Crowdfunding and Economic Growth:

Potential Effects on Investment Efficiency

Johan Holmberg
Acknowledgements:

Firstly, I want to thank my supervisor Kenneth Backlund for his support and guidance, two key components for the realisation of this thesis. I would also like to thank the helpful people at the institution who have helped in the process in various ways. Finally, would I like to summarise the experience of writing this thesis with a quote:

“I do remember one thing. It took hours and hours, but by the time I was done with it, I was so involved, I didn’t know what to think” – Adrian Belew
**Abstract:**
Crowdfunding is an alternative form of finance that have emerged with the widespread adoption of the internet. With the increasing utilization of crowdfunding, this thesis sets out to theoretically investigate whether crowdfunding could affect economic growth. If the choice of investment allocation mechanism could have any effect on the efficiency of investments made in the economy. The results show that crowdfunding could have a potential effect on the leakage of investments in the economy. The relative accuracy of the screening process and the transaction costs coupled with the method used for conducting the investments could affect the socially optimal proportion of investments conducted using crowdfunding.
Table of Content:

1 Introduction: ....................................................................................................................... 1
  1.1 Background: .................................................................................................................. 1
  1.2 Factors of economic growth: Stating the importance of capital and innovation .......... 2
  1.3 Innovation: The discrepancy between holders of ideas and capital.......................... 3
  1.4 Leakage of investments: ............................................................................................... 3
  1.5 Problem and Purpose: ................................................................................................. 5
  1.6 Outline: .......................................................................................................................... 5
2 Crowdfunding: ...................................................................................................................... 5
  2.1 Explaining the phenomenon ......................................................................................... 5
  2.2 Debt Crowdfunding: .................................................................................................... 7
  2.3 Equity Crowdfunding: ................................................................................................ 7
  2.4 Reward- and Donation Crowdfunding ..................................................................... 7
  2.5 Summary of Crowdfunding ....................................................................................... 8
3 Theoretical foundation: ....................................................................................................... 8
  3.1 The rationality of the crowd: ...................................................................................... 8
  3.2 Pre-market screening: .................................................................................................. 10
  3.3 Investments beyond money: ....................................................................................... 11
  3.4 Transaction costs for investments: .............................................................................. 12
4 Analysis .................................................................................................................................. 13
  4.1 The Reference Model: ................................................................................................. 13
  4.2 The Social Optimum .................................................................................................... 16
  4.3 Optimal Proportions: .................................................................................................... 19
5 Discussion: .............................................................................................................................. 23
6 Reference list: ......................................................................................................................... iv
1 Introduction:

1.1 Background:
Pod Point is a company formed in 2009 that provides products and services for electric motoring (Pod Point, n.d.a). They sell chargers for companies, individuals and have started to build an infrastructure for electric vehicles by creating a public network of chargers (Pod Point, n.d.a). Seeking capital for product development Pod Point launched a campaign selling equity on the crowdfunding website Seedrs in 2014 (Pod Point, 2014). The company sold 6.89% of its equity raising £1.47 million (Pod Point, 2014). Following the previous success, and in order to raise capital for a capital for an expansion, a second crowdfunding campaign was started. This time they used the crowdfunding website Crowdcube, selling another 6.49% of its equity, this time for £1,805 million (Pod Point, 2015) and mini-bonds for £373 thousand (Pod Point, n.d.b). By running these public campaigns on different websites on the internet the company managed to raise more than £3,6 million for their business.

Crowdfunding is a word used to describe various forms of fundraising, commonly via different web based platforms (Ahlers et al., 2015, p. 955) and it’s an alternative form of financing where consumers are able to provide capital for production (Kumar et al, 2015, p. 1). By creating new opportunities for small companies or individual entrepreneurs to raise capital, crowdfunding could potentially bridge the gap between the public and companies neglected by traditional financial backers (Sigar, 2012, p. 481). This phenomenon is recognized as a possible way of democratising the capital markets (Mollick & Robb, 2016, p. 73).

The body of published literature currently discussing crowdfunding is relatively limited but growing. 477 peer reviewed articles on the subject were available via EBSCOhost as of 2016-04-25. To my knowledge the literature discussing crowdfunding’s possibility to affect economic growth is limited. This thesis aims to fill some of the gap by developing a theoretical model based on the current literature and examine the possible growth effects of this additional capital allocation mechanism. Previous literature has studied various aspects of crowdfunding. Belleflamme et al. (2015) provides a description of crowdfunding, the design of crowdfunding platforms and discusses underlying factors behind the decision to turn to crowdfunding. Mollick and Robb (2016) discusses the possible democratization of the capital market as a result of crowdfunding using the result of previous studies. Greenberg and Mollick (2014) examine women’s historical disadvantage regarding raising capital for new ventures and crowdfunding as an exception. Younkin and Kashkooli (2016) investigates crowdfunding as a solution to
different problems including gatekeeping, also coordination, inexperience and patronage. Mollick and Nanda (2014) examines the difference between the crowds and experts’ screening of theatrical projects.

1.2 Factors of economic growth: Stating the importance of capital and innovation
Capital or producer goods has for a long time been acknowledged as an important factor of production. In the classical economics by the likes of Smith and Ricardo capital is one of three factors of production, the others being land and labour (Ricardo, 1817; Smith, 1776).

The influential Solow-Swan model of exogenous economic growth was written and published independently by Robert Solow and Trevor Swan in 1956. This model has managed to remain current to this day and includes several important insights. One of these was that the output of a worker is partly a function of the amount of capital at his or her disposal (Solow, 1956, p. 69). This view is agreed upon by many economists like James Tobin (1965) who also believed in a positive effect of capital intensity on productivity (p. 673). According to this view, growth per capita is partly a result of productivity changes due to a dynamic evolution of the capital stock. The significance of capital accumulation for economic growth is debated but it’s difficult to argue against the existence of positive productivity effects from capital goods. Both the strength and somewhat the limitations of capital accumulation are visible in the Solow-Swan model. The capital stock has an impact on productivity in the economy but this increased productivity comes at the cost of decreased consumption in the present and rising costs of capital depreciation. This conclusion of the capitals importance for production is fundamental for the neoclassical and classical theory of economics.

A factor frequently addressed in the context of theories of economic growth is innovation and technological efficiency. Joseph Schumpeter was one of the first economist to recognise innovation as the driving factor of economic growth (Carlin & Soskie, 2006, p. 538). Philippe Aghion and Peter Howitt later operationalised the concept of creative destruction, were new technology replaces the old resulting in a turbulent process resulting in growth, in a model. Economic growth is seen as the result of new innovation originating from the desire for monopoly profits but the new technology render the old obsolete (Aghion et al., 2015, p. 94). Generating new innovations demands labour which means that parts of the workforce have to engage in R&D instead of production (Aghion et al., 2015, p. 94). Robert Solow concluded that
roughly 87.7% of the rise in productivity between 1909 and 1949 in the USA was due to technical change increasing the productivity of the production factors (1957, p. 316). Later statistical analysis conducted using additional explanatory variables estimated the impact of technical change to be lower and explaining around a third of economic growth (Cameron, 1996, p. 2). The magnitude of the effect that increases in technological efficiency has on economic growth is debated. However, many agree on the existence of positive productivity effects from increasing technological efficiency.

1.3 Innovation: The discrepancy between holders of ideas and capital
One important insight from the Schumpeterian growth models is that new businesses or innovations doesn’t spring out of thin air and create themselves, they are in some ways a manifestation of the ideas of people. However, people with ideas are not always the same as the people with the financial means necessary in order to make an attempt at realising them. Inventors or entrepreneurs frequently have to search for external funds. This could mean that they turn to bankers, venture capitalists or government officials in order to obtain capital. Historically the privilege of deciding which ideas would receive monetary or institutional support and subsequently a chance at commercialisation have been largely confined to these small groups of experts (Mollick & Robb, 2016, p. 72). For example, venture capitalist are in a position to select ideas deemed appropriate before the market can have a say and companies in the seed stage denied finance has a disadvantage compared to companies granted funds. This is partly due to the increased difficulty in creating business ties due to lack of financial means to pay for goods and services (Ferrary & Granovetter, 2009, p. 346).

1.4 Leakage of investments:
Economic models acknowledge the importance of investment for the growth of production and to an extent the consumption in the economy, whether the resources invested is monetary or consists of labour. The investment entails a contemporary loss of consumption, either by returning output to the production as investments or the opportunity cost in production resulting from devoting parts of the workforce to R&D, in exchange for a higher future productivity.

The market economy is dynamic by nature. Over time new businesses enters and new products are developed and introduced to the market. It is no secret that some of these ventures succeed whilst other fails and that existing products or corporations may be forced out of the market.
Sometimes new products are rejected by the market. Schumpeter distinguished between two types of risks, technical failure of production and the risk of commercial failure (Schumpeter, 1934, p. 8). Between 1945 and 2004 then 19 empirical and peer reviewed studies placed the new product failure rate in the range of 30-49% (Castellion & Markham, 2013, p. 978). Newly founded corporations might also get rejected by the market. A study of Bavarian business ventures found that 23.7% of newly founded businesses was closed after two years and 37.1% after five (Brüderl et al., 1992, p. 235).

One might argue that this results in explicit and implicit costs from a socioeconomic perspective. Resources invested in failed projects had most likely been more productive if allocated for other uses. These inefficiencies in the allocation of investments on the market is part of the business reality and rarely questioned in economic literature. One possible question one could ask is if the choice of investment allocation mechanism could have any effect on this inefficiency, if investments made by the consumers could outperform the investments executed by the experts. Some argue that the deregulation of the equity crowdfunding market will result in increased misplacement of investments. Isenberg (2012) argues that investments in early stage equity is too difficult to standardise in a way which makes it comprehensible for consumers while retaining functional and legal validity and that a crowd of consumers lack the knowledge, time and funds necessary for conducting an adequate due diligence. Other studies suggest that crowds could have the ability under certain conditions to match or even surpass the judgements of experts (Budescu & Chen, 2014; Lorenz et al., 2011; Mollick & Nanda, 2015; Surowiecki, 2004). Individual judgement can succumb to different kind of bias and aggregating independent judgements of several individuals could under the right circumstances reduce this bias (Budescu & Chen, 2014; Davis-Stober et al., 2014).

Beyond failure rates there is also complaints of an underrepresentation of women and minorities in the venture capital market (Younkin & Kashkooli, 2016, p. 26). If there are obstacles for women or minorities in the financial intermediary market, then crowdfunding could possibly present a chance to circumvent these (Greenberg & Mollick, 2014, p. 35; Younkin & Kashkooli, 2016, p. 26).

A market with a perfect allocation of resources for product and business development could seem improbable. However, the proportion of new product and business failure suggest that
there might exist room for improvements. A reduction in the leakage of investments would likely have positive effects on economic growth.

1.5 Problem and Purpose:
Could the possibility of using crowdfunding as an alternative process of allocating capital increase efficiency of investments and thereby increase the growth rate of the capital stock and technological development?

The purpose of this thesis is to analyse crowdfunding’s potential to decrease investment inefficiencies and the possible welfare effects this could result in by its possible effect on capital accumulation and technological development.

This is a theoretical study partly due to the decentralized nature of the crowdfunding phenomena and partly due to the nature of the question investigated. The material used was found using EBSCOhost, Google Scholar, Google and the library at Umeå university. This thesis is theoretical in the sense that no empirical data was collected and analysed. The analysis will be limited to financial return crowdfunding models were the crowd functions in a similar fashion as traditional investors.

1.6 Outline:
A brief disposition of the thesis. Section 2 gives a description of crowdfunding. After that the theoretical foundation of the model be depicted in section 3. In section 4 the reference model will be presented followed by an analysis of the socially optimal proportions of investments conducted using either crowdfunding or financial intermediaries. After that a rule for optimal proportion will be presented. Lastly in section 5, there will be a discussion of the results and some concluding remarks.

2 Crowdfunding:
2.1 Explaining the phenomenon
As previously discussed, the term crowdfunding is used to describe various forms of fundraising, usually over the internet. The basic concept is that individuals with ideas and a need of financial backing can present their ideas in a forum (for example websites like Kickstarter, Indiegogo, Seedrs, Crowdcube and many others). Then the users of the site, or the
crowd, are free to decide whether they want to fund the idea or not. Crowdfunding offers a route to capital in addition to the previously existing ways of obtaining financial backing. It is common that each individual backer makes a small contribution when dealing with crowdfunding (Ahlers et al., 2015; Mollick & Kuppuswamy, 2014) and the volumes are instead reached through a large number of contributors (Sigar, 2012, p. 478). Crowdfunding is a growing phenomenon. According to Massolution’s annual crowdfunding industry reports the amount of funds raised worldwide has increased from 1.5 billion USD in 2011 (Massolution, 2013) to 11.08 billion USD in 2014 (Massolution, 2015). A large number of websites are participating in the market, crowdsourcing.org had as of 2016-04-06 a directory of 599 crowdfunding websites (Crowdsourcing, n.d).¹

The underlying contracts between the investor and the recipient varies. Belleflamme et al. distinguish between two broad categories of crowdfunding. One category consists of crowdfunding based on investments and the other on crowdfunding based on donations and rewards (Belleflamme et al., 2015, p. 12). Kirby and Worner define these as financial return- and community crowdfunding (2014, p. 8). The first category consists of crowdfunding models which includes monetary reward for the investor. In this category we find crowdfunding models in where the crowd functions in a similar fashion to a traditional investor. The underlying contract between supplier and recipient of funds can be based upon a loan contract, equity shares in the venture or a fraction of future income (Belleflamme et al., 2015, p. 13). Donation- and reward based crowdfunding are examples of models included in this category (Kirby & Worner, 2014, p. 9).

Depending on the platform and the form of contracts currently used, the time when the recipient receives the funds differ. “All or nothing” is a commonly applied type of contract clause which require that a critical amount is obtained before any funds are distributed. Another type of contract is the “keep it all” variety in this case the fundraiser receives the payments when they arrive and keeps them whether any pre-determined goal is reached or not (Belleflamme, 2015, p. 17).

¹ This is to my knowledge the most complete register of sites, but it’s important to take possible coverage issues into account.
2.2 Debt Crowdfunding: 
Debt crowdfunding is the leading model of crowdfunding in term of funding volume. In 2014 11.08 billion USD was raised via crowdfunding using debt contracts (Massolution, 2015). These are principally the same as regular debt contracts but commonly in smaller denominations than other common debt contracts like bank loans or corporate bonds. The minimum required investment in a loan on the crowdfunding platforms Prosper and Lending Club is $25 (LendingClub, n.d.; Prosper Marketplace, Inc, n.d.a). Both Prosper and LendingClub function in a similar fashion to a credit rating agency and assign a credit grade to each loan (LendingClub, n.d.; Prosper Marketplace, Inc, n.d.b) with the added element of facilitating the interaction between lenders and debtors.

2.3 Equity Crowdfunding:  
Equity crowdfunding entails a gathering of funds in exchange for equity stakes (Belleflamme et al., 2015, p. 13). This form of financing constitutes of an open plead for funds over internet where entrepreneurs hopes to catch the interest of a large group of investors (Ahlers et al., 2015, p. 955). Equity crowdfunding became legally possible 2013 in the USA, but earlier US legislation included limitations on individuals allowed to participate (Barnett, 2015). Regulations on equity crowdfunding varies across countries (Gabison, 2014, p. 408). The rights following the ownership of these stakes varies across platforms. Investors using the crowdfunding platform Crowdcube receives direct ownership of the shares (Crowdcube, n.d.). Whereas the platform Seedrs holds the investors shares as a nominee (Seedrs, n.d.). Other platforms like WeFunder holds the securities and acts as a proxy holding the information and voting rights2 (WeFunder, n.d.).

2.4 Reward- and Donation Crowdfunding  
The reward and donation-based models for crowdfunding is a prominent form of crowdfunding and constitutes a large portion of the overall crowdfunding market. During 2014 3.26 billion USD were transferred between agents using these contracts (Belleflamme et al., 2015, p. 13). With reward-based crowdfunding the investor receives a non-monetary return for the investment. This return can consist of an article of the finished product and other additional rewards depending on the amount invested (Hu et al., 2015, p. 332). This is the model used by platforms such as Kickstarter and Indiegogo. Kickstarter is currently one of the largest platforms for reward-based crowdfunding. According to themselves they have as of 2016-05-

---

2 If the start-up is using a WeFund which is the prominent form of fundraising on the site (WeFunder, n.d.).
raised more than 2.36 billion and have had 10.8 million different backers since the launch in 2009 (Kickstarter, n.d.b). There are also crowdfunding models that are donation-based. In these cases, the donor isn’t offered any reward for the donation. Examples of crowdfunding platforms operating using this model could be Patreon which allows individuals to become patrons of artists or bloggers etcetera giving a fixed donation for new creations (Patreon, 2013) or Razoo which provides a platform for charity fundraising (Razoo, n.d).

2.5 Summary of Crowdfunding
One can conclude that crowdfunding is a phrase describing a set of different financial interactions usually coordinated using the internet where a large number of individuals respond to an open plea for financial support. It also has increased in popularity during recent years and could possibly grow in the future as well. But with increasing volumes of capital distributed using this mechanism there is also a rising importance of understanding the economic implications of this phenomena.

3 Theoretical foundation of the model:
3.1 The rationality of the crowd:
Crowdfunding could potentially have a positive effect on the investment efficiency in the economy. The accuracy of statistical aggregates of the opinions of a diverse crowd can sometimes surpass the accuracy of individuals or even experts’ opinions when it comes to forecasting and estimation tasks (Budescu & Chen, 2014, p. 267; Lorenz et al., 2011, p. 9020; Surowiecki, 2005). Whether the wisdom of crowds is applicable to the funding of new start-ups is a question up for debate. Group irrationality is well documented and when it comes to financial backing of new business ventures then the crowd likely lacks the means necessary to conduct a proper due diligence (Isenberg, 2012).

Francis Galton’s 1907 article Vox Populi is sometimes referred to as an early documentation of the wisdom of crowds (Davis-Stober et al., 2014, p. 79). Galton investigated the accuracy of the aggregated guesses made by 787 participants in a contest at a livestock show and found, contrary to his expectations, that the aggregated estimations were surprisingly accurate. The aggregated guess deviated less than one percent from the true value of the goal variable (Galton, 1907). A mathematical principle behind this phenomenon is the possibility of improving statistical forecasts by combining different statistical methods using both simple and weighted
averages. Combining forecasts can improve the accuracy and reduce the variability of forecasting errors (Winkler & Makridakis, 1983, p. 157).

Specific conditions need to be fulfilled before any crowd wisdom can be extracted. The crowd has to be diverse and there has to be knowledge regarding the problem within the crowd, incentives for the individuals to make their best guesses and these guesses have to be independent (Simmons et al., 2009, p. 5). If the group of judges makes the same error then the aggregated judgement will be biased (Simmons et al., 2009, p. 5). Ulrik Nash argues in his article on systematic error in the wisdom of crowds that collective judgement is likely to be skewed if the assessors’ judgements are more accurate than chance and the particular true value is extreme compared to what is typical (2014, p. 11-12). Both articles suggest that the trust in the crowd’s wisdom should be adjusted by the knowledge of the crowd (Nash, 2014; Simmons et al., 2009).

Simmons et al. investigated the rationality of groups betting on American football over the course of 17 weeks. The subjects in the study were divided into four different groups performing prediction tasks under slightly different terms. Three groups predicted the outcome of a game based on a point-spread which had been altered in the favour of the underdogs. One group was uninformed of the alteration, one informed and the third bet on the point-spread before predicting an exact point differential (Simmons et al., 2009, p. 14-15). The fourth group predicted the exact point differential each game (Simmons et al., 2009, p. 15). The study found a presence of systematic bias which meant that the crowd favoured the favourites even when the odds were altered in favour of the underdogs (Simmons et al., 2009, p. 21-22). This was prevalent both when the subjects were uninformed of the alteration of the odds and when the subjects were informed of the alteration of the odds (Simmons et al., 2009, p. 22). Simmons et al. concluded that the crowd was systematically biased and not wise (2009, p. 32). The fraction of individuals beaten by the different crowds ranged from 0% for the crowd placing bets informed of the altered odds to 57.8% for the group unconditionally predicting exact point differentials (Simmons et al., 2009, p. 42). By reanalyzing this data, Davis-Stober et al. got a different result. They found that more than 50% of the individuals performed worse than the crowd based on analysis using their expected loss model (Davis-Stober et al., 2014, p. 95).

---

3 They combined forecasts made using different methods, not by different people.
Even if the crowd is uniformly and substantially biased there is evidence that the aggregated judgement still can be superior to the judgement of a single high-performing non-biased individual (Davis-Stober et al., 2014, p. 91). It seems like there’s currently no clear consensus regarding what criteria needs to be fulfilled in order for the crowd to be considered wise. Davis-Stober et al. defines crowd wisdom as when the squared expected error of the crowd is smaller than that of the individual (2014, p. 83) and Simmons et al. arguably presumes a measurement of crowd wisdom based upon the accuracy the crowds’ estimations relative to reality.

The wisdom of crowds-effect is diminishing when individual judgements aren’t independent, social influence lead to higher confidence but lower accuracy of estimates and (Lorenz et al., 2011, p. 9024) the threshold for herding behaviour, triggering convergence of estimates reducing diversity without any positive effects on group accuracy, is low when it comes to social influence (Lorenz et al., 2011, p. 9024).4

3.2 Pre-market screening:
Both financial intermediation and crowdfunding could provide a mechanism for pre-market screening and selection of new concepts and ventures. Ferrary and Granovetter performed an investigation of the role played by venture capital firms in Silicon Valley and stated that they play a critical role in evaluating and selecting start-up ventures at the seed stage (2009, p. 345-346). They also suggest that this pre-market selection saves resources if they are the ones best qualified for this screening, but also point out that potentially valuable inventions could be hindered from reaching the market by this process. Venture capitalists employ several different routines for reducing the risk of an unfavourable outcome when investing, but still the most likely primary outcome of a venture capital investment is failure (Lerner, 2002, p. F76).

Mollick and Nanda performed a study comparing expert- and crowd evaluation of theatre projects. They found that the crowd and the experts generally agree when it comes to which theatre are worthy of financial backing (2015, p. 17). In the most cases when the crowd and experts disagree then the crowd is willing to back projects rejected by the experts (Mollick & Nanda, 2015, p. 12). The study found no evidence that the projects backed only by the crowd faired any worse than the projects backed by both (Mollick & Nanda, 2015, p. 16). The

---
4 All that was needed was to inform judges of the estimations of others, no additional social psychological influences were allowed in the experiment (Lorenz et al., 2011, p. 9024).
fundraising was online and experts were only asked to evaluate and state whether they would back the project or not. Due to a low response rate and limited number of observations the results should be interpreted carefully. One can’t say that this study provides any definitive evidence of the crowds’ predictive capabilities matching that of the experts, but the article provides some empirical support for the theory. Crowdfunding could also be a potential filler of the financing gap left by decreasing bank lending after the recent financial crisis (Kirby & Worner, 2014, p. 21) and it is possible that it could provide funding of small businesses which otherwise would be unlikely to receive it (Borello et al., 2015, p. 17; Sigar, 2012, p. 481).

An effective pre-market selection should theoretically reduce the leakage of investments in the economy. Relative accuracy of prediction and quality of the pre-market selection of the crowdfunding crowd compared to the traditional gatekeepers or experts affects which capital allocation mechanism would be most efficient. There is also concerns for the possibility of fraud in crowdfunding settings which should be taken into account (Kirby & Worner, 2014, p. 5; Sigar, 2012, p. 481).

3.3 Investments beyond money:

Financial intermediaries can reduce moral hazard and adverse selection problems in the market by thoroughly scrutinizing ventures before financing them and monitoring the entrepreneur afterwards (Lerner, 2002, p. F75). This function can according to Lerner reduce some of the capital constraints on the market. Financial intermediaries, like venture capitalist, can besides from providing capital and screening provide access to networks by signalling the quality of the start-up and provide valuable competence regarding managerial, technological, industrial and legal issues (Ferrary & Granovetter, 2009, p. 348-349). These kinds of non-monetary assets could mean the difference between making it through hardships or not for a new venture and crowd funded companies may not have access to them (Gobble, 2012, p. 6).

Crowdfunding comes with other non-monetary assets. This way of financing involves an early test of the market potential for the concept. It also provides an opportunity for marketing products and receiving feedback from the consumers (Sigar, 2012, p. 481). Using crowdsourcing at the same time as crowdfunding provides a way of receiving support and suggestions regarding product development (Sigar, 2012, p. 481).
3.4 Transaction costs for investments:

Even if the allocation of capital would be perfect in the market there would be leakage in investments due to transaction costs linked to the allocation mechanism. For example, financial intermediaries have self-costs covered by generating income from maturity transformation or fee generating activities. Costs like the interest rate spread and fees are a form of leakage reducing the fraction of invested funds ultimately used for acquiring capital or financing technological development. A possible approximation of this leakage in financial institutions could be the net interest spread, the difference between the deposit and lending rates. According to the Federal Reserve Bank of St. Louis this interest spread has averaged 3.49 percentage points between the year 2000 and the third quarter of 2015 for commercial banks in the US (St. Louis FED, n.d.). The present value of this cost over the duration of the loans could give an approximation of the leakage from transaction costs for financial intermediaries when debt is used.

There is no obvious equivalent to equity crowdfunding using financial intermediaries. The underwriting commission of an IPO is around 5-7% (PWC, 2012, p. 8) this could give an approximation of the transaction costs of selling private equity using financial intermediaries.

There are explicit costs linked to crowdfunding platforms as well, for example explicit costs due to fees on the platform. These can take different shapes but a common method is to take a fraction of the raised capital and in some “all or nothing” cases there’s also fees on funds eventually returned. For example, the crowdfunding site Invesdor keeps transaction fees for unsuccessful funding rounds (Invesdor, n.d.). The site Kickstarter takes a 5% fee of the funds, not including payment processing fees, which range from 3-5% depending on the country and average size of payments, from each successful fundraising project (Kickstarter, n.d.). Another relatively large site Crowdcube has a similar fee structure on successful project but takes 6.5% of received funds and has additional fixed fees for administration and corporate services amounting to £2500, excluding VAT and payment processing fees (Crowdcube, n.d.b). There are also other effects of including additional people to the project. Additional cost can arise from this such as costs related to managing investor relations or administrative costs (Sigar, 2012, p. 482).
4. Analysis
4.1 The Reference Model:

Let’s set up a dynamic model of capital accumulation and technological development including crowdfunding. The goal of the model is to maximise the present value of all future consumption. The objective function is written:

\[
\text{Max } \int_{t=0}^{\infty} u(C_t)e^{-rt} dt
\]  

(4.1.1)

where \(u\) represent utility, \(C\) consumption and \(r\) the discount rate. We will assume a positive but declining marginal utility from consumption, or that \(\frac{\partial u}{\partial C} > 0\) and \(\frac{\partial^2 u}{\partial C^2} < 0\). In order to consume we have to produce as well and output \(Y\) during any given time period is assumed to be a function of capital stock \(K\), labour \(L\) and technological efficiency \(A\) at the time. Technological efficiency is assumed to be a function of accumulated net investments in technological development \(Q\). Writing in general form we get:

\[
Y_t = f(K_t, L_t, A_t(Q_t))
\]  

(4.1.2)

The first derivatives of output with respect to capital, labour and level of technological development is assumed to be positive. To simplify the analysis, we keep population and thereby labour constant and normalised to equal one. We will also normalise the relationship between technological efficiency and accumulated net investments in technological development. Investments will be allowed to be conducted in two ways in the model. Either via financial intermediaries like banks or venture capital firms or directly from consumers via crowdfunding. Other financing solutions exists, like investments using retained profits, but the number of options will be restricted to two in order to simplify the analysis. The proportion of total investments in capital goods conducted via financial intermediaries \(\theta_K\) and the remaining proportion of capital goods investments is assumed to be allocated by crowdfunding. Representing a proportion, \(\theta_K\) assumes values ranging from zero to one. There is an analogous definition of the proportion of investments in technological development conducted using financial intermediaries \(\theta_Q\).

A core concept in this model is the reduction of gross investments due to leakage in the form of transaction costs and misplaced investments. The leakage is assumed to be a function of the
overall volume of investment and how the investments are conducted. There are two sources of leakage in the model. One is the transaction costs (TC) linked to either path. This cost is assumed to be proportional to the volume of funds. The other factor is the level of accuracy between estimation and outcome, were invested funds in a project is viewed as a prediction of success by the investor. The correlation between intermediaries’ prediction and the favourable outcome is noted (Φ) and for the crowd (Ψ). This notation and concept builds on the work by Davis-Stober et al. (2014). These correlations are restricted to a value ranging between zero and one. This model uses modified correlation between prediction and goal variable with the correlation divided into two parts

\[ \Phi = \varphi + \gamma_{KI}(\theta_K) \quad \text{where} \quad \frac{\partial \gamma_{KI}}{\partial \theta_K} \leq 0 \]  
(4.1.3)

\[ \Psi = \psi + \gamma_{KCF}(\theta_K) \quad \text{where} \quad \frac{\partial \gamma_{KCF}}{\partial \theta_K} \geq 0 \]  
(4.1.4)

\[ \Phi = \varphi + \gamma_{QI}(\theta_Q) \quad \text{where} \quad \frac{\partial \gamma_{QI}}{\partial \theta_Q} \leq 0 \]  
(4.1.5)

\[ \Psi = \psi + \gamma_{QCF}(\theta_Q) \quad \text{where} \quad \frac{\partial \gamma_{QCF}}{\partial \theta_Q} \geq 0 \]  
(4.1.6)

Index K represent capital and index Q technological investments. The aggregated probability of favourable outcomes for both investment pathways is modelled to depend on two factors. The first factor noted (ψ) for crowdfunding and (φ) for intermediaries, represent the ability to pick the right project, in other words the statistical probability that any funded project will be successful given that there’s no interaction between investor and recipient. The second part of the functions is noted (γ) with four different index notations which represents the four different possible paths for investments. (γ) represents increased likelihood of success due to active intervention or interaction between investor and recipient of capital. This could for example be the competitive advantage of having access to a venture capitalist’s business network as a result of interaction with financial intermediaries or the possibility to crowdsource solution for problems for the crowdfunded project. These are assumed to have a neutral or positive effect on the likelihood of success, in other words γ ≥ 0, and that these advantages are assumed to be decreasing or constant with increasing usage (see expressions 4.1.3–6). If we see the investors efforts as a limited resource, an increasing number of different projects would lead to a lower average per project.
I represents gross investments in capital goods and \( Z \) represent gross investments in technological development, gross investments in the economy is determined as follows:

\[
Y_t - C_t = I_t + Z_t
\]  

(4.1.7)

Gross investment in capital goods in a given time period is equal to what’s left of output \( Y \) after consumption \( C \) and gross investments in technological development \( Z \). It’s possible to see from 4.1.7 that investments in capital goods is partially a function of investments in technological development. Every increment of investment in technological development \( Z \) lead to an equally large reduction in investments in capital goods \( I \). Investment in capital goods doesn’t give a one for one increase in capital stock due to two reasons, one is the depreciation of the existing capital stock during that period \( \delta K \) and the other culprit is the leakage of investment. The fraction of investments \( I \) conducted via intermediaries is determined by \( \theta_K \) and there are two types of leakages from this path. First we have leakage from misplaced investments modelled as the fraction of net-investments after transaction costs \( TC_I \) lost due to an unfavourable project outcome. This cost decreases as accuracy of intermediaries’ predictions \( \Phi(\theta_K) \) increases. There’s also transaction costs which are independent of the project outcome. Transaction costs due to financial intermediaries is assumed to be a fraction of net investments conducted using financial intermediaries. The fraction of investments conducted via crowdfunding is the fraction not conducted via financial intermediaries. The structure of the leakage is similar to that of the intermediaries, a fraction of net investments is lost due to imperfect accuracy and there exists an inevitable transaction cost which is independent of project outcome. By substituting \( Y \) using 4.1.2, capital accumulation will be modelled:

\[
\frac{\partial K}{\partial t} = f(K_t, 1, Q_t) - C - Z - \delta K - I\theta_K \left( (1 - TC_I)(1 - \Phi(\theta_K) + TC_I) \right) \\
- I(1 - \theta_K) \left( (1 - TC_{CF})(1 - \Psi(\theta_K)) + TC_{CF} \right) 
\]  

(4.1.8)

Accumulation of net investments in technological development will be modelled and determined in a similar fashion.

\[
\frac{\partial Q}{\partial t} = Z - Z\theta_Q \left( (1 - TC_I)(1 - \Phi(\theta_Q) + TC_I) \right)
\]
\[-Z(1-\theta_Q)\left((1-TC_{CF})(1-\Psi(\theta_Q)) + TC_{CF}\right)\]  

(4.1.9)

Investment in technological development \((Z)\) have a leakage function similar to capital investments.

4.2 The Social Optimum

The present value Hamiltonian function with an infinite-time horizon will be used to determine the socially optimal course of action. The Hamiltonian function can be used to solve dynamic constrained optimisation problems (Hoy et al., 1996, p. 843)

\[H_t = u(C_t)e^{-\alpha t} + \lambda_1 \frac{\partial K}{\partial t} + \lambda_2 \frac{\partial Q}{\partial t}\]  

(4.2.1)

The Hamiltonian multipliers (noted as \(\lambda_1\) and \(\lambda_2\)) represents the shadow price or the marginal effect on the objective function from changing the constraints (Hoy et al., p. 853). In the following case \(\lambda_1\) and \(\lambda_2\) represent the present marginal utility of increasing the constraint \(\frac{\partial K}{\partial t}\) and \(\frac{\partial Q}{\partial t}\) by one unit respectively.

These are the first order conditions of the Hamiltonian function, 4.2.1:

\[\frac{\partial H}{\partial C} = \frac{\partial u(C_t)e^{-\alpha t}}{\partial C} - \lambda_1 = 0\]  

(4.2.2)

\[\frac{\partial H}{\partial Z} = \lambda_1 \left(-1 + \theta_K \left((1 - TC_i)(1 - \Phi(\theta_K)) + TC_i\right) + (1 - \theta_K)((1 - TC_{CF})(1 - \Psi(\theta_K)) + TC_{CF})\right) + \lambda_2 \left(1 - \theta_A((1 - TC_i)(1 - \Phi(\theta_A)) + TC_i) - (1 - \theta_A)((1 - TC_{CF})(1 - \Psi(\theta_A)) + TC_{CF})\right) = 0\]  

(4.2.3)
\[ \frac{\partial H}{\partial \theta_K} = \lambda_1 \left( -I \left( 1 - \varphi(1 - TC_t) - \gamma_{KI}(\theta_K)(1 - TC_t) - \frac{\partial Y_{KI}(\theta_K)}{\partial \theta_K} \theta_K (1 - TC_t) \right) + 
\]
\[ I \left( 1 - \psi(1 - TC_{CF}) - \gamma_{KCF}(\theta_K)(1 - TC_{CF}) + \frac{\partial Y_{KCF}(\theta_K)}{\partial \theta_K} (1 - \theta_K)(1 - TC_{CF}) \right) \right) = 0 \] (4.2.4)

\[ \frac{\partial H}{\partial q} = \lambda_2 \left( -Z \left( 1 - \varphi(1 - TC_t) - \gamma_{ql}(\theta_q)(1 - TC_t) - \frac{\partial Y_{ql}(\theta_q)}{\partial \theta_q} \theta_q (1 - TC_t) \right) + Z \left( 1 - 
\]
\[ \psi(1 - TC_{CF}) - \gamma_{qCF}(\theta_q)(1 - TC_{CF}) + \frac{\partial Y_{qCF}(\theta_q)}{\partial \theta_q} (1 - \theta_q)(1 - TC_{CF}) \right) \right) = 0 \] (4.2.5)

\[ \frac{d\lambda_1}{dt} = -\frac{\partial H}{\partial K} = -\lambda_1 \left( \frac{\partial f(K_t,1,Q_t)}{\partial K} - \delta \right) = 0 \] (4.2.6)

\[ \frac{d\lambda_2}{dt} = -\frac{\partial H}{\partial Q} = -\lambda_1 \left( \frac{\partial f(K_t,\lambda,Q_t)}{\partial Q} \right) = 0 \] (4.2.7)

From the first order condition 4.2.2 is it possible to see that in optimum:

\[ \frac{\partial u(C_t)e^{-rt}}{\partial C} = \lambda_1 \]

We see that in optimum the marginal utility of consumption should be equal to the shadow price of investment. Since the shadow price emulates the increase of utility from a relaxed constraint this can be interpreted as the marginal change in utility from increasing either consumption or investment should be equally large in optimum.

From 4.2.3 we see that in optimum the marginal benefit in terms of utility of net investments in capital goods should be the same as that of net investments in technological development:

\[ \lambda_1 \left( 1 - \theta_K ((1 - TC_t)(1 - \Phi(\theta_K)) + TC_t) - (1 - \theta_K)((1 - TC_{CF})(1 - \Psi(\theta_K)) + TC_{CF}) \right) \]

\[ = \lambda_2 \left( 1 - \theta_A ((1 - TC_t)(1 - \Phi(\theta_A)) + TC_t) - (1 - \theta_A)((1 - TC_{CF})(1 - \Psi(\theta_A)) + TC_{CF}) \right) \]

From 4.2.4 and 4.2.5 we see that in optimum:
\[
I \left(1 - \varphi(1 - TC_i) - \gamma_{KI}(\theta_K)(1 - TC_i) + \frac{\partial\gamma_{KI}(\theta_K)}{\partial \theta_K} \theta_K (1 - TC_i)\right) = \\
I \left(1 - \psi(1 - TC_{CF}) - \gamma_{KCF}(\theta_K)(1 - TC_{CF}) - \frac{\partial\gamma_{KCF}(\theta_K)}{\partial \theta_K} (1 - \theta_K)(1 - TC_{CF})\right)
\]

and
\[
Z \left(1 - \varphi(1 - TC_i) - \gamma_{QI}(\theta_Q)(1 - TC_i) + \frac{\partial\gamma_{QI}(\theta_Q)}{\partial \theta_Q} \theta_Q (1 - TC_i)\right) = \\
Z \left(1 - \psi(1 - TC_{CF}) - \gamma_{QCF}(\theta_Q)(1 - TC_{CF}) - \frac{\partial\gamma_{QCF}(\theta_Q)}{\partial \theta_Q} (1 - \theta_Q)(1 - TC_{CF})\right)
\]

It is possible to see that when the proportions are optimal the marginal leakage from investing via financial intermediaries should be equal to the marginal leakage of investing through crowdfunding. We also see that in the case that

\[
\frac{\partial\gamma_{KCF}(\theta_K)}{\partial \theta_K} = \frac{\partial\gamma_{KI}(\theta_K)}{\partial \theta_K} = 0
\]

and

\[
\frac{\partial\gamma_{QCF}(\theta_Q)}{\partial \theta_Q} = \frac{\partial\gamma_{QI}(\theta_Q)}{\partial \theta_Q} = 0
\]

then 4.2.4 and 4.2.5 simplifies to

\[
I \left(1 - \Phi(1 - TC_i)\right) = I(1 - \Psi(1 - TC_{CF}))
\]

and

\[
Z \left(1 - \Phi(1 - TC_i)\right) = Z(1 - \Psi(1 - TC_{CF}))
\]

Theta is no longer a decision variable in need of marginal adjustments, either we get the case when one of the alternatives has strictly less leakage than the other. The optimal action would then be to exclusively chose that alternative. We could also get a situation where none of the alternatives are better than the other, if this is the case then marginally adjusting theta wouldn’t affect the outcome. This means that we get a corner solution except for the case when the investment leakage is equally large for both intermediary financing and crowdfunding, in this case we have no unique optimum solution.
From the first order optimum conditions 4.2.6 and 4.2.7 we do get the following optimum condition. Here we see that in optimum the marginal effect on output of increasing investments in technology should be equal to the marginal effect of increasing investment in capital goods reduced by the rising cost of capital depreciation. The consumable or investable surplus in output from marginally investing in technology should be equal to that of marginally investing in capital goods.

\[
\left( \frac{\partial f(K_t, Q_t)}{\partial Q} \right) = \left( \frac{\partial f(K_t, Q_t)}{\partial K} - \delta \right)
\]

### 4.3 Optimal Proportions:

To be able to derive a rule for optimal proportion of investments conducted via financial intermediaries then we have to specify the expressions describing the likelihood of a favourable outcome. In order to simplify the analysis then the expressions will only consist of two parts and be modelled as follows:

\[
\Phi(\theta_K) = \hat{\phi}_K - m_{KI} \theta_K^{\alpha_K} \quad \text{where} \quad \hat{\phi}_K = \Phi(\theta_K=0) = \varphi + \gamma_{KI}^{Max} \tag{4.3.1}
\]

\[
\Psi(\theta_K) = \hat{\psi}_K + m_{KCF} \theta_K^{\beta_K} \quad \text{where} \quad \hat{\psi}_K = \Psi(\theta_K=0) = \psi + \gamma_{KCF}^{Min} \tag{4.3.2}
\]

\[
\Phi(\theta_Q) = \hat{\phi}_Q - m_{QI} \theta_Q^{\alpha_Q} \quad \text{where} \quad \hat{\phi}_Q = \Phi(\theta_Q=0) = \varphi + \gamma_{QI}^{Max} \tag{4.3.3}
\]

\[
\Psi(\theta_Q) = \hat{\psi}_Q + m_{QCF} \theta_Q^{\beta_Q} \quad \text{where} \quad \hat{\psi}_Q = \Psi(\theta_Q=0) = \psi + \gamma_{QCF}^{Min} \tag{4.3.4}
\]

The accented and indexed phi and psi represents the aggregated probability of favourable outcomes when all investments are conducted using crowdfunding, or when theta is equal to zero. As the proportion of funds conducted via using either path the value of the active intervention of the financiers is assumed to decrease. As the proportions of investments increases the capability of these financiers is diluted over a larger number of projects, leading to a marginal decrease of the positive effects for any given project. The decrease in the effect of active intervention for financial intermediary investments and increase for crowdfunding investments as the proportion of investments conducted using financial intermediaries changes.
from zero to one is represented by \((m_{xCF})\) and \((m_{xI})\). Inserting these expressions into the Hamiltonian function we get new first order conditions.

\[
\frac{\partial H}{\partial \theta_K} = \lambda_1 \left( -I(1 - \hat{\phi}_K(1 - TC_I) + m_{KI}(1 - TC_I)\theta_K^{\alpha_K}(1 + \alpha_K)) + I(1 - \hat{\psi}_K(1 - TC_{CF}) - m_{KCF}(1 - TC_{CF})\theta_K^{\beta_K} + \beta_K m_{KCF}(1 - TC_{CF})(1 - \theta_K)\theta_K^{\beta_K-1}) \right) = 0 \tag{4.3.5}
\]

and

\[
\frac{\partial H}{\partial \theta_Q} = \lambda_2 \left( -Z(1 - \hat{\phi}_Q(1 - TC_I) + m_{QI}(1 - TC_I)\theta_Q^{\alpha_Q}(1 + \alpha_Q)) + Z(1 - \hat{\psi}_Q(1 - TC_{CF}) - m_{QCF}(1 - TC_{CF})\theta_Q^{\beta_Q} + \beta_Q m_{QCF}(1 - TC_{CF})(1 - \theta_Q)\theta_Q^{\beta_Q-1}) \right) = 0 \tag{4.3.6}
\]

From 4.3.5 and 4.3.6 we see that in optimum:

\[
\hat{\phi}_K(1 - TC_I) - m_{KI}(1 - TC_I)\theta_K^{\alpha_K}(1 + \alpha_K) = \\
\hat{\psi}_K(1 - TC_{CF}) + m_{KCF}(1 - TC_{CF})\theta_K^{\beta_K} - \beta_K m_{KCF}(1 - TC_{CF})(1 - \theta_K)\theta_K^{\beta_K-1}
\]

respectively

\[
\hat{\phi}_Q(1 - TC_I) - m_{QI}(1 - TC_I)\theta_Q^{\alpha_Q}(1 + \alpha_Q) = \\
\hat{\psi}_Q(1 - TC_{CF}) + m_{QCF}(1 - TC_{CF})\theta_Q^{\beta_Q} - \beta_Q m_{QCF}(1 - TC_{CF})(1 - \theta_Q)\theta_Q^{\beta_Q-1}
\]

We can rearrange expression 4.3.5 and simplify in order to obtain the implicit function:

\[
F = \hat{\phi}_K(1 - TC_I) - \hat{\psi}_K(1 - TC_{CF}) - m_{KI}(1 - TC_I)\theta_K^{\alpha_K}(1 + \alpha_K) \\
- m_{KCF}(1 - TC_{CF})\theta_K^{\beta_K} + \beta_K m_{KCF}(1 - TC_{CF})(1 - \theta_K)\theta_K^{\beta_K-1} = 0 \tag{4.3.7}
\]

From the implicit function theorem, we know that:

\[
\frac{\partial \theta_K}{\partial X} = -\frac{\partial F/\partial X}{\partial F/\partial \theta_K}
\]

(4.3.8)

We can use this to analyse the effect on optimal proportion by changes in the other variables in the function. 4.3.7 has the following derivatives:
\[
\frac{\partial F}{\partial \theta_K} = -m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} - m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} - m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} - m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K}
\]

\[= -m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} - m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} - m_{KI}(1 - TC_i)\theta_K^{\alpha K} - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K}
\]

(4.3.9)

\[
\frac{\partial F}{\partial \phi_K} = (1 - TC_i)
\]

(4.3.10)

\[
\frac{\partial F}{\partial \psi_K} = -(1 - TC_{CF})
\]

(4.3.11)

\[
\frac{\partial F}{\partial TC_i} = \phi_K + m_{KI}(1 + \alpha_K)
\]

(4.3.12)

\[
\frac{\partial F}{\partial TC_{CF}} = \psi_K + m_{KCF}\theta_K^{\beta K} - \beta Km_{KCF}(1 - \theta_K)\theta_K^{\beta K} - \beta Km_{KCF}(1 - \theta_K)
\]

(4.3.13)

\[
\frac{\partial F}{\partial m_{KI}} = -(1 - TC_i)\theta_K^{\alpha K}(1 + \alpha_K)
\]

(4.3.14)

\[
\frac{\partial F}{\partial m_{KCF}} = -(1 - TC_{CF})\theta_K^{\beta K} - \beta K(1 - \theta_K)
\]

(4.3.15)

\[
\frac{\partial F}{\partial \alpha_K} = -m_{KI}(1 - TC_i)(\ln(\theta_K)\alpha_K + \ln(\theta_K) + 1)
\]

(4.3.16)

\[
\frac{\partial F}{\partial \beta_K} = m_{KCF}\theta_K^{\beta K} - \beta K(1 - \theta_K)\ln(\theta_K) + 1)
\]

(4.3.17)

We could rearrange 4.3.9 to get:

\[
\frac{\partial F}{\partial \theta_K} = -m_{KI}(1 - TC_i)(\alpha_K + \alpha_K^2)\theta_K^{\alpha K} + \alpha_K(1 + \alpha_K) - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} + m_{KCF}(1 - TC_{CF})(\beta K - 1)
\]

\[
\frac{\partial F}{\partial \theta_K} = -m_{KI}(1 - TC_i)(\alpha_K + \alpha_K^2)\theta_K^{\alpha K} + \alpha_K(1 + \alpha_K) - m_{KCF}(1 - TC_{CF})\theta_K^{\beta K} + m_{KCF}(1 - TC_{CF})(\beta K - 1)
\]

The following analysis will be conducted under the assumption that 4.3.9 is negative.

Now can we analyse how optimal \(\theta_K\) changes when the other variables in 4.3.7 changes. From 4.3.10 we see that an increase of \(\phi_K\) would lead to an increase in optimal \(\theta_K\). This could be interpreted as if the accuracy of the financial intermediaries at its highest increases, ceteris paribus, then the optimal proportion of investments conducted using financial intermediaries’
increases as well. In 4.3.11 a reduction of optimal $\theta_K$ from an increase in $\bar{\psi}_K$ is observable. If the minimum accuracy of the crowdfunding crowd would increase, all else equal, then the proportion of investments conducted using crowdfunding increases in optimum. If one of the investment pathways become more efficient as an effect of a rising accuracy, all else equal, then we should increase the usage of that pathway. From 4.3.12 we can see that if transaction costs for financial intermediaries’ increases then we get two effects on optimal $\theta_K$ working in opposite directions. Firstly, if the value of maximum accuracy were to decrease due to a rising inevitable cost when using this investment mechanism, as observable in the first term, a reduction of the optimal proportion of investments conducted via financial intermediaries would occur. Secondly, then the importance of decreasing likelihood of a favourable outcome due to increased usage of the investment pathway is also reduced due to increasing inevitable leakage costs. This effect works in the opposite direction increasing optimal $\theta_K$. The transaction costs of crowdfunding have a slightly different effect on optimal theta as seen in 4.3.13. The first two parts of the derivative shows that as transaction costs for crowdfunding increases then the value of the current accuracy of investments conducted using crowdfunding decreases, so optimal $\theta_K$ increases. The third part shows a similar result, the increase in accuracy as a result of reduced usage loses its value as transaction costs increases. We would expect that the accuracy at any $\theta_K$ is larger than the expected change in accuracy with increased usage for both investment pathways. This would mean that if transaction costs for one of the alternative increases, ceteris paribus, then the efficiency of that alternative decreases. This would lead to a decreased usage of that investment pathway in the social optimum.

To specify exactly how optimal $\theta_K$ changes when a variable changes without specifying the other terms would not be possible. The direction of the derivatives comes from the derivative of the implicit function, 4.3.8 and 4.3.9. Since the derivative is divides by and then multiplied with a negative these cancel out each other.

In order to derive a condition for optimal theta then it’s necessary to make assumption regarding the exponentials. We could assume that we have a linear reduction of the benefits from active interventions from increased usage, that $\alpha_K = \beta_K = 1$. Then we could write 4.3.5 as:

$$\bar{\phi}_K(1 - TC_I) - \bar{\psi}_K(1 - TC_{CF}) + m_{KCF}(1 - TC_{CF}) = 2m_{KI}(1 - TC_I)\theta_K + 2m_{KCF}(1 - TC_{CF})\theta_K^1$$
We would get the following condition for optimal $\theta_K$:

$$
\theta_K^* = \frac{\hat{\phi}_K(1-TC_I) - \hat{\phi}_K(1-TC_{CF}) + m_{KCF}(1-TC_{CF})}{2(\hat{m}_{KI}(1-TC_I) + m_{KCF}(1-TC_{CF}))}
$$

(4.3.18)

The proportion of investments conducted using financial intermediaries is in 4.3.18 determined by the probability of a favourable outcome for financial intermediaries at its highest and the likelihood of a favourable outcome for investments conducted using crowdfunding at its lowest both with their respective transaction costs and the rates of which these probabilities changes with usage taken into account.

5 Discussion:

The ability to evaluate and pick projects worthy of financial backing is crucial in order for crowdfunding to be an efficient mechanism for allocating investments in the economy. To what extent a crowd is wise is an ongoing debate. There is a theoretical possibility of the crowd’s judgements being inferior, equal or even superior to the judgements of experts. More research has to be done in order to make any definitive statements and it is likely to vary depending on the branch of industry or nature of the project seeking funds.

I would argue for the possibility of a different relative accuracy of expert and crowd evaluation depending on the nature of the evaluated project. For example, entertainment is a field were consumer preferences should be considered a critical factor for commercial success. From a market demand point of view, it could be said that a concepts ability to convince a large number of potential consumers to part with money could give a stronger signal regarding the market potential of the concept than the ability to convince one or a few financial gatekeepers. Mollick and Nanda (2015) found some similarities in the outcome of a screening of theatre projects by the crowdfunding crowd and experts. In these industries then it is plausible that $\Psi \geq \Phi$ could be true. For other branches then the general knowledge regarding different subjects could be a hindrance for crowdfunding. It might be difficult for a crowd to evaluate the merits of projects dealing with developments of new medicine or developing catalytic converter for cars without any or limited knowledge of the subject. We would expect that $\Psi < \Phi$ in these cases. The relative accuracy of the crowd in comparison to the experts is likely to vary depending of the nature of the problem. Sometimes you could argue for a greater importance of knowledge about
the demand-side of the market and for these projects it is possible that \( \Psi > \Phi \), or that the crowds predictions could be more accurate than that of the experts. Other projects might be more demanding of knowledge regarding the supply side of the market. We could expect that \( \Psi < \Phi \), that the predictions of experts would be more accurate than that of the crowdfunding crowd in these cases. A uniform optimal proportion for the overall market would therefore seem unlikely.

It’s important not to overstate the importance of the financers for a project beyond their monetary contribution. The change in the likelihood of favourable outcomes due to a change the quantity of investments conducted using any given mechanism is likely to be modest, that the difference between (\( \gamma \)) at its highest and its lowest, or (m), is small. We would then observe many situations were one alternative would be strictly better than the other.

It is possible to question whether the websites used for crowdfunding provides the right circumstances for the wisdom of crowds to occur. Lorenz et al. (2011) shows that very little social influence is needed to offset the wisdom of crowds. As little as presenting the guesses of others has the potential of producing herding behaviour and reducing the quality of collective judgement. Popular sites feature elements like progress bars which shows the progression of investment toward funding goals, highlights different projects or shows how many people that have backed any given project. This mean that the independence of the judgements could be compromised reducing the accuracy of the collective judgements.

One problem with crowdfunding right now from a socioeconomic point of view is the high transaction costs which reduces the potential positive effects of crowdfunding. If we have transaction costs in the area of 8-10% of invested volume for crowdfunding, due to costs for using the platforms and payment processing fees, and a 5-7% transaction cost for financial intermediaries, then a significant superiority in the accuracy of crowd is needed to offset this difference and make it more socioeconomically beneficial than financial intermediaries. An interest rate spread for banks at 3.5% means that the present value of the transaction cost will vary depending on the length of the debt contract and the discount rate (\( r \)). For debt contracts with short times to maturity, around 2.8 years or less, then crowdfunding would lead to higher transaction costs than financial intermediaries. For longer contracts then this would be dependent on the discount rate, if the discount rate is positive then the present value of the transaction cost for debt contract with longer times to maturity would be lower for the financial
intermediaries. These transaction costs pose a problem for crowdfunding from an economics point of view, but it is possible that the costs could be reduced in the future as a result of technical advancements or economics of scale effects. As it is now, then the relatively higher transaction cost for crowdfunding in comparison to financial intermediaries could explain why crowdfunding constitutes only a small fraction of the financial market.

Crowdfunding is an exciting new form of finance and it has grown significantly over the last couple of years. As the quantity of investments conducted using crowdfunding increases then importance of understanding the phenomena and its socioeconomic implications has increased as well.
6 Reference list:


https://www.crowdcube.com/pg/crowdcube-fees-34. [Retrieved 22-04-2016]

http://www.crowdsourcing.org/directory. [Retrieved 06-04-2016]


WeFunder (n.d.). Common questions: WeFunds. WeFunder. https://www.wefunder.me/faq/common_questions. [Retrieved 2016-04-14]
