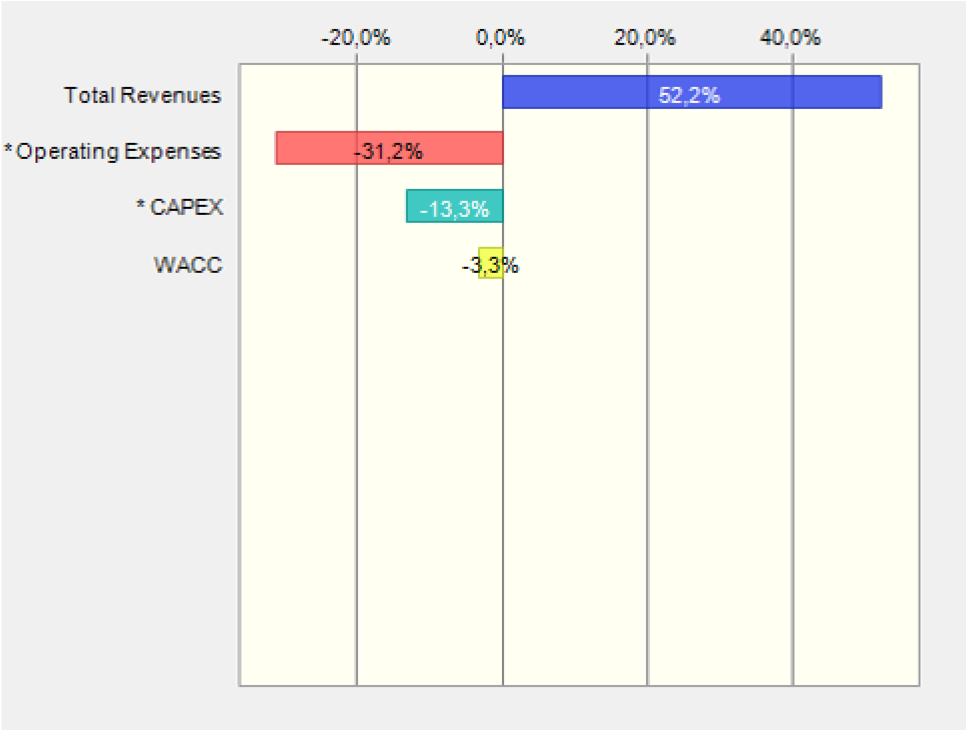


Figure 9 - Sensitivity Chart (Crystal Ball)

Total revenues are clearly the variable with most impact (52,2%), and it affects NPV in a positive way. Operating Expenses, CAPEX and WACC, have negative impact in the NPV by this order. As mentioned in the literature, analysts need to take CAPEX and Operating Expenses into consideration, and the prove is that they have considerable impact in the result. As with WACC, Damodaran stated, in his study of probabilistic approaches, that people should focus their time mostly in estimating cash flows correctly rather than estimating the cost of capital. This is corroborated with the only 3,3% impact that WACC has on NPV. His justification for this came from analyzing average market cost of capital obtaining a value of 8%, and even if this value wasn't correct, the difference of it being 8% or 9% wouldn't provide an NPV that different that justified the time spent on estimating it. The same applies for my results.

The simulation also provides the correlation that each variable has with the NPV. The values resemble the sensitivity analysis. It is presented in Figure 10:

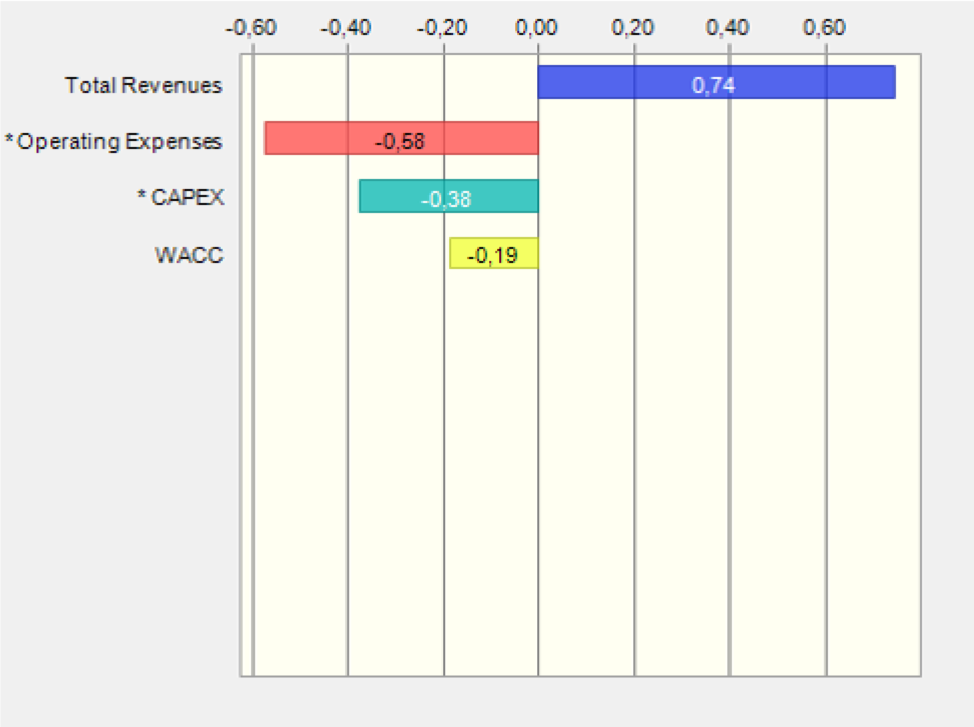


Figure 10 - Correlation Chart (Crystal Ball)

In summary, the simulation allowed for a great confidence in having a positive NPV. The company should totally accept this project, especially because there is a non-refundable subsidy supporting it.

7. Conclusion

Throughout the dissertation it is very clear that this "Clube de Fornecedores" initiative is a great contribution to the Portuguese economy. For a company like Hardware Development, that is very well positioned in the Portuguese market, looking to expand its operations to another level, is crucial to have this type of initiative supporting their activity. It shows that companies with growth and investment mentality, have the financial support they need if they present this type of applications. If majority of the suppliers involved in Bosch's initiative are this successful, then there are strong probabilities of them being actual big suppliers. This will have impact by reducing importations and expanding exportations. Which is Bosch's main goal.

The conclusion obtained from Discounted Cash Flow analysis is that the project must be accepted from the company. However, without the subsidy, this project is not profitable enough to compensate for the costs.

The risk analysis suggests that there is a 20,38% likelihood of a negative NPV on this project. Concerning the importance and impact on NPV of each input in the simulation, it is possible to conclude that revenues are the variable with highest impact (positive impact), followed by variables with negative impact being operating expenses, capital expenditures and WACC, respectively. As suggested by Damodaran (2007) we should focus our time estimating cash flows rather than weighted average cost of capital, which is explained by WACC's low impact on NPV.

Finally, as stated in the literature, Real Options is a methodology that companies like Hardware Development should consider in the future. A great contribution to finance would be the development of a "user friendly" software that allowed companies with limited time predict results based in options in an intuitive and fast way.

8. Bibliography

Black, F., & Scholes, M. (1973). *The Pricing of Options and Corporate Liabilities.* The Journal of Political Economy.

Brealey, R., Myers, S., & Allen, F. (2011). *Principles of Corporate Finance 10th Edition.* MGraw-Hill.

Brealey, R., Myers, S., & Allen, F. (2014). *Principles of Corporate Finance.* McGraw Hill.

Compete2020. (2020). Obtido de https://www.compete2020.gov.pt/

Copeland, T., & Antikarov, V. (2003). *Real Options: A practitioner's guide.* New York: Cengage Learning.

Damodaran, A. (2007). Probabilistic Approaches: Scenario Analysis, Decision Trees and Simulations. United States.

Damodaran, A. (2012). *Investment Valuation, Tools and Techniques for Determining the Value of Any Asset 3rd Edition.* New Jersey: Wiley.

Damodaran, A. (2014). *Applied Corporate Finance 4th Edition.* New York University: Wiley.

Dixit, A. K., & Pindyck, R. S. (1994). *Investment under uncertainty.* New Jersey: Princeton University Press.

Firer, C., Ross, S., Westerfield, R. J., & Jordan, B. (2012). *Fundamentals of Corporate Finance 5th Edition.* South Africa: McGraw Hill Publication.

Goedgart, M., Koller, T., & Wessels, D. (2005). *The right role for multiples in valuation.* New York: McKinsey & Company.

IAPMEI - Agência para a Competitividade e Inovação, I. (2016). *Guia Explicativo para a Criação do Plano de Negócios e do seu Modelo Financeiro.* StartUP Portugal.

Jakenová, J. (2015). Monte Carlo Simulation – Risk Analysis Tool of Investment Projects. (P. Ing. Jaroslava Janeková, Ed.) *Faculty of Mechanical Engineering*, pp. 261-263.

Palepu, K., & Healy, P. (2012). *Business Analysis & Valuation, Using Financial Statements.* Harvard University.

Palepu, K., Peek, E., Bernard, V., & Healy, P. (2007). *Business Analysis and Valuation Using financial statements:IFRS Edition.* Cengage Learning EMEA.

Reilly, F., & Brown, K. (2012). *Investment Analysis & Portfolio Management 10th Edition.* United States: South-Western Cengage Learning.

Sharpe, W. (1964). *Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk.* The Journal of Finance.

9. Appendix

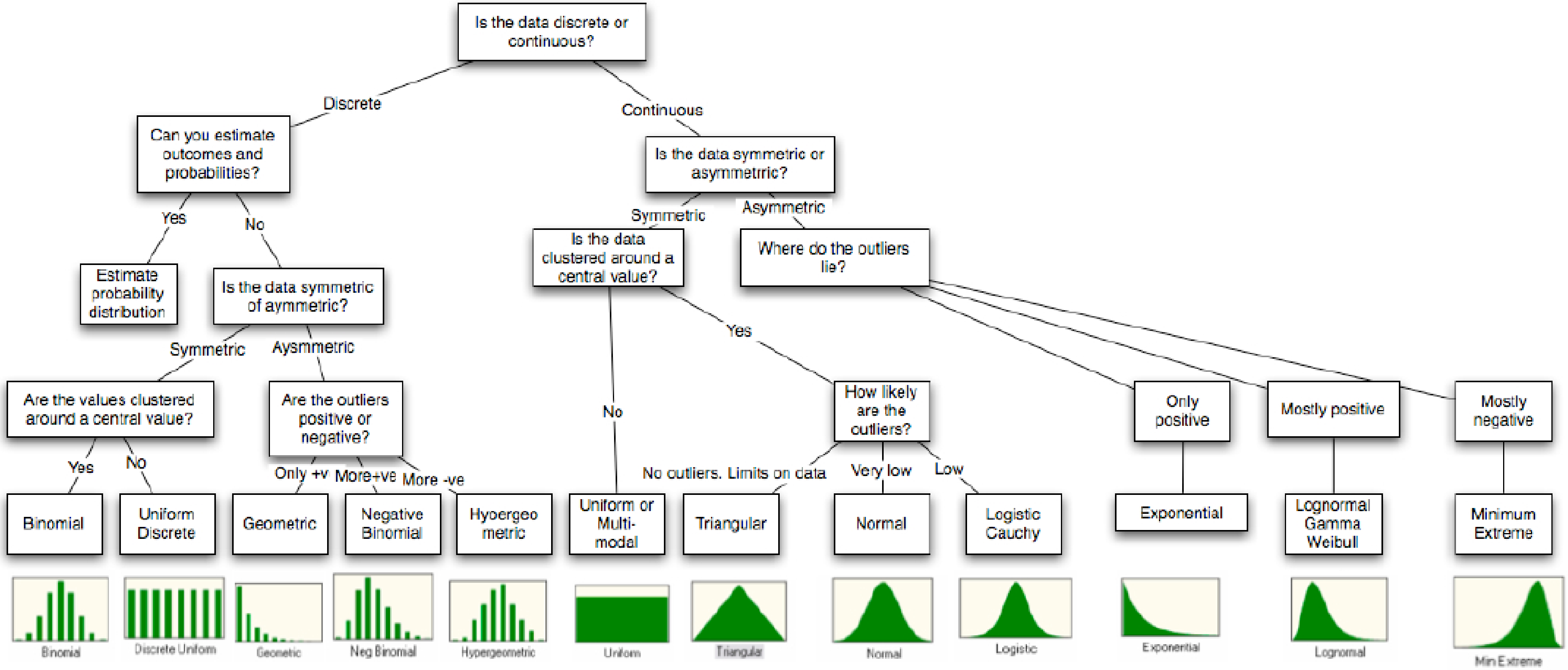
Appendix 1

Balance Sheet - Hardware Development (Values in Euros)	
Assets	**2018**
Fixed assets	6 853 150,00 €
- Intangible fixed assets	186 504,00 €
- Tangible fixed assets	1 227 544,00 €
- Other fixed assets	5 439 102,00 €
Current assets	6 958 562,00 €
- Stock	1 980 190,00 €
- Debtors	3 365 174,00 €
- Other current assets	1 613 198,00 €
* Cash & cash equivalent	567 337,00 €
Total Assets	13 811 712,00 €
Liabilities & Equity	
Equity	7 751 994,00 €
- Capital	50 000,00 €
- Other shareholders funds	7 701 994,00 €
Non-current liabilities	2 969 951,00 €
- Long term debt	2 969 951,00 €
- Other non-current liabilities	0,00 €
* Provisions	0,00 €
Current liabilities	3 089 767,00 €
- Loans	457 400,00 €
- Creditors	1 858 654,00 €
- Other current liabilities	773 713,00 €
Total Equity + Liabilities	13 811 712,00 €

Appendix 2

Portuguese Industry
Hardware Development Inc.
ARALAB - EQUIPAMENTOS DE LABORATÓRIO E ELECTROMECÂNICA GERAL, LDA
ENERMETER - SISTEMAS DE MEDIÇÃO, LDA
KRISTALTEK - LASER E MECÂNICA DE PRECISÃO, LDA
DISTRIM 2 - INDÚSTRIA, INVESTIGAÇÃO E DESENVOLVIMENTO, LDA
HBM FIBERSENSING, S.A.
AVEL - ELECTRÓNICA, LDA
COMPASSO D'ELITE - MÁQUINAS E EQUIPAMENTOS, LDA
FLOW SYSTEMS - SISTEMAS DE MEDIÇÃO DE FLUÍDOS, UNIPESSOAL, LDA
DIGITAL DEVOTION, LDA
EDIBRICK, S.A.
S4METRO - SOLUTIONS 4 METROLOGY, LDA
AMI - TECNOLOGIAS PARA TRANSPORTES, S.A.
N. F. PEGADO - EMPRESA DE SINALIZAÇÃO E PUBLICIDADE, UNIPESSOAL, LDA
FLYMASTER AVIONICS, LDA
SCHAUBTEC - TECNOLOGIA, COMÉRCIO DE MÁQUINAS E ACESSÓRIOS ÓPTICOS, UNIPESSOAL, LDA
MAIO, CARMO & MARTINS, LDA
ISENS - ELECTRÓNICA, LDA
MEGA - TECNOLOGIA DE COMANDOS, LDA
TMH INSTRUMENTATION, UNIPESSOAL, LDA
LUÍS CUPIDO TECHNOLOGIES, UNIPESSOAL, LDA
DINÂMICAMANIA, UNIPESSOAL, LDA
VASCOM - CABOS E TERMOMETROS, LDA
GT3KD - GREEN TECHNOLOGY DEVICES, LDA
LOCATIS - SISTEMAS DE NAVEGAÇÃO E TELEMÁTICA, LDA
FERLODI - INDÚSTRIA MECÂNICA DE PRECISÃO, UNIPESSOAL, LDA
SANETE - MAQUINAS DE PRECISÃO, LDA
MANUEL FERREIRA PINTO & FILHOS, LDA
ACUTUS, LDA
JANZ - CONTAGEM E GESTÃO DE FLUÍDOS, S.A.
JANZ - CONTADORES DE ENERGIA, S.A.
CQI - CONTROLO DE QUALIDADE EM MOLDES, UNIPESSOAL, LDA
CAPTEMP, LDA

Appendix 3



Is the data discrete or continuous?
Discrete
Continuous
Can you estimate outcomes and probabilities?
Yes
No
Estimate probability distribution
Is the data symmetric of aymmetric?
Symmetric
Aysmmetric
Are the values clustered around a central value?
Yes
No
Binomial
Uniform Discrete
Are the outliers positive or negative?
Only +v
More+ve
More -ve
Geometric
Negative Binomial
Hyergeo metric
Is the data symmetric or asymmetric?
Symmetric
Asymmetric
Is the data clustered around a central value?
No
Yes
Uniform or Multi-modal
How likely are the outliers?
No outliers. Limits on data
Very low
Low
Triangular
Normal
Logistic Cauchy
Where do the outliers lie?
Only positive
Mostly positive
Mostly negative
Exponential
Lognormal Gamma Weibull
Minimum Extreme
Binomial
Discrete Uniform
Geometric
Neg Binomial
Hypergeometric
Uniform
Triangular
Normal
Logistic
Exponential
Lognormal
Min Extreme

Appendix 4

Country	2019
Belgium	29,00%
Finland	20,00%
France	31,00%
Germany	30,00%
Italy	24,00%
Poland	19,00%
Romania	16,00%
Sweden	21,40%
United Kingdom	19,00%
Portugal	21,00%
Czech Republic	19,00%
Norway	22,00%
Greece	28,00%

Appendix 5

	Country	Cov (Ri,Rm)	Var (Rm)	Company's Levered Beta
SMITHS GROUP	GB	0,00156882933	0,002109118	0,743832101
SPECTRIS	GB	0,00156882933	0,002109118	0,743832101
WACKER NEUSON	DE	0,00255087082	0,001973525	1,292545555
SMA SOLAR TECHNOLOGY	DE	0,00279389202	0,001936236	1,442950153
RENISHAW	GB	0,00174184653	0,002109118	0,825865078
VAISALA A	FI	0,00130458190	0,002109118	0,618543953
ION BEAM APPLICATIONS	BE	0,00289473661	0,002213363	1,307845171
APATOR	PL	0,00188699797	0,002253013	0,837544383
STRATEC	DE	0,00269694464	0,002150074	1,254349485
BASLER	DE	0,00232690549	0,002035769	1,143010592
GEFRAN	IT	0,00221468268	0,002213363	1,00059606
JUDGES SCIENTIFIC	GB	0,00121301921	0,001729672	0,701300111
ELECTROMAGNETICA	RO	0,00177380561	0,001938215	0,915175025
OXFORD METRICS	GB	0,00152804797	0,002005403	0,761965513
REVENIO GROUP	FI	0,00246650440	0,002006806	1,229069686
APLISENS	PL	0,00098219164	0,001362669	0,720785043
SONEL	PL	0,00200418836	0,001960303	1,022387291
GUIDELINE GEO	SE	0,00201218130	0,001869027	1,076592883
NANOFOCUS	DE	0,00107964037	0,001860251	0,580373461
ALPHA MOS	FR	0,00275694158	0,00219184	1,257820815
SIEMENS	DE	0,00313211916	0,002109118	1,485037743
INFINEON	DE	0,00493629376	0,001984124	2,487895609
O2 CZECH REPUBLIC	CZ	0,00152206927	0,002211429	0,688274136
SOITEC	FR	0,00551834987	0,002109118	2,616425947
KITRON ASA	NO	0,00231520344	0,002212811	1,046272795
TELESTE OYJ	FI	0,00284286726	0,002035769	1,396458691
PARAGON	DE	0,00142164575	0,002014389	0,705745484
FIRST SENSOR AG	DE	0,00158727433	0,002022446	0,784828977
LPKF LASER ELECTRONICS	DE	0,00410063711	0,002036923	2,013152968
MOBOTIX AG	DE	0,00069785031	0,00202193	0,34514061
INCAP OYJ	FI	0,00213220486	0,00219184	0,972792339
INTICA SYSTEMS AG	DE	0,00211612839	0,00179624	1,178087482
EGIDE	FR	0,00328931547	0,0020281	1,621870402
ASPOCOMP GROUP OYJ	FI	0,00263241387	0,002032467	1,29518186
FILTRONIC PLC	GB	0,00327901734	0,002109118	1,554686861
MEVACO ΜΕΤΑΛΛΟΥΡΓΙΚΗ	GR	0,00146833803	0,002032319	0,722493872
DIGIGRAM	FR	0,00234131395	0,002246402	1,042250544
ELMOS SEMICONDUCTOR	DE	0,00359442877	0,002109118	1,704233498

Appendix 6

	Company's Debt-to-Equity	Company's Unlevered Beta	Unlevered Beta Corrected for Cash	Industry Unlevered Beta
SMITHS GROUP	1,016366266	0,407968944	0,423851112	0,750794645
SPECTRIS	0,622019213	0,494623295	0,507277851	
WACKER NEUSON	0,327083674	1,051740542	1,064799727	
SMA SOLAR TECHNOLOGY	0,960587257	0,862796337	1,224284229	
RENISHAW	0,179258932	0,721153745	0,747754489	
VAISALA A	0,731000547	0,390297692	0,464101945	
ION BEAM APPLICATIONS	2,029876517	0,535735936	0,574701302	
APATOR	0,708625773	0,532116497	0,549854865	
STRATEC	0,725283173	0,831963232	0,863935482	
BASLER	0,661396888	0,781290444	0,839165766	
GEFRAN	0,809377318	0,619515498	0,753834801	
JUDGES SCIENTIFIC	1,013460887	0,385138576	0,430930356	
ELECTROMAGNETICA	0,128478905	0,82602818	1,501832964	
OXFORD METRICS	0,261216751	0,628899462	0,738035181	
REVENIO GROUP	0,222566543	1,043305727	1,08183853	
APLISENS	0,077830468	0,678039609	0,735349255	
SONEL	0,151471425	0,910657085	0,994796721	
GUIDELINE GEO	0,394359246	0,821847728	0,891362118	
NANOFOCUS	1,784607891	0,258032578	0,345614793	
ALPHA MOS	0,85282523	0,791854502	0,943629155	
SIEMENS	1,626750613	0,694356425	0,782379492	
INFINEON	0,389204216	1,955211906	2,053198908	
O2 CZECH REPUBLIC	1,267161156	0,33965355	0,350120755	
SOITEC	0,976382124	1,563255193	1,690005788	
KITRON ASA	1,679659544	0,452905586	0,463884299	
TELESTE OYJ	1,042248927	0,761511258	0,96755498	
PARAGON	1,346465457	0,363313309	0,501224492	
FIRST SENSOR AG	0,790361859	0,50528074	0,577422156	
LPKF LASER ELECTRONICS	0,575639063	1,434945493	1,470646578	
MOBOTIX AG	0,844705353	0,216893085	0,219774462	
INCAP OYJ	0,987609607	0,543432787	0,595909951	
INTICA SYSTEMS AG	1,817064439	0,518536948	0,519346789	
EGIDE	1,066751778	0,93422554	1,101405593	
ASPOCOMP GROUP OYJ	0,704997313	0,828122532	0,913247705	
FILTRONIC PLC	0,653766367	1,016433652	1,254045182	
MEVACO ΜΕΤΑΛΛΟΥΡΓΙΚΗ	0,447801179	0,546343517	0,675859514	
DIGIGRAM	2,235074627	0,409979519	0,521641565	
ELMOS SEMICONDUCTOR	0,311344189	1,399274343	1,499859301	

Appendix 7

Capital Expenditures						
N°	Designation (SNC)	Date of Acquisition	Quantity	Unit Cost	Investment	Subject to Depreciations Annual Dep. Rate
2	Basic Equipment	2019	2	2 000,00 €	4 000,00 €	33,33%
8	Computer Software	2019	4	1 550,00 €	6 200,00 €	25,00%
10	Basic Equipment	2019	1	9 000,00 €	9 000,00 €	33,33%
11	Basic Equipment	2019	1	3 500,00 €	3 500,00 €	20,00%
12	Basic Equipment	2019	3	800,00 €	2 400,00 €	100,00%
13	Computer Software	2019	2	7 000,00 €	14 000,00 €	25,00%
14	Computer Software	2019	1	2 000,00 €	2 000,00 €	25,00%
25	Basic Equipment	2019	3	2 500,00 €	7 500,00 €	25,00%
32	Basic Equipment	2019	1	7 000,00 €	7 000,00 €	25,00%
33	Basic Equipment	2019	1	7 000,00 €	7 000,00 €	25,00%
34	Basic Equipment	2019	1	30 000,00 €	30 000,00 €	20,00%
35	Computer Software	2019	1	5 000,00 €	5 000,00 €	33,33%
36	Computer Software	2019	1	10 000,00 €	10 000,00 €	33,33%
38	Basic Equipment	2019	1	3 500,00 €	3 500,00 €	25,00%
39	Basic Equipment	2019	1	2 000,00 €	2 000,00 €	25,00%
43	Basic Equipment	2019	3	600,00 €	1 800,00 €	100,00%
44	Basic Equipment	2019	1	3 500,00 €	3 500,00 €	20,00%
45	Basic Equipment	2019	3	2 500,00 €	7 500,00 €	33,33%
46	Computer Software	2019	2	5 100,00 €	10 200,00 €	33,33%
47	Computer Software	2019	1	1 000,00 €	1 000,00 €	100,00%
48	Computer Software	2019	3	650,00 €	1 950,00 €	100,00%
49	Computer Software	2019	1	1 000,00 €	1 000,00 €	100,00%
51	Computer Software	2019	1	6 000,00 €	6 000,00 €	33,33%
52	Computer Software	2019	1	1 000,00 €	1 000,00 €	100,00%

Appendix 8

Nº	Designation (SNC)	Annual Depreciations						
		Annual Dep.	2019	2020	2021	2022	2023	2024
2	Basic Equipment	1 333,20 €	1 333,20 €	1 333,20 €	1 333,20 €	0,00 €	0,00 €	0,00€
8	Computer Software	1 550,00 €	1 550,00 €	1 550,00 €	1 550,00 €	1 550,00 €	0,00 €	0,00€
10	Basic Equipment	2 999,70 €	2 999,70 €	2 999,70 €	2 999,70 €	0,00 €	0,00 €	0,00€
11	Basic Equipment	700,00 €	700,00 €	700,00 €	700,00 €	700,00 €	700,00 €	0,00€
12	Basic Equipment	2 400,00 €	2 400,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€
13	Computer Software	3 500,00 €	3 500,00 €	3 500,00 €	3 500,00 €	3 500,00 €	0,00 €	0,00€
14	Computer Software	500,00 €	500,00 €	500,00 €	500,00 €	500,00 €	0,00 €	0,00€
25	Basic Equipment	1 875,00 €	1 875,00 €	1 875,00 €	1 875,00 €	1 875,00 €	0,00 €	0,00€
32	Basic Equipment	1 750,00 €	1 750,00 €	1 750,00 €	1 750,00 €	1 750,00 €	0,00 €	0,00€
33	Basic Equipment	1 750,00 €	1 750,00 €	1 750,00 €	1 750,00 €	1 750,00 €	0,00 €	0,00€
34	Basic Equipment	6 000,00 €	6 000,00 €	6 000,00 €	6 000,00 €	6 000,00 €	6 000,00 €	0,00€
35	Computer Software	1 666,50 €	1 666,50 €	1 666,50 €	1 666,50 €	0,00 €	0,00 €	0,00€
36	Computer Software	3 333,00 €	3 333,00 €	3 333,00 €	3 333,00 €	0,00 €	0,00 €	0,00€
38	Basic Equipment	875,00 €	875,00 €	875,00 €	875,00 €	875,00 €	0,00 €	0,00€
39	Basic Equipment	500,00 €	500,00 €	500,00 €	500,00 €	500,00 €	0,00 €	0,00€
43	Basic Equipment	1 800,00 €	1 800,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€
44	Basic Equipment	700,00 €	700,00 €	700,00 €	700,00 €	700,00 €	700,00 €	0,00€
45	Basic Equipment	2 499,75 €	2 499,75 €	2 499,75 €	2 499,75 €	0,00 €	0,00 €	0,00€
46	Computer Software	3 399,66 €	3 399,66 €	3 399,66 €	3 399,66 €	0,00 €	0,00 €	0,00€
47	Computer Software	1 000,00 €	1 000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€
48	Computer Software	1 950,00 €	1 950,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€
49	Computer Software	1 000,00 €	1 000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€
51	Computer Software	1 999,80 €	1 999,80 €	1 999,80 €	1 999,80 €	0,00 €	0,00 €	0,00€
52	Computer Software	1 000,00 €	1 000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00€

Appendix 9

Investment Board					
Nº	Designation (SNC)	Year	Quantity	Unit Cost	Investment
3	Materials	2019	4	50 000,00 €	200 000,00 €
4	Materials	2019	2	50 000,00 €	100 000,00 €
5	Materials	2019	2	50 000,00 €	100 000,00 €
6	Materials	2020	2	2 800,00 €	5 600,00 €
7	Materials	2020	1	500,00 €	500,00 €
9	Computer Software	2019	6	238,50 €	1 431,00 €
15	Other Services	2019	1	1 400,00 €	1 400,00 €
16	Other Services	2020	1	100,00 €	100,00 €
17	Travel Expenses	2020	1	700,00 €	700,00 €
18	Travel Expenses	2020	1	630,00 €	630,00 €
19	Other Services	2021	1	100,00 €	100,00 €
20	Travel Expenses	2021	1	700,00 €	700,00 €
21	Travel Expenses	2021	1	630,00 €	630,00 €
22	Specialized Services	2020	3	600,00 €	1 800,00 €
23	Specialized Services	2020	3	1 000,00 €	3 000,00 €
24	Direct Services	2020	1	10 000,00 €	10 000,00 €
26	Computer Software	2019	3	500,00 €	1 500,00 €
27	Direct Services	2019	2	750,00 €	1 500,00 €
28	Travel Expenses	2019	2	1 500,00 €	3 000,00 €
29	Other Services	2019	1	500,00 €	500,00 €
30	Materials	2019	1	25 000,00 €	25 000,00 €
31	Materials	2019	1	25 000,00 €	25 000,00 €
37	Other Services	2020	1	20 000,00 €	20 000,00 €
40	Other Services	2020	2	700,00 €	1 400,00 €
41	Travel Expenses	2020	2	1 800,00 €	3 600,00 €
42	Materials	2019	1	500,00 €	500,00 €
50	Travel Expenses	2019	1	2 500,00 €	2 500,00 €
53	Other Services	2019	5	750,00 €	3 750,00 €
54	Other Services	2019	4	1 500,00 €	6 000,00 €
55	Other Services	2019	1	1 000,00 €	1 000,00 €
56	Specialized Services	2019	8	790,00 €	6 320,00 €
	Indirect Costs	2019	-	-	147 314,68 €
	Indirect Costs	2020	-	-	60 723,95 €
	Indirect Costs	2021	-	-	59 397,05 €
	Indirect Costs	2022	-	-	26 804,53 €
	Indirect Costs	2019	-	-	48 962,69 €
	Indirect Costs	2020	-	-	35 614,34 €
	Indirect Costs	2021	-	-	37 154,92 €
	Indirect Costs	2022	-	-	9 192,69 €
	Indirect Costs	2019	-	-	20 849,79 €

Indirect Costs	2020	-	-	16 313,55 €
Indirect Costs	2021	-	-	16 347,59 €
Indirect Costs	2022	-	-	7 105,57 €