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„Signalling / Implications of Financing Decisions in Entrepreneurship“

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1 INTRODUCTION

The field of early-stage investment research has increased substantially in recent years. Its main focus lies on the entrepreneur's characteristics as well as on professional investors and their role and influence in the development of start-ups.

The informal investor market has gathered evermore attention in recent decades. However, there are still many questions to be answered in this rather young section of economic research. This is partly due to its very private nature, which makes large-scale gathering of information difficult and tedious.

Especially empirical research about the part the business angels play in the venture business, their influence and facilitation for further finance is rather scarce. The economic literature acknowledges business angles' role in supporting young ventures and providing seed capital (Coveney and Moore (1998)). However, their influence regarding venture capital deals is still debated and not entirely clear. The intention of this thesis is to add to this discussion with a quantitative analysis.

This thesis aims to find answers to the following questions in particular: 1.) In which way are business angels beneficial for entrepreneurs? 2.) Can they pose a signal to potential large-scale investors? 3.) How can their effects be distinguished and what is their magnitude? It will give insight into the impact these small-scale investors have on entrepreneurial success and how useful they can be to sort the wheat from the chaff in the ever-growing market of entrepreneurial ventures. This is an approach based on signalling and selection theory and can be considered an extension of the work of Busenitz, Fiet and Moesel (2005).

This paper will be structured in the following way: The theoretical part provides an overview of the different types of investments and highlights the significance as well as importance of informal investors in an economical context. Secondly, the principal-agent model, signalling, screening and incomplete contract theory will be summarized and a theoretical background for the influences will be provided. This will culminate in a model that will allow me to derive implications regarding the very nature of the above-mentioned influences. Afterwards, an unfortunately unsuccessful approach to the problem shall highlight the different methodologies one can use to tackle this topic. The empirical part of the thesis will examine in practice not only the differences

between business angel backed and venture capital backed firms but also employing the model to explain these divergences.
Finally, concluding thoughts will be given in the very last chapter and the thesis will be rounded off by a summary of the ideas that were collected through the analysis.

2 FINANCING POSSIBILITIES

One thing most new ventures have in common is the need for funding (Cassar (2004)). It is one of the main barriers and obstacles to start a venture. Dowling and Drumm conducted a survey among entrepreneurs concerning these issues (Dowling, Drumm (2003)). Almost 50% of those polled mentioned financing as their number one concern when it comes to creating a new company. They also found that secured financing had the highest effect on entrepreneurial success and failure.
However, most start-ups cannot supply these amounts of money from their own or founder's pockets. These kinds of financing sources are limited because of personal responsibility for mortgages, credit card debts and loans.

Therefore, entrepreneurs are in dire need of outside investors. Especially in the founding stages that require relatively few resources many make recourse to the 4 Fs: founder, family, friends, and fools (Bygrave and Quill (2006)).
They provide easy access to capital considering that at the early stage many ventures are not much more than a concept or an idea.
Yet, these sources of capital are not able to provide enough funding for later stages. Thus, other means of financing need to be drawn upon. There are many different types of funding and investors such as bank debt, mezzanine, venture capitalists (VCs), business angels (BAs), government and university grants, corporate investments and management buy-outs (Smith, J., Smith, R. and Bliss (2011)). Nevertheless, all of them have different focuses, conditions and pay-outs.

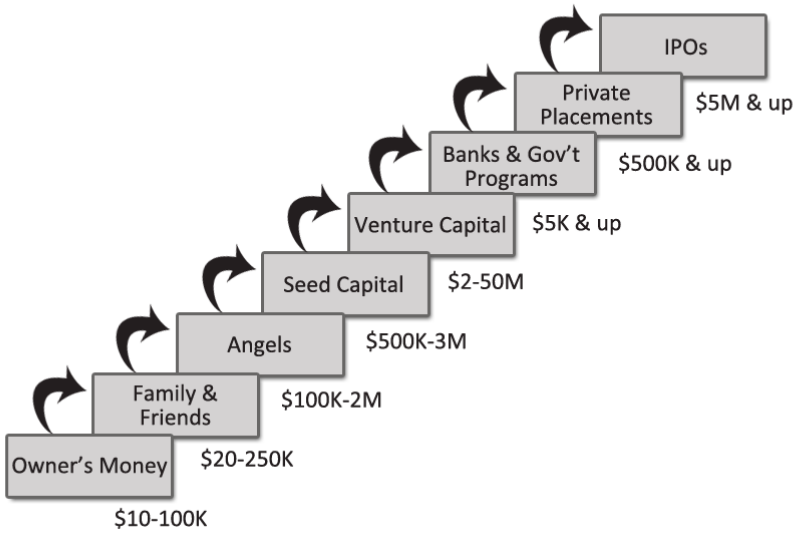

Figure 1 Typical financing for start-up companies (Kuratko (2012))

The figure above should not be taken as a linear investment path every company has to undertake. Moreover, the figure provides a timely categorization and shows the typical amounts certain investors can provide. Also, not all ventures have the same background and basis. Heavily asset based firms will have easier and earlier access to bank loans at viable conditions compared to firms dealing with intangible assets. In other words, depending on the venture, its environment and stage of development certain investors are better suited to fulfil its financing needs.

The two investor types of interest in this thesis are business angels (BAs) and venture capitalists (VCs). They are very frequently found in start-up investments and are contributing greatly to the overall economic situation (Kelly, Bosma, Amorós (2011)). Often the importance of business angels is understated, mostly because their investments are informal. Due to the very private nature of these investments they are often remaining undisclosed to the public. However, Florian Pützel (2001) and the Global Entrepreneurship Monitor (Bygraves and Quill (2006)) provide information about the impact and size of informal investment in comparison to VC financing.

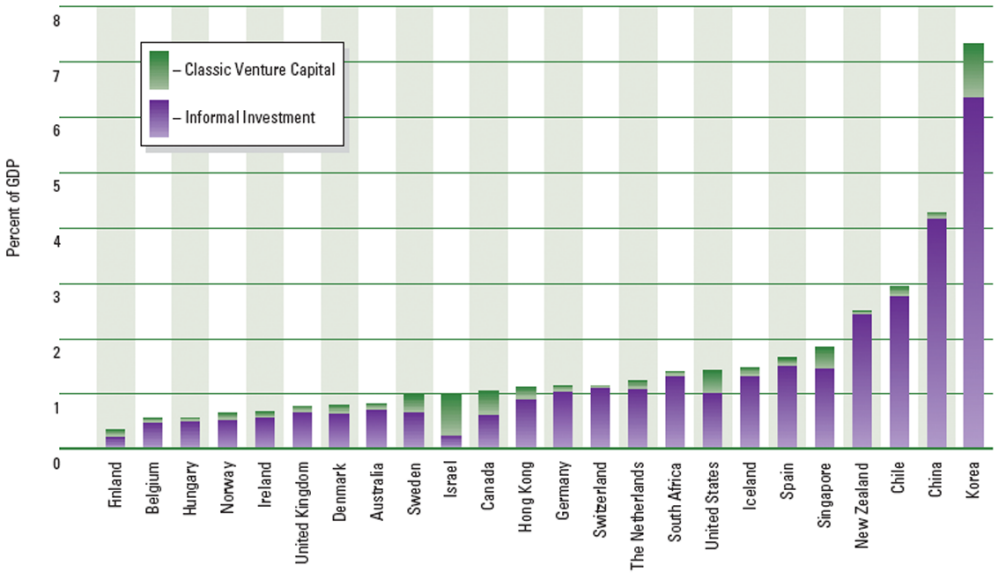

Figure 2 Investment in % of GDP (Pützel 2011)

The figure depicts the size and importance of the entrepreneurial investments and highlights that informal investment surpasses venture capital in volume in most countries by far. Nevertheless, both are of great importance for start-ups, and therefore, an interesting subject of study.

These two types of financing though rather different at first sight - can demonstrate a complementary relationship.

2.1 Business Angels and Venture Capitalists

Business angels are often private investors who have been entrepreneurs themselves (Kelly (2007)). Their reasons for investments are not exclusively driven by financial returns. Many want to experience the entrepreneurial process again and pass on their knowledge and experience (Mason (2006)). Besides their supportive role their focus on early stage investments makes them very attractive for young start-ups (Gompers, & Lerner (2004)).

> *"In particular, research has revealed that the typical business angel is a middle aged male who invests a relatively large amount of his personal wealth, most often in young and technology-oriented firms." (Politis (2008))*

Some highly wealthy entrepreneurs or start-ups that can get favourable bank loans and other sources of financing in the beginning might go straight to the VC market instead. Yet, for most entrepreneurs BAs fill a gap between seed financing and venture capital. (Freear, Sohl and Wetzel (2002))

In fact, this gap between seed capital and venture capital has increased substantially in the last decades (Siemon (2010)). This is partly caused by venture funds continually increasing in size. Hence, small investments become more and more uninteresting for VCs (Murray (1994)). This trend indicates that the role of business angels has and will become evermore important.

Finally, BAs have been shown to prepare new ventures for subsequent professional investors (Harrison, Mason (2000)). In other words, they are not only bridging the financial gap for small firms but help building and managing these businesses until they become sound and viable investment opportunities for VCs.

As already mentioned, business angels have a different relationship with entrepreneurs. This also affects their focus of valuation and the investment process.

BAs rely rather on monitoring and supporting the venture ex-post than exact contracting and in-depth analysis ex-ante. Their focus lies on the entrepreneurial team, which they can evaluate given their experience (Smith, Mason and Harrison (2010)). This does not mean that they do not have a look at the other aspects, which are important for an investment decision. Their industry knowledge allows for a quick and thorough valuation of the venture. Still, they spend less time on the due diligence and make up for it with increased ex-post involvement. The theoretical background for this approach can be found in “incomplete contract” theory explained in the next chapters.

Venture capitalists, on the contrary, are professional investors. Their investment focus lies on further developed ventures and in return they offer higher investment amounts (Amit, Brander, & Zott (1998), Zacharakis & Maeyer (1998)). VCs focus on elaborate contracts, extensive due diligence and valuation (Kaplan, Strömberg (2003)). They are hard to please and only take on very few ventures. Finally, one of the biggest differences compared to BAs is the amount of equity they demand in order to establish control over the venture and management. They also offer a strong investor

network and influence venture development and management. Furthermore, they prove very helpful in IPO situations (Jain and Kini (1995)). Finally, VCs are helpful in finding other co-investors in order to fulfil the financial needs of demanding ventures.

Overall, both types of investors are important and have certain benefits. How these differences and benefits impact venture deals and the theoretical background of the thesis will be given in the next chapters.

3 THE PRINCIPAL-AGENT-MODEL

The Principal Agent Model is a well-known concept strongly related to new institutional economics (NIE) and serves as the basis for this thesis.

> *The new institutional economics (NIE) is an interdisciplinary enterprise combining economics, law, organization theory, political science, sociology and anthropology to understand the institutions of social, political and commercial life. It borrows liberally from various social-science disciplines, but its primary language is economics. Its goal is to explain what institutions are, how they arise, what purposes they serve, how they change and how - if at all – they should be reformed. (Klein (2000))*

Before I get ahead of myself, I will elaborate on this concept, how it relates to an investment process and where its roots lie.

Michael Jensen and William Meckling can be considered the founding fathers of this theory built upon Ronald Coase's incomplete contract theory and the Coase Theorem (Jensen and Meckling (1976), Coase (1937)). Furthermore, its agency cost aspect is based on transaction costs, an idea and theory crafted by John Commons (1931) and popularized by Williamson (1981).

Simply put, Jensen and Meckling describe a situation where two parties engage in economic exchange with differing goals or self-interest and beset by agency costs induced by asymmetric distribution of information (Jensen and Meckling (1976)). This concept can be easily applied to an investment situation. The following figure depicts such a situation in an investor-entrepreneur relationship.

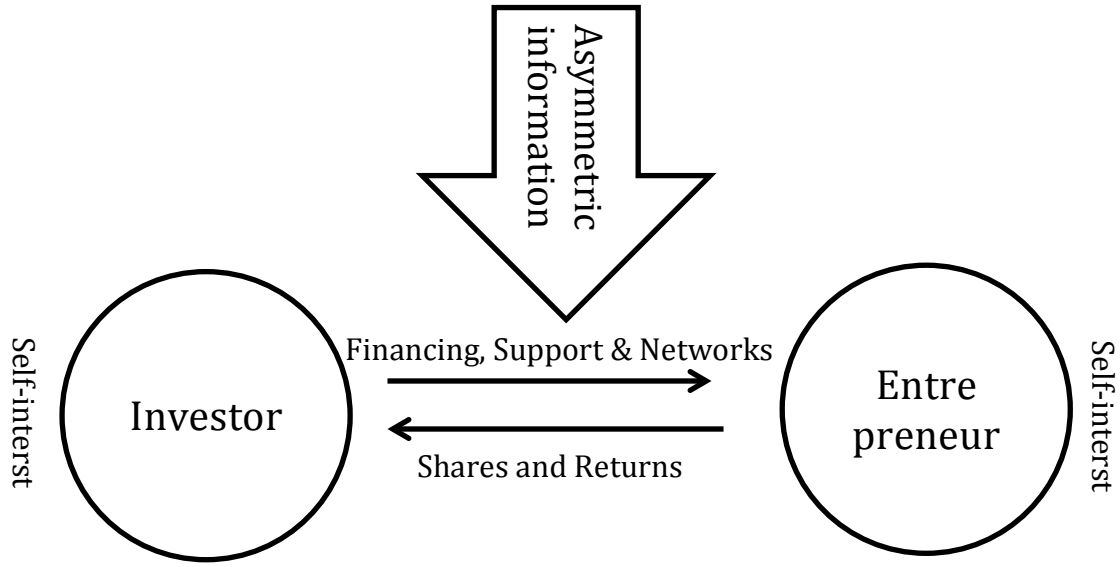

Figure 3 Principal-Agent model

While the investor provides financial aid and access to investor networks, the entrepreneur offers shares of their company, returns mostly through increasing firm value.

This trade would work without much ado in a world with perfect information for both parties. However, asymmetric information changes the situation dramatically. This information disparity creates opportunities for the better-informed parties to act in their interest, which can be rather harmful for their investment partners. The less informed parties might predict this and, therefore, change their behaviour and demands accordingly. Ultimately, this will lead to an outcome where both actors will be worse off even if they would continue their business relations.

Therefore, both parties might be interested to mitigate the effects of information asymmetry. But before solutions can be proposed I want to elaborate on asymmetric information and explain how it can be categorized and defined in an investment framework.

3.1 Asymmetric Information and Moral Hazard

Asymmetric information is a concept that has been apparent yet ignored for a long time. Notably neoclassical economics is based, among other things, on the assumption of perfect information and complete, perfect, enforceable contracts. Although it has been apparent that it will be violated in reality the consequences have been regarded as benign.

The first to elaborate on this issue were Akerlof, Spence and Stiglitz. They described the real consequences of information asymmetry and proposed solutions regarding how to deal with them. Most notably Akerlof wrote the paper called "Market for Lemons" (1970), which describes the concept of adverse selection, one of the problems of principal agent situations, very intuitively. I will present this example later when describing the problems and possible solutions to the principal agent problem.

Asymmetric information can be divided into four categories: hidden characteristic, hidden information, hidden action, and hidden intention (Picot, Dietl and Franck (2005)). All of these aspects of asymmetric information can be found in an investment process. Fortunately, there are ways to deal with it.

Firstly, hidden characteristic describes the problem that an investor cannot evaluate the features and quality of a product, service or the entrepreneur. In this case the quality of a product can refer to many characteristics including viability, ROI, market acceptance, competence and effort of the entrepreneur, potential sales as well as successful VC exit at the end of the investment window.

A professional investor should have no trouble evaluating the markets and ideas in question. However, the qualities and features of the entrepreneur are rather problematic to assess. Especially since the venture's success greatly depends on ability and effort put forward by the entrepreneur (Sudek (2006)). Therefore, it is not surprising that one of the most important criteria for investors is the start-up's team (Mason, Stark (2004)). Particularly in regard to his personal characteristics one can see that the entrepreneur has an information advantage over the investor.

Venture capitalists are eager to reduce risk were they can. Hence, knowledge about the entrepreneurial team is crucial. The more they know in this regard the better their contracts can accommodate both parties' interests. Eventually, this can have significant influence on monitoring and other control mechanisms. They are costly for the principal to implement as well as execute and might limit the entrepreneur to a point ultimately hurting the venture. The better balanced and the more accurately these measures are being used, the more efficient the venture can operate.

Still, one should not forget that it also works the other way around. Although the entrepreneur faces similar problems regarding the investor's characteristics they seem less sever. An entrepreneur would likely want a very reputable, supportive and competent investor, who provides a big investor network. It has been shown that entrepreneurs are likely to agree to more unfavourable terms in order to get a well-respected investor (Krishnan, Masulis (2012), Hellmann (1998)). However, since professional investors can establish a track record and rely on reputation for things such as syndication they can more easily convey their quality compared to the entrepreneur. Furthermore, IPOs allow investors to credibly disclose their investment information. Later I will discuss these hidden characteristics in the context of signal theory.

Hidden information and hidden action are very alike. The former describes a scenario where the principal cannot observe or assess the quality of actions taken by an agent. This might be due to a general lack of information or knowledge, i.e. ability. On the contrary, hidden action implies a situation where the agent's actions are unobservable. Both of these problems arise ex-post, which basically means after the contract has been signed and the investment has been made.
Usually, the hidden information scenario is the least troublesome. Professional, large-scale investors have the knowledge, means and negotiation power to take care of these things. The best-known contractual methods used are board mandates, conversion rules, investment staging, and generally higher involvement as well as monitoring of the venture (Gompers (1995)). Of course, there are many more, but this non-exclusive list shows that there are many ways to deal with these kind of problems in a contractual way. Nonetheless, one needs to keep in mind that all monitoring and

information acquiring tasks involve transaction and agency costs. In other words, an investor faces a risk-profit trade-off, which they try to solve.
Concluding hidden information and hidden action are aspects of asymmetric information that can be dealt with. Though occurring mostly after the investment has been contractually guaranteed, they are of concern and should be dealt with beforehand (Trester (1998)).

Finally, they face hidden intention, which refers to the phenomenon that a principal cannot determine what the real interest behind the agent's actions is, i.e. if he has an agenda. This problem is hard to deal with since it revolves mostly around a conflict in core interest. Many studies show that entrepreneurs can be reluctant to "give up" or sell shares of their company to begin with. This poses a problem, especially regarding future syndication, and can substantially weaken the investor-entrepreneur relationship from the very beginning. Along similar lines one can find problems concerning exit strategies. A high-scale investor is often under pressure to liquidate a venture in one way or another. For VCs, who have an investment window of about five to seven years, this often implies an IPO or a strategic acquisition (Cumming, & MacIntosh (2001), Schwienbacher (2005)). Both involve the founder to lose a substantial if not all power and ownership of his venture.
Finally, entrepreneurs often show a high urge for self-fulfilment and self-actualization, which means that they experience a desire to build up a company and realize their own ideas. This of course can often conflict with profitability and return goals set by professional investors. Aligning these very different interests is important in order to solve the issue of hidden intention and decrease the risk of moral hazard.
The latter describes a situation in which an agent has the possibility to take action, possibly benefiting them, while the principal has to take the risk either entirely or in part.

3.2 Adverse Selection

One of the many damaging consequences that can arise from information asymmetry is adverse selection. I already touched upon it mentioning George Akerlof's involvement in the theoretical groundwork. His paper "The Market for Lemons Quality Uncertainty and the Market Mechanism" (1970) illustrates the effects of adverse selection giving an easily comprehensible example of the second-hand car market. The setting is as follows (Akerlof (1970)): In a market for used cars only the owners/sellers know the true quality. All parties act rationally and a seller is not required to sell their car at all. In other words, the bargaining power is equal.

This leads to a situation where the buyer will only be willing to offer the price for an average quality car regardless of the car's real quality. The seller has no way to demonstrate his car's quality to the buyer. In other words, it is an outright sale.

Of course, an owner of a high quality car will not accept such an offer and since he does not need to sell his car under all circumstances he will exit the market.

This applies to all owners of above average quality cars. Ultimately, this will decrease the average quality in the market. Since buyers know the mean of quality they will readjust the amount they should offer.

Again, this leads to the same situation as in the beginning and one faces an indefinitely recurring loop. Ultimately, the market will completely dissolve itself. As already stated, this is a rather simplified example but it illustrates the dangers of asymmetric information quite well. To apply the exemplification above once just replaces car-owner with entrepreneur and buyer with investor.

However, one needs to keep in mind that some assumptions have been taken. In reality the situation looks a bit differently. Firstly, one has to acknowledge that the bargaining power in an investment situation is very different. Entrepreneurs cannot leave the market as easily since they desperately need funding. However, they might switch to a substitute such as a bank loan opposed to private equity. These other sources of financing might have more appealing terms. This already shows a possible solution based on contractual design.

3.3 Screening

In general, I am talking about the idea of screening, put forward by Michael Spence (1973) for the first time. Basically, the plan is to set up an assessment process for a directly measurable quality or ability that can separate groups.

The most notable example for this is education and academic performance in a job interview. It acts as a proxy for ability to perform the job in question (Spence (1973)).

The hypothetical set-up might look like this: There are two types of jobs in the labour market, some require an employee to have low and other high degree of skill, the former pay less than the latter. Firms cannot assess the skills of an applicant directly. However, they know that academic performance is highly related to skills required for the position.

Acquiring the academic education for the high degree of skill jobs requires financial investment for applicants. The ones who learn quickly need less time to earn a degree and, therefore, pay less for their education. Slower learners can also achieve this level of education, but take longer to do so. Hence, it is more costly for them.

A firm can now choose the required educational degree for a certain position and the salary they are willing to pay. A rational applicant will only take the high degree of skill job if the cost of getting the required education is less than the pay difference compared to a low degree of skill job. In other words, only people who are to some degree fast learners will accept this offer. Therefore, a company offering a high-paying job that requires the skill of fast learning can screen for the fastest learners via educational degrees.

Of course, this example relies on many assumptions. Foremost, that people are rational and plan long ahead of time, which is not always the case. However, it illustrates the point and functionality of screening. Education is used for this purpose in many cases including in investment situations. Nevertheless, there are a number of violations of the basic assumptions of this theory in reality. Especially rationality and the availability of information seem problematic. Many other reasons may play a role when it comes to choosing to attain a certain education. Additionally, education might have different effects on pay given other complementary traits. Finally, the example presented above postulates that an applicant perfectly knows his/her own ability to achieve a certain level of education or acquire a degree in a set time. In reality many people might not exactly know what they will be required to do and which traits and

skills they need to have, as well as what their interests are. Taking a look at the university or college dropout rates and cases of prolonged length of study support this claim. These are cases that a rational agent with perfect information might not undertake, but they still occur quite frequently (Snyder and Dillow (2012)).

That being said, screening does not always work perfectly. The agent needs to be aware of the contingencies and consequences the screening setup implies.

The previous example can easily be replicated in an investment environment. As already pointed out the traits of the entrepreneur are important in BA and VC valuation (Zopounidis (1994)).

How this concept exactly works in an investment situation will be shown in the next chapters.

3.4 Signalling

A very similar concept, known as signalling, can also be employed to tackle the problems of information asymmetry. As screening it is a concept developed by Michael Spence (19973, 1974), which has become quite prominent in economic literature. It is important to note that this chapter is based on the work of Vonnelly, Certo, Ireland and Reutzel (2011).

The main difference between screening and signalling lies in the role of the party taking the first action. In the case of screening the uninformed party sets up the contractual situation the informed party has to react upon. In signalling this is reversed – the informed party undertakes some action that might show their ability to perform on a job or to undertake a venture and the uninformed party reacts (Prasad, Bruton, & Vozikis (2000)).

Signalling in its essence describes the undertaking of an agent trying to credibly convey information about themselves to the market, a principal or other party. However, the value of the signal still stems from the principal or the other party assuming a high correlation between the signalled information and the ability they are looking for. On the contrary, a direct assessment might be undertaken to measure the real ability more or less exactly. This can be done with a training program or an internship in an employment situation, for instance. Furthermore, it has to be pointed

out that the signal needs to be credible. Simply stating one's ability, though truthfully but without any evidence, would not be conceived as such. There are numerous credible signals entrepreneurs try to use, as already mentioned, education is one of them (Backes-Gellner, Werner (2006)).

A good example other than education for a credible signal would be account information of portfolio performance for a position as an investment analyst. Exceptional performance with an investment portfolio might be highly related to the ability to accurately analyse companies or investment opportunities.

3.5 The Incomplete Contract Theory

The approaches towards solving information asymmetry can also be categorized in another way, which yields further insights concerning the investment process.

Categorizing these approaches cannot be done properly without mentioning the "incomplete contracts" theory. It is based upon the transaction cost theory and has been pioneered by Oliver Hart in the late 1980s (Grossman & Hart (1986), Hart & Holmström (1986), Hart (1989)).

The following is a summary of his findings and theories. The theory's major premise revolves around contracts being incomplete because of bounded rationality, costs and asymmetric information. Bounded rationality is a concept declaring that parties of the transaction do not have the ability to assess the contingencies of a contract due to its complexity or to foresee unlikely events. This matters to both, the agent and the principal. The former has to understand the contract and must be aware of consequences even given highly improbable circumstances, otherwise an agent might not act rationally and the contract set-up to enforce certain behaviour will be useless.

Furthermore, the principal must be able to enforce the contract and detect violation, which he might not be able to with a highly complex contract and contingencies. Lastly, he needs to foresee all possible contingencies and outcomes in order to draft a complete contract.

Secondly, one must remember that transaction costs occur in a real investment situation. Contracts are costly in many ways. They need to be drafted, which will take quite some time even if one does not include bounded rationality. Also, contracts need to be negotiated with the agent, which might ultimately lead to several revisions.

Moreover, verifiability is a big concern, especially given unlikely contingencies, which might be very complex. A well-written contract should allow a judicial power, such as a judge, to quickly and easily determine the state of affairs and resulting consequences. Finally, one must keep in mind that enforcing a contract can involve high costs if it needs to be handled by the system of justice.

Ultimately, these expenses can imply that some contingencies will not be taken care of contractually. This is especially relevant for very unlikely situations, which might yield rather small benefits compared to the transaction costs they entail.

Finally, asymmetric information might also be a hindrance for a complete contract. An agent might want some contingencies not to be placed in a contract in order to send a positive signal, ultimately leading to more favourable terms for him. For instance, an agent could abstain from demanding a paid parental leave clause because it might convey the notion they will utilize this clause in the foreseeable future. Hence, the employer, who will need to find replacement, which is of course costly, could in turn offer lower salary. In other scenarios such a claim might even lower the chance of getting the position in the first place. Interestingly, one can examine this kind of behaviour in the United States' labour market.

These are all reasons why contracts cannot be totally complete. Of course, they can be very complex and lengthy, which is needed in some situations. Consequently, a principal has to trade-off the degree of specify of a contract with costs of contracting. This requires him to find the optimal amount of detail necessary for the contract. Hence, bigger firms that either have their own legal department or can afford lengthy negotiations and contracts might do so. Notably, this is one of the many differences between institutional and private, informal investors. Based on the overall smaller investment size and funds business angels end up with less complicated and detailed contracts compared to banks or venture capitalists (Van Osnabrugge (2010)).

As already stated, all of these methods require ex-ante control and set-up. On the contrary, ex-post solutions are another way out of the asymmetric information based problems. In established companies this is achieved via the control ownership separation. An equity investment grants a share of the company and, thus, residual control rights. This is a substantial source of power for investors and in the worst case a safety of sorts. In other words, they can remove managers and, hence, exert control

over a firm's assets (Hart (1989)). However, this might not work for start-ups and small companies because there is a disparity between tangible assets and investment size. Possession of the firm's assets or ownership rights do not work as a safety in this situation, or at least not to the same extent as it would in the case of a big company.
Another solution requires a direct involvement in the company after the investment took place. This can take the form of either board control or advice and support for the management team.
However, these methods may seem rather vague and undefined and, therefore, unfit for a professional investor that has to answer to general partners or fund holders. This necessity for professionalism is very important and prevalent for venture capital investors, which is why they tend to favour ex-ante control and devote more time to due diligence than informal investors. A statement Van Osnabrugge (2010) elaborates on, coming to the conclusion that business angels and VCs differ in their approach to assert control.

In summary, VCs rely heavily on strong and explicit contracts as well as exact market analysis and screening to find the best ventures and reduce agency costs and moral hazard situations (Kaplan, & Strömberg (2004)). However, this does not mean that business angels are not scrutinizing a venture and the management team before coming to a decision. The theoretical basis provides some key points that are needed for the model introduced in the next chapter.

3.6 Business Angels and VCs in the Principal Agent Model

Although BAs and VCs are very different in many ways, the idea of them collaborating seems quite intriguing. First of all, good VCs seem to be fond of the idea to syndicate in order to pool managerial resources and experience. Bonnet and Wirtz recently shed light upon the rational and consequences of BA-VC collaboration. They state in their 2011 paper that this bond proves to be fostering strong growth rates in entrepreneurial ventures.
Furthermore, they find that these partnerships turn out to decrease agency cost and increase cognitive alignment. The causes of such effects can be roughly divided into

two categories. First of all, assessment and monitoring are very influential regarding agency costs. Secondly, business angels similar to entrepreneurs in their thinking and perspective and can, therefore, align their interests better (Franke, Gruber Harhoff, Henkel (2005)). Ultimately, this decreases likelihood of moral hazard problems and agency costs.

Additionally, Harrison and Mason (2000) conducted a survey regarding VCs perception of business angels and co-investing. Their findings can be perceived as a description of signal awareness. No matter how clear, credible and strong a signal might be it will not be helpful if the receiving party does not look for it or interprets it wrong.

One has to keep in mind that a business angel, given no further information, makes the investment process more complicated and inefficient for a VC. Firstly, the more parties involved the more difficult the alignment of interests becomes. Hence, the sole existence of a BA might increase transaction and agency costs for large-scale investors. Secondly, these small investors hold a portion of the company's equity. This has two apparent implications that impact the outcome of negotiations and contracts quite heavily. On the one hand, this increases the ownership-management diversion further since the entrepreneur loses part of his/her ownership rights. In turn, this makes it more difficult to align his and the investors interests. Furthermore, there is less equity left for the large-scale investor to buy, decreasing his power to secure the investment. The VC can deal with this either by intensifying security via demanding even more rights that are contractually guaranteed or increase monitoring efforts. Both of these actions will have most likely a negative impact on the first round and overall investment amount.

However, if the venture capitalist recognizes the benefits business angels are providing their perception of the viability of the deal will change for the better. The latter has been confirmed by Harrison and Mason's paper. Their survey shows that the above-mentioned drawbacks are recognized by 73% of those polled. However, 91% of all VCs surveyed recognized all or at least some of the benefits business angels provide.

When asked about VCs perception 45% declared that BAs act as a positive signal, 50% declared it will not change their investment strategy and none of those polled

identified the presence of a BA as a negative signal. Furthermore, 5% claimed it depends on the business angel, linking the signal to reputational effects. Unfortunately, I do not have sufficient data to implement the latter in my model. Moreover, they were asked about the influence business angels have on the likelihood of investment. One can interpret this as the significance or strength of the signal. Of those who claimed they view BAs as a signal 48% stated they would definitely be more likely to invest and 36% declared it depends on the business angel. More than 70% of those polled affirmed that they received and send-out deal referrals from such small-scale, private investors they had been in contact with. Granting insight and confirmation of the important role of BAs as a gateway to the formal investment market. All in all, this verifies the importance and signalling power of business angels.

Regarding the frequency of co-investing and successive investment they found that one third of the VCs surveyed had undertaken co-investments and 25% have done so ten times or even more often. On the contrary, successive investment is much more common with 50% of VCs having experienced this form of complimentary financing.

Freear and Wetzel have also presented these links between venture capitalists and business angels in an earlier study.

Furthermore, Hopp and Lukas (2013) had interesting findings regarding VC that can also help to determine the differences between VC and BA backed firms. They discovered that experienced venture capitalists viewed syndication more positively than their colleagues. Firstly, they perceive the additional and different experience and knowledge provided by another investor as very beneficial (Lerner (1994)). Secondly, due to their knowledge they are more capable to align interests of multiple investors and entrepreneurs. Finally, they found that these VCs are also more likely to engage in syndication.

This means that a good entrepreneur with a business angel might not only receive higher VC funds due to reduced agency cost and risk but also attract better venture capitalists (Hege, Plaomino, Schwienbacher (2003), Sørheim (2005)). In other words, the time to find a syndication partner and the rate of syndication can be used as a measurement of firm quality.

Another paper by Hopp and Lukas (2012) reveals that more experienced firms tend to monitor less frequently. Therefore, business angels might help entrepreneurs to get more experienced VCs, which ultimately increases their chance to become successful.

In short, these findings indicate a strong influence and important relationship between these two types of investors and strengthen the basis for the hypotheses of this thesis.

4 COMBINING THEORIES

Combining this knowledge about VCs and BAs with signalling, screening, and transaction and agency costs, a thesis can be fleshed out.

Similarly to the "market for lemons" example I will talk about high and low quality firms and entrepreneurs. A high quality firm embodies all the traits and abilities necessary to make a venture successful. This includes but is not limited to the managerial ability and knowledge, education, experience, ideas and creativity, sense of responsibility and many more (McClelland (1987)).

The actions a business angel takes, namely screening and supporting, disclosing interesting information regarding the quality of the firms and abilities of the managing entrepreneurs. They have withstood minute investigation and evaluation as well as gained the added value of the business angel. These details provide valuable information for potential VCs, since they have little to no data regarding the venture at this point.

As mentioned before, the venture capitalist and entrepreneur relationship is governed by asymmetric information to a large extent. Furthermore, due to their professional attitude, VCs will try to deal with this situation in an ex-ante way, i.e. extensive contracts. This makes every bit of additional information tremendously advantageous (Sheperd, Ettenson, Crouch (2000)). The less professional investors are affected risk and uncertainty, the more munificent they can act when it comes to contract terms and investment size. In different terms, resources previously taken up by monitoring effort or contracting can now be put to use differently. Finally, less frequent staging will increase the average investment amount per round.

So, given the risk-return and agency costs to investment trade-off I expect the investment amount to increase (Feenye, Haines and Riding (1999)).

In essence, the investment amount of the first VC round expresses the quality the venture capitalist assigns to the venture. Therefore, I want to compare BA-backed and VC-only based firms linked to selection and signalling. However, one shall not forget that the depiction above only refers to one example firm that is of high quality – low quality entrepreneurs might want to imitate this behaviour. This refers to signal credibility, which was mentioned above and makes this argument stand or fall. I will discuss this aspect in the next section.

4.1 Signalling Equilibrium

Finally, one more question has to be answered in order to make this theory robust and convincing. I am talking about the signalling equilibrium (Riley (2001)). A state that describes the behavioural results if the provided theory is applied to all market participants. Until now I mostly described the results for one type of firm. However, the signalling process will not work out properly if the signal is not reliable. In other words, if a low quality firm can imitate a high quality firm and has the incentives to do so the market or principal cannot use the proposed signal for differentiation. However, there is a second problem following up. If the signal were reliable one would expect only high quality firms to have business angels as initial investors and, consequently, very low to no bankruptcy in the long run. However, I do not expect such clear results.

First of all, I will deal with the problem of signal reliability and credibility (Riley (2001)). Just as a reminder, the core part of this theory revolves around the effects of the business angel. There are the screening, supporting and signalling effect. Simply put, I expect business angels to screen for quality firms and/or increase the firms' quality through their supporting role. This implies that business angel backing is a means to signal quality from entrepreneurs to the venture capital market. However, this is only credible if high quality ventures or firms with potential can get business angels on board. This is determined by the ability of BAs to screen. As already pointed out, BAs have a fair share of knowledge about their industry, the entrepreneurial process and due to their cognitive alignment can assess the founding team quite well. However, reputational effects are still important as already pointed out. Nevertheless, a BA investing in his industry can be assumed to have enough knowledge to undertake a basic screening.

Yet, there is a second very interesting dimension to this, namely the cost to attain a BA. That being said, one has to acknowledge that a high quality entrepreneur will face lower costs in the screening process than a low quality one. The development and preparedness of a firm is a signal that could be sent to some extent by low quality

firms. Similar to the education example, entrepreneurs with lower quality, ability or skill will have to increase their efforts and allocate more time to reach this state. Ultimately, this means higher costs for each assessment they go through. Very similar to window-dressing they need to focus much more time and effort to send the same signals and receive the same assessment. Moreover, one has to keep in mind that investment staging addresses exactly this problem, making it unattractive for low-quality firms to engage in window-dressing since the costs outweigh the gains by far.

Considering a low quality firm I can predict the following scenarios. Their first option is to engage in copying high-quality firms' characteristics to all possible extent for BA assessment. However, they will have to do the same again for the VC assessment shortly afterwards. Though the BA signal might mitigate the scrutiny of VC assessment the due diligence employed will still be much more intense than in the BA assessment.

Scenario number two allows the firm to use the same amount of time solely to prepare for the VC assessment. The time devoted to persuade the business angel might therefore be put to better use, decreasing the overall cost of signalling.

I assume that after the VC investment has been handled the investors learn the true value and quality of the venture. Therefore, the punishment or the probability of termination will be the same in both scenarios. Therefore, subsequent investments after the first VC round will give insight into the credibility of the signal. Should the signal prove to be unreliable I would expect a substantial drop in average investment amounts.

Now, summarizing the costs and benefits I can take a look at the likely outcome and equilibrium. Comparing the business angel scenarios additional costs to its benefits will produce the wanted insights. First of all, firms have to endure the costs of the short preparation time for the BA assessment giving the much earlier deadline. Secondly, they face the costs to acquire entrepreneurial characteristics especially appealing to a business angel that are not as important for a VC. As already explained in previous sections, BAs assessment is different, especially regarding the focus of the entrepreneurial team. Thirdly, the handling of the BA investment takes time otherwise used for further preparation for the VC assessment.

On the other hand there are the benefits a business angel can offer. Firstly, earlier seed capital. Financing of this kind can be seen as a means to develop a firm, hence, attracting more and bigger investors. Although this can be done by both kinds of firms I expect high quality entrepreneurs to use this much more efficiently. Furthermore, it could be seen as a form of sustainment, keeping the venture alive for longer. However, VC investments would keep the company alive for much longer due to its size. Secondly, the support the BA offers will help to prepare for further valuation by venture capital investors. However, this is also contingent on the firms real quality.
Finally, the signal and network the business angel can provide could increase the investment received by professional investors. Nevertheless, one needs to keep in mind that this only holds true for the first investment round since the real firm quality will be learned subsequently.

Given the costs and benefits, I can envision which kind of firms could be interested in a business angel investor. First of all, there are high quality firms and high ability entrepreneurs that might otherwise be unable to communicate their characteristics to a potential professional investor. They can greatly benefit from early investment and faster investment processes, caused by less staging and decreased assessment time. Furthermore, the less transaction costs the investor has to endure due to explicit contracting and monitoring the better for them.
Secondly, firms that can greatly profit from the business angels support. These are ventures that are of less quality as the former but have the potential to be developed and build into high quality firms. Otherwise they would risk to be terminated before they even reach VC investment stages or just plainly lack expertise to become successful.
Finally, low quality firms would have no incentive to get a business angel on board. They have to endure lots of additional costs and can only partly reap the benefits. Since the world is not all black and white I expect that a continuum of firms will benefit from business angels but not all of them. In equilibrium I can expect to see medium to high quality firms to engage with business angels. Still some high quality ventures might need more time to focus on development or are convinced they could do without a signal, so I expect that few will entirely skip the business angel and go

straight for the VC. Yet, this can only be classified as statistical noise and does not need to be fitted in the model.
Finally, all of this should lead to a situation where BA backed firms should demonstrate higher quality on average than solely VC backed ventures.

4.2 Theory and Model

Next, I will discuss how this theory could be tested and cast in a model. At first, I will show the differences in performance based on the choice of initial investor. Subsequently, I will refer to these as groups or group 1 and group 2. The former depicting VC only firms, while the latter are BA backed ones. The previous chapters made clear that I expect group 2 to outperform group 1 according to the theory put forward.
Next, I will confirm that the investment amount of the first VC round influences the success of a venture significantly. Also, I will give insight into the signal credibility via comparing the rounds following the first VC round in terms of investment.
After confirming differences between the two groups I will fit a model in order to explain where these diversities come from. There are two effects at work I want to separate, namely the selection and signalling/support effect.
The former refers to the BAs ability to screen and only take on high quality firms or the self-selection option, i.e. the possibility that high quality entrepreneurs simply choose BAs over VCs for seed investment. The latter describes the enhancement and amplification business angels could provide. They can support and develop mediocre ventures, provide networks and most of all signal their quality. I expect a selection effect to be at work, however, it is very unlikely that this is the sole source of all differences between the groups. The goal and expected result is to show that business angels are indeed valuable and important for certain firms, aiding them in attaining success.

To disentangle these very similar effects one usually employs tests like Heckman or propensity score matching. However, these models need characteristics that can be related to the investor choice. In this particular example I would need characteristics of firms and entrepreneurs prior to BA and VC investments.

Unfortunately, this kind of data is hard to obtain and not available for this thesis. Therefore, I chose a mediation model, which will allow disentangling the effects based on post group-selection information solely.

The model works as follows: At first I will look at the effect the group choice has on the success of the business, which gives the total effect or In other words, the mixed effects of selection, and signal and support. Then, I add the investment amount to the model. Everything the business angel can do for the entrepreneur is represented by investment amount. If the BA increases quality, offers a large investor network and helps to signal the firms hidden characteristics it will be captured by this variable. As already mentioned, one can see it as the VC expectations and their valuation.

If I add this so-called mediator variable, the effect of the group variable can and, in this case, should change. This adjustment is the indirect effect I am looking for. In other words, it is the explanatory power transferred from the group variable to the investment amount. The remaining effect is called the direct effect, which depicts the BA selection.

How does this come about? The business angel can only negligibly influence the venture after the VC has entered the scene. All of the benefits he could provide have been captured by the indirect effect or, in simpler terms, only affect the VCs and their investment conditions. If BAs still systematically influence the success of these ventures, although they have no control, it has to be because they selected better firms (or better firms select them).

Graphically the simplified model (without control variables) looks like this:

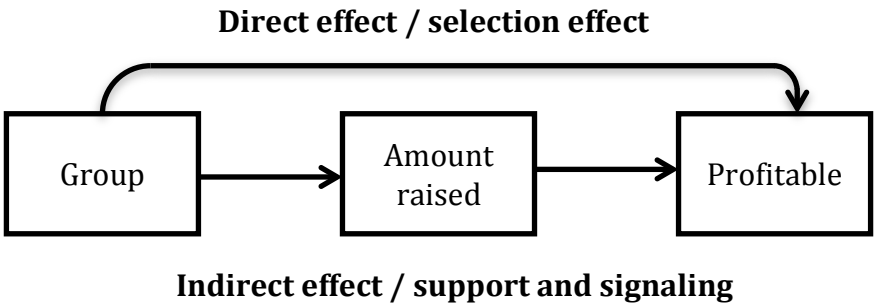

Figure 4 Mediation model with direct/indirect and selection/signalling effects

Please note that the above-illustrated indirect effect is not just the influence of "Amount raised" on "Profitable". However, it can be viewed as the path the indirect effect stems from when calculating it via model comparison. Further explanation will be given in the empirical section.

My main interest lies in determining the existence of both of these effects, their magnitude as well as their significance. In the next chapter I will give a summary of my proposed hypotheses.

4.3 Hypotheses

Not all of the proposed hypotheses fit well into the different theory chapters, which is why I decided to gather them in this section. I will now proceed to give a brief summary and then the list of hypotheses I want to test and refer to the theory they are based on in a few words.

As discussed in previous sections, there are multiple types of funding. Different stages in a start-ups life necessitate certain amounts of financing. Although investors have different investment volumes and amounts in mind they can be distinguished based on other criteria. Not only the financing structure (i.e. debt vs. equity) needs to be considered, but also the additional services provided are an important aspect.

Especially the difference between business angels and venture capital firms are of interest. Although former focus on earlier stages of start-ups requiring fewer funding, they also provide critical services that affect later performance. A business angel is likely the first professional to assess a start-ups business plan. This could convey a signal to potential later-stage investors. These firms show that they already have been put to scrutiny and did well enough to get a business angel on board.
Furthermore, value is added when having a committed, experienced and successful practitioner (BA) on board. Lastly, a business angel most likely has close ties to investor networks, which gives entrepreneurs easier access to new investors and VC firms.

Together, the value added through the business angels experience, their network and the signal should be enough to show significant differences in performance later on.
From the provided theory I want to derive the following hypotheses:

Hypothesis A (1):
Firms that have a business angel investor prior to their VC rounds show significant differences in first VC round investment amounts compared to firms that solely rely on venture capital in the beginning.

This hypothesis refers to the benefits of business angels being represented in VC valuations. I expect to find differences, which would imply that the investment amount could be used in the mediation model.

Hypothesis A (2):
The effect business angels have on the first round of VC investment will diminish in subsequent rounds.

This hypothesis should give insight into the learning process of the VC as well as the signalling equilibrium and signal credibility. If the VCs learn that most firms are of low quality after the first round, the signal would not be credible and the equilibrium could not be achieved. On the contrary, this hypothesis can confirm that a signalling effect is plausible.

Hypothesis A (3):
Business angels increase the chance to find VC syndication partners. Furthermore, they decrease the time needed to find these partners.

A hypothesis that refers to the theory that BAs lead to better VCs, which, in turn, are fond of syndication. The letter can be considered an indicator for venture success. Although this might not be used in the final model it can be regarded as a third success measurement. Therefore, this hypothesis' outcome could strengthen the theory of BA backed firms being more successful.

Hypothesis A (4):
Business angel backed firms are more likely to become profitable/successful and are faster at achieving those goals.

My theory suggests that I will find differences in success for BA and VC backed firms. This hypothesis should confirm this basic assumption.

Hypothesis A (5):
Business angel backed firms have less investment rounds after the first VC investment round.

This one is based on the idea of staging as a monitoring tool. Lower perceived risk should lead to a decrease in monitoring efforts, which should be reflected in staging.

Hypothesis A (6):
The time difference between the firms founding and their first VC investment is different depending on the group.

This hypothesis tries to rule out an alternate explanation for the proposed differences, namely that BA backed firms are better because the have more time to prepare for the VC evaluation. Therefore, the measured effects could not conclusively be attributed to the BAs support or signalling ability.

Hypothesis B (1):
The relationship between first round investment amount and the success variables, profitability and business status, is positive and significant.

This hypothesis is required to show if the investment amount sufficiently explains firm success and therefore can be used as a mediator. Also, it helps to find a bias that explains problems with one of the response variables.

Hypothesis B (2):
The effects the initial investor has on firm success can be split into a selection and a signalling effect, which are both significant.

As the theory suggested I should be able to split the proposed effect into a selection and a support / signalling part. This is the main hypothesis of this thesis.

Hypothesis B (3):
The signalling is of considerable magnitude, which I define as over 10% of the total effect.

If I find the effects in the former hypothesis I want to show how big the impact of signalling really is. It determines if the findings of this thesis have real-life implications.

The next chapter will comprise of data description, methods and empirics. Furthermore, I will try to remark implications and interpretations.

5 DATASET, VARIABLES AND DESCRIPTIVE ANALYSIS

Please note, the following empirical section is based on Jeffrey Wooldridge's books "Econometric analysis of cross section and panel data" (2002) and "Introductory Econometrics" (2012) as well as on Kohler and Kreuter's book "Datenanalyse mit Stata: allgemeine Konzepte der Datenanalyse und ihre praktische Anwendung" (2012). All of the shown results have been computed using STATA data analysis and statistical software. All of the shown methods are either integrated in STATA or have been made available for the software by their respective owners. Interpretations of the outputs have been realized based upon practical knowledge gathered from the university course "Data Analysis in Organization and Personnel" (Hopp (2011)) and online resources of the Stata Consulting Group, Institute for Digital Research and Education, UCLA.

5.1 The Dataset

This dataset has been provided by the Chair for International Personnel Management (IPM), University of Vienna and has originally been compiled by VentureSource.

It includes 7143 ventures from 15 European Countries financed by 2298 investors between 1969 and 2010. It is compiled as a panel dataset; each observation equals an investment round, tranche or change in investment structure or investor. The whole sample includes 19,676 observations, but not all variables are available for each observation.

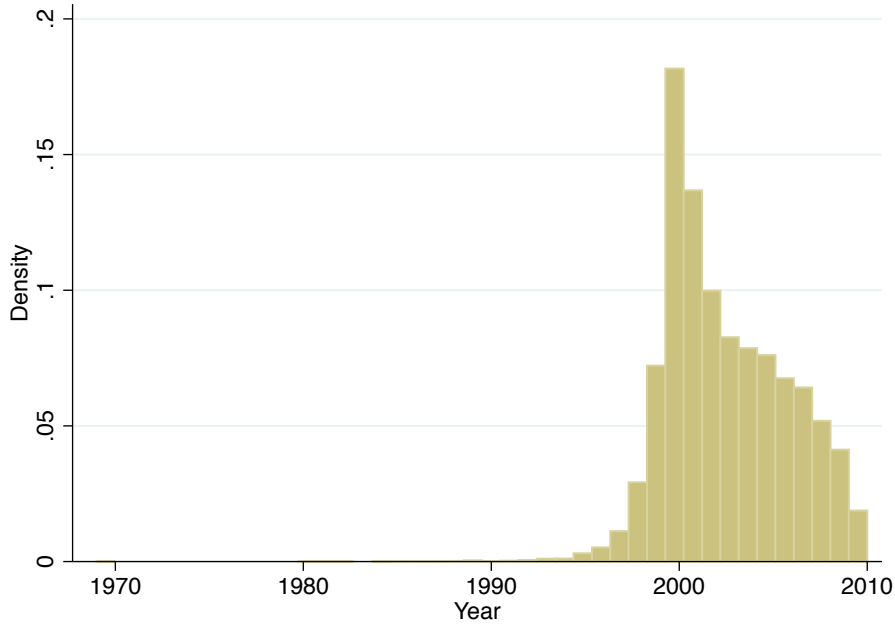

Figure 5 Histogram - Observations by year

The histogram above shows that most of the observations happen between 1995 and 2010. A sharp decline in 2010 is noticeable, which means that not all of 2010 has been observed in this dataset. Moreover, I want to stress that some biases are at work that will get sorted out in the statistics section, which render the years after 2008 rather unusable.

Private investment is the first step many firms take. Unfortunately, this information is undisclosed even sometimes after a venture capital investor enters the venture. Therefore, many firms may be not reported at all since they have not yet found a VC that disclosed this information to VentureSource. This is especially true for companies started close to the end of the observation window. Hence, all shown computations have been computed solely for the years between 1995 and 2008.

24 variables mostly text or string type have been provided by VentureSource and have been decoded by me. Amongst them one can find information regarding company name and location as well as industry, CEO name and founding year. Furthermore, basic information about the investor such as name, fund, lead- and co-investors as well as service provider is present. Finally, information regarding the investment such

as amount, date, tranche, series, type and additionally firm data like stage of development and business status has been provided.
Unfortunately, no data regarding investor characteristics or location have been provided. Furthermore, basic information, for example balance records or multiples (MVA, EVA, ROI or ROIC) to assess company performance, remain unobserved.

Combined 77% of observations were recorded in Germany, France and the United Kingdom. Speaking for a wide variety of legislative environments, which likely influences the quality and characteristics for entrepreneurs (Porta, Lopez-de-Silanes, Shleifer, & Vishny (1997)).

Finally, 15 main variables and a few variations have been used for compiling the statistics provided in the next chapters. However, further supportive variables like inflation have been gathered from external sources (Eurostat, European Commission) for data handling. They were used for data preparation, not for test or regression analysis. Other support variables and scalars have been computed from the previously mentioned 15 for data structuring and variable construction.

5.2 Variables Overview

This section comprises a short overview and explanation of the variables used in the empirical part of the thesis. First of all, many variables are used normally in Mann–Whitney–Wilcoxon (MWW) or Wilcoxon rank-sum tests. For t-tests and regressions they often need to undergo power transformation to satisfy certain requirements. The "t_" prefix will be used to mark those variables, which have been transformed. Furthermore, I needed to split the variables by group for unpaired t-tests. In these cases the groups are denoted with the post-fix "_g1" for VC backed and "_g2" for BA backed firms. Moreover, all investment amounts have been adjusted with and reflect values in 2010 Euros. I gathered the yearly inflation rates from Eurostat.

The names in parentheses are the variable names used in different statistical outputs, graphs and illustrations.

Investment amount first venture capital round

(Amount raised; investment_FVCR; t_investment_FVCR; t_investment_FVCR_g1; t_investment_FVCR_g2)

This variable depicts the investment amount of the first venture capital round in million €. This variable is mainly used to show the VCs valuation of the venture and, therefore, the perceived start-up's quality. For the VC backed firms this is the overall first investment. However, for the BA backed firms it is the investment amount of the first round a VC is lead investor instead of the business angel. This is the mediator variable used in the normal and multinomial logistic mediation model. In model illustration this variable is simply called "amount raised" for reasons of space. Furthermore, I will refer to it as such in subsequent explanations.

Investment amount first round

(investment_FR; t_investment_FR_g1; t_investment_FR_g2)

This variable denotes the very first round investment amount. For group 1 this is exactly the same as the first VC round investment. For group 2 this is the first business angel round investment.

Investment amount nth VC round

(t_investment_NVCR_g1; t_investment_NVCR_g2)

This variable is the investment amount split by round. The first observation is always the first VC round. The round venture capital investment round number is given in the table.

Group

(group)

This denotes the two investor related groups. Group 1 stands for firms that start out with a venture capital investor right away. Group 2 depicts firms that have a business angel as an initial investor for one or more rounds. Moreover, this variable is a support variable used for construction of other variables.

The value labels for this variable are "VC backed" for group 1 and "BA backed" for group 2.

Syndication

(syndication)

This is a dummy variable indicating VC syndication. 0 means no syndication at all and 1 means a new VC syndication for this round.

Syndication time

(synd_time; t_synd_time_g1; t_synd_time_g2)

This variable depicts the time a firm needs to find the first VC syndication partner measured from the firm creation date in days if it syndicates at all. Non-syndicating firms are not registered by this variable.

Profitable

(profitable)

A dummy variable indicating if a firm ever reaches the stage of development called "profitable". It is extracted from the stage of development at round variable. This means that even firms that reach profitability and then change to "shipping product" are marked as profitable. On the contrary, if a firm never reaches profitability the variable will be 0.

It is also used as the response variable in the first mediation model. Due to later explained shortcomings it will not be used for the final model.

Profitability Time

(t_prof_time_g1; t_prof_time_g2;prof_time)

This variable counts the days a firm needs to reach the stage of profitability from the firms founding date. Firms never reaching profitability are not registered by this variable.

Founding year

(fdate_year)

Gives the founding year for each firm. This variable is used to compile a founding frequency by year and group graph.

Business status

(business_status)

This variable is the final response variable in the mediation model. It only is a last round measurement and depicts the type of the venture via three categories.

The first category "bankruptcy" marks all businesses, which didn't survive. The second category includes all businesses that are privately held, which is the default starting category for all firms. This does not mean that the firm is doing badly. However, it means that it still has not been acquired or gone through IPO, which are the main exit strategies for VCs and the last category.

Firm age / time elapsed

(time_elapsed; t_timeelapsed_g1; t_timeelapsed_g2)

A variable that counts the days passed until the last recorded investment round has been completed for each firm. It is the firm's age after the last investment and not the firm's actual age right now.

Number of rounds

(num_rounds)

This variable gives the number of investment rounds after the first VC investment round for each firm.

Time first VC round

(time_FCVR)

This variable counts the days to the first VC investment rounds for each firm.

Industry

(Industry_main)

This is a categorical variable distinguishing four mayor industries. Industry one is "Business/Consumer/Retail", category two is "Healthcare", three stands for the "Information Technology" sector and number four contains all unclassifiable firms.

This is a control variable in the mediation model.

Year of last investment

(year_of_last_inv)

This variable simply contains the year the last investment round of a firm has been undertaken.

5.3 Descriptive Statistics of Variables

The variables described in the previous section will now be further elaborated on in a statistical sense. Firstly, I want to present a summary statistic with some basic information concerning the variables used.

Variable	Obs	Mean	Std. Dev.	Min	Max	Type
investment_FVCR	4142	3.824	11.602	0.01	305	interval
t_investment_FVCR	4142	0.436	1.308	-4.605	5.72	interval
t_investment_FVCR_g1	3788	0.442	1.225	-2.813	4.44	interval
t_investment_FVCR_g2	296	0.758	1.107	-2.120	3.75	interval
investment_FR	4102	3.625	11.512	0.010	305	interval
t_investment_FR_g1	3788	0.442	1.225	-2.813	4.44	interval
t_investment_FR_g2	263	-0.520	1.234	-3.912	3.35	interval
t_investment_NVCR_g1	8646	0.551	1.399	-3.912	4.60	interval
t_investment_NVCR_g2	781	0.751	1.461	-3.219	5.43	interval
group	4405	1.072	0.258	1	2	binary
syndication	10528	0.393	0.488	0	1	binary
synd_time	2518	1705	1316	121	18992	interval
t_synd_time_g1	2075	6.172	1.135	3.32	9.79	interval
t_synd_time_g2	441	5.814	1.136	3.32	9.81	interval
profitable	7143	0.219	0.414	0	1	binary
t_prof_time_g1	781	3.812	7.172	14.22	52.74	interval
t_prof_time_g2	90	34,156	6.896	14.05	49.68	interval
prof_time	871	2657	1198	355	6715	interval
fdate_year	7139	1998	6.201	1918	2009	date
business_status	19676	2.144	0.696	1	3	categorical
time_elapsed	18721	1777	1993.7	1	33495	interval
t_timeelapsed_g1	3908	1059	1276.7	1	21369	interval
t_timeelapsed_g2	316	992	982.8	2	8103	interval
num_rounds	19676	2.45	1.68	1	15	interval
time_FVCR	4224	1054	1257.16	1	21369	interval
Industry_main	19505	2.311	0.95	1	4	categorical
year_of_last_inv	7064	2004.54	3.21	1980	2010	date

Table 1 Summary statistics of variables

I want to make some general remarks regarding this table. Some observation numbers differ slightly. For example, the observation numbers of “t_investment_FVCR_g1” and “t_investment_FVCR_g2” do not add up to ”t_investment_FVCR” because the sample restrictions for the individual groups needed to be tighten in order to achieve a normal distribution. This means that some observations have been excluded from the transformed version.

Additionally, many investment amount variables have a negative minimum, which is simply because they have been power-transformed. Likewise, some variables split by group have been transformed with a different power than their mixed counter part in order to fulfil the normality assumption of t-tests and regressions. This explains why minima and maxima are not necessarily the same.

Next, some variables contain information regarding all investment rounds or the whole sample. In regressions and other outputs they are usually restricted to fit their purpose. For example, “fdate_year” includes the founding years for all firms of the sample yet all shown histograms are computed only using firms that are either VC or BA backed. Much alike, “time_elapsed” is provided for all firms for all investment rounds.

Moreover, as indicated all variables with a minimum of 0 and a maximum of 1 are dummy variables. This also includes the “group” variable, which only includes two categories coded with“1” and “2”. This has been done in order to make it more clear what is meant when referring to the “first” and “second” group. For calculating interaction terms the variable has been recoded properly.

Next, I will have a look at the distributions of some key variables. This should give some insights about the data transformation and possible biases. The graph below depicts the histogram of the first VC round investment amount after transformation.

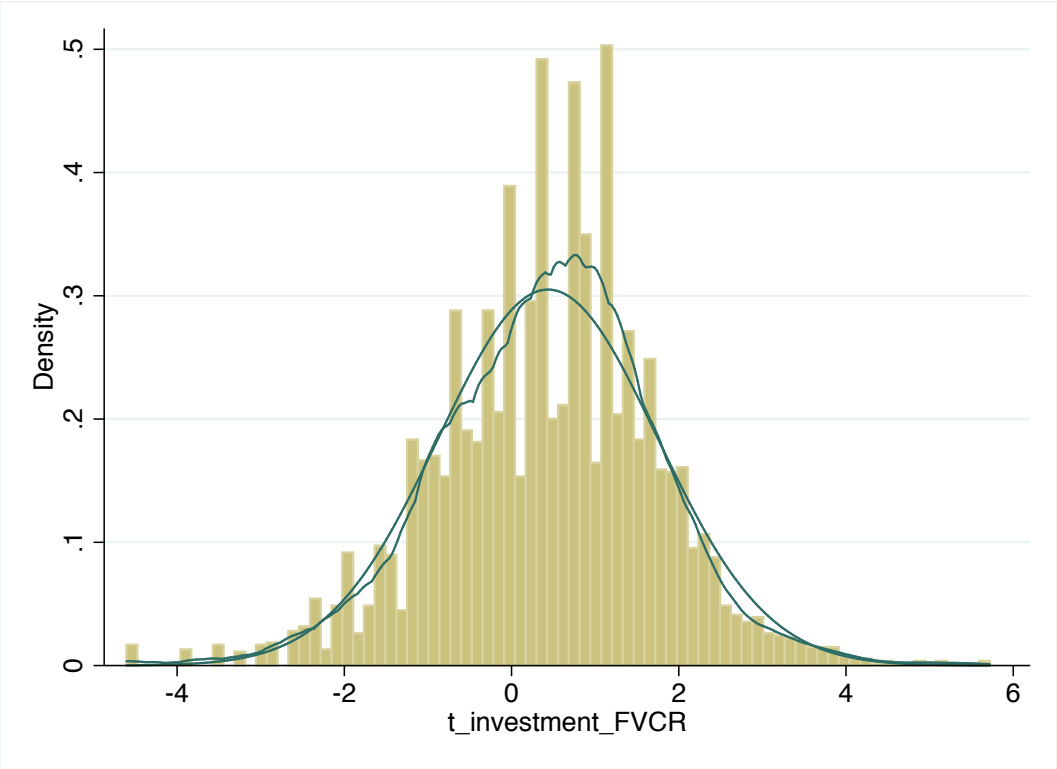

Figure 6 Histogram first VC round investment amount transformed

Most investments are rather small and a few are very large. Further investigation revealed that the 99 percentile lies at 37.4 million €. Even after introducing a restriction dropping all observations from 40 million € upwards the distribution remains heavily skewed. The data therefore has been transformed and cleaned from outliers to achieve the distribution shown above.

The same procedure has been applied to the syndication time, profitability time and time elapsed variables.

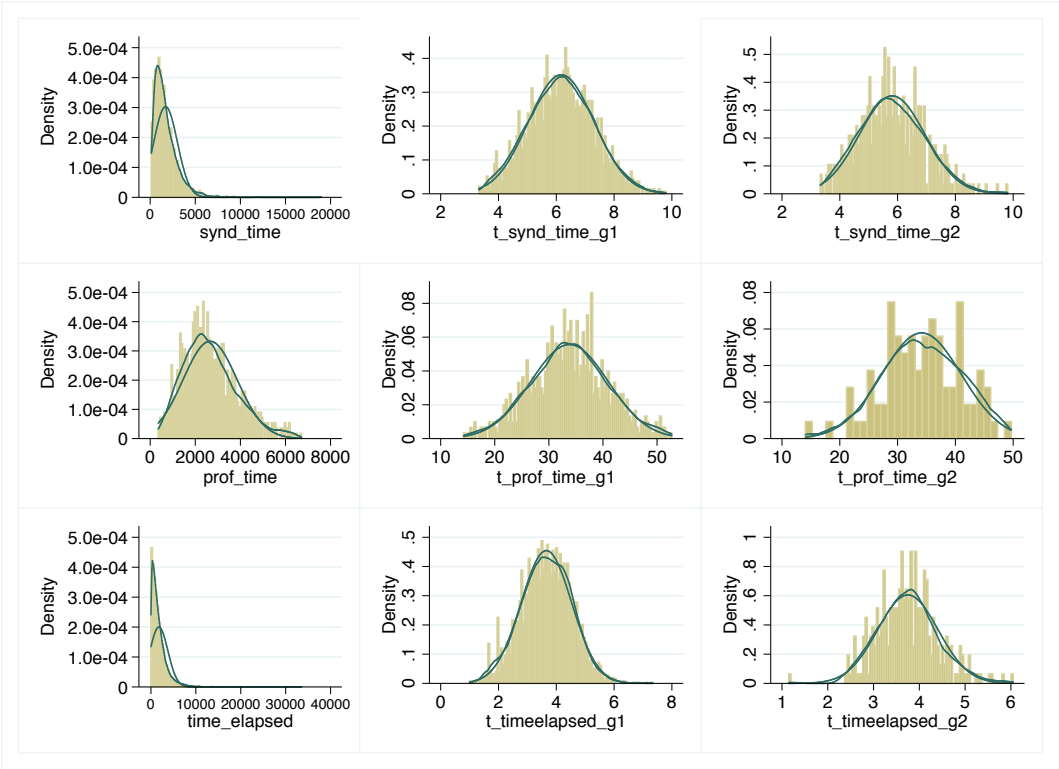

Figure 7 Histograms Syndication time, Profitable time and Time elapsed (normal/g1/g2)

The transformation and clean up did very well concerning the normality issues. Especially the syndication time and time elapsed variables suffered from this problem. However, one of the downsides of data transformation is a loss of informative content and power. Therefore, all the t-tests in the next section will be supported by Mann–Whitney–Wilcoxon test also called rank-sum tests. This test does not require normally distributed data and can therefore use the original variables. However, it is generally less reliable than the t-test. Hence, both tests together should help to get better results than one alone could (Wooldridge (2012)).

Next, one can find histograms regarding the number of rounds and years of last investments below.

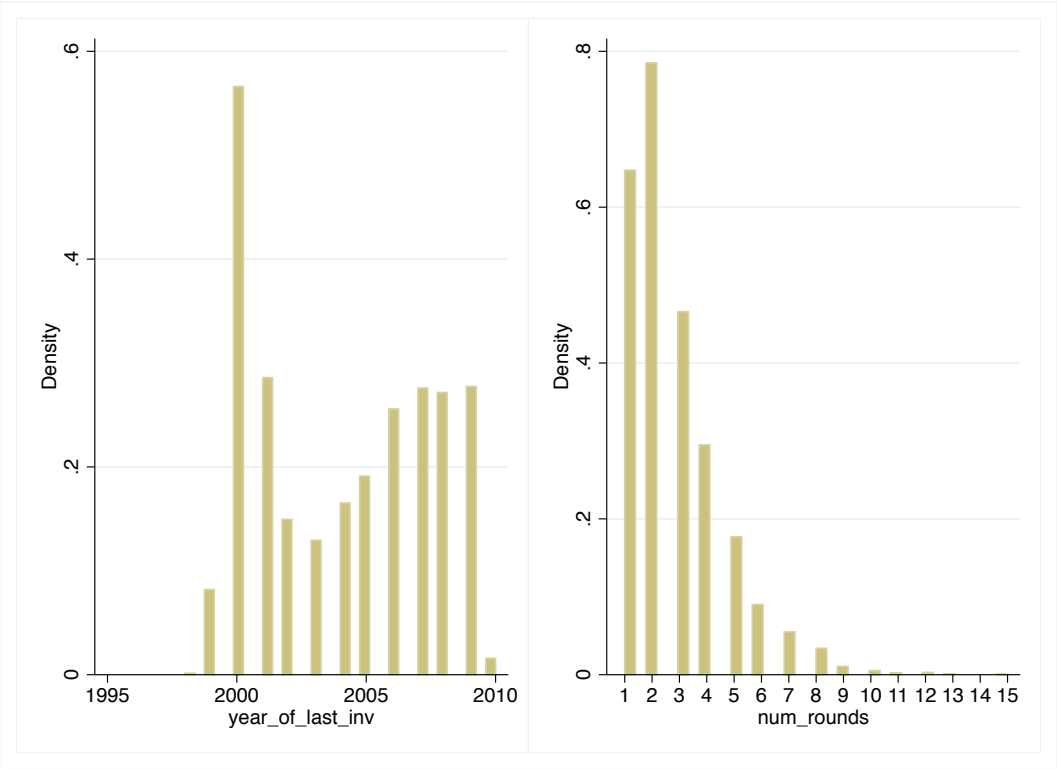

Figure 8 Histogram year of last investment / Number of rounds after first VC Investment

The graphs above show that most of the ventures exit the early stage after year 2000. Furthermore, the number of rounds after the first VC investment is an indicator for the staging practice discussed earlier.

Since descriptive statistics regarding the frequency of profitability, syndication and business status will be given in the empirical section later on I will not provide them at this point.

Finally, the next page will show the correlation table for all variables used for empirical analysis.

Table 2 Correlation table

	t_investment_FVCR	investment_FR	group	syndication	synd_time	profitable	prof_time	fdate_year	business_status	timeelapsed	num_rounds	time_FVCR	industry_main	year_of_last_inv
t_investment_FVCR	1													
investment_FR	0,489	1												
group	0,062	-0,0527	1											
syndication	.	0,1307	0,0874	1										
synd_time	.	0,3078	-0,1002	.	1									
profitable	-0,0496	-0,0336	0,035	.	.	1								
prof_time	.	-0,1586	0,0111	0,0084	1	.	1							
fdate_year	-0,0226	0,0018	-0,0309	.	.	-0,1849	.	1						
business_status	0,0918	0,0268	-0,0134	-0,0156	0,0699	0,1858	0,0955	-0,0877	1					
timeelapsed	-0,0584	-0,0515	-0,0581	-0,0679	1	0,085	1	-0,822	0,1326	1				
num_rounds	0,0873	0,0258	0,233	.	.	0,1085	.	-0,2492	0,2751	-0,1308	1			
time_FVCR	-0,044	-0,0404	-0,0139	0,0789	1	0,0803	1	-0,6544	0,0446	1	-0,1046	1		
industry_main	-0,0594	0,0023	-0,0123	0,0185	0,0845	-0,0264	0,0395	-0,0189	0,0148	0,0627	0,0647	0,0527	1	
year_of_last_inv	-0,0862	-0,0936	-0,0213	0,0383	0,2765	-0,18	0,3956	0,4292	0,2798	0,1664	.	0,1384	0,062	1

This table already indicates certain effects. I have to say in advance that all shown correlations are indeed significant at the 5% level. Next, I want to highlight some interesting aspects of this table.

Without prejudging I want to point out the group correlations. Especially the connection with investment, time, syndication, profitability and business status variables are very interesting.

All but the correlation with time variables seem to be positive and in the case of investment also fairly large.

Moreover, I want to point out the negative correlation between investment and profitability – an issue that will be topic in the modelling section.

But, not all correlations can be taken at face value. Some of the implied effects may not be linear or subject to a bias. For example solely interpretation of this table would suggest that more rounds increase the chance of success. Which is very likely due to a survivorship bias.

All of these implied effects will play a role in subsequent chapters and will be very interesting and some even challenging to interpret. However, this table already suggest that the proposed theory might yield viable results.

Therefore, I will move on to the next chapter where I present and analyse hypotheses regarding the differences between business angels and venture capitalists.

6 HYPOTHESES AND RESULTS

6.1 Hypotheses A - General Remarks

In the following chapter all hypotheses that have been proposed at the end of the theory section will be tested. The first part of this empirical section revolves around the testing of differences between BA backed and VC backed firms, i.e. Hypotheses A. Afterwards, Hypotheses B will be tested. However the structure for this part changes slightly, because some of the hypothesis cannot be tested individually. Furthermore, I want to demonstrate the influences of a bias for one approach. Therefore, the Hypotheses B will be divided into profitability approach and business status approach.

6.2 Hypothesis A (1)

I expect the amount raised for the first venture capital investment round to be different for the two groups.
Since this variable has a distribution very unlike the normal distribution it needed to be transformed. Therefore, it has been split by "group" and then both new variables where transformed with the same power. The power coefficient has been determined by the multivariate box cox transformation function in STATA. This function outputs an approximation of the best possible transformation coefficient to achieve a normal distribution. The same coefficient was used for both groups in order to keep the direction and differences between the groups' distributions intact.

Also data clean up seemed necessary. Certain investment amounts could not be considered normal. Especially investments over 300 million Euros have been eliminated. This seems reasonable since Sohl (2003) states that a VC firms' average fund size in 2001 (after the crash) was well over the 100 million $. At the same time a single round investments had an average size of 12 million $. Accounting for possible bigger fund sizes, the boom prior to the year 2000, and syndication rounds 300 million € seems a good cut-off point for the upper limit. Further investigation revealed that the very few bigger investments were of a very different nature and, therefore, should be excluded anyway. Most notably, a big holding firm receiving 1.2 billion € has been excluded from the sample.

Additionally, MAD (median absolute deviation) and IQR (interquartile range) methods have been employed to find outliers. Both are more robust than using the standard deviation to detect outliers, which is heavily affected by the outliers. On the contrary, MAD and IQR are robust against few large outliers. Also, they have shown to be more efficient in detecting these outliers (Hoaglin (1983)).

Furthermore, quartile and standardized normal distribution plots (STATA functions qnorm and pnorm) as well as box-and-whisker diagram and histograms have been employed to guarantee clean data. The following Skewness/Kurtosis test as well as the not shown Shapiro-Wilk and Shapiro-Francia tests indicate normally distributed data, a requirement for t-tests.

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
t_in~FVCR_g1	3.8e+03	0.9707	0.9852	0.00	0.9992
t_in~FVCR_g2	296	0.4476	0.8863	0.60	0.7400

Figure 9 S/K test - first VC round investment amount by group

The p-values for individual and joint tests clearly indicate that no significant deviation from the normal distribution could be found.

Two-sample t test with unequal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
~FVCR_g1	3788	.4424588	.019897	1.224594	.403449	.4814687
~FVCR_g2	296	.7583696	.0643961	1.107912	.6316357	.8851035
combined	4084	.4653554	.0190771	1.219143	.4279539	.5027569
diff		-.3159107	.0673999		-.4484656	-.1833559

diff = mean(t_invest~FVCR_g1) - mean(t_invest~FVCR_g2) t = -4.6871
Ho: diff = 0 Satterthwaite's degrees of freedom = 353.763

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Figure 10 T-test first VC round investment amount by group

The t-test above shows that there is a very significant difference between the two groups. The investment amount raised in the first VC round is much higher for firms that had a business angel before. The difference of 0.465 is also quite large compared to the means and standard deviation.

Power transformation and outlier detection have changed the data and might have reduced conclusiveness. Therefore, a second test has been conducted, namely the Mann–Whitney–Wilcoxon (MWW) test, which does not rely on normally distributed data.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

       group |      obs    rank sum    expected
-------------+---------------------------------
    VC based |     3839   7865759.5   7952488.5
    BA based |      303    714393.5    627664.5
-------------+---------------------------------
    combined |     4142     8580153     8580153

unadjusted variance   4.016e+08
adjustment for ties  -70645.641
                     ----------
adjusted variance     4.015e+08

Ho: inves~CR(group==VC based) = inves~CR(group==BA based)
             z =  -4.328
    Prob > |z| =   0.0000

P{inves~CR(group==VC based) > inves~CR(group==BA based)} = 0.425
```

Figure 11 Rank-sum test - first VC round investment amount by group

The null-hypothesis for this test is a bit different compared to a t-test. Therefore, the results are as follows: This test clearly shows that the two populations are from different distributions and that the probability of a random observations value taken from group 1 (VC-VC) is larger than that of a random observations value of group 2 is lower than 50%. In other words, the differences found by the t-test have been confirmed.

This means that the hypothesis can be accepted and this variable should work fine in the proposed model.

6.3 Hypothesis A (2)

Hypothesis A (1) already implied that those two groups experience differences when it comes to funding by venture capital investors in the first round. Determining how the periods before and after the first VC round compare could possibly give further insight into the nature of this phenomenon as well as into the mentioned signalling equilibrium.
Should the BA-VC group show significant higher investment amounts already in the business angel rounds, it could mean that firms of this group are generally better and business angels do not have much of an impact on the VC investment amount.

On the contrary, a much lower investment compared to the VC-VC first round is expected since VCs are generally more interested in later-stage and higher volume financing.

Assessing the rounds to come after the first VC investment can give some insights concerning signalling equilibrium. I expect that the differences from the first VC round do not sustain, otherwise group 2 firms might generally be better, which would likely mean a self-selection effect. On the other hand, if I find differences in favour of group 2 one might suspect that a lot of low-quality firms were able to fake the signal since the VC learns the real quality of the firm after the first round. This would disprove the signalling equilibrium mentioned before. However, if BAs have a very positive influence the difference will at least partly remain. All things considered, I expect the significance and magnitude of the investment amount differences to drop to a certain extent, but the relationship BA backed > VC backed should sustain.

Similar to Hypothesis A (1) data required some cleaning. The procedures used were the same - MAD, IQR, box-and-whisker diagram, standard quintile and probability plot, histograms and quality valuation – but were applied to all investment rounds this time.

Two-sample t test with unequal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
t_~FR_g1	3788	.4424588	.019897	1.224594	.403449	.4814687
t_~FR_g2	263	-.5198358	.0761146	1.234371	-.66971	-.3699616
combined	4051	.3799845	.0196051	1.247816	.3415477	.4184213
diff		.9622946	.0786722		.807473	1.117116

```
    diff = mean(t_investme~FR_g1) - mean(t_investme~FR_g2)        t =  12.2317
Ho: diff = 0                     Satterthwaite's degrees of freedom =  298.934

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Figure 12 T-test - BA investment amount (group 2) vs. first VC round investment amount (group 1)

The t-test shows the difference in investment amounts between the first round of the groups, which is the first VC round for group 1 and the (first) business angel round for group 2. One can observe a negative mean for group 2, which is expected, since business angels generally provide less capital than VCs, as shown in the first chapter.

Therefore, the results are as expected and predicted by theory. The mean difference and p-values indicate that group 1 receives much higher average investments in the first rounds. These results are highly significant at the 1% level and can be confirmed by the following Wilcoxon rank-sum test.

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

group	obs	rank sum	expected
VC based	3839	8084740.5	7875708.5
BA based	263	330512.5	539544.5
combined	4102	8415253	8415253

```
unadjusted variance   3.452e+08
adjustment for ties  -59852.103
                     ----------
adjusted variance     3.452e+08

Ho: inves~FR(group==VC based) = inves~FR(group==BA based)
             z =  11.251
    Prob > |z| =   0.0000

P{inves~FR(group==VC based) > inves~FR(group==BA based)} = 0.707
```

Figure 13 Rank-sum test - BA investment (group 2) vs. first VC round investment (group 1)

The p-value of 0.000 and the shown probability of 0.707 clearly indicate that the difference between the groups is significant and favours group 1.

Both outputs show that as expected business angel investments cannot compare to even the first rounds of venture capital firms in terms of investment amounts. Contrarily, if business angel investment would even come close to VC investment I would expect something to be amiss.

The next test will show the divergence in amounts after the first VC round. In other words, I compare VC rounds 1-7 for the two groups.

round	diff	group 1	group 2	# obs g1	# obs g2	Pr(T < t)	Pr(|T| > |t|)	Pr(T > t)
1	-0.3131	0.4113	0.7244	3819	303	0	0	1
2	-0.0046	0.6130	0.6176	2271	216	0.483	0.9659	0.517
3	-0.2963	0.6425	0.9388	1187	115	0.0287	0.0574	0.9713
4	-0.0563	0.7452	0.8015	661	68	0.3926	0.7851	0.6074
5	-0.0962	0.7848	0.8811	337	37	0.3726	0.7452	0.6274
6	-0.4203	0.6987	1.1190	184	19	0.1661	0.3323	0.8339
7	-0.4203	0.7627	1.0326	98	13	0.1661	0.3323	0.8339

Table 3 T-test table - VC investment amount, first to 7th VC round

The table above contains the summarized results of all t-tests for VC rounds one to seven. Further rounds have been omitted, although t-tests were conducted up to round ten. Unfortunately, the number of observations drops steadily rendering results from round seven on unreliable.

This table shows the difference in means, group 1 and 2 means, observations per group and the p-values for Ha: diff < 0, Ha: diff != 0 and Ha: diff > 0.

Since round six and seven have very few observations for group 2 and round one has already been analysed in the previous section, the focus shall lie on rounds two to five.

Remarkably, the difference remains negative for all rounds, indicating that group 2 shows a higher average investment amount. Furthermore, p-values show that this

difference in means becomes insignificant with the exception of round 3 (significant on the 5% level).

These results can be interpreted as a sign of signal credibility and overall firm quality. On the one hand a significant reduction of the effects observed in VC round one can be attested, which might indicates a learning effect by the VC firm.
The reduction reflects the real value of the firms. Highly significant results favouring group 2 would indicate that BA backed firms are inherently of higher quality. Significant results against group 2 would imply that business angel backed firms have been overvalued in VC round one and are of significant lower quality. This would be a sign of low signal credibility. In other words, the signal would seem to be very easily replicated by imitating low quality firms.
The presented results are neither of these two extremes. Although the coefficients still indicate that group 2 firms are better in quality, the difference is mostly insignificant. In other words, the results are as expected. Overall these findings support the hypothesis and reasoning regarding signalling and selection effects. They strengthen the theoretical basis for the models presented in later chapters.

6.4 Hypothesis A (3)

The following hypothesis revolves around the network a business angel and successively a venture capitalist may provide. Syndication is a good measurement of positive development of a start-up firm, especially in Europe (Hege, Palomino, & Schwienbacher (2003)). Syndication means that a new VC investor will additionally partake in the venture, mostly because a single VC cannot handle the kind of investment required at this stage or because the old investors have almost reached their investment deadline and need to exit. In both cases a new, professional investor needs to be found. It is rather unlikely that a firm with bad performance and without future prospects will find another professional VC to take over from the old one. Only very promising situations would be reason enough to consider syndication. Also, I will focus purely on syndications where the first investor will remain for at least one

more round. This should ensure that bad buy-out scenarios or divesting of low-quality ventures are very unlikely.

This hypothesis includes two tests, namely the speed at which syndication is achieved and the rate or frequency of syndication. Deriving from the reasoning put forward in the theoretical chapters I expect start-ups with business angels to find syndication partners faster and syndicate more often.

Since the data is severely skewed power transformation must be applied in order to be consistent with t-test constrains, i.e. the normality assumption. In order to detect eventual biases or problems a rank-sum test will follow. Before any tests were computed data has been analysed for outliers with the previously pointed out methods.

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
t_synd_tim~1	2.1e+03	0.9181	0.1435	2.15	0.3416
t_synd_tim~2	449	0.4456	0.1547	2.61	0.2707

Figure 14 S/K test - Time to first syndication

The S/K test above indicates that both groups' distributions appear to have no significant divergence from a normal distribution and are therefore eligible for the t-test.

Next, I will have a look at the t-test of time to syndication by groups.

Two-sample t test with unequal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
t_synd~1	2088	6.152607	.0253338	1.157617	6.102925	6.202289
t_synd~2	449	5.761815	.0563363	1.193745	5.651099	5.872531
combined	2537	6.083444	.0232957	1.173375	6.037764	6.129125
diff		.3907917	.0617704		.2694952	.5120881

```
    diff = mean(t_synd_time_g1) - mean(t_synd_time_g2)            t =   6.3265
Ho: diff = 0                     Satterthwaite's degrees of freedom =  641.874

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Figure 15 T-test - time to first syndication by group

The STATA output above clearly reveals a highly significant (at the 1% level), positive difference between the two groups' means. In other words, on average, VCs of firms with business angels need significantly less time to find syndication partners. Although the difference may seem small at 0.39 compared to the means of the groups, 6.45 and 5.76 respectively, one needs to remember that the data has undergone power transformation. This means that a 0.4 difference between 5.7 and 6.1 is actually much bigger than it would be between 1.4 and 1.8.

Before I analyse these results further the rank-sum test should be conducted.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

       group |      obs    rank sum    expected
-------------+---------------------------------
    VC based |     2077     2700722   2615981.5
    BA based |      441      470699    555439.5
-------------+---------------------------------
    combined |     2518     3171421     3171421

unadjusted variance   1.923e+08
adjustment for ties  -181.52054
                     -----------
adjusted variance     1.923e+08

Ho: synd_t~e(group==VC based) = synd_t~e(group==BA based)
             z =   6.111
    Prob > |z| =   0.0000

P{synd_t~e(group==VC based) > synd_t~e(group==BA based)} = 0.593
```

Figure 16 Rank-sum test - Time to first syndication by group

The test confirms the t-test results. The distributions are definitely different and the probability of 0.593 indicates that group 1 takes longer to syndicate.

Finally, the probability of syndication per group needs to be examined. T-tests are not well suited for the kind of variable I want to use (binary). However, a Person χ^2 test should help to determine if there is a significant difference in frequencies.

Key
frequency *column percentage*

Syndication	group		
	VC based	BA based	Total
0	3,578	460	4,038
	62.85	50.49	61.14
1	2,115	451	2,566
	37.15	49.51	38.86
Total	5,693	911	6,604
	100.00	100.00	100.00

Pearson chi2(1) = 50.4591 Pr = 0.000

Figure 17 Syndication frequency table by group and Pearson χ^2 test

The output above validates my premonition. Indeed, group 2 syndicates significantly more often than group 1 at the 1% level. While 37.15% of group 1's firms syndicate 49.51% of group 2's firms do, which is quite a notable difference of 12.36 percentage points. Put differently, group 2 syndicates 33.2% more often than group 1 does.

These results indicate first round investors affect not only investment amounts of subsequent rounds but also have further implications and consequences in later stages of a start-ups life. As pointed out in the theory chapters, I expect that business angel backed firms are more likely to find reputable and high-quality venture capital investors. These are characterized by handling syndication much better in terms of finding good, compatible partners and reducing agency and transaction costs arising from negotiations and contracting. If this kind of VC is more attracted to BA financed firms it could explain these results (Hopp, & Lukas (2012)). Also, it explains why syndication is achieved much quicker.

I think these findings are fitting my theory and support other results and the general notion of BA backed firms' quality and signalling capabilities.

Unfortunately, these results are not applicable to the mediation model. Syndication is a measurement of success and not a mediator. However, I believe that compared to profitability and business status it does not hold the same explanatory power. Syndication can indicate the venture is of high quality since they probably got an experienced venture capitalist. As the theory showed more experienced VCs are more likely to undertake syndication (Hopp and Lukas (2013)). However, the counterfactual, i.e. that the firm is of low quality because of a lack of syndication, cannot be confirmed as easily. Also, there are many other things that influence or show a firm's success that cannot be grasped by syndication alone.
In comparison, profitability and business status are rather solid measurements for firm success, which is why they are popularly used. Also, the business status is a very good measurement with indicators for certain failure and leaving the entrepreneurial stage (through IPOs for example). Delmar and Shane use a response variable very similar to my business status variable. They come to the conclusion that it is very well suited to determine venture success (Delmar, Shane (2003)).
In conclusion, syndication adds positively to the other results, but should ultimately not be used as a success measurement the alternatives. This is why this variable will not end up in the final model proposed in section "Hypothesis B".

Nevertheless, Hypothesis A (3) has been proven to be true and can be accepted. Indeed BA backed firms experience VC syndication more often. Furthermore, syndication partners are found significantly faster by VCs of BA backed firms.

6.5 Hypothesis A (4)

Similar to the last hypothesis I will now have a look at a very intuitive measurement of performance, namely profitability. Analogously, I will investigate, whether one or the other group achieves profitability faster or more often. Furthermore, a second, similar variable will be put to the test, namely the "business_status". Though a firm might become profitable over time, it does not necessarily mean it will survive (Ramskogler (2012)). Alike, the business status does not necessarily indicate that a firm might be successful in the long run, but one can draw implication from it. This

variable (business_status) has 3 possible outcomes: “1” represents “out of business” or “bankrupt”, i.e. a very clear termination and failure of the venture. “2” is a neutral state meaning the firm is still privately owned. However it can be perceived to have a positive touch. The longer the venture stays “alive”, the better its chance to ultimately become successful. Finally, “3” depicts a firm that has either been acquired or through an IPO. The former means that at least some value has been created for sure, while the latter indicates at least the willingness to raise new capital and carry on with the operation. Put differently, one can at least say that such a firm surely left the stage of entrepreneurship in a successful way.
Long stories short, testing with these variables can be used to derive a basic idea of a firm’s present state and future expectations. Finally, I have to mention that a bias is most certainly inherent – many firms going bankrupt will not have provided that information to the surveyors. However, since I already implemented control for early stage dropouts I can assume that this bias will only affect later stage termination. Under this reasoning, one can assume that this bias will be of similar magnitude in both groups and, therefore, straightened out when looking at the difference.

In order to get a better picture of the differences between the groups I will start by taking a look at the time to profitability. Should one group outperform the other, a deeper analysis will be required regarding the effects’ cause. In other words, does the ability to become profitable faster pose an inherent characteristic of the firm or can it be attributed to the support of a business angel. This is exactly what will be discussed under Hypothesis B.

However, at first some measures had to be taken to ensure all requirements of the t-test method have been met, therefore, data needed to undergo transformation and cleaning. Because of the same reasons mentioned in previous hypotheses two tests will be conducted, the t-test with the power transformed data and a rank-sum test with the normal data.

Firstly, it is necessary to make sure that continuous interval variable’s observations are normally distributed.

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
t_prof_tim~1	781	0.8570	0.3723	0.83	0.6596
t_prof_tim~2	90	0.3681	0.9448	0.83	0.6597

Figure 18 Time to profitability S/K-test by group

The p-value of the "Skewness/Kurtosis test for Normality" signifies that there is no significant difference compared to a normal distribution. Therefore, the requirements for a t-test are met.

Two-sample t test with unequal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
t_p~e_g1	781	33.81249	.256647	7.172354	33.30869	34.3163
t_p~e_g2	90	34.15552	.7268579	6.89558	32.71127	35.59977
combined	871	33.84794	.2419689	7.141158	33.37303	34.32285
diff		-.3430287	.7708373		-1.870288	1.184231

```
    diff = mean(t_prof_time_g1) - mean(t_prof_time_g2)            t =  -0.4450
Ho: diff = 0                     Satterthwaite's degrees of freedom =  112.376

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3286         Pr(|T| > |t|) = 0.6572          Pr(T > t) = 0.6714
```

Figure 19 T-test - time to profitability by group

The p-value of 0.6572 for Ha: diff != 0 clearly denotes that there is no significant difference between the two groups (even on the 10% significance level). In other words, the presence of a business angel does not influence the time needed to become profitable. However, one shall bear in mind that group 2 might experience a slight bias since by its very nature it has at least one investment round more to go through, namely the first round with the business angel. Then again exactly this issue will be of concern in hypothesis A (6).

One could interpret these findings in the following way: The time needed to make a business become successful probably has much more to do with other, not observed, variables like the overall economic situation and might only be influenced by a firms quality to a rather small degree.

However, the results from the t-test can be confirmed by the following MMW test:

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

       group |      obs    rank sum    expected
-------------+---------------------------------
    VC based |      781      339298      340516
    BA based |       90       40458       39240
-------------+---------------------------------
    combined |      871      379756      379756

unadjusted variance  5107740.00
adjustment for ties       -8.12
                     ----------
adjusted variance    5107731.88

Ho: prof_t~e(group==VC based) = prof_t~e(group==BA based)
             z =  -0.539
    Prob > |z| =   0.5899

P{prof_t~e(group==VC based) > prof_t~e(group==BA based)} = 0.483
```

Figure 20 Rank-sum test - time to profitability by group

The p-value of 0.5899 evidently shows that there is no significant difference in distributions even at the 10% level. Therefore, this part of the hypothesis has been disproved.

Next, I will investigate the possibility of differences in profitability likelihood. Again, I will utilize Person χ^2 test to determine if there is a difference in frequency in both profitability and business status. Furthermore, the measurement of business status will more likely be relevant since profitability seemingly could be biased.

The variable only indicates if a firm becomes profitable until the last investment in the dataset. The counterfactual does not mean that a firm will never become profitable but that it did not in the years observable. Very likely some firms that have been founded in the late 2000s are not yet profitable. However, the data on hand only includes observations until 2010. If a firm becomes profitable afterwards it will not show in the dataset. Hence, the results need to be interpreted with caution.

Key
frequency *column percentage*

profitable	group VC based	BA based	Total
0	3,194 78.11	229 72.47	3,423 77.71
1	895 21.89	87 27.53	982 22.29
Total	4,089 100.00	316 100.00	4,405 100.00

Pearson chi2(1) = 5.3933 Pr = 0.020

Figure 21 Profitability frequency table by group and Person χ^2 test

The table's frequency statistic, as well as the p-value (0.02) provided by the χ^2 test indicates a significant difference in frequency (at the 5% level). While only 21.9% of group 1's firms become profitable until the end of their investment rounds, 27.5% of group 2's firms do. In other words, I can show a 5.6 percentage point difference and 25% higher frequency for group 2 compared to group 1.

Moreover, a look at the distribution of last investment rounds over time per group can give an insight concerning the magnitude of the before remarked bias.

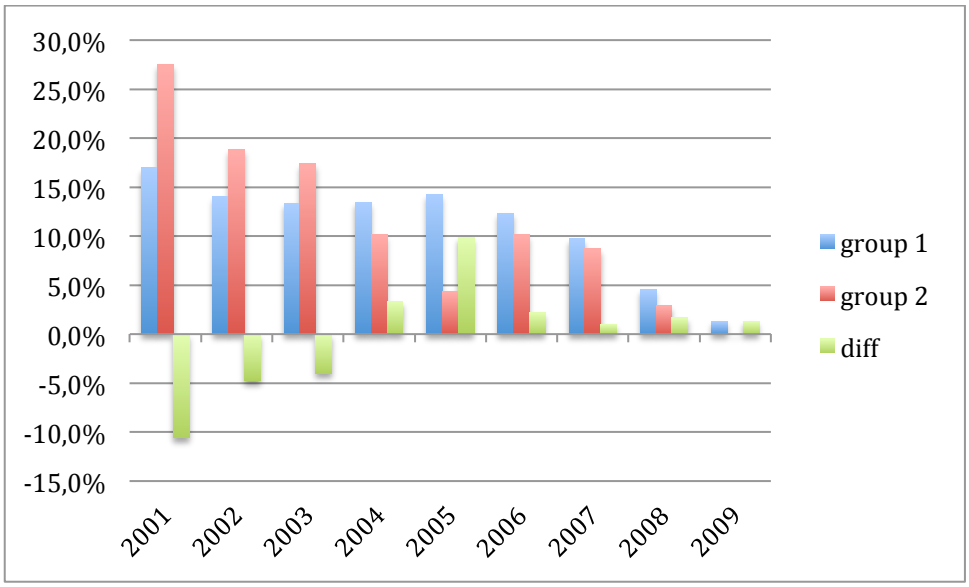

Figure 22 Firms founded per year in percentage of total firms found for group

The graph above shows the frequency of firm founding per year and group. The measurement is given in percentage of total firms founded per group. Also, the difference for each year is depicted. A negative difference means that group 2 has relatively more new firms this year than group 1 and vice versa. The average investment horizon of a venture capital investor is 5 to 10 years. Therefore, only firms established after 2000 are of concern.

Since the profitability is likely to occur towards the end of the investment horizon it can happen that the last observation of a firm does not equal the last investment, i.e. further rounds are likely to happen after 2010. Hence, firms created after 2002 most likely have not achieved profitability yet but could do so afterwards.

The graph shows that especially in the years 2002 - 2005 a considerable difference in the number of firm creation could bias the results. Cumulatively, an excess of 14% of VC backed firms might have been classified as unprofitable although they might become profitable in the future. However, the post 2000 firms only account for 35% of all VC only companies. That being said, all of these 14% needed to actually become profitable in order to render the previous results insignificant. Therefore, I can conclude that this will render the bias irrelevant if looking at the difference in profitability frequency between the two groups. To be sure I omitted the 2005, which tips the frequencies in favour of the venture capital only group since mainly the 2002 & 2003 bias against group 2 remains. Recompiling the frequency table shall indicate

if the bias is problematic or not. If a significant difference remains one can assume that this bias can be considered minor and rather irrelevant.

Key
frequency *column percentage*

profitable	group VC based	BA based	Total
0	2,913 76.70	224 72.03	3,137 76.34
1	885 23.30	87 27.97	972 23.66
Total	3,798 100.00	311 100.00	4,109 100.00

Pearson chi2(1) = 3.4752 Pr = 0.062

Figure 23 Profitability frequency table by group and Person χ^2 test (year 2005 omitted)

This is the new output with firms established in 2005 being omitted, getting rid of the largest part of possibly wrongly classified group 1 firms. In contrast to the first output slight changes happened. Group 1's frequency of profitability rose by 1.4 percentage points affecting the p-value. The results are more or less the same, however, the Pearson χ^2 test's results are now only significant at the 10% level. Still, the same pattern as before can be made out. Profitability occurs significantly more often for firms of group 2.

Overall, this indicates a difference in profitability in favour of BA backed firms. However, alternative variables should be considered. Therefore, I will move on to the next, very similar success measurement.

Next, I will have a look at the variable "business_status". The variable itself has some properties that "profitable" is lacking. Firstly, the possible outcomes are rather permanent – Bankruptcy, and Acquisition/IPO do not leave as much room for interpretation. Secondly, the neutral state might increase effectiveness of classification.

However, it also has one major drawback: The business status is only available as an overall measurement at the end of a firm's observation window. Nevertheless, I believe it can give insights that the profitability measurement alone cannot. The remains assumption is the same – I expect the business angels' group to reach a positive outcome more frequently than the venture capitalists' group.

At first I will have a look at the relationship between first-round investor (groups) and the business status.

business_status	group		
	VC based	BA based	Total
Bankruptcy	884	73	957
	24.05	24.50	24.09
Neutral / Privately h	1,900	134	2,034
	51.70	44.97	51.20
IPO/Acquired	891	91	982
	24.24	30.54	24.72
Total	3,675	298	3,973
	100.00	100.00	100.00

Pearson chi2(2) = 6.8792 Pr = 0.032

Figure 24 Business status frequency table by group and Person χ^2 test

The table above indicates the number of observations and frequencies in a contingency table. Firstly, one can observe great differences in distribution comparing the two groups. Business angel backed firms diverge from the neutral state and have more presence in the negative as well as positive state. However, the difference in frequency of group 2 firms compared to group 1 is higher for IPO/Acquired than for bankruptcy. Furthermore, the difference between positive and negative state though still small is much higher for group 2 (6.04% points) than for group 1 (0.19% points). Finally, the p-value of 0.032 indicates that these differences are significant at the 5% level.

In other words, business angels seem to have a strong influence on success. But I am not finished yet. Since timing and pace of progression are important measurements and indicators for start-ups I decided to provide and compile the firm age at the last

observation. It might not be as strong and reliable as the time measurement for profitability but some interesting aspects are to be found nonetheless. The following table depicts mean firm age in days for each business status and group respectively.

Means of time_elapsed

business_status	group: VC based	group: BA based	Total
Bankruptc	1772.0618	1635.8182	1748.1975
Neutral /	2668.6764	2318.2336	2621.3909
IPO/Acqui	2660.0809	2348.573	2622.2063
Total	2518.9597	2179.4582	2472.6221

Figure 25 Firms' age in days by business status and group

One sees that independent of business status group 2 firms are much younger. A t-test confirms this overall difference at a 0.1% level. However, if the first status is tested alone the results change and the difference becomes insignificant. This can be interpreted in the following way: BA backed firms do not terminate unsuccessful ventures faster, which could be caused by the need of all investors to agree to a shutdown. In other words, the more investors are partaking the more unlikely termination.

Another explanation for these results might be staging. Normally increased monitoring through staging means that smaller but more investment rounds will take place in the same amount of time. However, the time between investments can only be reduced by a certain extent. In other words, though round times might be reduced the overall VC investment will take longer.

In turn, this would raise the question why the BA backed firms do not take on further investment and remain in the dataset for the same time as the others. The answer might be that they are not in a dire need of capital after all those VC rounds or they left the entrepreneurial stage and start building the venture further before the VC exits. Also, it can be in the investors' interest that the firm grows supported by its own funds at a certain stage since new investors would dilute their shares and self-propelled growth can increase their ROIC.

This explanation would fit into the theoretical framework and the hypothesis. Firms that work faster and more efficiently will reach their last investment round quicker. Since VCs do not liquidate their investment right after the last investment round one might observe firms that are rather young yet not acquired or in IPO.
All things considered, the time advantages, business status and profitability differences show enough evidence to accept the hypothesis fully for business status, partly for profitability and, therefore, partly overall.

All in all, both measures of performance are useful and will be considered in the model section. Although business status looks very promising, it might not capture early success quick enough in contrast to profitability. Yet, this kind of performance and success measurement has been proven to work well in other research (Ruhnka, Feldman, & Dean (1992), Busenitz, Fiet, & Moesel (2004), Delmar, Shane (2003)).
Additionally, profitability is a widely used performance measurement and should be at least touched upon. Further insights will be given in the model section.

6.6 Hypothesis A (5)

Venture capitalists have a multitude of measures at their disposal when it comes to balancing of risk through contractual agreements. The more common ones concerning deal structure would be timing/staging and number of investment rounds. Increasing the number of investment rounds in the same time horizon leads to shorter round times, smaller per round investment amounts and ultimately better and more frequent control. The information advantage induced by the business angel therefore should decrease the perceived risk and, hence, decrease the number of investment rounds.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

       group |      obs    rank sum    expected
-------------+---------------------------------
    VC based |     4089     9159769     9008067
    BA based |      316      544446      696148
-------------+---------------------------------
    combined |     4405     9704215     9704215

unadjusted variance   4.744e+08
adjustment for ties   -26522065
                      ----------
adjusted variance     4.479e+08

Ho: num_ro~s(group==VC based) = num_ro~s(group==BA based)
             z =   7.168
    Prob > |z| =   0.0000

P{num_ro~s(group==VC based) > num_ro~s(group==BA based)} = 0.617
```

Figure 26 Rank-sum test - number of rounds after first VC round by group

The rank-sum test above compares the groups' number of rounds after the first VC investment round. The p-value of 0.000 and the rank-sums clearly indicate that firms with business angel investors have less investment rounds with the VC afterwards. It is worth mentioning that the previous hypotheses help to interpret these results. If one would not know the results and frequencies of the success measurements and tests, one might think the reduced number of rounds is due to more frequent bankruptcy of BA backed firms. However, since the results from the previous section disprove this reasoning a different interpretation can be taken. Conclusively it seems that venture capitalist investors indeed view BA backed firms as less risky due to business angels and, therefore, reduce monitoring via staging.

Furthermore, these insights are very valuable when considered together with previous observations. Measures of risk control might be used in a trade-off fashion. Put differently, a VC might trade-off higher investment amounts with stronger control. However, this result indicates that there is indeed no downside or countermeasure to the increased investment amount firms of group 2 experience, as shown in the first hypothesis. Therefore, the concept that a business angel helps to decrease information asymmetry by signalling has been strengthened tremendously.
This means that the proposed hypothesis has been confirmed and can be accepted.

Next, I will deal with the idea of a time advantage of group 2 that might bias my results.

6.7 Hypothesis A (6)

Formerly, I already touched on a bias that might as well have skewed the results thus far. Most hypotheses that have, hitherto, been tested compared outcomes of the first round financing choice (group) after or at the first round VC investment. However, one has to keep in mind that by definition group 2 undergoes at least one more investment round than group 1 in the early stage. Hence, this business angel round might grant more time for development and preparation for the VC pitch. Clearly a better-prepared and further developed firm will reduce the venture capitalist's perceived risk. Especially elaborate market research and prototypes are rather time-consuming, but demonstrate the management's aptitude and grant further information concerning the likelihood of success. Therefore, I will now try to disprove that these advantage might be due to longer preparation time. On the contrary, it rather depicts the quality of the firm and value added by the business angel.

Ultimately, better preparation is a reason why a venture capital investor might associate less risk with a firm, hence, grant higher investment amounts and implement fewer control mechanisms.
Thus, this time advantage might explain the differences I demonstrated between the groups. Especially the investment amount and control mechanisms could be affected. Therefore, I will now test how much time these groups have at their disposal in order to prepare for a potential VC investor.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

       group |      obs    rank sum    expected
-------------+---------------------------------
    VC based |     3571     6952204   6936667.5
    BA based |      313      592466    608002.5
-------------+---------------------------------
    combined |     3884     7544670     7544670

unadjusted variance   3.619e+08
adjustment for ties  -878.41054
                     ----------
adjusted variance     3.619e+08

Ho: swap(group==VC based) = swap(group==BA based)
             z =   0.817
    Prob > |z| =   0.4141

P{swap(group==VC based) > swap(group==BA based)} = 0.514
```

Figure 27 Rank-sum test - time from creation to first VC investment

The data could not be made to fit a normal distribution. Even after removing outliers and power transformation the deviation of kurtosis could not be eliminated. Although a t-test with non-normal kurtosis can still be informative under very restrictive circumstances, it is a rather difficult to deal with and interpret the results. Therefore, solely the Wilcoxon-rank-sum test is utilized for this analysis.

The p-value of 0.4141 clearly reveals that there is no significant difference between the distributions. Also, the probability (0.514) that a random drawn observation's value from group 1 exceeds that of group two is nearly 50%. In other words, I can conclude that no significant time difference can be found, i.e. both groups take about the same amount of time from the firms' creation to the first VC investment round.

These findings have additional implications. Outstandingly, group 2 manages to firstly get hold of a business angel and secondly of a VC in the same amount of time group 1 needs to find a VC alone. This speaks for the support and network access added by business angels.

After all, I can derive that business angels have a direct effect on VC investment and can significantly aid a firm in early stages. These findings not only illustrate BA influence, but also strength the hypothesis of a signalling effect.

However, one might argue that this is a sign for low-quality BA backed firms. They seemingly use the money invested by the BA inefficiently and, therefore, need quickly need new funds. This is why they start looking for VCs earlier.

This reasoning can be countered quite easily. First of all, if enough firms would exhibit this behaviour BA backed firms' quality would be considerable lower and, therefore, a significantly lower chance for success were to be found.
Secondly, this argument revolves around a firm that "burns" BA funds so quickly that it needs the financing of the size provided by VCs. Hence, the investment received by a business angel is negligible if it comes to sustaining survival. For example, in this dataset the average BA investment lies at roughly 50.000,00 Euros while the average VC investment lies at almost 4 million Euros solely for the first round. Put differently, if the firms needed millions to stay afloat the BA investment would be negligible.

In conclusion, analysis and testing of Hypotheses A produced findings regarding the differences between venture capital only and business angel aided firms. Most notably, firms of group 2 are out-performing group 1 in many categories, like investment amount, profitability, syndication, timing and perceived risk. Furthermore, I showed some evidence regarding signalling and selection effects, their possible causes, magnitude and direction. I will proceed to test the proposed model(s) in the next chapter in order to explain the nature of the differences uncovered.

6.8 Hypotheses B– General Remarks

In the last chapter I established that there are certain differences between the two groups of interest. The previous empirics showed that BAs have a large influence on firm quality, which should be reflected in the VCs' investment amount. This chapter is all about how these differences can be explained.

As mentioned, it is inherently possible that strong biases are dictating the results. However, evidence from Hypothesis A (5) & A (6) suggest that these are not as strong as initially though and, therefore, I can proceed to build and test a model to find the origin of the mentioned effects. The theory laid out in the first few chapters suggests that I can split the effects of interest into two categories.

I propose a selection effect and a signalling effect to be the cause of the differences examined in the previous chapter. The important question I want to answer is: What are the magnitudes of these effects and are they both significant?

Hypothesis B (1):

The relationship between first round investment amount and the success variables, profitability and business status, is positive and significant.

Hypothesis B (2):

The effects the initial investor has on firm success can be split into a selection and a signalling effect, which are both significant.

Hypothesis B (3):

The signalling is of considerable magnitude, which I define as over 10% of the total effect.

The easiest way to distinguish between them is via a mediation model. One can build such a model upon a two-stage model. The following illustrations should help visualize it.

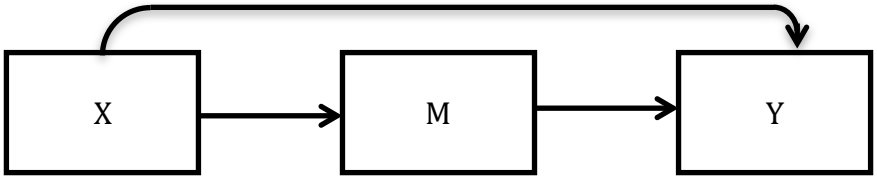

Figure 28 Mediation Model

The illustration above is a standard 2-stage model where the independent variable X explains the mediator variable M, which in turn explains the dependent variable Y. Also, the group variable X explains the success measurement (profitable or business status) Y directly. This means that the mediator M partly takes on some of the explanatory power of X. To actually calculate the effects one has to split this model into different regressions. This will be shown in the next two chapters.

It does not make much sense to split the following chapters by hypotheses because the effects' significance and magnitude are mostly calculated at the same time. Therefore, I will divide the chapters by response variable (profitable/business_status). At first I will show the mediation model with the profitability measurement. The second section will revolve around the business status variable.

6.9 The Profitability Approach

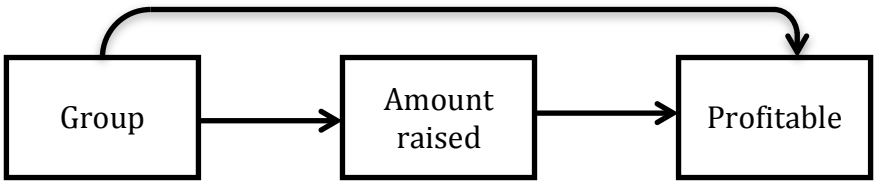

Figure 29 Simplified mediation model

The illustration above shows the mediation model for the profitability approach.
Firstly, better selection leads to firms that have a higher chance to become profitable (direct effect). Secondly, the choice of a BA increases the firm's value, which should be represented in the VC investment amount or valuation. In turn, this explains future profitability.

The relationship between group variable and profitability has been present in the previous chapter. The connection between investment amount and profitability has not yet been confirmed.

Therefore, I will analyse this relationship between first VC round investment and this success measurement next. As already shown, there is a strong relationship between the choice of initial investor (group) and the investment amount received in the first venture capital round. As explained earlier, I expect a (strong) relationship between the investment amount and firm success, i.e. profitability, based on the theory provided in earlier chapters.

Hypothesis B (3):
The relationship between first round investment amount and the performance variables, profitability and business status, is positive and significant.

Therefore, I will now test this hypothesis for both dependent variables – profitable and business_status.

```
Logistic regression                               Number of obs   =       4142
                                                  LR chi2(1)      =      10.17
                                                  Prob > chi2     =     0.0014
Log likelihood = -2211.9651                       Pseudo R2       =     0.0023
```

profitable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
t_investment_FVCR	-.0903842	.0283548	-3.19	0.001	-.1459586	-.0348099
_cons	-1.191431	.0384739	-30.97	0.000	-1.266838	-1.116023

Figure 30 Investment amount to profitability relationship (regression)

Unexpectedly, I observe a negative significant relationship between profitability and investment amounts. This is contradicting the reasoning provided earlier. I suspect a data related problem, probably a bias created by economic circumstances. Since a lot of firms included in this dataset are technology based and have been created around the time of the "dot-com bubble", I expect this to be the cause the issue at hand.
Simply put, the economic circumstance enhanced expectations regarding technology based firms and, therefore, average investment amounts increased. After the crash in

early 2001 many of these firms went bankrupt. But even if the failure rate had stayed the same, the results would be skewed because an average firm in this time received above average funds compared to other periods in time (Ljungqvist and Wilhelm (2002)).

A possible solution would be to standardize the investment amount variable. Since the immediate effect of the expectation-driven increase in investment amounts is a much higher volume, one can standardize by it. In simpler terms, instead of the actual amount invested in the first VC round I take the fraction this investment has related to the overall volume of first VC round investments in the same year.

```
Logistic regression                               Number of obs   =       3037
                                                  LR chi2(1)      =      36.60
                                                  Prob > chi2     =     0.0000
Log likelihood = -1727.6761                       Pseudo R2       =     0.0105
```

profitable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
t_investment_FVCR_ST	-.1555689	.0260253	-5.98	0.000	-.2065776	-.1045603
_cons	-2.108469	.1864205	-11.31	0.000	-2.473846	-1.743091

Figure 31 Investment amount to profitability relationship (standardized by investment volume)

Above one can find the output that has been computed with the standardized version of the independent variable. Again one can observe the same negative, significant coefficient. Ergo, the problem still exists.

After further investigation I found the answer to the problem, which lies in the construction of the profitability variable. As mentioned earlier, the "profitable" variable has been extracted from the stage of development per round (SODR) variable. In addition, this variable has a number of other categories. These are, besides special categories for pharmaceutical companies: product development, product in beta test, restart, shipping, and start-up.

At first, I thought that these stages have a linear property or sequence. After some re-examination I discovered that this is not entirely true. Though there is some sort of order it is not completely linear. Firms seem to mostly begin in the start-up or product development phase, while they end in the shipping or profitable stage. One might

think this is due to some firms going out of business or bankrupt after they start shipping and never become profitable.

After some investigation I found that at least one third of all firms, that experience both stages (shipping and profitable) at some point in time, end with the shipping stage. Therefore, it is clear that profitable is not necessarily the conclusion of the stage of development chain. Therefore, it is not reliable as a success measurement.

However, I found further general indicators that profitability is unreliable for data such as mine. Comparing investment amounts in the first VC round, number of rounds, firm age, and year of the last investment explains where the bias really stems from.

SoD (Stage of Development)	Investment amount FVCR	Number of rounds	Firm age (days)	Year of last investment
	Mean	Mean	Mean	Mean
Product Development	0.48	2.09	1163.66	2006.00
Product In Beta test	0.49	2.33	1140.00	2005.67
Profitable	0.33	3.10	2606.12	2004.67
Restart	0.90	3.50	2129.38	2003.50
Shipping	0.44	2.68	1808.72	2004.53
Startup	0.04	1.14	754.71	2006.50

Table 4 Investment amount, number of rounds, firm age and last investment year by stage of development

The table above summarizes previously mentioned variables. Again it is worth mentioning that investment amount has been log-transformed. Therefore, differences that seem minor might actually be very significant. The stage “Restart” has been added for the sake of completeness. The number of observations for this category is, unfortunately, too small to warrant further investigation.

Additionally, categories listed under SoD refer to the stage of development at the end of a firm’s observation window.

At first glance, it is evident where the bias I try to eliminate is coming from. After all, the stage “Product Development” outperforms “Profitable” and “Shipping” in terms of first VC round investment amount quite noticeably.

Evidently, firms ending with "Product Development" are classified as 0 in the "profitable" variable. This explains why I found a negative relationship between investment amount and profitable.

Next, I need to answer the question if these firms are really ending at this development stage and are terminated or if they simply stop appearing in the dataset. The latter could be called a response bias. Firms that cease to exist but do not report it could skew the results in said way. However, this does not explain the high investment amounts.

Given the average year of last investment and I can show that most of these firms have been founded after the year 2000. The early termination reasoning implies that a systematic overvaluation must have taken place, otherwise the high investment amounts would remain unexplained.

Furthermore, the firms I am looking at already have a VC investor on board, who discloses the information. Even if the firm is liquidated and cannot or does not want to provide information about this event the investor should. Unless VCs are deliberately manipulating data this kind of bias is rather improbable for my sub-sample.

However, I propose an alternative explanation, namely data censoring. This bias has been mentioned already in previous chapters.

The number of rounds, firm age, and year of last investment can shed some light on this issue. All of these variable show that firms at the stage of "Product development" are younger than their counterparts labelled as "profitable". The former averagely clock at 1163 days, but the latter have an average lifespan of 2600 days. Furthermore, one can observe that this equals about one round difference. Moreover, the average time per round is a bit more than 2 years. The final piece of information comes from the year of last investment. The first category's last year of observation(s) is 2006, while it is 2004 for categories "profitable" and "shipping".

This means that the data is probably censored. Adding that the dataset exhibits a significant lack of observations in the years of 2008 to 2010 makes this even more evident. This means that many of these high investment firms in product development might receive their next investment round either in years 2008 to 2010 and have not been registered or simply after 2010. This is, given the last year of investment and average round time, quite likely.

The high investment amounts in the first VC round just reflect the expectations and valuation of venture capitalists. The ventures in question just have not had enough time to put the received resources to use.
Finally, all of these firms are still classified in a category that falls under non-profitable.

In the end, I can draw the following conclusion. The bias most likely stems from young firms that have not reached the end of their investment window and fall into the period of data censoring. The investments can be explained by VCs' future expectations. These firms are all classified as not profitable, although their future prospects are conceived to be very bright and, therefore, they bias the outcomes of the success measurement "profitable".

This illustrates the problems profitability measures can cause and indicate that it should not be used as a success measurement in the model. It demonstrated how easily results can be prone to biases and since many studies rely on this or very similar measurements it should be seen as a call to caution.

Fortunately, the business status variable does not show these shortcomings as the regression below shows.

```
Multinomial logistic regression                   Number of obs   =       3870
                                                  LR chi2(2)      =      96.94
                                                  Prob > chi2     =     0.0000
Log likelihood = -3974.2588                       Pseudo R2       =     0.0120
```

business_status	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Bankruptcy						
t_investment_FVCR	.099448	.0308204	3.23	0.001	.0390411	.159855
_cons	-.7481309	.0414906	-18.03	0.000	-.829451	-.6668109
Privately_held	(base outcome)					
IPO_Acquired						
t_investment_FVCR	.3030865	.0315399	9.61	0.000	.2412694	.3649037
_cons	-.8379053	.0442108	-18.95	0.000	-.9245569	-.7512536

Figure 32 Investment amount to business status relation (regression)

The output clearly indicates that the relationship between investment amount and positive business status is positive and significant. Interestingly, this is also true for the negative business status – an effect I will talk about in the next chapter.

Nevertheless, this indicates that Hypothesis B (1) is only partly true. Only the business status variable exhibits the described properties. Therefore, I can only partly confirm this hypothesis.

In order to show the ultimate effects this problem can cause if the variable would be implemented in a model, I will also provide results of the profitability mediation model and compare them with the business status outcomes.

The full binary mediation model is specified in the following way. "Profitable" is the response variable, "group" has been assigned as the independent variable, and "amount raised" is the mediator. Finally, the industry sector "industry main" has been added to account for other firm characteristics as a control variable. It is a commonly used control variables and should be included to ensure comparability and avoid biases. In addition $E_{1\&2}$ denote the respective error terms or noise for each regression.

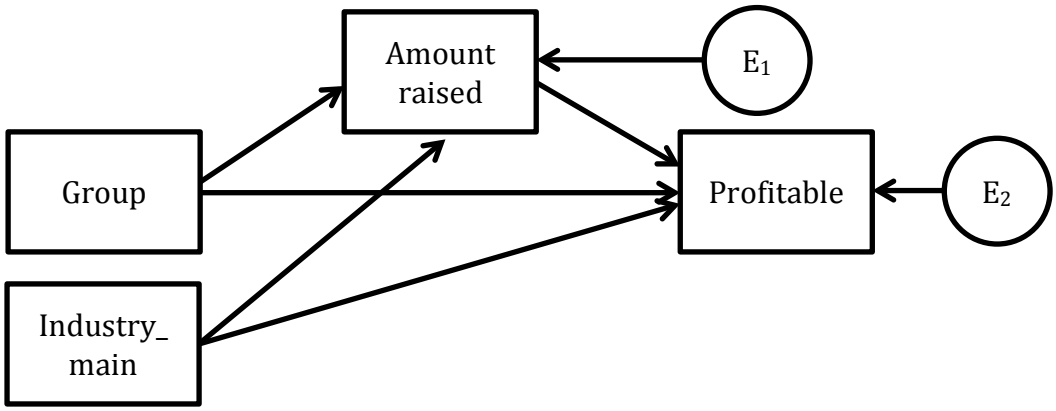

Figure 33 Mediation model

This model was realized via the STATA command "binary_mediation" created by Philip Ender (2012), while the theoretical basis for this method has been established by David Kenny (2008, 2009). This is also called the product of coefficients approach, and while there are others this is the most straightforward one.

Normally, logistic meditation models suffer from lack of comparability between the coefficients if the response variable is dichotomous. The appropriate solution for this problem is to standardize or rescale the coefficients with the standard deviation(s) (Kenny (2008, 2009)). Fortunately, "binary_meditation" already takes care of this and allows me to compare coefficients and effects without a hassle.

In order to see the problems "profitable" generates I not only need to take a look at the computed effects but also at the regressions. There are three regressions to consider. These are illustrations of the 3 regressions of questions and their respective results.

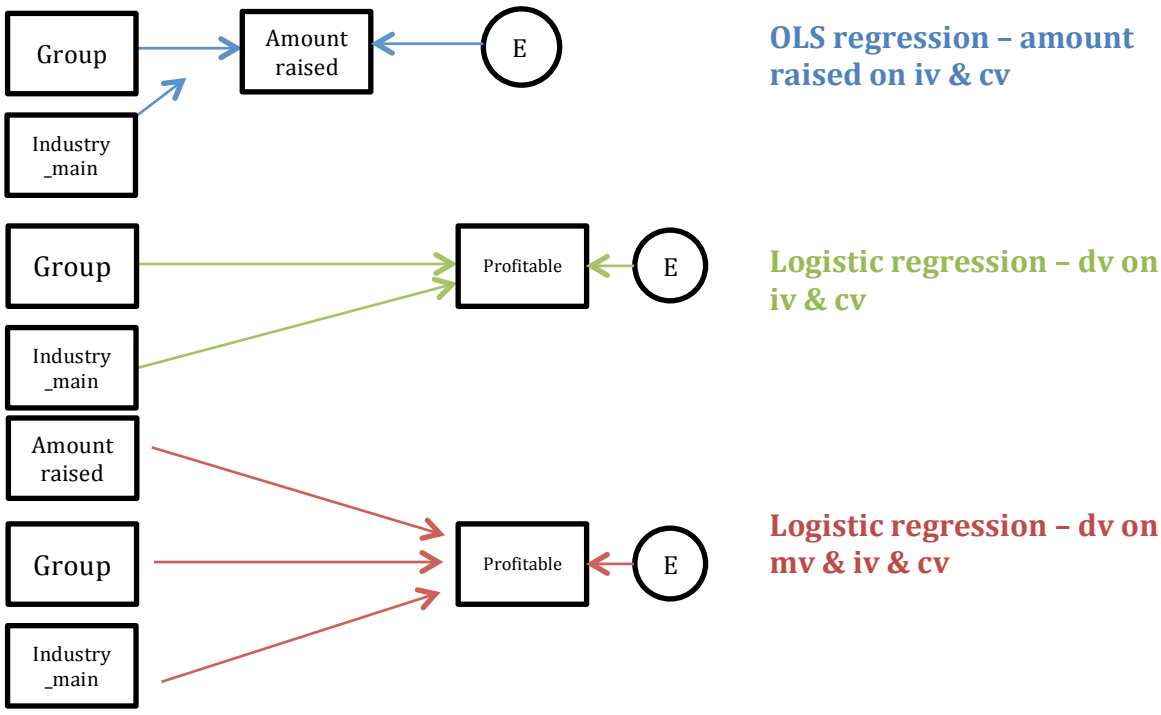

Figure 34 Binary mediation model - the 3 regressions

The regressions below clearly show the relationship between investment amount and profitability depicted by a highly significant coefficient of -0.105 (regression 3). However, the other results are in line with the theory and reasoning provided in previous chapters.

OLS regression: t_investment_FVCR on iv (a1 path)

t_investmen~R	Coef.	Std. Err.	t	P>|t|	Beta
group	.3426977	.0834663	4.11	0.000	.0672938
industry_main	-.065742	.0236237	-2.78	0.005	-.045611
_cons	.5741668	.0548563	10.47	0.000	.

Logit: dv on iv (c path)
Logistic regression

profitable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
group	.3731796	.1406026	2.65	0.008	.0976036	.6487557
industry_main	.0045897	.0428631	0.11	0.915	-.0794205	.0886
_cons	-1.222944	.0997252	-12.26	0.000	-1.418402	-1.027486

Logit: dv on mv & iv (b & c' paths)
Logistic regression

profitable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
t_investment_FVCR	-.105638	.0299252	-3.53	0.000	-.1642902	-.0469857
group	.4115089	.1412971	2.91	0.004	.1345716	.6884461
industry_main	-.0024338	.0429739	-0.06	0.955	-.0866612	.0817935
_cons	-1.167289	.1009385	-11.56	0.000	-1.365125	-.9694537

Figure 35 Binary mediation regression output

The first outcome shows that there clearly is highly significant, positive relationship between the first round investor and the first VC round investment. In other words, a business angel as an initial investor increases the venture capitalist's investment amount. Furthermore, the industry control variable is highly significant, which is to be expected. It describes discrepancy in investment needs between industries. Especially the technology sector is characterized by lower investment requirements given that the need of tangible assets is not the same as in the retail or pharmaceutical sector. It is important to test if the control variable influences the other results by comparing a model with and without the control variable (not shown in the above output).

However, industry does not significantly affect the group variable's coefficient. Also, its magnitude is much smaller than the group variable's.

Nevertheless, it should remain in the model as a control variable. In regression number two and three it appears to have no significant effect (p-value 0.915 & 0.955) for the 5% significance level.

The first logistic regression, "Logit: dv on iv (c path)" depicts the so-called reduced model without the mediators effect. As expected, I find the group variable's coefficient to be highly significant. This comes without surprise since the previous t-tests already implied this result. These outcomes are important when comparing them to the third regression.

The final, full model adds a mediator to the reduced mode. In other words, the estimation for the group variable's coefficient is now controlled by the mediator. One clearly sees that the coefficient for the first VC round investment amount is highly significant, yet negative and much smaller than the still significant group variable's. These effects are clearly influenced by afore mentioned bias. Without it I would expect this relationship to be significant and positive.

I am also interested in the magnitude of indirect and direct effects. Lastly, it is important to remark the coefficients in these logistic regressions are not directly interpretable. They are given in log-likelihoods and, therefore, can only be used for a vague first assessment. As I mentioned, the direction (sign), significance and relative magnitude can be seen in this output. However, marginal effect analysis is needed to provide a direct interpretation. Since I already pointed out what the bias does to the mediator, I do not think more exact measurement needs to be provided.

Now, that the underlying regressions and effects have been shown I will have a look at the separation of effects. Below one can find the output describing the magnitude of direct, indirect and total effect.

```
Indirect effects with binary response variable profitable
        indir_1 = -.00435513       (t_investment_FVCR, continuous)
total indirect  = -.00435513
 direct effect  = .04819989
  total effect  = .04384476
       c_path   = .04382307
proportion of total effect mediated = -.09933067
ratio of indirect to direct effect  = -.09035559
ratio of total to direct effect     = .90964441
Binary models use logit regression
```

Figure 36 Binary mediation model - direct and indirect effects

Evidently, the indirect effect (-0.0043) is negative and much smaller than the direct effect (0.0481). The ratio between indirect and direct effect is -0.09, which means that the former is 10 times bigger than the latter.

Without knowledge about the inherent problems of the profitability variable the interpretation of this output would be as follows.

After the venture capital investor takes over as lead investor I expect little to no further influence by the business angel. But the business angel should facilitate getting better conditions and/or higher quality VC investors for the first VC round. This will have an indirect effect on later performance, hence profitability.

In the case at hand a small and negative indirect effect and a positive great, direct effect are observed. Therefore, a business angel increases the VC investment amount, which, in turn, decreases likelihood to become profitable. However, this effect is rather small compared to the remaining direct effect, which indicates that profitability in this model is almost entirely explained by better selection. In different terms, BAs are rather successful in selecting but their services and signal ability, which have very limited influence, lead to VC investors that are disadvantageous concerning profitability.

It is important to state that output does not contain any information regarding the significance of the direct and indirect effect or its standard errors, which are rather important.

These need to be computed via bootstrapping. This is a resampling method and can be used to compute the accuracy of the regression estimates (Efron, Tibshirani (1993)). It is mostly used if the theoretical distribution is unknown or too complex. In the resampling procedure a set amount of observations is drawn from the dataset with replacement. This process forms a new sample and will be iterated, in this case 10.000 times. Afterwards, one has a large number of samples constituting a new distribution. The new samples are related to the old sample as the old sample is to the population (Mooney, Duval (1993)). It can, thereafter, provide information regarding the sample I previously could not get.

In this case, I bootstrap the standard errors, p-values and confidence intervals for the direct, indirect, and total effect.

```
Bootstrap results                               Number of obs     =      4142
                                                Replications      =     10000

      command:  binary_mediation, dv(profitable) iv(group) mv(t_investment_FVCR) cv(industry_main)
        _bs_1:  r(tot_ind)
        _bs_2:  r(dir_eff)
        _bs_3:  r(tot_eff)
```

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf.	Interval]
_bs_1	-.0043551	.0016717	-2.61	0.009	-.0076315	-.0010787
_bs_2	.0481999	.0194749	2.47	0.013	.0100298	.08637
_bs_3	.0438448	.0194045	2.26	0.024	.0058127	.0818768

Figure 37 Binary mediation - bootstrapped p-values, confidence intervals and standard errors

The output above depicts the direct and indirect effects of the binary mediation model as well as the bootstrapped standard errors and confidence intervals.

The number of samples is crucial for the validity of the results and while additional samples reduce sampling error, computation needs to be preformed in a timely manner. However, a definite number of resampling iterations cannot be stated due to ever-increasing computational power of modern CPUs and great diversity of models applicable for bootstrapping. Yet, the STATA documentation provides some insight into the accuracy-iteration relationship (Gould and Pitblado (2001)). Also, a look at recent publications with similar models can be used as a reference point. Therefore, I set the number of resampling iterations to 10,000.00.

Now, to the results shown in the table above. The abbreviations *_bs_1*, *_bs_2*, and *_bs_3* refer to the (total) indirect, direct and total effect. On first glance, one can see that the p-values indicate significance and high significance for the indirect and direct effect on the 5% level. This comes a bit surprising since the indirect effect's coefficient seemed to be very close to zero and hardly noticeable compared to the direct effect.

However, this confirms the results discussed before. Would I trust these outcomes I inferred that most of the difference between VC and BA backed firms stems from a better selection done by the business angel and that the services and signal they provide has a negative effect on success.

These results were rather unexpected and would disprove the hypothesis, which states that business angels contribute greatly to a firm's success. Fortunately, I found the bias and, therefore, I can say that on cannot trust these results and implications. The point of this exercise was to simply show what such unexpected biases and problems can cause and how they can completely distort the results.

The next chapter will clarify how these effects really look like with an unbiased performance measurement, namely the business status.

6.10 The Business Status Approach

Now, I will have a look at the results if the model's response variable is "business_status". Unfortunately, I cannot employ the same method as before since this variable has 3 categories and is, therefore, not applicable for the binary mediation model.

The KHB method fathomed by Karlson, Holm and Breen (2010, 2011) allows for multinomial logistic regressions, which can be used for a ternary variable like "business_status" (Allison (1995)). It is worth mentioning that the same problem concerning regression comparability arises as it did in the binary mediation model. However, it is solved in another manner, namely through substitution of the mediator

variable with its residuals. It is a much more complicated method, but the implications are the same: The reduced and full model become comparable, allowing me to decompose the total effect into direct and indirect effect. The so-called remaining residuals are used to compensate for changes in regression structure.

	(1) business_s~s	(2) business_s~s
group		
Reduced	0.177	0.354*
	(1.15)	(2.39)
Full	0.141	0.246
	(0.92)	(1.66)
Diff	0.0353**	0.108***
	(2.60)	(4.18)
N	3818	3818
Conf.-Ratio	1.250	1.441
Conf.-Perc.	20.00	30.59

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Figure 38 Summarized results KHB Multinomial logistic regression for Business status

The table above shows the results provided by the KHB method. Since I operate with a multinomial response variable I am given two separate results. Both of these are results compared to a base outcome. In this case, I chose the neutral, privately held state as a reference point.

The table headers stand for (1) business_status being 1 ("bankruptcy") and (2) business_status being 3 ("IPO/Acquisition").

Coefficients of "Reduced" indicate the total effect, while those of "Full" show the direct and "Diff" the indirect effect. The ratio of indirect to direct effect can be found under "Conf.-Ratio" and the indirect effect as a percentage of the total effect is listed as "Conf. Perc.".

First of all, one can note a significant (at the 5% level) total effect for the positive business status and a not significant total effect for the negative one.

This means one can detect neither a selection nor a signalling/supportive effect in the latter case. Yet, the indirect effect seems to remain highly significant. The

significance of this partial effect is not what it seems to be at first glance. It determines that the difference between the full and reduced model is significantly different from zero. In other words, the indirect effect is significantly different from zero, i.e. it is part of the total effect, which in turn is non-significant. Hence, the indirect effect though not zero is not significant.

This is in line with previous findings regarding the frequency of bankruptcy shown in Hypothesis A. These findings are consistent with the reasoning and theory put forward in previous chapters.

Therefore, I will now focus on the positive business status. It shows that the total effect (reduced model) is certainly positive and significant for the 5% significance level, which is already a good start. However, in the full model it seem significance has been lost. Further investigation, being shown in the next few pages, indicates that the direct effect is still significant at the 10% level. The indirect effect is highly significant at the 0.1% level and compared to the total and direct effect bigger than expected. Also, compared to the profitability model this indirect effect is positive, which is exactly what theory and reasoning predicted.

Although one might think the ratio between direct and indirect can be just calculated from the coefficients this is not true due to rescaling. Confounding ratio (Conf.-Ratio) and percentage (Conf.-Perc.) depict the magnitude of the indirect effect in relation to the total effect after rescaling.
Rescaling is necessary in order to make regressions comparable, but it influences coefficients and, therefore, needs to be accounted for when calculating the exact total to indirect effect ratio. Both confounding variables tell me that the indirect effect's share of the total effect amounts to 30%.

This certainly shows that the ramifications of the early stage investor choice are quite important and reflected in first VC round investment. Compared to the profitability model the indirect effect is much bigger, positive and significant, indicating that business angels contribute greatly to firm success via support and signalling.

This means that Hypotheses B (2) and B (3) can only be partly accepted because of the problem of the profitability variable. For the business-status variable both hypotheses have been confirmed.

This shows how skewed and problematic the use of a simple profitability measurement can be and that a one should be wary and consider possible biases and alternative variables for validation.

6.10.1 Regressions

Next, I will have a look at the full model's regression. As already mentioned, the shown coefficient and results have to be seen as a comparison to the base outcome. Choosing another basis will yield other outcomes, however, I am positive that the neutral state conveys my findings most clearly. Furthermore, it has to be noted that the regression interpretation only shows implications towards the direct and indirect effects. Simply stating a regression coefficient is the effect would be wrong. The exception to this is the total effect, which simply is the effect of the group variable on business status in the reduced model.

Lastly, the regressions are multinomial logistic ones, which means that the coefficients are given in log-likelihoods and marginal effects are needed for a literally interpretation. These will be provided later on.

Also, please note that the variable "t_investment_FVCR" has been shortened to "t_invest_FVCR" because this user-written program restricts the variables' character length.

```
Multinomial logistic regression                   Number of obs   =       3818
                                                  LR chi2(6)      =     103.94
                                                  Prob > chi2     =     0.0000
Log likelihood = -3918.8173                       Pseudo R2       =     0.0131
```

business_sta~s	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Bankruptcy						
t_invest_FVCR	.1030695	.0320211	3.22	0.001	.0403094	.1658296
group	.1412006	.1533484	0.92	0.357	-.1593567	.4417579
industry_main	.0286029	.0442437	0.65	0.518	-.0581131	.1153189
_cons	-.815627	.1041105	-7.83	0.000	-1.01968	-.6115742
Privately_held	(base outcome)					
IPO_Acquired						
t_invest_FVCR	.3158349	.0328848	9.60	0.000	.2513819	.3802879
group	.2455671	.1470576	1.67	0.095	-.0426606	.5337947
industry_main	.0806341	.0444597	1.81	0.070	-.0065053	.1677734
_cons	-1.032875	.106849	-9.67	0.000	-1.242295	-.8234545

Figure 39 Multinomial logistic regression - full model

The output shown above depicts the full model that has been used in the mediation and indirect effect calculation before. I will focus on the part for "IPO_Acquired". As one can quickly see, the investment amount of the first VC round is highly significant and positive for both outcomes. This illustrates that the investment amount of the first VC round seemingly is a good proxy for success. Also, it depicts the path of the indirect effect, which is not the direct effect itself, but shows that the variable is a well-suited mediator. Secondly, group variable is borderline significant at the 10% level. This is the source of the direct effect and explains why it was labelled as insignificant (at the 5% level) in the other output.

Again, it is important to remark that these coefficients do not entirely reflect the effects I mentioned before. However, they are able to show what the underlying relationships are.

Thirdly, the industry control variable is significant at the 10% level. However, its coefficient is rather small, but one must be careful since the control variable might influence other coefficients. This is something the regression alone does not show. Specific tests are available but the easiest method is to treat the control variable as a mediator as well. If no visible changes occur it has no influence on the other variables, which is the case here (output not shown).

In simpler terms, some industries might have an overall higher or lower bankruptcy/success rate, but the relationship between initial investor, investment amount and success remains unaffected.

Next, I will have a quick look at the reduced model to highlight the changes that ultimately constitute the effects I showed earlier.

business_sta~s	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Bankruptcy						
group	.1706782	.1529678	1.12	0.265	-.1291332	.4704896
__000001	.0987791	.0310402	3.18	0.001	.0379415	.1596168
industry_main	.0266345	.0440653	0.60	0.546	-.0597319	.113001
_cons	-.763238	.1026017	-7.44	0.000	-.9643337	-.5621423
Privately_held	(base outcome)					
IPO_Acquired						
group	.3501467	.146587	2.39	0.017	.0628415	.6374518
__000001	.2987599	.0317527	9.41	0.000	.2365259	.360994
industry_main	.0583708	.0442523	1.32	0.187	-.0283622	.1451037
_cons	-.8474819	.1038255	-8.16	0.000	-1.050976	-.6439877

Figure 40 Multinomial logistic regression- reduced model

Some of the earlier findings are also implied here. This model depicts the total effect mentioned in the KHB output.

Firstly, the insignificant total effect of the negative business status outcome is reflected in the group's coefficient and p-value (0.265). Similarly, the significant total effect for the positive business status is implied in the IPO_Acquired section again by the group coefficient and p-value (0.017). This indicates significance at the 5% level as the KHB output in this chapter also showed. The last thing seeming out of place is the "__000001" variable. These are the residuals used for establishing comparability with the full model.

6.10.2 Marginal Effects

For a more literal and comprehensive interpretation a look at the marginal effects is suggested (Wooldridge (2012)). At first, a look at the marginal effects at means for the positive business status outcome in the full model.

```
Average marginal effects                        Number of obs   =       3818
Model VCE    : OIM

Expression   : Pr(business_status==IPO_Acquired), predict(outcome(#3))
dy/dx w.r.t. : t_investment_FVCR group industry_main
```

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
t_investment_FVCR	.0520077	.0055528	9.37	0.000	.0411244	.0628909
group	.0376964	.0270303	1.39	0.163	-.0152821	.0906748
industry_main	.0131345	.0077433	1.70	0.090	-.0020421	.0283112

Note: dy/dx for factor levels is the discrete change from the base level.

Figure 41 Average marginal effects at means

The interpretation goes as follows: If the transformed investment amount provided by the VC in their first round increases by 1 unit at the mean the probability of success increases by 5% on average. This is shown by the dy/dx coefficient of 0.052 and the p-value of 0.000, which indicates significance at the 0.1% level.

This variable has been transformed with a power of 0, meaning it has been log-transformed. Therefore its coefficient can be also interpreted as a measure of elasticity. In other words, a 1% increase in the original, untransformed investment amount on average increases chances for falling into business status 3 by 0.052%. This does not seem much but at means it amounts to a 5% higher chance of success for a firm with an investment of about 7 million € compared to 3 million €.

Furthermore, on average firms of group 2 have a 3.7% higher probability to become successful compared to group 1. Interestingly, this effect is not significant anymore. The next analysis will shed some light on this issue.

These were only average effects, which must be considered under a “ceteris paribus” assumption. This means that the changes shown are the average changes over all the values of the selected variable given that the other variables stay at the mean. In other words, these are only very general statements. In order to get a more in-depth interpretation I need to have a look at the marginal effects at representative points.

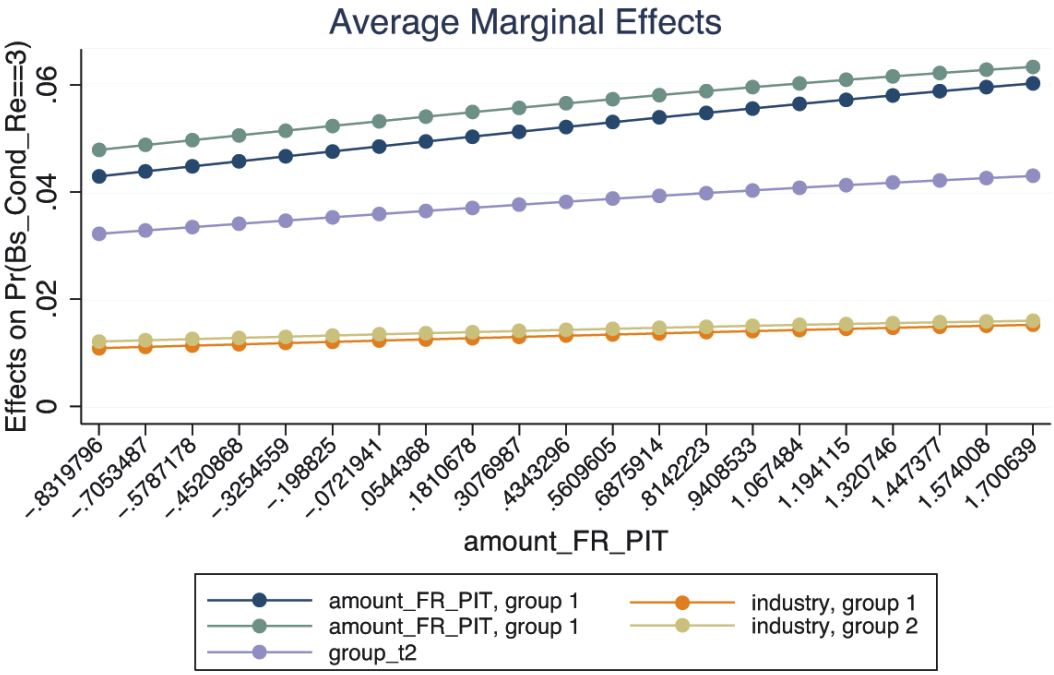

Figure 42 Marginal effects at representative values

The graph above depicts these conditional, marginal effects at certain points. They have been calculated for 21 values between the investment amount's mean plus/minus one standard deviation. Moreover, I split the investment amount's effect by group. I decided not to isolate the individual effects by industry, since it is only a control variable and would clutter up the graph. Nevertheless, I investigated and can assure that the marginal effects do not vary significantly for different industries.

Overall, the outcomes seem to look very consistent. The general trend seems to be that with higher investment amounts marginal impact on probability increases. Even though this effect looks rather small, gaining about 2% points over two standard deviations, it is not. First of all, the effects I got are generally rather small because I fit a very simple model for a complex issue. A much more sophisticated model would be needed to explain all effects entirely. Secondly, at the lower end a firm would experience a 0.04% increase per 1% higher investment and on the upper end it is 0.06%. This is 2% points translate into 50% **higher** increase in probability. Put differently, a one-unit increase in transformed investment amount at -.8 equals roughly a 4% increase of probability for a positive outcome. At 1.7 transformed investments amount the probability rises by about 6%.

Similarly, the group effect is rather stable and independent of the firms' first VC round investment. The group variable has a positive impact of 3-4% on success. However, this effect is not significant. It becomes almost significant for very low values of the investment amount with a p-value of 0.125.

Lastly, I took a look at the change of confident intervals. These have been excluded due to them cluttering up the graph. Fortunately, significance does not change for any of the model's variables.

All things considered, the effects seem to change too little given the theory and since the distribution is wide–spread I will show the results for investment amount from minimum to maximum.

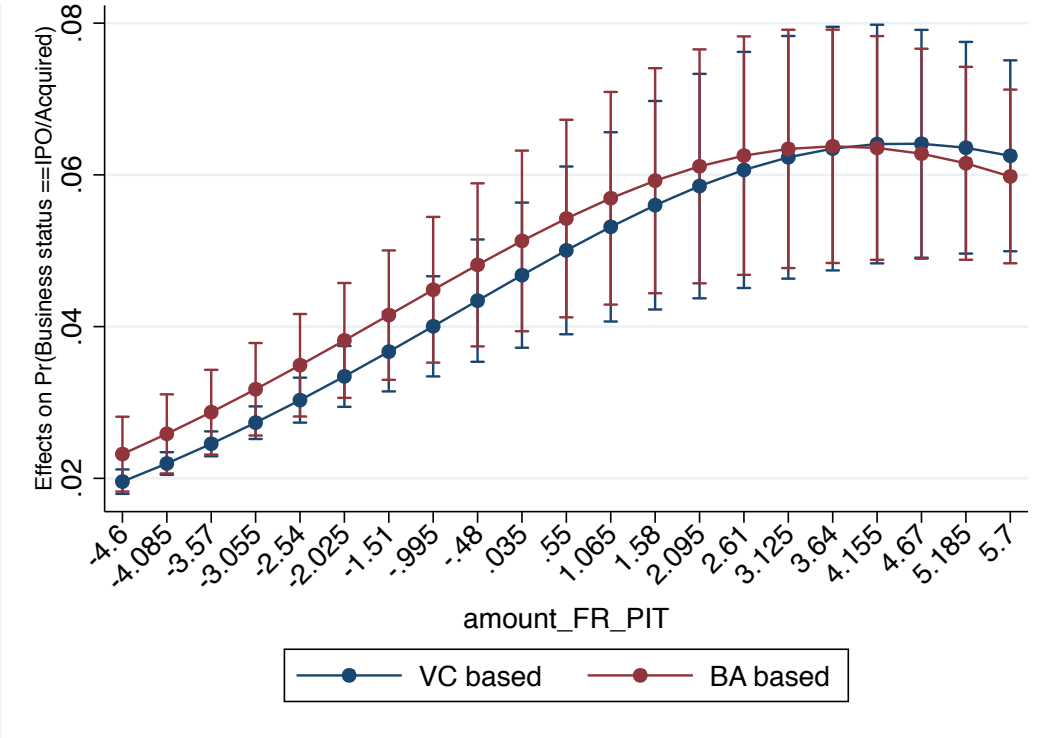

Figure 43 Conditional marginal effects by groups with confidence intervals

The graph above shows the conditional marginal effects. Industry is held at the mean and the investment amount effect is divided by the group variable. The shown interval of [-4.6;5.7] translates to [0.1;305] in million €.

This graph looks much more like what I expected. Naturally, the increase in probability rises with the investment amount. The graph shows a curvature, which has its highest point at 3.64, which equals 38 million €.

In previous chapters I talked about the value of business angels being dependent on how important he/she is for a firm and how efficient the BA can be put him/her to use. This kind of relationship is reflected in the graph. For the lowest quality firms a BA has no significant influence shown by the 95% confidence interval including the value 0 for firms under -4.10 (0.017 million €). This implies a BA cannot help ventures if they seemingly have no potential.

Firms of medium to high quality receive a 2.5-6.3% increase in probability to become successful per additional investment unit. Here the business angel might be able to influence firm performance greatly and for high quality ventures the signalling aspect might increase the additional success probability even more. The seemingly highest quality firms with investments amounts over 39 million € exhibit a bit less of an increase in probability per unit compared to the 6.3% medium-high quality firms. This does not come unsurprising since a firm that has no need for managerial advice or that one that has good network connections will not be able to extract the same value added from a BA compared to a medium quality firm. Also a 1% increase in investment is harder to achieve at this point.

That being said, the graph fits very well considering the theory and reasoning. A flat curve would have been much more surprising. Very cautiously I propose that a very similar relationship could be made out for the indirect effect. At higher quality levels signalling quality will be more beneficial than for medium (yet good) quality firms. These marginal effects just imply this relationship and I cannot say that the indirect surely will behave like this. However, it seems realistic given the reasoning behind it.

Finally, one can easily see that VC backed and BA backed firms have different coefficients regarding the investment amount to success relationship. In order to examine the significance of this effect I will introduce an interaction effect in the next section.

6.10.3 Interaction Effect

An interaction effect is the product of a dummy variable combined with another independent variable. The implications and interpretation are a very different to normal variables.

Firstly, the investment amount influences the response variable to some extent, depicted by the coefficient for "t_investment_FVCR". This coefficient is the same for both VC backed and BA backed firms, i.e. it is the "mixed" coefficient. The interaction term shows how much this relationship changes for the second group. For example, if the investment influence on success were much higher for group 2 one would observe a positive and significant interaction term. On the contrary, if it does not divert from the mixed coefficient substantially it will not be significant.

I expect to exhibit an interaction coefficient that is not significantly different from 0 given that the differences in the graph before were rather small. Fortunately, this is indeed the case as the regression output below shows.

business_status	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Bankruptcy						
t_investment_FVCR	.1065152	.0321144	3.32	0.001	.0435722	.1694583
group	.2189355	.1748418	1.25	0.210	-.1237481	.561619
group# c.t_investment_FVCR 1	-.125271	.1271678	-0.99	0.325	-.3745153	.1239732
industry_main	.0349282	.0441611	0.79	0.429	-.051626	.1214825
_cons	-.825388	.1041615	-7.92	0.000	-1.029541	-.6212352
Privately_held	(base outcome)					
IPO_Acquired						
t_investment_FVCR	.3089838	.0330004	9.36	0.000	.2443043	.3736633
group	.3672388	.1772087	2.07	0.038	.0199161	.7145616
group# c.t_investment_FVCR 1	-.150087	.1231277	-1.22	0.223	-.3914129	.0912389
industry_main	.0813517	.0443402	1.83	0.067	-.0055535	.1682569
_cons	-1.028698	.1067155	-9.64	0.000	-1.237857	-.8195398

Figure 44 Multinomial regression with interaction term

The interaction term is called "group#c.t_investment_FVCR" in the output above. In both, the positive and negative business status, the term is insignificant even at the

10% significance level with a p-value of 0.325 and 0.223 respectively. This means that the group has no impact on the effect of the investment amount on success.
The interaction term tells us if the VC evaluation has more or less explanatory power and influence for one of the two groups. If VC and BA firms of the same quality were to have different success/failure rates it can be caused by a bias or bad measurement. The results provided indicate that the investment amount is a good measurement of quality and I do not have to be concerned regarding a bias.
Next, I will perform robustness tests for the shown full model in order to determine the reliability of results.

6.10.4 Robustness Tests

Firstly, I conduct a Wald test for misspecification for combining outcome categories. Misspecification of the model would occur if two business status categories could be collapsed. Below one can find the test's output. The p-values of 0.009, 0.0 and 0.0 indicate that in all cases the null-hypothesis can be refuted. Hence, the model is correctly specified. If it were not, a simply logistic model would be better suited for my purposes.

```
**** Wald tests for combining outcome categories

 Ho: All coefficients except intercepts associated with given pair
     of outcomes are 0 (i.e., categories can be collapsed).

Categories tested |      chi2   df   P>chi2
------------------+-------------------------
Bankrupt-Privatel |    11.675    3    0.009
Bankrupt-IPO/Acqu |    32.089    3    0.000
Privatel-IPO/Acqu |    95.275    3    0.000
-----------------------------------------
```

Figure 45 Wald test for combining outcome categories

Secondly, I have to test for the "Independence of irrelevant alternatives" assumption that comes with the multinomial logistic regression model. This assumption is concerned with the already touched upon problem of choosing a base-outcome. Should the effects or likelihoods change depending on the presence or absence of an irrelevant alternative or choice the assumption would be violated. In other words, I am

testing if any of the effects change should I choose another (maybe not specified) base outcome.

```
**** Hausman tests of IIA assumption

 Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

 Omitted |      chi2   df   P>chi2   evidence
---------+----------------------------------
       1 |     2.609    4    0.625   for Ho
       2 |   868.567    4    0.000   against Ho
       3 |    -0.052    4    1.000   for Ho
-------------------------------------------
```

Figure 46 Hausman test for Independence of irrelevant alternatives

Here I am testing the hypothesis "Odds are independent of other alternatives". The table above shows the 3 possible base outcomes, negative, neutral, and positive and p-values in the last column. These p-values indicate if I can reject the null-hypothesis that the odds are different for this basis. As one can easily see, there is no need to worry – the p-values are very high meaning that I cannot reject the null-hypothesis in cases 1 and 3. In other words, in these cases effects and odds do not change if I would change the base outcome. Only number two shows a p-value of 0.0, which is expected since it already is the base outcome I chose for the regression this test is based upon. Therefore, the model does not violate the IIA assumption.

Finally, I have to considered collinearity problems and compute variance inflation factors. These factors show how the standard errors of one variable change given that it would or would not be correlated with the other variables.

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R-Squared
t_investment_FVCR	1.01	1.00	0.9926	0.0074
group	1.00	1.00	0.9959	0.0041
industry_main	1.00	1.00	0.9964	0.0036
Mean VIF	1.01			

	Eigenval	Cond Index
1	2.2025	1.0000
2	0.8733	1.5881
3	0.8420	1.6174
4	0.0822	5.1767

Condition Number 5.1767

Eigenvalues & Cond Index computed from scaled raw sscp (w/ intercept)

Det(correlation matrix) 0.9924

Figure 47 Collinearity Diagnostics

The output above shows that VIF (variance inflation factors) are low and very close to 1. Moreover, none of the variables exhibit Eigenvalues very close to 0 while having Condition Index numbers over 10. Given the interpretation suggestions by Menard (1995) this means that multi-collinearity is not an issue for my model.

Overall this means that the proposed model is holding up in technical terms and no issues regarding assumptions or methodology could be found. Also, the effects I wanted to show followed the provided theory and reasoning. The KHB method revealed that a direct and indirect effect could be made out. This confirms the proposed selection and support/signalling effect. I showed how well the model is working and proposed an interesting relationship for the signalling effect.

Therefore I will confirm Hypothesis B (2) and Hypothesis B (3) as accepted for the business-status approach.

7 LIMITATIONS

Some limitations have been uncovered in the course of the empirical section of this thesis. I want to briefly summarize them in order to give a sense of the reliability of my results as well as to show possible starting points for future works.

First of all, the thesis has shortcomings in regards to the methodology. I think given the data I managed to work with it in the best possible way. Yet, additional information regarding entrepreneurs' and investors' characteristics would open up possibilities to matching-techniques and endogeneity and self-selection tests that would make findings much more reliable.

Secondly, the amount of business angels in this dataset could be considered problematic. The number of observations can become rather low, especially, if further subdivisions of the sample are made. The hypothesis regarding later VC rounds was such a case. I tried to point out if too few observations were available to gain clear conclusions.

Next, the observed years seemed to be problematic. Only the years between 1995 and 2008 had enough observations to make conclusive tests and statements. Additionally, I am convinced that a censoring and response biases are at work outside of this interval, which cannot always be dealt with.

Finally, I have to remark that more control variables are needed to strengthen my results. The industry alone is not enough to account for other environmental influences or biases.

Lastly, I want to describe an approach that did not work. It shows how the above-mentioned shortcomings limit the possible explanations, which eventually weakens the findings of my thesis.

7.1 Restricted Business Angel Supply

I want to highlight a third explanation for the differences between business angel and venture capitalist backed firms.

The main assumption is that if business angels were seen as a good, they might exhibit a supply shortage. The data shows that only 10% of all ventures that receive VC investment have been backed by business angels.

This shortage opens up the possibility of cherry picking for BAs. They are so few that they do not have to fight for the best ventures. This implies that they get more favourable terms and do not have to invest into any ventures, which would be considered only of medium quality. The venture capitalists on the other hand are many and have to fight for the best firms and, therefore, are not disinclined to take on medium quality firms that still, very likely, achieve their demanded ROI.

This situation leads to a systematic advantage for business angels. Their firms are simply better, not because of their ability to select or the services they provide, but because they can only take the very best.

One way to test this theory is to examining changes induced by a shortage in top performing ventures. Now, the BAs should be forced to take on medium quality ventures too. In turn, their success rate should drop significantly. In the year 2001 the "Dot-Com bubble" burst, which happened to affect the venture market on a very similar way (Howcroft (2001)). A comparison of pre- and post-2001 entrepreneurial activity and success for business angels might give crucial insights.

Unfortunately, I could not find enough data to support this hypothesis. First of all, the limitation to BA backed firms vastly reduced the number of observations. Secondly, the timely separation proved to be rather problematic. The success rate directly after 2001 is contaminated with failing business that have been overvalued and funded before 2001, so they skew the results. In order to tackle this problem two observation windows are constructed. The first one includes firms that have been found and received investment for at least 5 years before 2001. The choice of 5 years stems from the lower bound of VC investment windows (Cumming, & MacIntosh (2001), Schwienbacher (2005)). In other words, around 5 years after the first investment VCs begin to execute their exit strategy. Even if this is not true for all firms, most of them will likely be rather advanced and on the way to be liquidated. Similarly, the next 2-3

years after 2001 are probably contaminated with firms failing due to overvaluation. This means that only firms receiving their first financing after 2003 are suitable for comparison.

However, firms that receive their first investment around 2006 are very likely to be victim of a censoring bias. After the year 2008 observation number plumbed while the quantity of firms failing to respond increases dramatically.

This means that firms receiving their first investment in 2006 do not have the same amount of time to become successful compared to the pre 2001 control group. This renders the comparison and its results unreliable. Even if the time intervals were chosen differently, the generally low number of observations renders all results disputable at the least.

8 CONCLUSION

8.1 Hypotheses

I want to give a short summary regarding the hypotheses and show which ones could be accepted or not, and if so why.

Hypothesis A (1):

Firms that have a business angel investor prior to their VC rounds show significant differences in first VC round investment amounts compared to firms that solely rely on venture capital in the beginning.

This one has passed with flying colours. The evidence was very conclusive and the hypothesis can be accepted without a problem.

Hypothesis A (2):

The effect business angels have on the first round of VC investment will diminish in subsequent rounds.

The results of this hypothesis were mixed. It actually checked for different scenarios, i.e. signals can be faked or firms are inherently better due to self-selection. The tests helped to rule out some extremes. Under strong self-selection the valuation and investments in the first VC round would not differ from subsequent ones. If the signal is not credible many firms would be overvalued and in the first round and receive much lower investment in subsequent rounds. My results were mixed. The effect did diminish by a bit, indicating that the signal is credible and self-selection is not strong. Therefore the hypothesis has been accepted.

Hypothesis A (3):

Business angels increase the chance to find VC syndication partners. Furthermore, they decrease the time needed to find these partners.

The results of this one indicated that BA backed firms might get better VCs. Also, it strengthened the results of business status and profitable by showing that BA backed

firms are more likely to experience syndication. The results were conclusive and the hypothesis has been accepted.

Hypothesis A (4):
Business angel backed firms are more likely to become profitable/successful and are faster at achieving these goals.

This hypothesis confirmed the theory that BA backed firms have better chances of success. Therefore it paved the way for the models tested later. However, the second part regarding the speed at which firms become successful was problematic. For the profitability measurement I could not find evidence that the one or the other group is significantly faster. However, for the business status variable the results showed that group 2 firms are indeed faster when it comes to being acquired or doing an IPO. Both of these variables measure success, but they are quite different. The success measured by business status is not necessarily the same as the one from profitable. Therefore, the hypothesis could only be partly accepted for the business status variable.

Hypothesis A (5):
Business angel backed firms have less investment rounds after the first VC investment round.

A hypothesis confirmed that higher investment amounts of BA backed firms are not "bought" by accepting increased monitoring. The hypothesis has been conclusively confirmed.

Hypothesis A (6):
The time difference between the firms founding and their first VC investment is different depending on the group.

The hypothesis clearly showed that there was no difference in time needed to get a VC on board, measured form the firms' creation to the first round VC investment. Therefore, the hypothesis has been clearly refuted. Hence the alternative explanation

of BA backed firms having more time to prepare, ultimately weakening the measurability of the BAs effect has been disproven.

Hypothesis B (1):
The relationship between first round investment amount and the success variables, profitability and business status, is positive and significant.

This hypothesis showed that the profitability variable was not useable for the mediation model. The relationship between investment amount and success measurement (profitable) did not work as expected. I proposed an explanation based on a censoring bias. I also showed how this effect impacts the mediation model. The hypothesis could only be partly accepted for the business status variable.

Hypothesis B (2):
The effects the initial investor has on firm success can be split into a selection and a signalling effect, which are both significant.

The results were very different for the profitability based and business status based model. The former proved to have an underlying bias changing the results dramatically. Therefore the only remaining working measurement for success, business status, can be used to determine if this hypothesis is correct. The results from the business status approach were conclusive and implied that indeed a selection and a signalling effect are at work. However, the former was not significant at the 10% level and therefore I can only partly accept the hypothesis. As I said, the data is rather restrictive and the result with a p-value of 0.12 was very close. It surely indicates that a selection effect is possible.

Hypothesis B (3):
The signalling is of considerable magnitude, which I define as over 10% of the total effect.

Finally, I found that the signalling effect in the final model (business status) was significant and accounted for 30% of the total effect. This means the hypothesis can

be clearly accepted. It showed that business angels definitely have a positive and most of all considerable effect on ventures' success.

8.2 General Remarks

I was able to show theory-derived, quantifiable differences between business angel and venture capital only based firms. The former syndicate more and faster, they receive higher investment amounts in their first VC round. Furthermore, the investment amounts before the first VC round are significantly lower for BA firms, which mitigates their overall increased quality. Moreover, business angel backed firms have higher rates of profitability and are more inclined to exit the entrepreneurial stage via acquisition or IPOs.

Results that showed that business angels are indeed very important for the whole venture market and the economy. Furthermore, the collaborative synergies of the two very different investors could be highlighted, giving reason to the choice of first round investor. And finally, the sources and effects of these differences have been underscored and measured.

I demonstrated that BAs select good firms, but also build mediocre ones. I showed that business angles give support and ultimately pose a very positive signal to the venture capital market. The latter has been revealed to have substantial magnitude; hence it explains the edge BA backed firms have over VC only firms very well. Also, an interesting non-linear relationship between investment amount and success has been demonstrated. This constitutes strong evidence for very often only theorized forces and processes in the investment situation. Moreover, these results can be taken as advice and insight for venture capitalists, business angels, and entrepreneurs alike.

I tried to challenge the proposed theories and provide counter-arguments to my best knowledge and ability. This is a very integral part of this thesis since the model employed relies heavily on the validity and reliability of underlying theory.

Nevertheless, it must be stressed that the given data did not provide conclusive evidence above all doubt as the limitations chapter indicated. Certainly entrepreneurial characteristics, economic situation, policies, investment market, and many other underlying aspects might prove very influential. Unfortunately, these properties of the investment process could not be modelled and given proper attention in this thesis.

Even with its problems this thesis raised interesting points and provided thought-provoking result.

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10 APPENDIX

10.1 Abstract (English)

This thesis aims to clarify the impact of business angels on venture capital deals. The approach taken is based on screening and signalling theory and tries to answer the following questions: 1.) In which way are business angels beneficial for entrepreneurs? 2.) Can they pose a signal to potential large-scale investors? 3.) How can their effects be distinguished and what is their magnitude?

The theoretical reasoning presented is backed up by empirical analysis employing a basic mean comparison tests and mediation models. The main findings of this thesis are that business angels' signalling effects are significant and of account for a big part of the value added by these small-scale investors. The findings have been tested for robustness and self-selection effects have been ruled out.

10.2 Abstract (German)

Diese Masterarbeit setzt sich mit der Rolle von Business Angeln im Investitionsprozess von Venture Capital Finanzierungen auseinander.

Die hier gezeigten Erklärungsansätze fußen in der Signalling- und Screening-Theory und sollen im Speziellen die folgenden Fragen beantworten:

1.) Was sind die Vor- und Nachteile von BAs für Entrepreneure? 2.) Können Business Angel ein Signal für die Qualität eines Unternehmens gegenüber Großinvestoren darstellen? 3.) Wie können die verschiedenen Effekte der Business Angel unterschieden und getestet, sowie deren Ausmaß gemessen werden?

Die theoretischen Erklärungsansätze werden durch empirische Tests und ein Mediationsmodell untermauert. Die Ergebnisse zeigen, dass Business Angel einen Signaleffekt aufweisen und dass dieser sowohl signifikant als auch von großem Ausmaß und maßgeblich für Venture Capital Investitionen und Unternehmenserfolg zu sein scheint. Jedoch haben auch die Unterstützung und Erfahrung, welche ein BA dem Unternehmen zur Verfügung stellt, einen erheblichen Einfluss. Des Weiteren wurden diese Resultate auf Robustheit getestet und etwaige Selbstselektion konnte ausgeschlossen werden.

10.3 Curriculum Vitae

STUDIUM

Universität Wien

Masterstudium Betriebswirtschaft
(SS 2011 – WS2013)

Masterarbeit: „Signalling / Implications of Financing Decisions in Entrepreneurship“

Spezialisierungen:
Organisation und Personal (Personalökonomik)
Corporate Finance

Bakkalaureatsstudium Betriebswirtschaft
(*WS 2008 –WS2010)*

Bakkalaureatsarbeit: „Deception from an economic point of view“

Spezialisierung:
Organisations- und Personalmanagement
Finanzmanagement

Principles of Finance
Innovations- und Technologiemanagement
Supply Chain Management

Sprachen: Spanisch, Russisch

WEHRDIENST **Jägerbataillon 18, St. Michael in der Obersteiermark**
(2007 -2008)

SCHULBILDUNG

BG/BRG Leoben - Humanistisches Gymnasium
(1999-2007)
Sprachlicher Schwerpunkt
Spanisch, Latein
Abschluss mit Erfolg

BERUFSERFAHRUNG

Tutor
Fakultät für Informatik / Department Knowledge Engineering - Tutor,
Universität Wien
WS2009 – SS2010

E-Tutor
Fakultät für Wirtschaftswissenschaften / Lehrstuhl für Internationales Personal Management – E-Tutor,
Universität Wien
WS2010 – SS2011

Angestellter
Superevent – Dataentry, Testing & Support, Projektmanagement
2012 – Heute

AUSSERCURRIUCLARE TÄTIGKEITEN

Accenture Campus Challenge 2010
SS2010

Mitarbeiter der Österreichischen HochschülerInnenschaft der Fakultät für Wirtschaftswissenschaften
Medienreferent (*2009 – 2013)*
Finanzreferent (2010 –2013)

Mandatar Fakultätsvertretung der Österreichischen HochschülerInnenschaft für Wirtschaftswissenschaften
2011 – 2013

Mandatar der Universitätsvertretung der Österreichischen HochschülerInnenschaft der Universität Wien
2009 – 2013
Mandatar der Bundesvertretung der Österreichischen HochschülerInnenschaft
2011 – 2013

BESONDERE KENNTNISSE

- EViews, SPSS, Stata
- 4D Cinema, Blender (Animation & 3D Development)
- Inkscape, Omnigraffle (Grafik)
- JavaScript, HTML, PHP, Java, C++; Audit! (Basiclike),

SPRACHKENNTNISSE

- Deutsch (Muttersprache)
- Englisch (fließend)
- Spanisch (Grundkenntnisse)
- Russisch (Grundkenntnisse)