On the cost of crowdfunding
a cost of capital approach

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On the Cost of Crowdfunding

A Cost of Capital Approach

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Abstract
Crowdfunding is a relatively new way of funding for entrepreneurs. This exploratory study aims to understand the costs for this type of funding named the Cost of Crowdfunding. The interaction between the entrepreneur and the investors appears to be a crucial factor in the model of the Cost of Crowdfunding. The proposed model starts from an utility function for the investor to determine the amount invested based on various parameters. In order to simplify the model a deterministic model is firstly explored and analyzed. Afterwards two extensions are introduced towards a stochastic and more realistic model with the interesting opportunity to provide pivot chances for a successful crowdfunding campaign. In addition a survey is conducted to better understand other driving factors which are deemed to be important by the entrepreneur and which may (in)directly impact the Cost of Crowdfunding positively or negatively. This adjusted Cost of Crowdfunding will be introduced as the more comprehensive Total Cost of Crowdfunding.
Preface

This study has been performed to obtain the degree in Master of Science in Operations, Management and Logistics at Eindhoven University of Technology. I have executed this project between March 2014 and September 2014 at Seeds BV, a subsidiary of ABN AMRO bank. Being an intern at Seeds, a crowdfunding platform sponsored by the bank, proved to be very interesting. Especially as at first glance one would not expect the combination of these two types of financial institutions, with crowdfunding being innovative and perhaps even disruptive, to get along with each other in harmony. In practice the combination of different types of funding harvest the best results for investors and entrepreneurs. Within that context Seeds is on a strong track to improve the crowdfunding concept. Not only within the bank, but also within the branch itself Seeds is trying to take crowdfunding one step further. I hope my study contributes to this goal.

As I could not have completed this study on my own I would like to thank the Seeds' team for their enthusiasm and support, in particular Merijn Zaat. From ABN AMRO my special thanks go out to Jos Wieleman. The discussions we had were more than needful to focus on the right subjects within the crowdfunding-jungle. Also, you inspired me with your passion and intelligence about the crowdfunding concept and your vision on how it should be positioned within ABN AMRO.

From the Eindhoven University of Technology I would like to thank my supervisors from the OPAC group for supporting me while diving into this rather new and uncommon subject. Special thanks to my first supervisor, Arun Chockalingam, for being so open-minded and ever enthusiastic about crowdfunding. My second supervisor, Matthew Reindorp, provided always useful feedback to keep me on the right track and maintain the required academic level. I am thankful for being part of such an intelligent and enthusiastic team.

Furthermore I would like to thank my parents, girlfriend and friends for supporting me during the later stages of my academic life. Being a student at the university were really enjoyable and valuable for me and I will always have great memories about this phase of my life.

Richard van Baardwijk
Executive Summary

As startups experience more problems while acquiring funding, alternative ways of funding have been introduced to help bridge the early stages of development: the Valley of Death period. Crowdfunding being an emerging popular one. For the last years Crowdfunding is growing in terms of total funding provided and attention gained. However Crowdfunding is not yet researched in depth on various subjects. One of them being the actual cost for a crowdfunding campaign. In this thesis firstly a closer look is being taken at these cost, referred to as the Cost of Crowdfunding. This Cost of Crowdfunding is the theoretical rate between the costs and the acquired capital also referred to as the return on investment as proposed by the entrepreneur to the investor. Secondly the Total Cost of Crowdfunding is introduced, which also includes the (in)direct gains and losses which impact the Cost of Crowdfunding.

The research was conducted at Seeds BV, a subsidiary of the ABN-AMRO bank. Seeds is a crowdfunding platform that focuses on facilitating the interaction between the entrepreneur and potential investors. While crowdfunding campaigns can be used for many types of companies, projects or just ideas, Seeds is mainly focusing on entrepreneurs who are socially involved with their service or product. The Investor’s Agreement, which is the contract between the two participants, states the various obligations. These participants being the investor and the entrepreneur. Furthermore it proposes one of the most impactful factors for the Total Cost of Crowdfunding; the return on investment as proposed by the entrepreneur to the investors.

The contrary position between the investor and the entrepreneur is a crucial driver in the presented model of the Cost of Crowdfunding. On one hand there is the entrepreneur who prefers the costs to be as low as possible for the capital acquired, while on the other hand there is the investor who will decrease the investments as the return on investment will be (too) low. A building block for the investor’s model is searched within the utility literature where the inverse exponential utility function is being selected. Parameters are introduced to model the various standardized investor behaviors. These parameters are representing the wealth (or available funds) for the investor, the hypothetical risk-free asset, the scaling parameter and the risk premium or the risk aversion called alpha. Alpha consists of many factors influencing the risk aversion for an investor. For example alpha can contain factors which represent the believe in the product and the rating of the management, the status of the economy etc. This behavior is visualized in Figure 1.
The investor’s model is deterministic and will return the total invested amount for a given return on investment for one investor or a group of investors which are behaving homogeneous. The Cost of Crowdfunding model will give a result in terms of an optimal return on investment for the various defined investor groups or individual investors. Various return on investments are an option as already in practice companies work with extras or perks which represents differences between the level of investments and their return. The solution for the optimal Cost of Crowdfunding is unique and will give the lowest Cost of Crowdfunding while the restriction, the target capital needs to be acquired, is still respected.

For a single investor or a whole investor group it is always interesting to know where the best value can be gained from a specific return on investment. In other words; if there was only one group or one investor, what would an entrepreneur propose as an return on investment to gain the most value out of his/her offer. This value can be seen as: an entrepreneur does not want to pay a lot to the investor, but wants to gain some funding nevertheless. While increasing the return on investment the increase in costs is two-sided. On one side the invested amount is increased thus in absolute terms the entrepreneur has to pay-out more, however as the return on the investment also increased the entrepreneur has to, again, pay-out more. The Slope price is introduced to estimate this specific point and gain insight where the entrepreneur ‘wants to be’ with the return on investment. The Slope price is able to give quick guidelines of reasonable areas for the return on investment and a first check of the price sensitivity of a crowdfunding campaign.

To make the model more realistic it is made stochastic by extending it in two directions. One direction is that the arrival of various investors is being randomized. Thus, for a new investor it is not known to what type of investors group he/she belongs. The other direction is to include chances for an actual investment. The deterministic model only provided the height of the investment when an actual investment is made. These probabilistic models can be used to better predict the total invested amount in a crowdfunding campaign if meaningful values can be set for the parameters.

Next the descriptive and predictive power of the models have been validated. For this purpose we took a closer look at two crowdfunding campaigns which were successfully funded with the support of Seeds’ platform. Firstly, one crowdfunding campaign is analyzed and the parameters are chosen in such a way that the total invested amount per investor group is close to what was achieved in
reality. The estimates for the risk-free asset are taken from the LIBOR-rates and the scaling parameter is set to match investors who are gradually increasing their investments. The wealth is being determined by taken the weighted average of the investor group’s individual investments. If the weighted average is far off the maximum amounts invested for that specific investor group other adjustments may have been made. Only alpha (the risk aversion) has to be determined hereafter. These results for alpha open up doors for more insights in the distribution of the investors groups and the parameters. Secondly the parameters have been successfully applied to the other Crowdfunding campaign. Within the two crowdfunding campaigns used it is clear that they follow different styles to attract investors which may reflect their own type of strategy for a successful campaign or ‘type of crowdfunding company’.

In order to determine the first factors for the Total Cost of Crowdfunding a survey was conducted where the target group consisted of entrepreneurs with and without experience in crowdfunding and who owned startups. The main findings where that there are indeed factors influencing the Total Cost of Crowdfunding both positively and negatively. Entrepreneurs agreed on the statement that a crowdfunding campaign also functions as an marketing campaign and it increases brand awareness. Furthermore a majority of entrepreneurs who had crowdfunding experience are positively towards crowdfunding platforms and determines their support as beneficial. Although it seems that a crowdfunding campaign takes a lot of effort investors disagreed upon the statement that it would take considerable more effort when compared to traditional funding methods. In particular the majority of the entrepreneurs with experience disagrees with the statement that an unsuccessful campaign minimizes any second chances for the business. Furthermore these entrepreneurs with experience do more disagree than agree on the question whether the crowdfunding platform costs are too high.

It can be concluded, firstly, that the proposed mathematical approach provides a tentative but promising model for the (Total) Cost of Crowdfunding and provides a guideline on how to further optimize the costs by the entrepreneur. Secondly, the crowdfunding platform can play an important role in evaluating the insights and to help set the parameter’s values for new contracts and campaigns. Thirdly the entrepreneurs can use the model to analyze the various trade-offs in the campaign with respect to the characteristics and sensitivities of the target group of potential investors.
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### List of Variables

- $i$: A specific investor or investor group
- $N$: Number of investors or investor groups
- $w_i$: The wealth or available funds for investor or investor group $i$
- $\beta_i$: Invested amount by investor or investor group $i$
- $\gamma_i$: Return on investment (ROI) for investor or investor group $i$
- $\alpha_i$: Risk premium for investor or investor group $i$
- $\gamma_f,i$: Risk-free rate for investor or investor group $i$
- $\tau_i$: Scaling parameter which describes the slope for increasing investments for investor or investor group $i$
- $TC$: Target capital as set for a crowdfunding campaign
- $\theta_i$: The Slope price for investor or investor group $i$
- $\omega$: Number of undefined investors
- $p_i$: Chance for an individual investor to belong to investor group $i$
- $q_i$: Chance for an investor or investor group to make an investment
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Numerous success stories of crowdfunding have reached the world’s prime media as for the last decennium. One of those stories originated from MIT lab researchers where they proposed a project to produce an affordable, professional 3D printer. Using the Kickstarter crowdfunding platform as their crowdfunding platform the researchers managed to successfully fund their idea backed up by around 2000 ‘backers’. The original goal of $100,000 was easily achieved as they reached a total funding of $2,945,885\(^1\). Starting with mini-investments as low as $1; various projects, companies or mere ideas have been funded by thousands of investors. Crowdfunding has shown a spectacular growth and seems to be going strong.

1. Introduction
As crowdfunding is relatively new a small introduction is written about the concept and the crowdfunding platform Seeds where this research was conducted.

1.1. A crowdfunding snapshot
Crowdfunding on its own has been around for decades, however the real potential, along with the acknowledgement of scientific research, has only been discovered around 2000 with the creation of the first crowdfunding platforms such as ArtistShare\(^2\). The real growth seems to have kicked in since 2005 and crowdfunding is multiplying rapidly in terms of available platforms, projects and amount of invested money (Massolution, 2012). Terminology and definition of this phenomenon varies across the different articles, however the concept stays the same. This paper will define crowdfunding as the following:

*Crowdfunding is the process where a two-sided market is formed by a request from entrepreneurs to a relative large number of investors to provide relative low investments amounts for funding in exchange for a form of value, generally supported by a web-based platform.*

In other words crowdfunding is the process where funding for projects, ventures or mere ideas is provided by a relative large group of individuals, commonly referred to as the ‘crowd’. This process is mostly backed up by a crowdfunding platform which supports the interaction between the individuals and the entrepreneur. A lot of attention is drawn upon the success stories where entrepreneurs acquired more than they could ever have foreseen. Crowdfunding is very interesting to study as the more theoretical financial matters are combined with a crowd who has a certain feel for or attitude towards a crowdfunding campaign. The concept is unexplored or unexplained on a lot of subjects and while traditional funding methods normally were focused on a negotiation between entrepreneurs, banks and angel investors, it is nowadays trending for all kind of investors who like to support an entrepreneur, enjoy the thrill of an investment or want a specific reward.

Crowdfunding is transitioning rapidly from small more charity-like projects to a billion dollar industry (Massolution, 2012). Kickstarter alone, one of the most famous and biggest crowdfunding platforms, indeed recently passed one billion dollar in pledges\(^3\). Crowdfunding offers a financial mode to gain funding and is, in general, attractive for entrepreneurs in order to acquire seed capital. Appealing

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2 http://www.artistshare.com/v4/About consulted at 14-3-2014
3 https://www.kickstarter.com/1billion consulted at 27-3-2014
success stories include the smartwatch called Pebble which first failed to attract conventional investors⁴, but acquired about ten million dollar through crowdfunding where their initial target amount was only $100,000. Apart from all those success stories a lot of crowdfunding projects are failing. Kickstarter shows us an average success rate for crowdfunding campaigns of about 45%. This success rate can be seen throughout the various crowdfunding platforms available. Furthermore, a crowdfunding campaign is often a time-consuming process for the, mostly, inexperienced entrepreneurs. Next to these low rates of success more downsides are being heard once a crowdfunding campaign has been indeed successful. A high Cost of Capital is one of the most stated ones⁵. We will refer to this Cost of Capital for crowdfunding as the (Total) Cost of Crowdfunding which will be more elaborated later on. This Cost of Crowdfunding is for most companies unclear and it appears to vary a lot. This thesis will try to explore this (Total) Cost of Crowdfunding.

1.2. Seeds

Seeds is the crowdfunding platform of ABN AMRO, a major bank in the Netherlands. By studying the crowdfunding process of an entrepreneur from the start till the end we are able to understand motivations, risks, benefits, decisions made etc. for both the investor and the entrepreneur. Seeds offers, at the time written, one crowdfunding mode to the investor and entrepreneurs which is formalized in their ‘Investors Agreement’. This Investors Agreement is the contract which provides all the duties and rights for both parties in the crowdfunding process. Furthermore, Seeds offers a stage to entrepreneurs, once they are through the first rounds of investigation, from a neutral point of view. An investigation of the applicants is needed to ensure that reasonable entrepreneurs with their business plans are entering the whole process and to ensure the professionalism of crowdfunding within Seeds. Seeds offers, like most crowdfunding platforms, a ‘no cure, no pay’ treatment. This treatment states that when an entrepreneur does not acquire their target amount, they do not have to pay any fees apart from the earlier inquired (small) entrance fees. If the crowdfunding campaign has been successful and they do acquire their target amount, a fee of five percent of the total amount gained has to be paid. More crowdfunding models and modes will be elaborated in the thesis. Seeds as crowdfunding platform only focuses on facilitating the interaction between investor and entrepreneur and will only support the entrepreneur by checking their business plan and crowdfunding campaign to ensure its professionalism as stated before.

1.3. Research objectives

For firms crowdfunding seems to be appealing, however little to no research has been done on its cost. This report will present a mathematical model of the theoretical cost of Crowdfunding. The theoretical cost for a crowdfunding campaign are the rates which are paid out to the investors who invested in the project or company. In addition a small step will be made to include more ‘practical’ cost (or gains) as studies show that a lot of different factors apart from the cost matter in the decision whether to choose for Crowdfunding or not.

For the main objective the following question can be asked: What is the Cost of Crowdfunding? This question is more focused on the ‘what’ in terms of how one should estimate it and from what components it consists. Once those elements are clear the quantitative answer in an absolute

⁴ http://go.bloomberg.com/tech-deals/2012-04-17-rejected-by-vcs-pebble-watch-raises-3-8m-on-kickstarter/ consulted at 27-3-2014
(currency) or a relative (percentage) manner can be estimated and the Cost of Crowdfunding can be evaluated and compared to other forms of funding. As crowdfunding uses many investors and has an agreement (contract) with every individual, another question interesting for research is: Are different returns needed for various investors? This question leads to focus on how one would construct the contract proposed to investors in terms of the returns. In the next chapter relevant literature will be reviewed to understand the concept and the dynamics of crowdfunding better from a scientific point of view.
2. Review relevant literature
First, a start is made by shortly investigating the motivations for the entrepreneur to participate in a crowdfunding campaign. This eventual participation is mostly supported by a crowdfunding platform. The role of those crowdfunding platforms along with their ability to support the entrepreneur to bridge the Valley of Death through the use of various crowdfunding models and modes will be elaborated secondly. In the ‘Contract’ paragraph the contract which binds all the stakeholders is explained by investigating its characteristics. The contract characteristics include; the regulations, implied risk and profit, financial flexibility and the Cost of Crowdfunding. The latter will be elaborated thoroughly in terms of Cost of Crowdfunding components by following the crowdfunding periods proposed by Voorbraak (2009) and dividing them further into macro-, meso- and microeconomics components.

2.1. Motivations for crowdfunding
Entrepreneurs, normally, have difficulties with acquiring their seed capital through the use of bank loans, equity, angel investors or venture capital. The credit crisis tightened credit constraints and made the Valley of Death’ even wider (Lavinsky, 2010). This Valley of Death occurs in the time range where an entrepreneur does, in general, not have any production and/or does not gain any profit with their business while they need minor funds to start or continue business. This gap is caused by the fact that the high risk within those entrepreneurs in terms of credit history, default rates and a low exit value is too risky and costly for banks. Equity is often avoided by entrepreneurs to prevent loss of control/profit and an ‘initial public offering’ is mostly costly (Curragh, Leveque, & Dhar, 2012) or not a real option. In addition there seem to be way more entrepreneurs who require seed capital than that there are angel investors and venture capitalist who provide venture capital. Thus, in terms of supply and demand there is not enough supply to fulfill the funding demand. Personal funds along with the funds acquired from friends, family and fans/fools (FFF) is generally the first step to acquire capital (Cumming & Johan, 2009) but is likely to be insufficient.

Figure 2: Stages of entrepreneurial firm development (Tomczak and Brem, 2013)
The above mentioned funding possibilities such as; bank loans (debt), equity, angel investors, venture capitalists and FFF, all have their own (dis)advantages and may be more preferable for different industries or entrepreneurs themselves. Those (dis)advantages include factors such as: cost of capital, financial flexibility, loss of ownership/control, loss of profit, bankruptcy costs etc. This early stage of entrepreneurial firm development which has been updated by Tomczak and Brem (2013) to include crowdfunding, shows that crowdfunding is a possible alternative for seed capital and early stage crowdfunding. Furthermore, literature shows us that there is more behind crowdfunding than just an alternative to bridge the Valley of Death. As Zaat (2011) shows, potential benefits as understood by the entrepreneur include “...Company PR, lower cost of financing, addressing new customers, obtaining engaged investors, market validation and participating in something innovative”.

2.2. Platform

Once a company is convinced that crowdfunding is the right method for them, the next move is to choose between direct and indirect crowdfunding as described by Tomczak and Brem (2013). Direct crowdfunding is the option where a company launches their own campaign without the support from a crowdfunding platform. Entrepreneurs generally make use of a crowdfunding platform in order to support their campaign, which is called indirect crowdfunding. Hemer (2011) states that crowdfunding platforms have a wide range of activity and intensity. Their services differ from just offering the platform to extensive guidance in the crowdfunding campaign. The vast majority of these platforms are web-based in order to reach the biggest ‘crowd’ and to minimize process costs (Ordanini, Miceli, Pizzetti, & Parasuraman, 2011), hereby reducing the geographical constraints.

Two types of funding are considered as crowdfunding initiatives; ex ante and ex post facto funding. Ex ante is the most popular form and does not provide a completed project or prototype but, as stated by Kappel (2009), “…financial support is given on the front end to assist in achieving a mutually desired result’. An example for ex ante crowdfunding, also given by Kappel (2009), would be the political campaign for Obama where many donations and other forms of support resulted in a successful campaign for Obama. Ex post facto funding does provide a prototype or a completed project/product, as in the case with Pebble. Crowdfunding platforms sometimes specialize themselves in one of those two types.

Crowdfunding platforms provide various payout models to the entrepreneurs. The most general ones, as suggested by Tomczak and Brem (2013) being shown below:

<table>
<thead>
<tr>
<th>All or Nothing</th>
<th>Entrepreneur gets the full amount (or more) which was the requested amount.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All and More</td>
<td>Entrepreneur is allowed to gain the invested capital even if it is below the requested amount.</td>
</tr>
<tr>
<td>Holding</td>
<td>Platform creates a subsidiary company as an individual holding for each of the crowdfunding ventures that are to be funded (Hemer, 2011). It acts as a single investor.</td>
</tr>
<tr>
<td>Club Membership</td>
<td>Potential funders are recruited in a closed circle form, thereby avoiding some security regulations.</td>
</tr>
</tbody>
</table>

Table 1: Payout models (Tomczak & Brem, 2013)
The reward modes offered to the investors can be split into non-equity and equity rewards although hybrid forms are common. Underlying investment modes are: passive investment, active investment donation and other (Tomczak & Brem, 2013), (Schwienbacher & Larralde, 2010), (Metzler, 2011). A passive investment is made when an investor invests money but does not seek active cooperation within the company, such as a regular bank loan. With an active investment the investor does have influence on the entrepreneur’s project result. This form of investment is best viewed as a stock purchase. Investors who donate money do not require a reward in any standard way and seem to enjoy value in a more intangible form (Gerber, Hui, & Kuo, 2012). As stated in the article from Tomczak and Brem (2013), there is a possibility of hybrid modes and other forms, thus ‘Other’ is included.

The right type of reward mode should be offered to the right type of investor and as Kuppuswamy and Bayus (2013) state: different types of incentives lead to different expected behavior from investors. A successful crowdfunding campaign is thus heavily influenced by the type of incentive (reward) and the marketing campaign. Etter, Grossglauser and Thiran (2013) provide insight that the crowdfunding campaign should be launched ‘hard’ in order to create momentum, as investors are more eager to invest as the accumulated amount invested increases. This behavior is called the ‘Herding behavior’ (Zhang & Liu, 2012).

2.3. Contract
These crowdfunding platforms, as described earlier, provide extra support for the entrepreneurs to complete the crowdfunding campaign successfully by facilitating the interaction between entrepreneur and investor. This facilitation comes in the form of providing the entrepreneurs and investors investment contracts and offering a stage to the entrepreneur.

As crowdfunding is relatively new, regulations are still being debated and researched on. Apart from the positive momentum crowdfunding has in the media, critical voices are being heard. The critics are mostly skeptic about crowdfunding on subjects as: fraud, rate of success, confidentiality and added value.6 ‘Proceed at your peril: Crowdfunding and the securities act of 1933’ by Heminway and Hoffman (2011) is a fine example which shows that the current laws are not able to handle such a disruptive technology completely. As for crowdfunding itself is quite promising, they indeed state that crowdfunding is yet in an unstable state.

These investment contracts imply the (assumed) trade-off between risk and profit. The investments in crowdfunding are very risky in terms of default rate: in the Netherlands 30% of the entrepreneur has quit their business in the first year and 50% in 5 years, as showed in a report by ING7. Furthermore, the vast majority of the crowdfunding modes do not provide any collateral in case of bankruptcy and the investment will be completely lost. Following the risk-return hypothesis crowdfunding platforms do indeed offer high profits to investors. Crowdfunding contracts provide in
general various payouts and actions dependent on thresholds and scenarios. These contracts determine a large part of the eventual Cost of Crowdfunding.

### 2.4. Cost of Capital

The cost of capital is an important factor for companies. A capital structure consists of debt and equity where crowdfunding is generally shared under the equity term. Optimal capital structure theories and hypotheses are around and provide optimizations by implementing marginal costs and benefits in trade-offs between, for instance, financial flexibility, cost of capital, leverage, growth, agency costs and other financial ratios.

Bancel and Mittoo (2002) provide insights that financial flexibility is the most important factor for choosing a particular capital structure. Where financial flexibility is defined as: “…the need for preserving flexibility will normally imply the maintenance by the corporation of a substantial reserve of untapped borrowing power.” Companies want to be financial flexible as they are uncertain about the future in term of company results and future contingencies on macroeconomics. Another statement made by companies Bancel and Mittoo found is: ‘With the use of debt, we try to minimize the weighted average cost of capital’. Thus, an optimal capital structure in terms of a minimized cost of capital and/or the financial flexibility is preferred by companies. There are big differences between countries and crowdfunding modes which state where crowdfunding belongs to. By using the term Cost of Crowdfunding an indirect proposal is made to include this term next to debt and equity in the cost of capital. The friction whether crowdfunding belongs to debt or equity on regulatory basis is not the only reason why this action might be justified. A crowdfunding campaign has its own impact and obligations on multiple levels, financial flexibility not the least of them.

### 2.5. Cost of Crowdfunding

The different parts of the capital structure have their own cost of capital and are influenced by various factors. We can distinguish the more traditional cost of capital calculations for the crowdfunding part which only takes the repayments into account (referred to as the Cost of Crowdfunding) and a Cost of Crowdfunding including all side costs and gains in terms of factors which will be referred to as the Total Cost of Crowdfunding.

As stated before, the factors influencing the Total Cost of Crowdfunding can be broken down into: macroeconomic, mesoeconomic and microeconomic dependent factors. Furthermore the microeconomic factors can be, again, split into three different periods. These periods are the pre-crowdfunding period, the crowdfunding period and the post-crowdfunding period, as described by Voorbraak (2009).

The Cost of Crowdfunding can be investigated with the help of, for instance, Utility Functions and Real Options. Utility functions are used to investigate what combinations of goods a customer prefers in order to reach a certain level of satisfaction. This can be enhanced into a function which desires a certain level of crowdfunding (the required amount) for a combination of investors. Real options could be of use in order to gain a better insight on the Cost of Crowdfunding with use of an ‘Input Mix Option’. This Input Mix Option can be seen as different ways of input (for example different type of investors) in order to attain the same outcome; the crowdfunding amount which is aimed for. Other options include differencing the intensity of the operation, expanding options, initiation moment.

Factors of importance in macroeconomics are the economic or business cycle a country or world is in. The positioning of the entrepreneur’s start on this cycle might influence the cost of capital as is
gained from the insight that recessions, such as the credit crisis, lead to tighter credit constraints which leads to a higher cost of capital for debt, as described earlier. For the Cost of Crowdfunding however, this relationship is more or less inversed. Namely, as economics are booming, interest rates offered by banks and companies are generally higher in comparison to interest rates offered in a recession. Lynch (2013) stated interesting thoughts about the timing to start a business and proposes that the best time would be in a recession in terms of costs and success rates. Thus, the position of an economy on the business cycle might have an influence on the Total Cost of Crowdfunding in terms of interest paid and its success rate.

Mesoeconomics take the branch or industry specific factors into account. Those factors are, for instance, preferred financial flexibility, opportunities for asset substitution, fluctuations in sales etc. (Harris & Raviv, 1991) (Jensen & Meckling, 1976). Furthermore the Capital Asset Pricing Model, based on work from Harry Markowitz (1991) is widely used to estimate the cost of equity partly based on ‘beta’. Where this beta is, mostly, industry based and which takes the sensitivity to systematic risk into account. Mesoeconomics play a bigger role in the question whether a project/company is suitable for crowdfunding than in the Total Cost of Crowdfunding. Some industries are just not as suitable for crowdfunding as others, capital intensive industries are an example.

Microeconomics will have a big impact on the company’s Cost of Crowdfunding. During the pre-crowdfunding period, which ranges from the moment the entrepreneur decides to enter a crowdfunding process until investors are able to start to invest in the entrepreneur, vital parts for the estimation of the Cost of Crowdfunding are being determined. These include; the fraction of the revenue which is paid out; the date of maturity; the revenue thresholds. Fees can be incurred by the crowdfunding platform to participate in the screening and preparations for the actual crowdfunding period.

The crowdfunding period starts when investors are able to pledge their investment through the use of the crowdfunding platform and ends when the set time has expired or the target amount has been acquired. In this period the marketing campaign should start in full force in order to bridge the ‘cold start’ problem (Ward & Ramachandran, 2010) and to launch hard as stated by (Etter, Grossglauser, & Thiran, 2013). The costs for the crowdfunding campaign are not fully wasted if it does not attract investors right away. Awareness is raised for the entrepreneur’s product or company and hence, the first indirect costs and gains might occur. Indirect costs as the campaign is, based on literature, recommended but not required for the entrepreneur. It is not required as there is a chance the crowdfunding campaign will be successful without any form of interference by the entrepreneur, one might argue that those chances would indeed drastically decrease. Indirect gains occur as the crowdfunding campaign contributes to an increasing awareness of the company/product. Awareness is one the most important factor considered by management, as a consumer must be aware of the product or company to be able to buy or use the offered service (Macdonald & Sharp, 2003).

The post-crowdfunding period starts with the cost for the crowdfunding platform. Most of the platforms use the ‘no cure, no pay’ model and thus there are no cost if your crowdfunding campaign is not successful, apart from very small ‘introduction’ fees. If it is successful, the vast majority of the platforms request a fee based on a percentage of the crowdfunded amount. Furthermore, the entrepreneur has to fulfill his duties as have been agreed upon in the contract. This includes, for instance, the actual repayments and ‘extras’ as offered in their crowdfunding campaign. As the
repayments are related to the thresholds proposed in the pre-crowdfunding period, mostly an independent accountant has to check the financial statements which are being prepared by an accountant from the entrepreneur’s company. This implies significant indirect costs. Once again it is thus important for the entrepreneur to think about his post-crowdfunding ‘management’ in the early stages of the whole process (Carbone, 2013).
3. Approach

Crowdfunding and its costs are not investigated in depth as became clear from the literature study above and while crowdfunding shows many opportunities as an alternative to bridge the Valley of Death it has yet to be evaluated on various areas. Before an explanation can be given for the Total Cost of Crowdfunding with all her various factors, a model for the most essential part has yet to be explored; the Cost of Crowdfunding. Our goal in this report is to provide a model which formalizes the Cost of Crowdfunding.

The microeconomics play a big (or even the biggest) role in the Cost of Crowdfunding by using a contract or ‘Investors Agreement’ which gives an estimation for the Cost of Crowdfunding. However, there has been, at the time written, no or little research on how this contract is constructed in an optimal way. The construction of this contract requires the understanding of the relationship between the two participants; the entrepreneur and the investor. This relationship is essential as the entrepreneur offers the contract to the investor, who determines if it is beneficial to invest or not. On one side the entrepreneur does not want to offer a high return on investment to the investor as the Cost of Crowdfunding will be high. But as the willingness of the investors determines the chances on a successful crowdfunding campaign, the entrepreneur does not want to offer a return on investment which is seen as too low, as investors might back-off which results in a unsuccessful crowdfunding campaign. By grasping this relationship within a mathematical model, the entrepreneur is able to simulate and estimate the expected total invested amount by all investors with its corresponding Cost of Crowdfunding. In order to start working with the Cost of Crowdfunding the following methodology is followed:

Firstly, a research will be conducted in order to recognize vital parts or ‘building blocks’ for such a model on the Cost of Crowdfunding. These building blocks consist of the various variables which have to be included and the general form of the expression. Once these components have been explored the Cost of Crowdfunding model will be assumed to be deterministic which allows us to understand the basic relation between the entrepreneur and investor. After the deterministic model has been created and analyzed in terms of behavior, steps can be taken to make the model stochastic which leads to a more realistic model. This report focuses especially on the deterministic Cost of Crowdfunding model. The deterministic model is the first step to formalize the relationship and to make the crowdfunding process more analytical. With this model we are able to run simulations and tests for insights about the behavior of the model and its assumptions and from a practical point of view we can provide a strong benchmark for the entrepreneurs.

Secondly, a start is being made to explore the various components influencing the Total Cost of Crowdfunding through the use of questionnaires. To find the components for the Total Cost of Crowdfunding and approve their existence, questionnaires will be provided to a target group which consists of (innovative) entrepreneurs as present in the database of TechCrunch. Some entrepreneurs are considering crowdfunding as a way of funding, but are not yet in the crowdfunding period, while others already have experience. Hereby, we are able to understand the components which are found meaningful by those (potential) entrepreneurs with and without experience. In cooperation with the literature review we are thereby able to support components as proposed by the target group and to understand consensus in newly proposed components.
4. Methodology

As there is no framework for these costs yet, to the best of our knowledge, this report is primarily focused on exploring and building a framework. Secondly first steps are being taken to validate such a model by the use of two successful crowdfunding campaigns. The behavior of the proposed deterministic model will also be validated, however, by the use of simulations and sensitivity analysis. Once this deterministic model has investigated it will be made more realistic by including chances on events, as a crowdfunding campaign is far from deterministic. One of these extensions to make it more stochastic includes a formula which returns chances an investor will make an actual investment based on the return on investment as proposed in the contract by the entrepreneur.

To grasp the factors which are not included in the more theoretical Cost of Crowdfunding questionnaires are being used. By proposing own thoughts about the existences of these factors to the target group we are able to get an understanding on how entrepreneurs are judging them. The goal of these extra factors is to adjust the Cost of Crowdfunding into a more ‘total’ view on the Cost of Crowdfunding. As numerous studies showed that the use of crowdfunding leads to all sort of indirect gains or costs and their impact on the Cost of Crowdfunding is important to understand the motivation for an entrepreneur. Also, this gives a better indication on the expected cost of a crowdfunding campaign. The proposed model will give a realistic expectation of the Cost of Crowdfunding which can be used by entrepreneurs as a guideline. Assumptions are made on the behavior of potential investors for a crowdfunding campaign. The most fundamental ones being:

**Investors will prefer a higher return on investment over a lower one.**
In order to make the model not unnecessary complex standardized investing behavior is followed where a rational investor will prefer a higher return on investment over a lower one in the same crowdfunding campaign.

**Investors will gradually invest more as the return on investment is increased.**
In line with the previous assumptions to follow standard investment behavior it is assumed that an investor will diverse its portfolio between a crowdfunding campaign and an hypothetical risk free asset. If the return on investment is increased, ceteris paribus, the investor will gradually move more funds into the crowdfunding campaign.

**Investors can be grouped in investor’s groups which are behaving homogeneously.**
Although investors are individuals their behavior can be grouped to simplify the model and its results.

**The entrepreneur will prefer a lower cost over higher cost when the same capital is acquired.**
The entrepreneur will also follow standard investing behavior from a cost perspective and thus will always prefer less costs over more if both amounts would give the same return.

In chapter 5 the Investor’s model is being proposed and explained. This model is for an individual or for one group of investors who are behaving homogeneously. Chapter 6 will be focused on the Investor’s model with multiple investors or investor groups. Also problems according the uniqueness of the solution as provided by the model are being figured out. Chapter 7 will explain how to use the solution and provide another feature of the Investor’s model in terms of the “Slope Price”. Chapter 8 will consist of two methods which make the model more stochastic and realistic and provides a
formula to estimate the chance of an investor actually making an investment. The results of the survey are being discussed in chapter 9.
5. Investor’s model

A major part of the Cost of Crowdfunding for entrepreneurs comes from the return on investment offered to the investors as stated in earlier chapters. In this part the relationship between those two stakeholders and this return on investment within crowdfunding are more elaborated in order to understand the model proposed later on.

5.1. Relationship

The relationship as stated in the literature study between entrepreneur and investor has two strongly different points of view. On one side there is the entrepreneur who wishes to acquire his target capital by paying as little as possible to the investors. While on the other side there is the investor who wishes to gain the highest amount of (extra) wealth from his/her investment. We assume that every investor would value more money over less money (a higher return over a lower return). Searching for a right method of modeling these two behaviors leads to the use of utility functions. The relationship between the two stakeholders can be formalized within one function and shows the Cost of Crowdfunding formula for the entrepreneur where the utility function for the investor is included. This relationship shows both behaviors of the entrepreneur and investor. Namely, the function for the entrepreneur where he/she will prefer the acquired capital for a as low as possible Cost of Crowdfunding and an utility function for the investor where he/she will prefer a higher return on investment for the same amount invested. The Cost of Crowdfunding for the entrepreneur is derived from the utility function for the investor as the entrepreneur has to take into account the reactions from the investors on his offers and not vice versa. These two functions are further elaborated in the next chapter.

5.2. Relationship model

The Cost of Crowdfunding formula is the function where the entrepreneur is mainly focused upon. The Cost of Crowdfunding in this case is nothing more than the definition in the name itself and as explained in the previous chapters it purely focuses on the pay-out rate or proposed return on investment. In other words a standard definition of any cost of capital where it is calculated how much an entrepreneur has to pay for every acquired amount of money. This can be expressed as shown below where the invested amount by investor \( i \) (\( \beta_i \)) and the offered Return on investment (\( \gamma_i \)) are introduced.

\[
\text{Cost of Crowdfunding (CC) for N number of Investors:} \quad \frac{\sum_{i=1}^{N} \gamma_i \cdot \beta_i}{\sum_{i=1}^{N} \beta_i}
\]

The entrepreneur will try to minimize this Cost of Crowdfunding function for \( \gamma_i \) while acquiring his target capital (\( TC \)) and thus the objective will be expressed as:

\[
\min_{\gamma_i \geq 0} \frac{\sum_{i=1}^{N} \gamma_i \cdot \beta_i}{\sum_{i=1}^{N} \beta_i}
\]

subject to \( \sum_{i=1}^{N} \beta_i \geq TC \)

Although there are options within crowdfunding contracts where the entrepreneur does not have to pay the proposed return on investment when it does not fulfill the requirements for a payment, it is
assumed that the entrepreneur will expect to fulfill these and thus pay the proposed return. Also it is assumed that promised investments by the investors will be paid. The function for the invested amount by investor in case he/she will make an investment, $\beta_i$, will be derived and elaborated in the next chapter as assumptions have to be made in order to grasp its behavior and implications on the CC.

5.3. The invested amount

First, it is assumed that the behavior of the investor is deterministic once its parameters have been defined. By making this assumption it is possible to state that for a specific offered return on investment an investor invests an $X$ amount of money, guaranteed. A way to model this behavior is by using the inverse exponential function which founds its base in the exponential utility function. This exponential utility function $u(x)$ is shown below:

$$u(x) = 1 - \frac{e^{-ax}}{a}, \alpha > 0$$

Here “$x$” is the variable the investor wishes to maximize such as consumption. In the investor’s case there is no way to maximize or minimize his/her return. The investor will just react to a given return on investment offered by the entrepreneur, which we refer to as “$\gamma_i$” as stated before. “$\alpha$” represents the degree of the investor’s risk aversion. The form of this formula is used as a multiplier for the base wealth of the investor, as the proposed (extra) wealth received by the investor is the utility he gains. In order to take the relative return offered by the company into account we follow the modern portfolio theory and capital asset pricing model which leads to the inclusion of the risk-free rate as offered by an (hypothetical) asset. This hypothetical asset will be defined by bank interest rates for individuals in this report. This will lead to the following part which has to be included: $(\gamma_i - \alpha_i) - r_f$, where the Risk aversion rate “$\alpha_i$” can be seen as a premium return rate needed by the investor on top of the proposed return on investment to offset his risk-aversion and in order to actually make an investment based on the investor’s own thoughts and assumptions. In the next chapter “$\alpha_i$” will be more elaborated. To further customize the behavior of the investors a scaling parameter “$\tau_i$” is introduced. The scaling parameter “$\tau_i$” within the exponential factor shows us how fast an investor is likely to increase his/her investments when the offered return on investment is increasing. A higher scaling parameter will increase the slope of the graph and vice versa. The new formula based on the building blocks above must have the property where the invested amount equals zero in case the offered return is equal to the bank interest rate if the investor’s risk aversion is zero: $(\gamma_i - \alpha_i) - r_f = 0$. To implement this specific point, the original “$\alpha$” in the denominator is replaced by $1 - \alpha_i$ and the range for “$\alpha$” is updated accordingly. The decision to use $1 - \alpha_i$ instead of $1 + \alpha_i$ lies in the behavior at all the points where $(\gamma_i - \alpha_i) - r_f < 0$. When $(\gamma_i - \alpha_i) - r_f < 0$ is given and $1 + \alpha_i$ is used in the denominator the investor will have an investment greater than zero while this does not correspond with the investor’s behavior as explained previously; the investment should be zero. Using $1 - \alpha_i$ in the denominator follows the behavior as described and the investor will only start investing in case $(\gamma_i - \alpha_i) - r_f > 0$. Note that “$\alpha$”, “$\tau_i$” and “$r_f$” are specific for an investor or investor type for a crowdfunding campaign.

In short, the formula proposed for the invested amount by an investor if he/she will make an investment is based on the Wealth of the investor ($w_i$), the investor’s Risk Aversion ($\alpha_i$), the Risk Free rate ($r_f$), the offered Return on investment ($\gamma_i$) and the investor’s scaling parameter ($\tau_i$).
Invested amount by Investor $i$ ($\beta_i$): $w_i \left(1 - e^{-\tau r_i(y_i-a_i)-r_{f,i}}\right)/(1 - a_i)$, where $\beta_i \geq 0, y_i \geq 0$

The total expression for the Cost of Crowdfunding objective for the entrepreneur would then be:

$$\min_{y_i \geq 0} \sum_{i=1}^{N} y_i \cdot w_i \left(1 - e^{-\tau r_i(y_i-a_i)-r_{f,i}}\right)/(1 - a_i)$$

subject to $\beta_i \geq 0, y_i \geq 0, \sum_{i=1}^{N} \beta_i \geq TC$

This formula is specific for every crowdfunding campaign. In the next parts these formulae are further explained by simulation.

### 5.4. Alpha

Alpha was shortly explained along the way as the factor which represents the risk aversion and shown as an risk premium which the investors needs to offset his risks.

Alpha can consist of a number of factors which the investor thinks are meaningful for his premium/risk aversion estimation. Factors may, for example, include the investor’s belief in the product, the entrepreneur or the company as a whole, the industry or branch, the momentum of the economy (booming or crisis) etc. Along these more ‘general’ factors which influence alpha, the investor will have all sorts of specific or individual factors which only matter to the investor himself. In other words: the spread the investor is calculating which is based on his own assumptions in “$\alpha_i$”, will be compared to the estimated return from another asset (in this case the risk-free rate for the investor).

From a practical point of view it is next to impossible to estimate the right alpha for every investor involved for every crowdfunding campaign and as later will be much more explained the alpha shows more the characteristics of an investor or investors group on average.

### 5.5. Visualization

The terms ‘individuals’ and ‘investors’ have been used so far, however, these terms can be switched accordingly with a ‘group of investors’ as it is assumed that every investor within a specific group of investors (such as small, medium and big investors) is behaving homogenous. Firstly the focus will be upon individuals before the switch to groups will be made and further explained. This means that an individual does have his/her own offered return on investment and it could be possible that two investors would both invest €100,- but have different return on investments. While this might seem to be a peculiar way to approach potential investors, it is a common used strategy already. The difference in the return is however not often gradually increasing and may consist of a few investment ‘blocks’ where a different return on investment is offered per different block. The difference is also often expressed in so called ‘extras’ or ‘perks’ and not in a financial form. These perks are (in)tangible rewards which are mostly received right away upon investing, examples are; t-shirts, a free ticket/product, a guided tour through the company etc. When the extras are becoming more valuable or ‘special’ the more you invest, it is also a representation for a difference between a
more theoretical return on investment to the investor. After the model is shown and explained the implications for the contract are elaborated. For the model the following boundaries are defined in order to set the ‘playing field’ of the simulations and its behavior in order to visualize realistic results:
- The offered return on investment, \( \gamma_i \), will normally have values ranging from \( 0\% < \gamma_i < 25\% \) with steps of \( 0.005\% \) or \( 0.01\% \).
- The scaling parameter \( \tau_i \) uses the domain where \( 1 < \tau_i < 750 \)
- The investors wealth, \( w_i \), cannot be negative and is differently capped for every investor. \( w_i > 0 \)
- The Risk-Free rate, \( r_{f,i} \), for individuals can differ. Some investors will only have an option to use the rate as given on their savings account while ‘larger’ investors will use the market return. \( 0\% < r_{f,i} < 25\% \)
- The risk aversion rate, \( \alpha_i \), can range from \( -100\% < \alpha_i < 100\% \). A strong negative value shows the option to include donations from investors where they do not require any form of rewards or just minor returns. A big positive value shows a strong risk aversion.

Note that other values may be considered, but to set up a domain for simulations the ranges above were used. Below in Figure 3 a representation is given on how this behavior can be visualized for various investors as an example.

![Invested amount vs. Return](image)

**Figure 3: Different investors and their behavior visualized**

<table>
<thead>
<tr>
<th>Investors parameters</th>
<th>( w_i )</th>
<th>( r_{f,i} )</th>
<th>( \alpha_i )</th>
<th>( \tau_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investor 1</td>
<td>€3.000</td>
<td>4%</td>
<td>4%</td>
<td>30</td>
</tr>
<tr>
<td>Investor 2</td>
<td>€1.500</td>
<td>1.5%</td>
<td>2%</td>
<td>100</td>
</tr>
<tr>
<td>Investor 3</td>
<td>€200</td>
<td>1.5%</td>
<td>-8%</td>
<td>40</td>
</tr>
<tr>
<td>Investor 4</td>
<td>€4.000</td>
<td>6%</td>
<td>8%</td>
<td>500</td>
</tr>
</tbody>
</table>

**Table 2: Parameters of the investors in Figure 3**
Figure 3 consists of four different investors where especially investor 3 and 4 stand out. Investor 3 does not really care about the return on investment and will more or less donate his/her available resources to the entrepreneur. A lot of time this behavior can be seen among friends, family and more socially involved companies. Investor 4’s behavior can be seen as a big investor who will invest all of his/her available resources for that particular crowdfunding campaign if the return on investment fulfills the investor’s requirements.

Note that these functions do not say anything about the chance that the investor will actually make an investment. However, if the investor does make an investment, this model will return the amount invested for a specific return on investment. Later on the chance for an investor to make an actual investment will be elaborated. The value of the parameters should be validated by analyzing the target group of investors before running simulations. The function can be customized in such a way that standard or average investment behavior is represented.
6. Multiple investors model
For one investor the Cost of Crowdfunding is nothing special for the entrepreneur as the cost just equals the offered return on investment and the optimal solution for a specific target capital is easily obtained as the model is assumed to be deterministic.

However, when extra investors are introduced there will be a lot of possibilities for the total invested amount and its corresponding Cost of Crowdfunding. The total number of points which need to be analyzed are all the different combinations between the return on investments for the investors. First the focus will be on a model which consist of two investors. Later on, one investor is added in order to analyze the influence of this extra investor in the 3- or more investors model.

6.1. 2-Investors model
As stated earlier, there is a possibility that the return on investments proposed to the two investors are not equal. Thus, one investor might be offered a return on investment of 5,05% while the other investor is offered 7,45%. If these combinations are plotted together with their total invested amount a graph such as the one below (Figure 4) can be obtained. The following parameters have been used for investor 1: \( w_1 = \text{€}3000, r_{f,1} = 3\%, \alpha_1 = 4\%, \tau_1 = 10 \) and investor 2: \( w_2 = \text{€}1500, r_{f,2} = 3\%, \alpha_2 = 2\%, \tau_2 = 10 \). The target capital for these two investors together has been set at: \( TC = \text{€}2500 \).

![Image](image_url)

**Figure 4: 3D plot for total invested amount and the two return on investments (ROI) for both investors**

The return on investment is abbreviated to ROI in the title of the graph. In this case the dotted plane through the graph shows the target capital \( (TC) \) as a constraint proposed by the entrepreneur. The grey points above this plane are all the points which satisfy this constraint. As a matter of fact, only the grey points are, so far, interesting to the entrepreneur and in particular the points which offer the lowest Cost of Crowdfunding. Unfortunately, this graph does not provide any information about
the Cost of Crowdfunding. When zoomed in on this grey area it is necessary to calculate the Cost of Crowdfunding accordingly and plot it against the total amount invested. This graph is shown in Figure 5. The 3D-effect within this 2D-graph is obtained because the Cost of Crowdfunding consists of two investors in this case.

![Graph showing the Cost of Crowdfunding and total invested amount.](image)

**Figure 5: Total invested amount plotted against the Cost of Crowdfunding**

It is clearly visible that there is some sort of ‘efficient frontier’ which represents the curve with points on the edge furthest to the left. The entrepreneur would always like to be on this efficient frontier, because in this case the entrepreneur would gain the most value for the Cost of Crowdfunding. If one would be only interested in the lowest possible Cost of Crowdfunding while still acquiring his target amount (as we will focus on from now on), one should chose the most left and lowest point possible in the graph located within the red circle. This Cost of Crowdfunding can be retraced to the individual investments (and thus return on investments) made by the investors if the solution is unique.

When the Cost of Crowdfunding is plotted against the two different returns on investments for the investors while the target capital is acquired the following graphs are obtained in Figure 6. Note: it is the same graph but from different angles.
Figure 6: Different angles for the Cost of Crowdfunding versus the two ROI’s for two specific investors

There seems to be indeed one optimal Cost of Crowdfunding rate which can be obtained. In the following chapter a more detailed explanation is given of the uniqueness of this solution.

6.2. Uniqueness

From the earlier Cost of Crowdfunding graphs one might argue already that it seems to be that there is only one point which can be exactly on this frontier. As the underlying utility functions are based on the assumption that every investor prefers more value over less value and entrepreneurs prefer less cost over more cost, this leads to the statement that there is non-satiation and both the investor and entrepreneur are always in search for more value and lower cost. As the exponential utility function is used every extra percentage for the return on investment offered to the investor is perceived as ‘less value’. An example would be that an extra one percent in return would be a lot if the entrepreneur’s return equals two percent, but will be marginal way less if its return was already twelve percent. This is called decreasing marginal utility and is visualized by the slope of the behavior graphs for the investors themselves.

In order to show the uniqueness of the solution graphically the following procedure is being followed: In case there are two investors available and a specific return on investment is offered to one of them, it is known what investor 1 will invest and how much money the entrepreneur still need from the second investor in order to acquire his target capital. Because this amount of money is known, it is also known what the corresponding minimum return on investment the entrepreneur should offer to get the other part of the capital from the second investor. By following this method for every possible return on investment for investor 1, all the Cost of Crowdfunding rates are being given where the acquired capital is exactly equal to the target capital. By plotting all these Cost of Crowdfunding rates against the return offered to investor 1 (in Figure 7) and 2 (in Figure 8) we are able to see how the Cost of Crowdfunding behaves for both returns on investments individually when the constraint is exactly met.
There indeed seems to be one point where the Cost of Crowdfunding is the lowest and this has only one solution as is shown by the two graphs for this specific case. This specific case is determined by the investor’s parameters \( (r_f, i, \alpha_i, \tau_i, w_i) \). However when similar simulations are performed for different parameters this behavior stays the same. Another validation is the graph in Figure 9 where all the possible Cost of Crowdfunding rates are plotted against all the values for both returns on investments for the investors where the target capital is exactly acquired. Note that this graph is been constructed by combining Figure 7 and Figure 8 into a 3D-plot.

Note that these are the same graphs, but plotted for different angles to gain a better view of the curve it follows. Indeed, there is only one optimal solution for a minimal Cost of Crowdfunding.
However, one more problem should be tackled. There may be a case where a minor increase in the total invested amount could lead to a lower Cost of Crowdfunding. Although the underlying utility functions do disprove any possibilities on such an event as the invested amount will always increase (with a decreasing marginal utility as stated before) if the return on investment will increase and the previous Cost of Crowdfunding versus ROIs graph (Figure 9) does also support this statement. In order to show this numerically all total invested amounts above the target capital are plotted against the optimal Cost of Crowdfunding rates for that particular invested amount by small (practical insignificant) increases (Figure 10).

![Optimal Cost of Crowdfunding vs. total invested amounts](image1)

![Cost of Crowdfunding for small increases in the TC](image2)

Figure 10: Optimal Cost of Crowdfunding for an increasing required capital

Figure 11: Efficient frontier for the Cost of Crowdfunding for an increasing required capital

Note that the right graph (Figure 11) shows the ‘efficient frontier’ for multiple invested amounts as was explained earlier. As the characteristics of the underlying functions pointed out it is clear that indeed the optimal solution for the Cost of Crowdfunding is obtained when the acquired capital is equal to the target capital and it is unique. Although the left graph seems to be linear it is not, as is shown in Figure 12. In this graph all the optimal Cost of Crowdfunding points are plotted against different Target Capitals which range from €10,- to €4490,-. It is clearly visible that the Cost of Crowdfunding shows a somewhat exponential behavior. Although this graph is again for the proposed specific case where the investor’s parameters are given, similar behavior is obtained for various investor’s parameter values.
Although our numerical study suggests that there is no chance that a lower CC is obtained for a small increase in the total invested amount it is possible in practice due to the coarseness of the model. This is shown Figure 13. Here one is able to see that although the point marked with a red “A” has an invested amount which is closer to the initial target capital of €2500,–. But the point with a red “B” has a lower Cost of Crowdfunding, namely around 0.15 or 15% instead of 0.24 or 24%. This coarseness is caused by the steps by which the returns offered to the investor are increased, as the step size increases so does the ‘rounding’ error. Smaller steps lead to edges being more refined and so will the result be. The example in Figure 13 indeed had a large step size of 0.5%. For example: A more refined result would be acquired when one would simulate the model where the returns increase with steps of 0.00001% from 0% until the proposed maximum of 25%. However, as this greatly increases the computation time while the model is proposed as a guideline this might not be worth the trade-off between time and result. Another result is given in Figure 14 and while it has the same investor’s parameters as Figure 13 the step size for the return on investment was decreased to 0.1%, the difference in accuracy of the solution is clearly visible. The difference has been decreased as the best solutions are close together in the area marked by the red circle.
6.3.3- or more investors model

As a solution was given for the 2-persons model so it is possible to find a solution for three or more investors. However, it is not possible to show the relationship between those three or more investors visually as multiple dimensions are necessary (three investors would lead to a 4D-graph). The relationship between the Cost of Crowdfunding and the total amount invested can still be shown and is done so below in Figure 15 for three investors.

Figure 15: Total invested amount plotted against the Cost of Crowdfunding

Again the ‘efficient frontier’ is visible and shows us the best Cost of Crowdfunding options with corresponding ‘Invested Amount’ points. Indeed, the behavior of this graph is equal to the graph for two persons in Figure 5. This behavior stays the same for more than three investors and states there is always one optimal point and an efficient frontier. The upcoming chapters explain what insights those models are able to give to the entrepreneur.
7. Constructing the contract
The model and its solution eventually results in a proposed contract for the entrepreneur. In this chapter an explanation is given on what this solution means and how to interpret it.

7.1. Groups of investors
As stated before the terms investor or group of investors can be switched without any problems in this model as it is assumed that a group of investors behaves homogeneously. Within crowdfunding campaigns it is generally accepted to place your possible investors within specific target groups. A general differentiation is made between two groups on their amount invested where one is representing small investors and the other group represents the big investors. Investors could be separated from each other based on any sort of parameter or characteristic and for example the model proposed includes already various tools to simulate different investors such as their wealth, risk aversion etc. However, for most crowdfunding campaign it is most likely not worth it to overdo the defining of various investor groups. There is however a noticeable distinct between the most common group as was pointed out earlier. A lot of articles state that one of the most important groups for attracting capital are friends, family & fans (FFF). Big investors are still very relevant in crowdfunding campaigns and most likely there will be also a group of medium investors who see crowdfunding more as a hobby where there is a chance on a good return. It is clear that this FFF-group has a different investment characteristic than the few big investors the company might be able to attract, but note that this does not mean per se that the FFF-group are always small investors and vice versa. In order to create groups one should generalize the investors which could lead to some investors being way off their expected investments. Also interesting perks may drive investors over the edge to invest a bit more (or sometimes less). This distinction between two or three groups can be seen in numerous crowdfunding campaigns where the size of the investment is plotted against the frequency. Two examples for the distinction in three groups, which is taken from Seeds’s own crowdfunding campaign data publicly available, are given below. The first one is from Greenjoy\(^8\) in Figure 16 where the size of all investments is rather small but a distinction between three groups is still visible among the 116 investors in total. The groups are centered around €50, €100, and €250. For this campaign it was only allowed to increase your investment (starting at €50) by €10 and only one person invested €70, which explains the spike downwards. If one would sum up investments below €100 as their difference is small, two groups can be distinguished.

---

\(^8\) [https://www.seeds.nl/ondernemingen/greenjoy/investeringen](https://www.seeds.nl/ondernemingen/greenjoy/investeringen) consulted on 5-8-2014
The second, recent successful crowdfunding campaign comes from Lokalinc where the frequency plot among the 48 total investors is shown in Figure 17\(^9\). When the investments below €150,- are summed up again, in order to clear out the small absolute difference, a distinction between the groups centered around ≤€100,-, €500,- and €5000,-. These groups could be seen as the small, medium and big investors as proposed previously.

\[\text{Frequency of investments}\]

![Frequency of investments](chart)

Figure 16: Amount invested vs. Frequency for Greenjoy

Figure 17: Amount Invested vs. Frequency for Lokalinc

7.2. The “Slope price”

By defining those different groups along with their characteristics the entrepreneur is able to simulate a guideline for the various returns on investments he/she has to offer to the investors and thus construct the investment contract. As explained earlier the different returns are generally accepted although not always shown in a pure financial form. If an entrepreneur is simulating his/her target groups and it results in a big difference between the groups in terms of the return on

\(^9\) https://www.seeds.nl/ondernemingen/lokalcinc/investeringen consulted on 5-8-2014
investment, the entrepreneur should understand how to represent this difference in the ‘extras’ if the entrepreneur prefers to provide an equal return on investment for every investor.

Next, a method is proposed to estimate a ‘guideline’ on the estimation of an optimal return on investment for one investor group in particular. If one would take a specific defined target group, as shown below in Figure 18, it would be interesting to see what the best point on the curve is; where the most value is gained for a specific return. In other words: as the curve and the underlying function shows there is a trade-off point where an increase in the return (and thus costs) might not be out valued by the increase in the invested amount. In order to gain insight where this trade-off has its tipping point the derivative to the return is calculated and multiplied by the absolute costs (the return on investment multiplied by the Invested amount) in a specific point. This value is from now on referred to as the ‘Slope price’ ($\theta_i$). The Slope price does not take into account the standard constraint for the target capital. Only the optimal point for an investor with the non-negative constraint for $\beta_i$ is included.

For a specific investor group $i$, this Slope price ($\theta_i$) is obtained in the following way. The Invested amount formula for the investor group is derived with respect to $\gamma_1$:

$$\frac{\partial \beta_i}{\partial \gamma_i} = \tau_i \cdot w_i \cdot \frac{e^{-\tau_i((\gamma_i - a_i) - r_{f,i})}}{(1 - a_i)} \text{ subject to } \beta_i > 0$$

The Slope price is calculated by multiplying the derivative ($\frac{\partial \beta_i}{\partial \gamma_i}$) with the absolute costs $\gamma_i \cdot \beta_i$.

$$\text{Slope price for investor } i(\theta_i) = \frac{\partial \beta_i}{\partial \gamma_i} \cdot \gamma_i \cdot \beta_i$$

Note that this expression is in terms of €2. While this seems to be rather peculiar it is explained as follows. The relationship between $\gamma_i$ and $\beta_i$ results in an impact on the total cost which is two-sided. If the entrepreneur increases the return on investment for the investor the cost for the invested amount are increased. However, as the total invested amount is higher since the return on investment is increased the costs are again increased. Thus, an increase in the return on investment leads to a higher return which has to be paid out by the entrepreneur but also to a higher invested amount where over the payments to the investors are calculated.

To find the maximum the slope price is derived with respect to $\gamma_i$ and solved for 0.

$$\frac{\partial \theta_i}{\partial \gamma_i} = \frac{\partial^2 \beta_i}{\partial \gamma_i^2} \cdot \gamma_i \cdot \beta_i + \frac{\partial \beta_i}{\partial \gamma_i} \cdot \beta_i + \frac{\partial \beta_i}{\partial \gamma_i} \cdot \gamma_i \cdot \frac{\partial \beta_i}{\partial \gamma_i} = 0 \text{ subject to } \beta_i > 0$$

Note that this analytical solution is hard to solve because of the non-negative constraint for $\beta_i$. Below the method is shown in a numerical way and it is more easily solvable (and understandable) in programs such as Excel. As an example the investors group 1 is plotted with: $w_i = €3000$, $r_{f,i} = 3\%$, $\alpha_i = 4\%$, $\tau_i = 30$ in Figure 18.
This graph (Figure 19) shows that the area around 9,80% is preferable as the most value is gained from the invested amount of money. Reducing the return results in lower costs but also a lower amount invested and increasing the return results in a higher amount invested but also higher costs. These movements with their benefits (lower costs and a higher invested amount) do not outweigh their counterparts (lower invested amount and higher costs). By doing this for various investors groups one is able to come up with an estimation on what the preferred returns for the groups are from the entrepreneur’s point of view. In case the entrepreneur would come up with a return on investment for all groups, the total amount invested can be checked and a raw estimation of the Cost of Crowdfunding can be calculated. The y-axis does not show a meaningful value other than that a higher value is more preferred than lower values.

In case this total amount fulfills the capital constraint \((IC)\) the entrepreneur can search for a better (lower cost) solution by using the Cost of Crowdfunding model. If the total amount acquired does not fulfill the capital constraint the entrepreneur knows the return on investments have to increase in order to be able to acquire his target capital. If the return on investments proposed by the Slope
price was already expensive to the entrepreneur, it is likely that the entrepreneur does not enter a crowdfunding campaign as the costs will only increase.

**Implications of the Slope price**

Note that this Slope price method is highly exploratory and leads to varied returns in terms of accuracy and consistency. For example, the factor $\tau_i$ has a big impact on the slope of the graph resulting in a big impact on the result of the Slope price itself. For low values of $\tau_i$, the optimal return on investment as calculated by the Slope price for a specific group might not be reached within a reasonable range for the return on investment. For high values of $\tau_i$, the Slope price returns an optimal return on investment which leads to $\beta_i \sim \frac{1}{2}w_i$. This approximation from numerical studies suggest that the Slope price is more or less evolving around return on investments which leads to the expression earlier: $\beta_i \sim \frac{1}{2}w_i$, however for ‘normal’ values of $\tau_i$ this $\beta_i$ can still be relatively far from half the wealth. The corresponding return on investment can thus still provide an interesting insight where to gain the most value out of an investor. The use of the Slope price should therefore only be limited to estimate rough estimates for a preferable area of the return on investments. Furthermore the Slope price supports the intuitive feeling that being at the front or at the far end of the invested amount graph for an investor such as in Figure 18 is not preferable. These areas are not preferable as they are either providing a too low invested amount or a cost which is relatively high. More research is needed to really understand the behavior of the Slope price and to provide an analytical solution.
8. Stochastic model
The importance of making the model stochastic is not only needed to make it more realistic. The entrepreneur can gain valuable insight in the chances on having a successful campaign. However, this is only the case if the entrepreneur understands his target group very well and can assign meaningful parameters to the various groups he or she proposes. Once the target groups and their characteristics are determined in a valid way the model’s results can give insights to the entrepreneur on the proposed returns for the investor, the reasonability of the whole campaign, the amount of work. For example, if the output states that with high returns to the investors the chances of success are still not high, the entrepreneur is able to see that the marketing which supports the crowdfunding campaign should not be taken lightly. In the end, the model only serves as a guideline as there are many other factors influencing the chances of success and the investing behavior of individuals.

8.1. Random arrival of investors
Various methods are available to make the proposed model more stochastic and thus more realistic. One way of modeling this stochastic component is stating that before a person invests in a crowdfunding campaign it is not known to which group he or she belongs. It is possible that the investor belongs to the group with the small investors and in that case the investor’s behavior is defined. Thus, one could randomize the total invested amount by randomizing the distribution of the population of these unknown investors and define to which group they belong. The deterministic part of the behavior is still in play being; it is known what an investor will invest when his parameters are known and the Return on Investment is given. It is expected that normally there are more small investors than big ones (note that this is expected although some crowdfunding campaigns may attract more big investors than others and may even pass the number of their small investors!) and one could say that an ‘unfair dice’ is being rolled to determine the investors group. As the input is stochastic so will the output give chances to a crowdfunding campaign being successful or not. By calculating the number of success (total invested amount is equal or greater than the target capital) divided by the number of runs it is possible to come up with a chance on success. In this model an extra variable is introduced which represents the chances on having a small or a big investor; \( p \) and \( (1 - p) \), when an investor arrives. For multiple investors this would lead to a chance of \( p_i \) for an investor belonging in group \( i \). Furthermore a variable which corresponds with the total number of undefined investors has to be introduced; \( \omega \). Note that \( \beta_i \) now represents the amount invested by a single investor in investor group \( i \). The expected amount invested for a specific return on investment for two investor groups equals:

\[
\text{Expected total amount invested: } \omega \times (\beta_1 \times p + \beta_2 \times (1 - p))
\]

Apart from providing a chance to a crowdfunding campaign another interesting point can be analyzed in this extension. Most crowdfunding platforms state that their support consist of multiple factors where their ability to reach a large crowd is always included as one of the more important factors. By reaching a bigger crowd the model is able to show the difference between the chances. A bigger crowd will lead to a higher chance on success. In case the entrepreneur is considering direct crowdfunding the entrepreneur might quantify the extra potential investors as attracted by the use of the crowdfunding platform. In that case a trade-off can be calculated where an increase in the
chance on having a successful campaign will lead to higher cost (as the crowdfunding platform inquires fees).

As an example the graphs below (Figure 20 & Figure 21) provide insight on these results. The following parameters have been used for Investor 1: \( w_1 = \€3000 \), \( r_{f,1} = 3\% \), \( \alpha_1 = 4\% \), \( \tau_1 = 10 \) and investor 2: \( w_2 = \€1500 \), \( r_{f,2} = 3\% \), \( \alpha_2 = 2\% \), \( \tau_2 = 40 \). The return on investments were set at \( \gamma_1 = 15\% \) for investor 1 and \( \gamma_2 = 17\% \) for investor 2. The target capital for these two investors together has been set at: \( TC = \€157.000 \). The ‘unfair dice’ or the distribution of the investors was set at 80% small investors and 20% large investors with a total of 100 investors. A big investors has an wealth which is always greater than the wealth of a small investor.

![Cumulative chance on a successful crowdfunding campaign](image1)

![Chance on a successful crowdfunding campaign](image2)

Note that that the left function (Figure 20) has saved all the information from previous runs into the next runs, while the right graph (Figure 21) starts with a clean sheet every run.

### 8.2. Chance on an actual investment

As potential investors arrive at the point where they will think about making an investment, they will either make an investment or they will not. By providing a simulation for this type of behavior an extra step is being added to make the model more realistic. It is only logical to assume that not one hundred percent of the potential investors in the target group as identified by the entrepreneur will make an actual investment.

Thus while the investors type has been defined upon their arrival as explained in the previous chapter there is still a chance they do not make an investment. This chance variable is represented by \( q_i \), as every investor or investor group has their own investment chance.

With this addition to the previous model the expected total amount invested for a specific return on investment for two investor groups equals to:

\[
\text{Expected total amount invested}: \omega \ast (\beta_1 \ast p \ast q_1 + \beta_2 \ast (1 - p) \ast q_2)
\]
In this case an extra explanation and definition for “\( q_i \)” is given. While the random arrival of undefined investors in the previous chapter is not related to the characteristics of the person himself as the investor will gain the characteristics only after the investor has been assigned to a group of investors, the chance of the investor making an actual investment will be related to its characteristics. This is likely as it is expected that the chance on an investment will be increased if the return on investment increases. However, the investor will still keep his risk aversion and the spread versus a hypothetical risk-free asset in mind. Thus, the relationship between these three variables is copied from our invested amount model “\( \beta_i \)”.

By using the Logit function as a base various positive attributes are being obtained. Firstly the Logit function will return values between zero and one and thus can be considered as chances on investments by the investors. Secondly the base of the logarithm is the natural logarithm “\( e \)” which corresponds with underlying assumptions for the invested amount model “\( \beta_i \)”.

\[
\text{Chance on an investment } q_i = \frac{e^{(\gamma_i - \alpha_i) - r_{f,i}}}{1 + e^{(\gamma_i - \alpha_i) - r_{f,i}}}
\]

For an visualization the following group is being modelled with: \( w_i = €3000 \), \( r_{f,i} = 3\% \), \( \alpha_i = 4\% \), \( \tau_i = 30 \)

![Chance on investment vs. Return on investment](image)

**Figure 22:** Chance on investment for a specific crowdfunding campaign

Note that different values for the parameter will only show a ‘minor’ increase or decrease in the chances and will most likely vary between a chance of 0,40 and 0,60. Although it seems that these chances are still pretty much centered around the values of a coin flip, this does make sense. A higher return on investment will increase the chance and although it seems to be only minimal; on a large crowd a small increase will still have its impact on the total invested amount. On the other hand chances of zero or one seem to be not too realistic either. There will always be a few investors who will not invest no matter how high the return on investment is.
9. Validation

In this section a start will be made to validate the model in terms of its ability to represent real life cases with reasonable parameter values. In order to do the two crowdfunding projects “Greenjoy” and “Lokalinc” from previous chapters will be used. Firstly Lokalinc is analyzed to provide estimates for the parameters in the model. Secondly, these parameters are used to predict the invested amount for Greenjoy. After the parameters are adjusted to match Greenjoy's realization for the invested amount, differences will be explained. The extras are not yet indicated in the beginning and the return on investments are equal for all groups with in a crowdfunding campaign.

9.1. Obtaining estimates

Lokalinc will be used for the first estimates of the model’s parameters. The table below is built from the information available on Seed’s website.

<table>
<thead>
<tr>
<th>Investment</th>
<th>Frequency</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>€10</td>
<td>4</td>
<td>€ 40</td>
</tr>
<tr>
<td>€20</td>
<td>5</td>
<td>€ 100</td>
</tr>
<tr>
<td>€30</td>
<td>1</td>
<td>€ 30</td>
</tr>
<tr>
<td>€60</td>
<td>1</td>
<td>€ 60</td>
</tr>
<tr>
<td>€100</td>
<td>7</td>
<td>€ 700</td>
</tr>
<tr>
<td>€180</td>
<td>1</td>
<td>€ 360</td>
</tr>
<tr>
<td>€200</td>
<td>2</td>
<td>€ 400</td>
</tr>
<tr>
<td>€250</td>
<td>1</td>
<td>€ 250</td>
</tr>
<tr>
<td>€380</td>
<td>1</td>
<td>€ 380</td>
</tr>
<tr>
<td>€420</td>
<td>11</td>
<td>€ 4.620</td>
</tr>
<tr>
<td>€500</td>
<td>3</td>
<td>€ 1.500</td>
</tr>
<tr>
<td>€1000</td>
<td>2</td>
<td>€ 2.000</td>
</tr>
<tr>
<td>€1500</td>
<td>1</td>
<td>€ 3.000</td>
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<tr>
<td>€2000</td>
<td>2</td>
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<tr>
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<td>5</td>
<td>€ 25.000</td>
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<tr>
<td>Total:</td>
<td>48</td>
<td>€44.730</td>
</tr>
</tbody>
</table>

Table 3: Distribution of the investments in Lokalinc

The groups as proposed in the previous chapters are used indicating that the group of small investors \((i = 1)\) are shown in the light green part of the table (euro 100 or less). The medium investors \((i = 2)\) in the light grey area and the big investors \((i = 3)\) in the light blue area (euro 1000 or more). For an investor’s group the following parameters have to be estimated: \(w_i, r_{f,i}, \alpha_i\), and \(\tau_i\). In order to estimate the risk-free rate for the three different groups the LIBOR-rate\(^\text{10}\) is used. This results in raw estimates of: \(r_{f,1} = 2\%, r_{f,2} = 4\%, r_{f,3} = 5\%\). The maximum return on investment proposed is 130% and \(\gamma_i\) will thus be equal for the three groups. For the scaling parameter \(\tau_i\) it is assumed to be small (10) and equal for every group to simulate investors who slowly invest more and to be able to make some changes. In order to gain insights on the wealth of an investor group \(w_i\) a weighted is calculated for the average investment in a group. For group with small investors (group 1) this equals €52,-. Medium investors have a weighted average investment of €376,- and big investors €3.315,-. To calculate the wealth of an investor group this €52 will be rounded to €55,-. Although €50,- might be a more intuitive solution €55,- is chosen; when a closer look is being taken

to the realization a large group did invest €100,- and has a big portion in the weight to up the average wealth and investments. Note that this €55,- is still less than the maximum amount investment of €100,-. While the model stated that the investors cannot invest more than their wealth this statement is focused on an average investor in that group. In order to estimate the wealth of the next group of medium investors the weighted average is again calculated which equals €376, furthermore the maximum of an investment in that group is being taken into account by taking the average between these two: \( \frac{€376+€500}{2} \approx €438,16 \), this will be rounded to €450,-. Indeed those rounding methods can be quite ambiguous, however this method is followed to create raw estimations for the first benchmarks. The same method is followed to estimate the wealth for the big investors which is rounded to €4.200,-. Now, only the alphas have to be estimated and these will be valued by following a reversed calculation. As the total investments are known by each group the alpha can be estimated to be as close as possible. The result is shown below.

<table>
<thead>
<tr>
<th>Type of investor</th>
<th># of investors</th>
<th>γᵢ</th>
<th>wᵢ</th>
<th>αᵢ</th>
<th>τᵢ</th>
<th>Invested per person</th>
<th>Total invested</th>
<th>Realisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>18</td>
<td>30%</td>
<td>€55,-</td>
<td>0%</td>
<td>2%</td>
<td>10</td>
<td>€51,66</td>
<td>€929,80</td>
</tr>
<tr>
<td>Medium</td>
<td>19</td>
<td>30%</td>
<td>€450,-</td>
<td>6%</td>
<td>4%</td>
<td>10</td>
<td>€385,21</td>
<td>€7.319,02</td>
</tr>
<tr>
<td>Big</td>
<td>11</td>
<td>30%</td>
<td>€4.200,-</td>
<td>9%</td>
<td>5%</td>
<td>10</td>
<td>€3.268,17</td>
<td>€35.949,87</td>
</tr>
</tbody>
</table>

Table 4: Investors model comparison with the realisation of Lokalinc’s crowdfunding campaign

9.2. Using estimates on different crowdfunding campaigns

The alphas obtained in the previous chapter for Lokalinc will be used to see if they are closely related to the ones for Greenjoy and if these values lead to a result which is approximating the realization. In Greenjoy’s case slightly different groups are proposed as proposed in the previous chapter. Three groups are being considered instead of two in order to use the alphas from Lokalinc for more insights. The maximum return on investment was set on 150% by the entrepreneurs.

<table>
<thead>
<tr>
<th>Investment</th>
<th>Frequency</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
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<td>€50</td>
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</tr>
<tr>
<td>€70</td>
<td>1</td>
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<td>€3.700</td>
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<td>€150</td>
<td>6</td>
<td>€900</td>
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<tr>
<td>€180</td>
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<td>€180</td>
</tr>
<tr>
<td>€200</td>
<td>1</td>
<td>€200</td>
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<tr>
<td>€250</td>
<td>12</td>
<td>€3.000</td>
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<td>€4.000</td>
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<tr>
<td>€2500</td>
<td>2</td>
<td>€5.000</td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>€20.000</td>
</tr>
</tbody>
</table>

Table 5: Distribution of the investments in Greenjoy

Apart from the \( τᵢ \) and \( Tᵢ \) which are equal to the ones used for Lokalinc \( wᵢ \), has to be calculated again. Similar to Lokalinc an weighted average for the small investors is obtained and rounded to €75,-. For the medium investors this equals €275,- and the big investors €1.750,-. As a closer look is being taken into the maximum amounts invested per investors group, there might be no need for extra adjustments. The amount of €275,- seems to be realistic for the medium investors as only a
handful of investors are investing €500,- while way more are quite below the €275,- weighted average. For the big investors group the weighted average also seems to be a nice estimate as there are only four investors which are spread evenly throughout the two investments of €1,000,- and €2,500,-. All parameters are set and the alphas from Lokalinc will be used to get a first estimation.

<table>
<thead>
<tr>
<th>Type of investor</th>
<th># of investors</th>
<th>( \gamma_i )</th>
<th>( w_i )</th>
<th>( \alpha_i )</th>
<th>( \tau_{f,i} )</th>
<th>( \tau_i )</th>
<th>Invested per person</th>
<th>Total invested</th>
<th>Realisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>87</td>
<td>50%</td>
<td>€75,-</td>
<td>0%</td>
<td>2%</td>
<td>10</td>
<td>€74,38</td>
<td>€6471,30</td>
<td>€6.220,-</td>
</tr>
<tr>
<td>Medium</td>
<td>25</td>
<td>50%</td>
<td>€275</td>
<td>6%</td>
<td>4%</td>
<td>10</td>
<td>€269,64</td>
<td>€6.741,04</td>
<td>€6.780,-</td>
</tr>
<tr>
<td>Big</td>
<td>4</td>
<td>50%</td>
<td>€1.750</td>
<td>9%</td>
<td>5%</td>
<td>10</td>
<td>€1.697,45</td>
<td>€6.789,92</td>
<td>€7.000,-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Invested per group</th>
<th>Total invested</th>
<th>Realisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>€20.002,16</td>
<td>€20.000,-</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Investors model comparison with the realisation of Greenjoy’s crowdfunding campaign

This is as close as one can get for a rough estimation and no adjustments are really necessary to get closer to the realisation. However, there are for sure differences which are interesting. For example if the return on investment would be equal for the two companies (e.g. Greenjoy’s gamma is reduced to 30%) this would lead to way lower alphas for the investor groups in Greenjoy when the same amount invested should be acquired. This might indicate that investors are more positive towards Greenjoy than Lokalinc. Perhaps they believe more in the business case, or simply like the product they offer more etc. All these factors which could be included in alpha as explained earlier can play a role. Also the extras which were not mentioned so far can play a big role to push investors over an edge to actually invest or invest more. After all, small investors in Greenjoy are willing to pay on average about €20,- more (and have, as a logical result of having the same parameters, about €20,- more wealth). The estimations to get the wealth for the various groups has a big impact on the eventual invested amount per person or group, this impact is furthermore increased in combination with the cut-off values where an investor belongs to the small investor or medium investor groups . In order to gain insight on this result the extras are being discussed for the small investors in the next chapter.

### 9.3. The impact of extras and the return on investment

Lokalinc selects the best products from local stores in Amsterdam where they focus on: Inspiring Local Shopping\(^1\). Greenjoy offers sloops to rent which have an electrical engine and are thus silent and less harmful for the environment\(^2\). The extras for Lokalinc and Greenjoy for our group of small investor were:

<table>
<thead>
<tr>
<th>Thresholds:</th>
<th>€10</th>
<th>€50</th>
<th>€60</th>
<th>€100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenjoy</td>
<td>-</td>
<td>One hour free of sailing</td>
<td>-</td>
<td>One hour free of sailing plus one free hour to give away as a present</td>
</tr>
<tr>
<td>Lokalinc</td>
<td>Included in the Wall of Fame on the website</td>
<td>-</td>
<td>Tailor-made Lokalinc T-shirt plus first extra</td>
<td>Goody Bag full of products from local stores plus first extra</td>
</tr>
</tbody>
</table>

Table 7: Extras for small investors for Lokalinc and Greenjoy

\(^1\) [https://www.lokalinc.nl/what-is-lokalinc](https://www.lokalinc.nl/what-is-lokalinc) consulted at 9-9-2014

\(^2\) [http://greenjoy.nl/over_greenjoy/](http://greenjoy.nl/over_greenjoy/) consulted at 9-9-2014
It is interesting that there is only one investment made in Greenjoy which is not exactly on a border (there is one investment of €70,-). Also the extras seems to represent more value to the investor as one hour of free sailing should normally be more expensive than a Tailor-made T-shirt and an inclusion in the Wall of Fame. Lokalinc had more small investments; eleven below €100,- and seven at €100,-. Out of the small investors only one choose to invest €60,- and acquire the T-shirt. Thus, apart from liking one company more than another there seems to be extras which are more appealing than others. Another point of interest lies in the distribution of the investors groups as seen in Table 8. Although Lokalinc has way less investors they acquire more money and seems to gain more attention from big investors. Greenjoy on the other hand seemed to be especially liked by small investors.

<table>
<thead>
<tr>
<th></th>
<th>Greenjoy</th>
<th>Lokalinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small investors</td>
<td>87</td>
<td>18</td>
</tr>
<tr>
<td>Medium investors</td>
<td>25</td>
<td>19</td>
</tr>
<tr>
<td>Big investors</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 8: Distribution of the group of investors

While it is hard to exactly prove why this difference occurs without a full study or research, a combination of the factors: appealing extras, the return on investment and the focus of the company itself will most likely play role. As one can imagine a sloop rental company where extras offer a free boat ride is appealing more people on average than a company focused on Inspiring Local Shopping which offers ‘smaller perks’ for the same investment. The higher amount of big investors could indicate that these investors are more interested in the return on investment and a promising business case, but the proposed return on investment was lower than Greenjoy’s. This seems to be counter intuitive but may be explained as follows: the return on investment will be only paid if the thresholds are being met for payment. These thresholds are based on turnover levels. Big investors might be not as confident as Greenjoy themselves that Greenjoy will reach those levels and be more believing in the planning of Lokalinc. Of course, an entrepreneur could offer a pay-out rate of a thousand percent, but if that amount is only paid out when he reaches a turnover of one billion, there is not much ‘expected value’ in that statement. An idea to quantify all these factors for alpha would be that a crowdfunding campaign is rated on these various subjects. A subject for rating could be for example: the amount of fun to invest, the complexity of the product/service, the impact on society/nature etc.

The points of interest as described shortly above are able to show the ‘type’ of company for a crowdfunding campaign. Some might be more focused on appealing perks for smaller investors, while others are attracting more the big investors and do not focus heavily on providing cool extras.
10. Questionnaire
As the deterministic model has been explored and explained along with the extension to make it more stochastic so will the next chapter focus on the results from the questionnaire. The questionnaire has been sent out in order to gain more insights on the components for the Total Cost of Crowdfunding. As pointed out in the literature study, a lot of entrepreneurs state that an crowdfunding campaign includes indirectly a marketing campaign. This is an example of an indirect gain of the crowdfunding campaign. Normally a marketing campaign should be carried out after a bank loan has been obtained in order to inform the public about the brand or product, however this is partially already achieved by a crowdfunding campaign. In that case, the Cost of Crowdfunding includes a part of the original cost for the marketing campaign and a ‘high’ Cost of Crowdfunding could still be justified.

10.1. Target group
The target group consisted of entrepreneurs/companies listed on TechCrunch’s database called CrunchBase\textsuperscript{13}. Crunchbase is a database for startups and young companies. Within the database both companies are present who were or are being funded by crowdfunding and companies who used other ways of funding. This is an interesting division between the target group. For the questionnaire an invitation to participate was sent out to about six thousands companies. 127 questionnaires were started and 77 were completely answered. The focus on the financial and more abstract components of the crowdfunding process as explained in the introduction email seem to negatively affect the number of participants. As some responses stated that they did not have the required knowledge (or time) to participate in such a survey. Nevertheless, interesting points can be concluded from the results and from the responses as written by the participants when they were asked to explain themselves more clearly.

10.2. Summarized results
The survey was set up in four blocks. In the first block the participants were asked about their background; whether they had experience with crowdfunding or knew what it was about. The second block was about the participant’s helicopter view on crowdfunding in general. Possible advantageous factors were asked about in the third block and the fourth block was all about the possible disadvantageous factors. While the survey proposed a lot of factors already, there was enough room for the participant to write his/her thoughts down and he/she was encouraged to do so. The full results can be found in the appendix and in this chapter a summarized result is given on the most interesting results. We focus especially on the results in the cross tabulation as it shows the differences between participants without any experience in crowdfunding and participants with experience.

First block: crowdfunding background
Half of our group (54 total) has experience with crowdfunding, where experience is explained as: invested in a campaign or used it as a way of funding. The other half who does not have any experience is however for the majority (44 total) familiar with the crowdfunding process in general and only 9 participants pointed out they had no experience and were not familiar with crowdfunding whatsoever.

\textsuperscript{13}http://www.crunchbase.com/
Second block: helicopter view on crowdfunding
This block consisted of three questions about their general view on crowdfunding. The first question asked shows on average a positive attitude towards the contribution to a better business climate. While this might seem to be a logical conclusion, an extra option for funding is always good, an interesting shift takes place between participants with and without experience. The group with experience is more distinct about their positive attitude.

Table 9: Survey block 2 general view
This behavior is also seen in the second question, however not in the third. The question if crowdfunding will play a much bigger role in the future as a funding method next to traditional funding methods was more positively answered by the group without experience. Even a few (6 out of 42) from the group with experience disagreed with the statement. The group who is familiar with the crowdfunding agreed for the majority (32 out of 40) with the statement.

Third block: possible advantageous factors
For possible advantageous factors seven subjects were proposed. Although no group rejected the proposed statements, there were difference in how they approved them. Below the seven statements are shown along in their cross tabulation form.

Table 10: Survey block 3-1 possible advantageous factors
The groups do somewhat agree while being modest that the crowdfunding campaign acts like an market research: “It can be used to get a feel for market demand.” Crowdfunding in terms of a market research is rather unforgiven. If the market research within the crowdfunding campaign is not positive the crowdfunding campaign will probably not be successful and, most likely, no capital is acquired. The next two statements are eagerly agreed on across the groups and without much dispute. This shows that some indirect gains are gained through the use of crowdfunding. Clearly while getting funded through crowdfunding, the crowd must have been informed in order to gain investments and thus potential buyers and users are being motivated.
From the statements above it is clear that there is much discussion about the first statement. The second statement provides an insight that the group without experience is more modest about their agreement, but the people who have got experience support the statement in general and one quote even states: “The support of the crowdfunding platform is critical.”

Contrary to the previous advantageous factors are the possible disadvantageous factors. It is known that for some entrepreneurs a crowdfunding campaign is seen as a costly and time-consuming process. These time-loses can be seen as indirect loses which might have to be taken into account for a Total Cost of Crowdfunding. Again we proposed seven possible disadvantageous factors, where the results will be shortly described below.
The first statement where crowdfunding takes more effort when compared to traditional funding methods seem to be mostly disagreed on by the participants. This is closely related to the second statement. One participant even stated: “Traditional funding is very time consuming[...].” Crowdfunding seems to be for most participants not necessarily more resource-heavy than traditional funding. Another interesting part is that although most platforms have an success rate around 50%, the participants do not really have a clear opinion about the third statement: the uncertainty for a crowdfunding campaign being successful or not is too high.

<table>
<thead>
<tr>
<th>Have you got any experience with Crowdfunding?</th>
<th>A non-successful campaign minimizes any second chances for the business</th>
<th>Platform costs are too high when compared to what they offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Strongly Disagree: 2 19 10 7 0</td>
<td>Strongly Disagree: 5 5 15 11 6 1</td>
</tr>
<tr>
<td></td>
<td>Neither Agree nor Disagree: 38</td>
<td>Neither Agree nor Disagree: 39</td>
</tr>
<tr>
<td></td>
<td>Agree: 0</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Total: 38</td>
<td>Total: 39</td>
</tr>
<tr>
<td>No</td>
<td>Strongly Disagree: 1 18 16 4 0</td>
<td>Strongly Disagree: 5 25 38 8 1 77</td>
</tr>
<tr>
<td></td>
<td>Neither Agree nor Disagree: 39</td>
<td>Neither Agree nor Disagree: 39</td>
</tr>
<tr>
<td></td>
<td>Agree: 0</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Total: 39</td>
<td>Total: 39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are you familiar with the Crowdfunding process in general?</th>
<th>A non-successful campaign minimizes any second chances for the business</th>
<th>Platform costs are too high when compared to what they offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Strongly Disagree: 1 18 12 3 0</td>
<td>Strongly Disagree: 0 10 22 2 0</td>
</tr>
<tr>
<td></td>
<td>Neither Agree nor Disagree: 34</td>
<td>Neither Agree nor Disagree: 34</td>
</tr>
<tr>
<td></td>
<td>Agree: 0</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Total: 39</td>
<td>Total: 39</td>
</tr>
<tr>
<td>No</td>
<td>Strongly Disagree: 0 0 4 1 0</td>
<td>Strongly Disagree: 0 0 5 0 0 5</td>
</tr>
<tr>
<td></td>
<td>Neither Agree nor Disagree: 5</td>
<td>Neither Agree nor Disagree: 0</td>
</tr>
<tr>
<td></td>
<td>Agree: 0</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Total: 5</td>
<td>Total: 5</td>
</tr>
</tbody>
</table>

Table 13: Survey block 4-1 possible disadvantageous factors

Again the participants do not agree that a unsuccessful crowdfunding campaign minimizes chances for the business. “A skilled entrepreneur/marketer can find many reasons to explain why a crowdfunding campaign has failed, in a way that does minimal damage to a startup brand. The essence of modern startup life is business experimentation and individual crowdfunding campaigns can be understood as running experiments.”
Table 15: Survey block 4-3 possible disadvantageous factors

The first statement is closely related to the previous statement about the possibility for a second-chance once the crowdfunding campaign has been not successful. The participants are both agreeing and disagreeing with it. Note that the group with experience does agree on the statement but the group without does generally not. An explanation could be that the brand might take some damage but the business itself (the product or service) still has a chance, maybe under a different name or by using a different marketing approach. As our previous statement about the level of transparency being advantageous for the company was more or less agreed on, so do the participants mostly disagree with the contrary statement.

Insights provided by the participants

Some participants did indeed explain or elaborate their answers. While most of these answers were confirming some choices or stated conditions for some events such as: “The required level of transparency to investors is advantageous. Only if the entrepreneur makes a conscious effort to make everything transparent.” Some additional concerns were typed out where a major concern was focused on regulations to prevent fraud. “Companies can take advantage of the naivety of crowdfunding investors with little or no knowledge of their business, sector and investment in general. Regulations can prevent crime and fraud.” On the other hand some did see it as an advantage: “The lack of strong regulations is an advantage. Is a strong advantage for early stage startups, since in an early stage, there’s a chance a startup may pivot.”

Also the quote: “And in many cases the CPA (Cost per action) is roughly equal to the unit revenue, so the marketing costs are roughly equal to the revenue raised from the campaign. As a result, crowdfunding is a new an interesting way to ‘launch’ a new product, but it is not a viable alternative to angel, seed fund, or other early stage venture funding.”, shows that some see crowdfunding more as a launch and pure marketing than as a method focused on acquiring funding.

Furthermore one comment was given which was focused on the post-crowdfunding period: “Crowdfunding can cause problems for startup companies later. As all investors have to give approval for certain company actions (e.g. raising more cash), [...], then such companies will have an administrative headache, cost and slow process compared to those with e.g. 5 investors.” Although this comment was more focused on crowdfunding where an equity approach is followed there is a truth in the costs or effort needed for the post-crowdfunding period. At Seeds, for example, it is included in the Investor’s Agreement that the entrepreneur gives a quarterly update about the
company. While this might seem to be only minor activities needed, some entrepreneurs see this as an increase in expenses or resources lost.

For the Total Cost of Crowdfunding the following factors might be interesting to quantify: a market research is indirectly done; brand awareness is increased; a marketing campaign is indirectly done. These factors are positively influencing the Total Cost of Crowdfunding and will decrease the eventual costs as extra gains occur (e.g. brand awareness is increased) or other company expenses can be cut (e.g. a marketing campaign after the crowdfunding campaign). Negative factors are not as easy to conclude from the survey. The comment made about the post-crowdfunding period seems to be a good indication that not much entrepreneurs are aware of (or did experience) such post-crowdfunding management but it still induces costs.
11. Discussion

In this chapter an overview is given on what is achieved by doing this research and its findings. Furthermore the implications and limitations are given as well as some areas which might be suitable or interesting for follow-up studies.

11.1. Result

The research has proposed a way to model the Cost of Crowdfunding within the context of the investing behavior of investors or investors groups. Thereby constructing the contract while focusing on an optimal solution for the return on investment. Although validation in practice has to occur the first steps has been taken to understand the investment behavior from a mathematical point of view and to be able to run simulations with such a model. While in practice a lot of intuition comes into play to determine the return on investment to the investors and the possible extra perks, there is, to the best of our knowledge, no model around which seem to be able to come up with a solution based on a few general parameters. Practically the model is not easy to use as a lot of time will go into researching these parameters and assign meaningful values to them. In particular the parameter “\( \alpha_i \)” is an interesting parameter which value is hard to assess. Next to the more objective parameters such as “\( \gamma_i, \tau_i \)” and “\( \gamma_i, \alpha_i \)” is really specific for all individuals and includes apart from his/her risk aversion the representation of the investor’s ability to understand the industry, the product, his/her belief in the whole project and all other factors which the investor thinks are necessary for a good valuation. Some people may refer to “\( \alpha_i \)” as the ‘gut feeling’ of the investment which seems play a bit role for a lot of investors. By formalizing the invested amount (\( \beta_i \)) for an investor or investors group as:

\[
Invested \text{ amount by Investor } i (\beta_i): \omega_i \left( 1 - \frac{e^{\left(-\tau_i\left(\gamma_i-\alpha_i\right) - r_{f,i}\right)}}{(1 - \alpha_i)} \right), \text{where } \beta_i \geq 0, \gamma_i \geq 0
\]

a really flexible function is created which can be tuned to represent most of the standard investment behavior and where only “\( \alpha_i \)” is an parameter which is hard to value. The choice to let “\( i \)” represent groups of investors instead of individual investors is based on practical reasons. Firstly, the time needed to understand all investors to give them their specific “\( \alpha_i \)” and model is probably too high and secondly the time needed for simulations increases quickly for every added investor. Assumptions can be made on the potential investors to group them without losing much of the models value.

The Slope price as explored is an interesting way to get quick insights for every investor group and is from a practical point of view more useful although the solution does not provide an optimal solution for the contract. By defining the Slope price as:

\[
Slope \text{ price for investor } i(\theta_i) = \frac{\partial \beta_i}{\partial \gamma_i} \times \gamma_i \times \beta_i
\]

the terms are in €2% as the impact per movement in percentage is two-sided. An increase in the return on investment leads to a higher total invested amount and thus more costs for the entrepreneur. But also a higher return on investment leads to a higher rate which has to be paid out to the investor (even if the total invested amount would stay the same) and again an increase in costs are the result.
After a raw validation for the model and its parameters it could be concluded that the model works on first sight and interesting insights can be obtained from the differences between the parameters for two different crowdfunding campaigns. Some entrepreneurs may focus more on big investors and will accordingly adjust their extras and return on investment. This focus may come from their own opinion about the right focus for their crowdfunding campaign or their type of product/service which may be more appealing of various kind of investors.

The survey resulted in a few factors which may be interesting to quantify and eventually include in an estimation for the Total Cost of Crowdfunding. The factors being: a market research is indirectly done; brand awareness is increased; a marketing campaign is indirectly done. These factors or indirect gains should be included in a positive manner as they decrease the Total Cost of Crowdfunding. Only one negative factor came out of the survey being the resources needed for the investors in the post-crowdfunding period.

11.2. Limitations and further research
While the model seems to be working nicely for an estimation of an optimal Cost of Crowdfunding, there are limitations and further research is needed.

First of all, only theoretical standard investment behavior is viable for modeling. The term theoretical is used as the model assumes that an investment gradually increases as the return on investment is increasing. However, behavior is often observed where investors would pledge a sum of money to an investment and they will increase it in blocks and not gradually. This example is visualized below in Figure 23:

![Invested Amount](image)

*Figure 23: Visualization of assumed to be non-standard investment behavior*

In this case somebody would be willing to donate some money while the return on investment is zero to low and as soon as it reaches the investors threshold to increase its investment, the investment is increased to a much bigger amount. However, as the individual investors can be grouped up even non-standard behavior will on average approach the more gradually increasing investment behavior. Furthermore the choice to use utility functions might be questionable and other functions are capable of modelling such behaviors and may lead to analytically nicer models.
When a closer look on the parameters of the model is being taken it is visible that the construction of “\( \alpha_i \)" is really tough. Tough in terms of how an entrepreneur would quantify the alphas for its investors and what all components of “\( \alpha_i \)" could be as the parameter is specific for every individual or group for every crowdfunding campaign. More research is needed to see if “\( \alpha_i \)" would consist of parameters which may be broken down into the macro-, meso- and microeconomic factors for the investors. On the other hand, once the parameters are more or less generalized a way has to be found which gives an obtainable value for these parameters. Although a market research would most likely return some insights, this is probably not a real option for an entrepreneur who wants to gain funding and start its business. The crowdfunding platforms might play a role in this part. As they have knowledge about the various branches and what type of company they represent they may be able to give average values for those specific industries with the product or service in mind. This would also lead to more added value for the platforms, as they can provide more insight about the potential investors group and their characteristics.

The Slope price is a small feature in the model which may lead to faster insights on the investor groups. In the end however, the Slope price as well as the model itself is more focused on giving a well-reasoned solution as a guideline. On one hand investors will always have the ability to behave way off the expectations and on the other hand (too) many factors play a role within a crowdfunding campaign which determine if it is going to be successful or not. This model is, at the time written, the first one which tries to model the investors to gain insights and a solution for the eventual Cost of Crowdfunding, but many more improvements can be made. The validation provided shows many more interesting starting points for further research. Providing labels for a type of crowdfunding company can be helpful for the right focus on the target groups. The method to calculate the wealth of an investor or investor group has a big impact in the eventual amount invested. Whether the wealth of a group needs to change for every crowdfunding campaign or some average can be estimated for an industry or investor group is another great possibility for further research.

The Total Cost of Crowdfunding is even one step further and the report only touched upon the first factors which may come in play and tried to translate the survey participants’ point of view on those (in)direct gains and/or losses into factors which matter. Based on quotes by entrepreneurs it is known that crowdfunding is so much more than just getting funded, but in order to quantify the most important components for the Total Cost of Crowdfunding a lot more research is needed.

At the last stages of this research another promising formula was being formulated to model the investments from the investors. This model will be shortly elaborated below.

Instead of using the inverse exponential utility function for the base and the form of the eventual model it is now replaced by the Cobb-Douglas utility function. The Cobb-Douglas function is still used in combination with the Logit function to determine the chances on an actual investment. The Cobb-Douglas function would use a capital constraint for the available wealth of the investor and calculates the optimal allocation of its capital. Again two possibilities are available for the allocation of the capital; a crowdfunding project or an hypothetical asset. Both of these options have their own return on investment as the previous model. This model is able to estimate the optimal solution for an allocation of funds.
Works Cited


Etter, V., Grossglauser, M., & Thiran, P. (2013). Launch Hard or Go Home! Boston: ACM.


Appendix

In Appendix A-D an example setup is given for the program “R” version 3.1.1\(^{14}\) which is able to run simulations for the Investor’s model. Note that many other methods are available and these examples are just included for those interested in extending it or to re-run analyses without building scripts from scratch themselves. Firstly the possible return on investments are created in Appendix A and which will be used further on. Only the basic building blocks are being given for the sake of clarity. The package “Scatterplot3D” has been used to create he 3D-graphs\(^{15}\).

Appendix A: Creating return on investment possibilities

It is important to update the first row of the .txt-files which will be created to \(x^{“x”}“y”\) for two investors and \(x^{“x”}“y”“z”\) for three investors.

For two investors and a step size of 0.001

```r
ROI1 <- seq(0,0.25, by=.001)  # ROI for investor 1
ROI2 <- seq(0,0.25, by=.001)  # ROI for investor 2
x <- c()
y <- c()

#creates vectors containing all combinations
for (h in 1:length(ROI2)){
  for (i in 1:length(ROI1)){
    x <- c(x,ROI1[i])
    y <- c(y,ROI2[h])
  }
}
Data <- list(x,y)
write.table(Data, "Dataxy001.txt", sep="\t", row.names=FALSE, col.names=TRUE)
```

For three investors and a step size of 0.001

```r
ROI1 <- seq(0,0.25, by=.001)  # ROI for investor 1
ROI2 <- seq(0,0.25, by=.001)  # ROI for investor 2
ROI3 <- seq(0,0.25, by=.001)  # ROI for investor 3
x <- c()
y <- c()
z <- c()

#creates vectors containing all combinations
for (g in 1:length(ROI3)){
  for (h in 1:length(ROI2)){
    for (i in 1:length(ROI1)){
      x <- c(x,ROI1[i])
      y <- c(y,ROI2[h])
      z <- c(z,ROI3[g])
    }
  }
}
Data <- list(x,y,z)
write.table(Data, "Dataxyz001.txt", sep="\t", row.names=FALSE, col.names=TRUE)
```

\(^{14}\) [http://cran.r-project.org/](http://cran.r-project.org/) consulted at 12-9-2014

\(^{15}\) [http://cran.r-project.org/web/packages/scatterplot3d/index.html](http://cran.r-project.org/web/packages/scatterplot3d/index.html) consulted at 12-9-2014
Appendix B: Solution for two investors

mydata <- read.table("Dataxy001.txt", header=TRUE);

x <- mydata$x       # possible ROI's investor 1
y <- mydata$y       # possible ROI's investor 2

f1 <- 0.03          # Risk Free Rate Investor 1
f2 <- 0.03          # Risk Free Rate Investor 2
p1 <- 0.04          # Risk premium Investor 1
p2 <- 0.02          # Risk premium Investor 2
w1 <- 3000          # Wealth Investor 1
w2 <- 1500          # Wealth Investor 2
to1 <- 10           # Scaling parameter Investor 1
to2 <- 10           # Scaling parameter Investor 2
TC <- 2500          # Target Capital

FUNC <- function(x,y) {
  a <- w1-w1*exp(-to1*(x-(f1+p1)))/(1-p1)  # invested amount Investor 1
  b <- w2-w2*exp(-to2*(y-(f2+p2)))/(1-p2)  # Invested amount Investor 2
  a[a<0] <- 0  # makes negative values zero
  b[b<0] <- 0  # makes negative values zero
  IA <- (a+b)
  CoC <- (a*x+b*y)/(a+b)
  return(list("ROI1"=x,"ROI2"=y,"CoC"=CoC,"IA"=IA))
}

data <- FUNC(x,y)

s3d <- scatterplot3d(data$ROI1[data$IA<TC], data$ROI2[data$IA<TC], data$IA[data$IA<TC], highlight.3d=TRUE, col.axis="blue", col.grid="lightblue", main="Invested Amount versus ROI", zlim=c(0,TC+1000), xlab="ROI for Investor 1", ylab="ROI for Investor 2", zlab="Invested amount", pch=20, angle=70)
s3d$plane3d(TC,0,0)
s3d$points3d(data$ROI1[data$IA>=TC], data$ROI2[data$IA>=TC], data$IA[data$IA>=TC], pch=10, col="grey")

dev.new(1)
plot(data$CoC[data$IA>TC], data$IA[data$IA>TC], main="Invested Amount versus Cost of Crowdfunding", xlab="Cost of Crowdfunding", ylab="Invested Amount")

## to zoom in on optimal solution ##

dev.new(1)
plot(data$CoC[data$IA>TC & data$IA<TC+30], data$IA[data$IA>TC & data$IA<TC+30], main="Invested Amount versus Cost of Crowdfunding", xlab="Cost of Crowdfunding", ylab="Invested Amount")

min(data$CoC[data$IA>TC])
data$IA[data$IA>TC & data$IA==min(data$CoC[data$IA>TC])]
data$ROI1[data$IA>TC & data$IA==min(data$CoC[data$IA>TC])]
data$ROI2[data$IA>TC & data$IA==min(data$CoC[data$IA>TC])]

dev.new(1)
s3d <- scatterplot3d(data$ROI1[data$IA>TC], data$ROI2[data$IA>TC], data$CoC[data$IA>TC], highlight.3d=TRUE, col.axis="blue", col.grid="lightblue", main="Cost of Crowdfunding versus ROI's", xlab="ROI for Investor 1", ylab="ROI for Investor 2", zlab="Cost of Crowdfunding", pch=20, angle=0)
Appendix C: Estimating if a crowdfunding campaign is successful

```
Investors <- 100  # n.o. investors
ROI1 <- .15       # ROI for investor 1
ROI2 <- .17       # ROI for investor 2
COS <- 8          # Chance on small investor 80% = 8 etc.
COIS <- .75       # Chance on investment made for small investors, 95% = .95 etc.
COIL <- .60       # Chance on investment made for big investors, 95% = .95 etc.
f1 <- 0.03        # Risk Free Rate Investor 1
f2 <- 0.03        # Risk Free Rate Investor 2
p1 <- 0.04        # Risk premium Investor 1
p2 <- 0.02        # Risk premium Investor 2
w1 <- 3000        # Wealth Investor 1
w2 <- 1500        # Wealth Investor 2
to1 <- 10         # Scaling parameter 1
to2 <- 40         # Scaling parameter 2
TC <- 110000      # Target Capital

x <- c()          # ResultChance <- c()
resultCoC <- c()   # ResultInv <- c()
TIA <- c()         # TI <- sum(resultTIA) + sum(resultTIB)
TIB <- c()

x <- sample(1:10, Investors, replace=T)
for (i in 1:sum(x <= COS)){
  y <- sample((0:100)/100,1, replace=T)
  if (y = COIS) {
    a <- 0
  } else {
    a <- w1-w1*exp(-to1*(ROI1-(f1+p1)))/(1-p1)
  }
  a[a < 0] <- 0
  TIA <- c(TIA,a)
}

for (j in 1:sum(x > COS)){
  z <- sample((0:100)/100,1, replace=T)
  if (z = COIL) {
    b <- 0
  } else {
    b <- w2-w2*exp(-to2*(ROI2-(f2+p2)))/(1-p2)
  }
  b[b < 0] <- 0
  TIB <- c(TIB,b)
}

TI <- sum(c(TIA)) + sum(c(TIB))
CoC <- (ROI1*sum(TIA)+ROI2*sum(TIB))/(TI)

print("Expected acquired capital")
Investors*(COIS*(COS/10)*a+COIL*((10-COS)/10)*b)
```
Appendix D: Chance on success for multiple runs

In this syntax a crowdfunding campaign is multiple times checked whether it reaches its target capital and thus will be successful or not. This information is being saved for numerous runs in order to come up with a chance on success or failure.

```r
Investors <- 100  # n.o. investors
runs1 <- 100  # number of times a run for a crowdfunding campaign is done
runs2 <- 10  # number of runs a crowdfunding campaign is analyzed
ROI1 <- .15  # ROI for investor 1
ROI2 <- .17  # ROI for investor 2
COS <- 8  # Chance on small investor 80% = 8 etc.
COIS <- .75  # Chance on investment made for small investors, 95% = .95 etc.
COIL <- .60  # Chance on investment made for big investors, 95% = .95 etc.

f1 <- 0.03  # Risk Free Rate Investor 1
f2 <- 0.03  # Risk Free Rate Investor 2
p1 <- 0.04  # Risk premium Investor 1
p2 <- 0.02  # Risk premium Investor 2
w1 <- 3000  # Wealth Investor 1
w2 <- 1500  # Wealth Investor 2
to1 <- 10  # Scaling parameter 1
to2 <- 40  # Scaling parameter 2
TC <- 110000  # Target Capital

generate results:
x <- c()  # result of for (l in 1:runs2){
y <- c()  # result of for (p in 1:runs1){

c <- c()  # for the spread between chances leave this rule out and replace with the rule below
ResultChance <- c()
ResultCoC <- c()
ResultInv <- c()

# for the spread between chances leave this rule out and replace with the rule below
ResultRuns <- c()

for (p in 1:runs1){
    # for the spread between chances leave this rule out and replace with the rule below
    ResultRuns <- c()

    for (l in 1:runs2){
        TIA <- c()
        TIB <- c()
        x <- sample(1:10,Investors, replace=T)
        for (i in 1:sum(x<=COS)){
            y <- sample((0:100)/100,1, replace=T)
            if (y>=COIS) {
                a <- 0
            } else{
                a <- w1-w1*exp(-to1*(ROI1-(f1+p1)))/(1-p1)
            }
            a[a<0] <- 0
            TIA <- c(TIA,a)
        }
    }
}
```

51
for (j in 1:sum(x>COS)){
    z <- sample((0:100)/100,1, replace=T)
    if (z>=COIL) {
        b <- 0
    } else {
        b <- w2-w2*exp(-to2*(ROI2-(f2+p2)))/(1-p2)
    }
    b[b<0] <- 0
    TIB <- c(TIB,b)
}

TI <- sum(c(TIA))+ sum(c(TIB))
CoC <- (ROI1*sum(TIA)+ROI2*sum(TIB))/(TI)

if (TI >= TC) {
    c <- c(c,1)
} else {
    c<- c(c,0)
}

ResultCoC <- c(ResultCoC, CoC)
ResultInv <- c(ResultInv,TI)
ResultRuns <- c(ResultRuns,1)

Chance <- length(which(c==1))/sum(ResultRuns)
ResultChance <- c(ResultChance,Chance)

print("Expected acquired capital")
Investors*(COIS*(COS/10)*a+COIL*((10-COS)/10)*b)

plot(ResultChance, main="Chance on a succesfull campaign", xlab="Run number", ylab="Chance")
range(ResultChance)
mean(ResultChance)
Appendix E: Survey Results
A lot of space was accommodated to let the participants explain their answers or thoughts. These results are being omitted due to privacy.

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Possible)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Entrepreneur</td>
<td>15</td>
<td>16%</td>
</tr>
</tbody>
</table>

2. Have you got any experience with own startups?

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>101</td>
<td>92%</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>9</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>110</td>
<td>100%</td>
</tr>
</tbody>
</table>

3. Are you familiar with startups of others and/or their general process?

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>8</td>
<td>89%</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>1</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>9</td>
<td>100%</td>
</tr>
</tbody>
</table>

4. Have you got any experience with Crowdfunding?

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>54</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>54</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>108</td>
<td>100%</td>
</tr>
</tbody>
</table>

5. Are you familiar with the Crowdfunding process in general?

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>44</td>
<td>83%</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>9</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>53</td>
<td>100%</td>
</tr>
</tbody>
</table>
6. In this part we will call upon your ‘helicopter view’ in order to validate the Crowdfunding method. Traditional funding methods are for example: bank loans, angel investors and public offerings.

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total Responses</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crowdfunding currently contributes to a better business climate for startups.</td>
<td>3</td>
<td>4</td>
<td>28</td>
<td>43</td>
<td>11</td>
<td>89</td>
<td>3.62</td>
</tr>
<tr>
<td>2</td>
<td>Crowdfunding is doing well and a good alternative funding method next to traditional funding methods for commercial companies/startups.</td>
<td>3</td>
<td>7</td>
<td>16</td>
<td>52</td>
<td>11</td>
<td>89</td>
<td>3.69</td>
</tr>
<tr>
<td>3</td>
<td>Crowdfunding will play a much bigger role in the future as funding method next to traditional funding methods.</td>
<td>1</td>
<td>6</td>
<td>23</td>
<td>42</td>
<td>17</td>
<td>89</td>
<td>3.76</td>
</tr>
</tbody>
</table>
8. This part will cover factors of the Crowdfunding process which might be important for a more reasonable judge of Crowdfunding as funding method. These factors will be split into factors which can be advantageous or disadvantageous. The setting which will be used, unless stated otherwise, is: a company enters the Crowdfunding process and starts a Crowdfunding campaign.

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total Responses</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A market research is indirectly done.</td>
<td>2</td>
<td>9</td>
<td>23</td>
<td>39</td>
<td>7</td>
<td>80</td>
<td>3.50</td>
</tr>
<tr>
<td>2</td>
<td>Brand awareness is increased.</td>
<td>1</td>
<td>2</td>
<td>16</td>
<td>48</td>
<td>13</td>
<td>80</td>
<td>3.88</td>
</tr>
<tr>
<td>3</td>
<td>A Crowdfunding campaign is indirectly used as marketing campaign.</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>52</td>
<td>16</td>
<td>80</td>
<td>4.01</td>
</tr>
<tr>
<td>4</td>
<td>A non-successful Crowdfunding campaign prevents time/resources losses later on.</td>
<td>4</td>
<td>20</td>
<td>28</td>
<td>24</td>
<td>4</td>
<td>80</td>
<td>3.05</td>
</tr>
<tr>
<td>5</td>
<td>The required level of transparency to investors is advantageous.</td>
<td>1</td>
<td>7</td>
<td>27</td>
<td>38</td>
<td>7</td>
<td>80</td>
<td>3.54</td>
</tr>
<tr>
<td>6</td>
<td>The lack of strong regulations is an advantage.</td>
<td>4</td>
<td>20</td>
<td>29</td>
<td>22</td>
<td>5</td>
<td>80</td>
<td>3.05</td>
</tr>
<tr>
<td>7</td>
<td>The support of the Crowdfunding platform is beneficial.</td>
<td>1</td>
<td>4</td>
<td>15</td>
<td>47</td>
<td>13</td>
<td>80</td>
<td>3.84</td>
</tr>
</tbody>
</table>
11. Below statements are made about possible disadvantageous factors. Again the setting which will be used, unless stated otherwise, is: a company enters the Crowdfunding process and starts a Crowdfunding campaign.

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Total Responses</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It takes considerable more effort when compared to traditional funding methods.</td>
<td>13</td>
<td>37</td>
<td>22</td>
<td>5</td>
<td>0</td>
<td>77</td>
<td>2.25</td>
</tr>
<tr>
<td>2</td>
<td>It takes considerable more resources when compared to traditional funding methods.</td>
<td>14</td>
<td>38</td>
<td>18</td>
<td>6</td>
<td>1</td>
<td>77</td>
<td>2.25</td>
</tr>
<tr>
<td>3</td>
<td>The uncertainty involved with the campaign being successful or not is too high.</td>
<td>2</td>
<td>26</td>
<td>32</td>
<td>12</td>
<td>5</td>
<td>77</td>
<td>2.90</td>
</tr>
<tr>
<td>4</td>
<td>A non-successful campaign minimizes any second chances for the business.</td>
<td>3</td>
<td>37</td>
<td>26</td>
<td>11</td>
<td>0</td>
<td>77</td>
<td>2.58</td>
</tr>
<tr>
<td>5</td>
<td>Platform costs are too high when compared to what they offer.</td>
<td>5</td>
<td>25</td>
<td>38</td>
<td>8</td>
<td>1</td>
<td>77</td>
<td>2.68</td>
</tr>
<tr>
<td>6</td>
<td>Brand damage is being taken when a campaign is not successful.</td>
<td>3</td>
<td>27</td>
<td>21</td>
<td>25</td>
<td>1</td>
<td>77</td>
<td>2.92</td>
</tr>
<tr>
<td>7</td>
<td>The required level of transparency is disadvantageous for a company.</td>
<td>9</td>
<td>32</td>
<td>26</td>
<td>8</td>
<td>2</td>
<td>77</td>
<td>2.51</td>
</tr>
</tbody>
</table>