Assortative Mating in Venture Capital and its Effect on Performance of Deals

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Abstract

The venture capital (VC) industry is an important part of economic and innovation growth. However, due to asymmetric information and thus high uncertainty, the decision-making process of venture capitalists might suffer from behavioral biases. This thesis looks at whether European deals made between founders and investors whose institutions share the same nationality are less successful in the long run. Findings from current literature as well as theoretical model based on a game theory lay a foundation for a hypothesis that in fact, this underperformance is present. Furthermore, as a consequence of the instrumental variable strategy, I found some evidence that deals formed between investors and founders from the same country indeed to some extent do underperform in the long run.

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Introduction

In today's digitalized world it is easier than ever to start a business by writing code and thus creating a product. Founders then often seek resources elsewhere than in banks due to the high probability of failure of their business and that is where angel investors and VC funds come in. The VC industry experienced unprecedented growth in the number of deals made in recent years (Pitchbook, 2022). The trend has not been observed only in the US, which is a traditional location of VC funds, but also in other parts of the world including Europe. In the past, the best companies in the world such as Alphabet Inc. and Apple Inc. were early on in their lifetime supported by VC funds (Pitchbook, 2022). As was the case with these companies, the developed VC industry may encourage talented founders to continue scaling their businesses and thus undoubtedly drive innovation in the region. VC funds such as Sequoia Capital or Andreessen Horowitz are legendary as well as their partners. However, the decision-making process of venture capitalists when contemplating an investment in a start-up or a middle-stage company is quite complex. There is a high information asymmetry and uncertainty involved and therefore the positive outcome is often a question of margins, and minor details might play an important role. Usually, only one in ten investments succeed, though success often means return in thousands of percentages. Therefore, a space for potential behavioral biases unfolds.

This study describes and provides some theoretical and empirical evidence of such bias. It studies whether European deals that are made between VCs and companies from the same country underperform in the long run. The argument is that given the high uncertainty in the decision-making process, a venture capitalist will choose a founder that shares with her a common trait – here nationality - and thus does not base her decision solely on the fundamentals of the company, as a conventional economic theory of a rational agent would predict. Generally, the occurrence of a pairing of individuals with a common trait was first formally defined by Becker (1973). The author, with a particular focus on the marriage market, gives a name to this common phenomenon – assortative mating. Over the years many authors (Jiang et al., 2013; Torvik et al., 2022; Schwartz, 2013; Greenwood et al., 2014; Eika et al., 2019) have studied assortative mating, however, only a few have researched it in the context of VC deals. Botazzi et al. (2016) and Gompers et al. (2016) studied the potential occurrence of underperformance in VC deals due to behavioral biases. The former study focuses on the relationship between trust and deals' performance, whilst the latter paper links a common trait of venture capitalists and founders and its effect on the performance of deals. Both studies found some evidence of underperformance.

This paper builds on the research of behavioral bias in VC deals. Furthermore, it adds a theoretical framework partly based on game theory, which offers explanations of why such underperformance could be present. I model the negotiation between investors and founders as a moral hazard problem, where investors choose founders with uncertainty regarding their behavior after the deal, as some work and some shirk. More precisely, I use two models, where the first is based on a game theory logic using moral hazard, whilst the second is a model based on Degryse et al. (2022), where both moral hazard and monitoring costs are incorporated. Introducing exogenous beliefs is crucial and it is shown that a shared trait leads to a higher probability of a deal as well as underperformance. The empirical part of this paper is then slightly different from both methods used in Botazzi et al. (2016) and Gompers et al. (2016) as I pursue an instrumental variable regression to deal with confounders. The main objective is to look at the performance of past deals and whether there is a link between assortative mating and the outcome of the deal. Data about VC deals and VC funds as well as founders is difficult to attain in general. Information is often not transparent and might suffer from a sample selection bias. Therefore, because of these issues, I support findings from the empirical part with the aforementioned theoretical framework.

The paper is structured as follows – in the literature review section I discuss relevant literature about both the VC industry and assortative mating with a particular focus on the most relevant papers. Secondly, I introduce two theoretical frameworks; one based on a game theory and the other on the moral hazard model used in Degryse et al. (2016). Thirdly, I pursue an empirical analysis and discuss its main results and limitations. The last part concludes, evaluates, and proposes further research in this area.

Literature review

The literature review is divided into three subsections – firstly, I cover the VC industry itself, secondly, I devote some space to the concept of assortative mating, and thirdly, I shall merge both topics and discuss primary papers from this area which to a large extent inspired and influenced this paper. Regarding the VC industry, I will not only highlight recent trends and volumes but also focus on the inception of this sector as well as the description of the business model. Understanding the VC business model's mechanics and knowledge of history is crucial to grasp the choice, relevance, and importance of the research question. Furthermore, knowledge of the VC business model is essential for the theoretical and empirical part of this paper. Concerning assortative mating, I describe it with respect to the animal kingdom, marriages, and social inequalities. Lastly, I shall join both topics and briefly discuss three papers that researched a similar topic as this paper – *Theory of Marriage: Part I* by Becker (1976), *The Cost of Friendship* by Gompers et al (2016), and finally *The Importance of Trust for Investment: Evidence from Venture Capital* by Botazzi et al. (2016).

Venture capital industry

VC fund is usually a financial institution that invests money in early-stage companies. The money invested often originates not only from the fund but also from the outside investors so called limited partners (LP). As the money is invested in the companies at the beginning of their lifecycle, there is a high probability of failure and thus these investments are deemed as highly risky. On the other hand, the conventional trade-off between risk and return applies and therefore investments in VC funds are accompanied by high returns provided the investments prove to be successful. To name some examples out of many - Bessemer Venture Partners (BVP) publish memos about companies they invested in the past. These memos are essentially a simple due diligence and forecast analysis of their initial investments. For instance, the BVP decided to invest in Pinterest in 2010, when it only had two employees and lacked a proper business model including monetization (BVP, 2022). The probability of going ever public was estimated as 1% by BVP at the time of the initial investment (BVP, 2022). Nowadays, Pinterest's stock is trading at around $20 per stock, roughly 80% down from its all-time high in early 2021 (Yahoo Finance, 2022). Therefore, compared to public equity, returns in multiples of hundreds are not unusual.

Business model

Business models of VC firms differ to a large extent as it depends on their preferences and objectives. Some specialize in investing in early-stage companies (start-ups) whilst others aim for firms in the middle stage of their cycle. Generally, there are four stakeholders in the whole process – entrepreneurs or founders, outside investors, investment banks, and venture capitalists, where venture capitalists create a bridge between founders and investors, whilst investment banks become relevant when a company plans an initial public offering (IPO) (Bob Zider, 1998). Incentives from founders to get VC funding is intuitive. Since these companies usually cannot develop their full potential without further funding, they seek alternatives to bank loans since the interest rates charged by banks are often high. Intuitively, this applies mainly to start-ups as banks deem these companies very risky and thus propose high interest payments on potential loans (Bob Zider, 1998).

On the other side of the spectrum, it is very costly for mid-stage companies to raise equity and thus the relevance of VC is also high. When it comes to forecasting the probability of success in deals, it is usually the case that only one or two out of ten companies succeed and finish in IPO (Bob Zider, 1998, Nexit Ventures, 2022). This is the reason why VC partners look for roughly 10x and more return on their investments. Another nonsignificant part of the costs are the management fees which are usually around 2-3% of the total size of the fund (Bob Zider, 1998). It is therefore not surprising that VC firms also often have a say in management decisions, and it is not unusual to provide expertise or directly contribute to decisions regarding companies' future (Nexit Ventures, 2022). The extent to which VC funds are active in this kind of decision-making process is subjective, and again depends on the preferences of the fund. The high probability of failure exists because of specific factors such as uncertainty regarding external factors, for example, economic climate and capital costs. However, arguably a strong explanation for such a low probability of success is high asymmetric information from the beginning of the deal. Sometimes it is the case that there is not enough time for proper due diligence analysis of the firm and VC firms must decide quickly. One extreme example is the hedge fund Tiger Global Management, in which the due diligence for some deals in 2021 took only a day or two (Everett Randle, 2021). In general, a VC fund can be anything from having a significant say in the management of a startup to only investing in mid-stage companies and holding its share for a couple of years.

History

One might think that VC funds are a recent phenomenon. However, the first venture was established by MIT president Karl Compton and Harvard scholar General Doriot as early as 1946

(Gompers & Lerner, 2001). Their fund was greatly successful with most of the profit coming from Digital Equipment Company (Gompers & Lerner, 2001). The next milestone for the VC industry was arguably improvements of the Employee Retirement Income Security Act (ERISA) that meant a regulatory boost and thus general improvement in conditions of the industry (Gornall & Strebulaev, 2015). Before this regulatory change, nearly 0% of IPOs were backed by VC whilst after it grew to 42% (Gornall & Strebulaev, 2015). Gornall and Strebualev (2015) performed a difference in differences analysis to study the effect of the regulation boost on the VC industry and broader economy. They compared the US with other western countries in G7 and found that before the change in the regulation, there were similar trends in the VC industry in both groups. However, after 1979, 88 out of the 300 largest companies were backed by VC in the US whilst only 11 were in G7 countries (Gornall & Strebulaev, 2015). The claim that VC-backed companies are important for the economy does not necessarily imply that VCs themselves are important, however, the study concludes that "if it were not for the US VC industry, at least one-sixth of the largest 300 US public companies would not have existed or achieved such success" (Gornall & Strebulaev, 2015, p.30). Even though the regulation boost undeniably helped the industry, there was a decline in VC-related investments in the 1980s, which was then offset by a steep boom in the 90s as growth companies were becoming popular. At the end of the 90s, the dotcom frenzy was accumulating, and it is no coincidence that VC activity peaked in 1999 (Gompers & Lerner, 2001).

In the last decade and especially in the last two years, the VC industry experienced the highest volume on record (Nexit Ventures, 2022). Since the real interest rates were in many countries close to 0 or even negative, there was an incentive to borrow and use this money for any sort of investment, VC being one of the many options. The year 2021 was by far the highest year on record by the number of deals as well as volume (Nexit Ventures, 2022). This was undoubtedly partly caused by unprecedented monetary and fiscal stimuli, quantitative easing, and close to 0 real interest rates – cheap capital. However, because of the changing global economic paradigm, we are witnessing at the moment, 2022 and the following years are unlikely to top it. Moreover, there are certain similarities between the dot com frenzy and covid fiscal and monetary stimuli regarding both public and private equity (Coatue Management L.L.C., 2022). Based on this evidence, one might expect a plunge in VC activity in the following years as it happened after the dot com bubble. However, I do not intend to speculate on future trends as there are neither relevant nor suited to this paper and thus the main takeaway from the history of the VC industry is that it is a very much cyclical economic activity with a rich history, especially in the US.

Venture capital in Europe and the United States

Since the empirical part focuses on the European deals, there is a need to clearly state the differences between the European and especially the US VC scene. As the previous subchapter described, there is no surprise that VC was developed in the US due to technological and economic supremacy. European governments imposed and arguably still do a great deal of regulations and thus the unwanted side effect is the slowed growth of innovation (Karsai, 2018). It is not a coincidence that Silicon Valley is not located in Europe but indeed in the US. When the Europeans saw that the US venture capital brings an undeniable contribution towards innovation and thus the economy, they sought to support VCs in Europe as well. In the 90s and early 00s, Europe was still deemed as nascent in VC (Hege et al., 2008). For instance, the value of all deals in Europe was just a quarter of the US deals with Europe being more populous and roughly the same economic powerhouse at that time (Hege et al., 2008). However, Hege et al. (2008) argue that not only there were fewer deals in Europe in the 90s and early 00s, but also, they were on average less successful. They empirically study performance proxied by the exit and internal rate of return (IRR) with solid data from the VentureXpert database as well as tailored questionnaires sent to VC funds. The study finds that at that time, US venture capitalists had better screening skills and managed better agency problems (Hege et al., 2008). In this context, an agency problem refers to the situation, when a founder of the company that finishes being supported financially or by providing expertise, is not motivated enough and suffers from moral hazard – that is, since the decision to support a given company has been made, there is no motivation for the founder to fully focus on her company and thus she shirks. According to Hege et al., (2008) US venture capital funds "use more systematically financial instruments that convey residual control in case of poor performance, namely convertible securities, and they activate contingent control more frequently, as measured by the replacement of entrepreneurs and the termination of projects." (Hege et al., 2008, p.4). The authors also add that relationship banking, which is better in Europe, does not seem to have any impact on the quality of deals. In simple words, the European VC scene was lacking skilled VC partners demonstrated by a lack of screening skills and poor management of agency problems at the time of the research.

In the past decade, European VC experienced unprecedented growth. In 2021, the deal value peaked at just over €100 billion, which is ten times more than in 2011 (Pitchbook, 2021). The number of deals has tripled since the same year, yet Europe is still lacking behind the US, where the deal value reached an immense €316b and the number of deals was 60% higher than in Europe (Pitchbook, 2021). The number of unicorns, that is start-ups that were valued at $1b and more, was also the highest in the US (488), followed by China (177) and Europe (74) (Pitchbook, 2021). Another interesting aspect

of the European VC market is that roughly 77% of all deals were made in the following regions and countries – Benelux, France, the United Kingdom, Ireland, and DACH – Germany, Austria, and Switzerland (Pitchbook, 2021). Whilst it is not clear whether the quality of European deals has improved, there is evidence that Europe as a region grew significantly yet still lacking to a large extent behind the US. For instance, in 2018 VC investments in the US represented 0.38% of the GDP, whilst in Europe it was only 0.04% (Pitchbook, 2022).

Why is VC important in the first place? The answer is innovation. There is evidence that the existence of VC has an impact on innovation (Gompers & Lerner, 2021, Kaplan & Lerner, 2017). Botazzi and Rin (2002) sum it up by stating that the "venture capital industry is a cornerstone of America's leadership in the commercialization and technological innovation" (Bottazzi & Da Rin, 2002, p.231). Innovation is influenced by many factors, mainly it is market competition, foreign investments, stable economic climate, and low real interest rates (Pece et al., 2015). The last factor was arguably the reason behind record highs in the VC world seen last year. Schumpeter's concept of creative destruction could be nicely used in the VC context (Forbes, 2022). Prior to achieving better and more effective outcomes, it is often necessary to engage in a process of deconstruction. In other words, VC financing leads to innovation, which in turn leads to creative destruction (Pece et al., 2015). According to MIT, Economics "over the long run, the process of creative destruction accounts for over 50 percent of productivity growth." (Caballero, 2008, p.1). Usually, it is difficult to identify a clear link between the presence of VC funds and innovation due to the lack of data from VCs. Some estimate that VCs are three or even four times more powerful than an investment in R&D when it comes to innovation (Kaplan & Lerner, 2017). An increase in innovation then empirically leads to a positive impact on economic growth, where innovation is often proxied by the number of patents in a given country (Pece et al., 2015).

Assortative mating

Genes and animal kingdom

There is a saying that opposites attract. However, the following lines show that empirically it is rather the reverse as individuals and even animals tend to mate, marry, and create partnerships with mates who are similar in certain aspects. Thus, there is evidence of positive sorting according to specific traits such as nationality, ethnicity education, or genetics. For completeness, the term homogamy captures this positive sorting (Sociology Dictionary, 2022).

Assortative mating is a phenomenon that can be observed not only among humans but also in the animal kingdom. Jiang et al. (2013) define assortative mating as "when there is a correlation (positive or negative) between male and female phenotypes or genotypes across mated pairs" (Jiang et al., 2013, p.1). They argue that both positive and negative assortative mating is observed, however, the former is much more pronounced. According to this study, it is the disruptive selection that favors positive assortative mating. Disruptive selection describes changes in genetics where extreme values for a trait are favored (Biology Dictionary, 2017). There is also evidence that genetics play a role in the mating process. Torvik et al. (2022) found proof of genetic similarity between partners regarding height and educational attainment. Thanks to the unique Norwegian dataset, the authors were able to track partners as well as siblings to control for problems with endogeneity that might arise. Overall, this study finds yet another evidence of positive assortative mating and even stresses that it could help to understand social inequalities within society.

Marriage and social inequalities

In 1973, the later laureate of the Nobel prize in Economic Sciences, Gary Becker, published an influential paper A Theory of Marriage: Part 1, where he explicitly defined a model where positive assortative mating in the marriage market is optimal. Becker argues that when traits such as lifestyle, attractiveness, or religion are complements, assortative mating is positive (Becker, 1973). The Theoretical part of this paper as well as the later subchapter will thoroughly describe Beckers' ideas.

Since the 1970s many authors brought more evidence on the phenomena of assortative mating. Schwartz (2013) discusses a matching in romantic relationships based on socioeconomic status, race, ethnicity, and religion. He describes the search for a partner as "costly (in terms of both time and money), and people compete with one another for preferred mates." (Becker, 1973, p.452). There are two hypotheses about why empirical evidence shows homogamy among couples as Schwartz refers to it (Schwartz, 2013). The first is the matching hypothesis which implies that everyone prefers a partner who is somewhat like themselves. The second is the competition hypothesis which predicts that people always prefer someone better than themselves with respect to traits such as education or wage. However, since every participant in this hypothetical market has such a preference, everyone matches with someone very similar to themselves (Schwartz, 2013). Therefore, both hypothesis leads to the same prediction of homogamy. Kaljmin et al. (1994) also discuss these hypotheses and further offer an explanation that preferences for similarity rise from the goal to develop a similar lifestyle and thus produce "social confirmation and affection" (Kalmijn, 1994, p.426). Schwartz (2013) further details relatively recent trends in the traits according to which people sort.

Firstly, there is evidence for positive assortative mating through education, yet this evidence is not always clear (Schwartz, 2013). Secondly, according to the available data homogamy is presently based on the same race (Schwartz, 2013). Arguably, this might gradually decrease given the current social climate around racism as the marriage of heterogeneous couples regarding gender is a social norm unlike in Becker's times. However, interestingly there is evidence that interracial couples are more likely to break up (Schwartz, 2013). Thirdly, the changing paradigm does not apply only to race but also to gender. In Becker's times marriage was not as egalitarian and flexible institution as it is now (Schwartz, 2013). Therefore, men and women have more freedom to choose love over other reasons to marry (Schwartz, 2013). From a different perspective, however, since women are not as restrained and are more financially independent nowadays, they could choose someone, who is indeed similar and a truly suited partner. Therefore, the effect can be mutually beneficial. Lastly, high inequality within the society supports homogamy since there is a higher cost of "marrying down" (Schwartz, 2013, p.455).

Unlike Schwartz (2013), Greenwood et al. (2014) report clear evidence for positive assortative mating in education. Moreover, the paper reports an increase in educational homogamy since the 1960s. To provide robust results, the authors use three different measures for the calculation of assortative mating – linear regression coefficient of schooling between wife and husband, Kendall's rank correlation, and deviation from the random matching. Figure 1.1 shows these three measures and the increase in assortative mating over time. Note that the y-axis is three different scales for the three aforementioned measures. Kendall's rank correlation was decreasing for a non-insignificant amount of time. Nevertheless, the two remaining measures are increasing in time, which provides sufficient evidence for increased homogamy in time. There is however also some effect on household income. More precisely, "in 2005 if a woman with post-college education (C+) marries a man with a less-than-high-school education their income would be 92 percent of mean household income. This rises to 219 percent if her husband also has a post-college education. So, at some level, sorting matters for household income." (Greenwood et al., 2014, p.3). Since Greenwood et al. (2014) paper studies only US data, there was an ambiguity about this phenomenon having cross border impact. Eika et al. (2019) confirm that similar trends can be seen in other countries such as Germany, Denmark, Norway, and the UK. At the same time, Eika et al. (2019) confirm Greenwood's et al. (2014) results – people in the US with the same level of schooling were roughly 1.9 times more likely to match compared to the random matching, whilst in 1962 it was 1.7 times and in 1940 even 1.3 times (Eika et al., 2019). Moreover, as can be seen in Figure 1.2, there is a positive correlation between assortative mating and Gini coefficient across different countries than the US where A refers to Denmark, B to Germany, C to the UK, and D to Norway. Mare (1991) finds that heterogamous marriages are much less likely to occur

for people with a college degree. The study also emphasizes that barriers to heterogamous marriage increased between the 1930s and 1990s as a result of higher average educational attainment, higher age at leaving school, and higher age at marriage (Mare, 1991). The underlying intuition is that the duration of one's education positively correlates with the likelihood of marrying a partner who possesses a similar level of education. Note that this is in line with trends from both Greenwood et al. (2014) and Eike et al. (2019). Mare (1991) only explains why it is the case. Overall, one should keep a critical eye, however, the consensus and evidence from the literature are convincing, and generally, people, and indeed even animals, tend to choose somewhat similar mates.

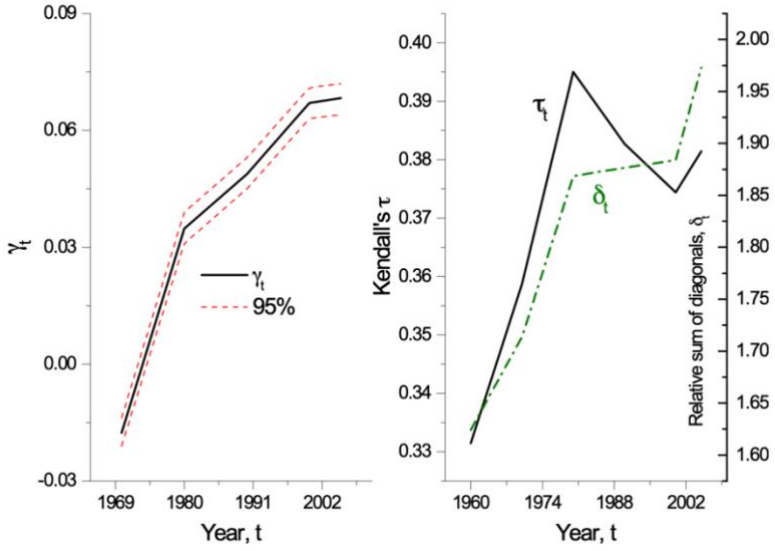

Figure 1.1 – Three different measures of assortative mating in education. Adopted source: Greenwood et al. (2014).

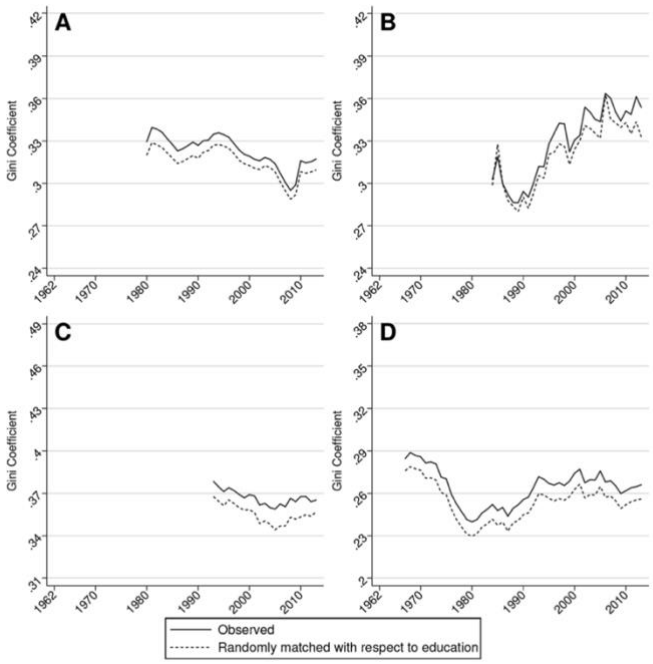

Figure 1.2 – Positive correlation between assortative mating and Gini coefficient, where A stands for Denmark, B for Germany, C for the United Kingdom and D for Norway. Adopted source: Eika et al. (2019).

Assortative mating and venture capital

Becker (1973)

The first discussed paper is *A Theory of Marriage: Part 1* written by Becker (1973). The author defines a theoretical foundation for assortative mating. The motivation of the paper is that up until the 70s, none or few economists attempted to study and define one particular type of market – the marriage market. At the first sight, the marriage market does not seem to be the most relevant and impactful market for economists to study. However, the vast majority of people in the entire world participate in this market and thus the number of participants will be much larger than in other conventional and more salient markets that had been widely studied in the past – e.g. stock market. Becker (1973) argues that the impact of "marital patterns" is massive regarding for example population growth, labor force participation, and inequality (Becker, 1973, p.814). Becker's paper focuses solely on the theory and essentially shows that economic analysis is possible to apply to the marriage market – marriage is a voluntary activity, it is a utility maximization problem and there is competition between men and women (Becker, 1973, p.814). In essence, Becker (1973) defines Z as an aggregated good of household products such as the quality of meals, children, or prestige (Becker, 1973, p.816). The main optimization problem is that spouses can spend their time either in the labor market getting wage for which they buy market goods or in the household producing a good Z. Becker

(1973) then demonstrates that "the gain is greater the more complementary are the inputs" (Becker, 1973, p.820).

The theory behind assortative mating is first discussed regarding the optimal sorting of men and women in the market. Optimal sorting exists if each participant finds the person who maximizes her income and if there exists none who would enhance one's wellbeing without making the current partner worse off (Becker, 1973, p.823). Although Becker (1973) does not explicitly state it in this paper, the described optimal sorting is Pareto efficient. Next, Becker (1973) assumes that men and women differ only in one trait, which is defined as A (Becker, 1973, p.825). One can assume that this trait is for instance education. Assortative mating is then determined based on the effect of an increase in A of both mates and whether a separate or simultaneous increase has a higher impact on the output Z – that is, they are complements or substitutes. Mathematically, it is the derivative of Z with respect to A:

$$\frac{\delta^2 Z(A_m, A_f)}{\delta A_m A_f} \gtrless 0.$$

According to this condition, Becker (1973) argues that positive mating is optimal when traits are complements and negative mating is optimal when traits are substitutes (Becker, 1973, p.826). In other words, in the case of positive assortative mating, traits such as the education of both spouses reinforce the total output of the household. Overall, Becker (1973) offers an elegant and intuitive theoretical foundation for the phenomena of assortative mating. The following two papers are more empirically focused and provide evidence of Becker's theory.

Gompers et al (2016)

The Cost of Friendship is a catchy name of a paper written by Gompers et al. (2016), which assesses the underperformance of deals, where VC investors behind the deal were sorted according to positive assortative mating theory. Therefore, not only they record assortative mating in VC deals, but they also bring sufficient evidence of their underperformance.

Similarly, to Becker (1973), Gompers et al. (2016) point out that it is not clear whether positive assortative mating is superior to negative assortative mating and vice versa. For instance, regarding the group work of students at university or colleagues in the workplace, one can argue that similarities within the group help the team as a whole – the ability to make decisions or easier communication (Gompers et al., 2016, p.627). On the other hand, if people are very much the same, they can suffer from confirmation bias (Gompers et al., 2016, p.627). Indeed, in today's world employers seek the

diversity of their employees, which potentially drives innovation and progress. Therefore, the effect of assortative mating on performance is ambiguous and thus it is the main motivation for the authors to study it.

Gompers et al. (2016) take advantage of an impressively detailed dataset consisting of over 3000 individual venture capitalists. The impressive part is that much of the information regarding venture capitalists such as education or ethnicity is handpicked data from the internet. Regarding the empirical part, the authors use a probit model with the dependent variable Deal and Success, where the latter is equal to 1 if the deal results in an IPO. To report more than a simple correlation, the author group factual VC pairs and counterfactual where the latter is based on randomization. Therefore, without the presence of assortative mating, what is the probability that two venture capitalists from the same higher education institution end up on the same deal. Authors manage to sort venture capitalists based on ethnicity, gender, former employment, and education. For instance, they observe that venture capitalists with degrees from Ivy League institutions are more likely to cooperate by roughly 17% than a randomized matching (Gompers, et al., 2016, p.633). If both participants are from the same ethnic group, they are 33 % more likely to match on the same deal (Gompers et al., 2016, p.633). Regarding the success of the deal, if both venture capitalists have a degree from an Ivy League institution, it increases the probability of a deal resulting in an IPO, whilst the same ethnic background or shared employment lowers the probability of success (Gompers et al., 2016, p.635). Therefore, in the former case, positive assortative mating leads to better performance, whilst for the latter case positively sorted deals underperform. The authors also look at the repeated collaborations among venture capitalists. They find that overall, the frequency of cooperation is increasing in positive assortative mating (Gompers et al., 2016, p.637). The authors also try to explain why it is that assortative mating occurs and why it has such an effect on performance. They come up with two hypotheses. First, cooperation with like mates may represent utility itself and thus the "investment hurdle" is decreased (Gompers et al., 2016, p.638). Therefore, the choice is completely rational as an economic agent derives utility from such a partnership. Second, the negative impact on performance can be explained by poor decision-making due to for instance confirmation bias – authors call this treatment effects (Gompers et al., 2016, p.638). Thanks to their empirical strategy including an instrumental variable, they conclude that it is likely the latter.

Botazzi et al (2016)

The last paper is *The Importance of Trust for Investment: Evidence from Venture Capital* written by Botazzi et al. (2016). However, as the title suggests, it focuses on trust and how it affects deals in venture capital. Arguably, assortative mating is to some extent hidden behind the definition of trust.

Botazzi et al. (2016) define their measure of trust as "preconceptions that people of one identifiable group have for people from another identifiable group" (Bottazzi et al., 2016, p.2284). It is plausible that people trust one another based on specific traits such as ethnicity, nationality, or education. It is not an implausible claim that people tend to trust others that are somewhat similar. Therefore, even though not explicitly stated by the authors, assortative mating is at least to some extent applicable to this study.

The null hypothesis is naturally that trust does not matter (Botazzi et al., 2016, p.2284). Venture capitalists are thought of as bright and smart individuals, and therefore one would expect that they do not suffer from behavioral biases. Nevertheless, the authors find that a one percent increase in trust between different nationals leads to an increased probability for a deal of 7%. (Botazzi et al., 2016, p.2285). The novelty regarding this study is the fact that it focuses on Europe, which makes sense from the perspective of measuring trust as it might not be that diverse in the United States. The trust measure is computed according to the Eurobarometer survey from the 90s, where participants are asked on a scale of 1 to 4, how much they trust a specific country (Eurobarometer 46.0, 1996). By construction, trust can be characterized as prior beliefs and thus is not based on ex post-experience (Botazzi et al., 2016, p.2288). The authors use a logit model with many independent variables such as GDP difference or distance between VC and a company to control for the potential endogeneity issues. Unlike in Gompers et al. (2016), the outcome of the deal in this paper is measured by three variables – IPO, Exit, and Failure (Botazzi et al., 2016, p.2285). The result confirms that not only trust helps to form a deal but also might have a detrimental effect on the performance of the deal. Therefore, similarly to ethnicity from Gompers et al. (2016), high trust is related to underperformance. However, the authors too raise the issue of selection and treatment effects. To further study these effects, they build an index as a prediction from the regression and then analyze how investors select based on companies' observable characteristics. Since the results are very much correlated with the trust measure, the authors conclude that a selection effect is in place. Overall, this paper brings yet another evidence of underperformance when assortative mating, even though implicitly, is in place.

The empirical section and partially the theoretical part of this paper are based on these three studies. Becker (1973) was the first to define assortative mating theoretically, Gompers et al. (2016) studied a very similar research question to this paper but focused on the relationship between venture capitalists rather than the investor-founder relationship, whilst Botazzi et al. (2016) looked at the effect of trust and performance of deals. Correspondigly to Becker (1973), I aim to look at assortative mating theoretically. However, I incorporate the decision-making process and describe a game theory setup in which a behavioral bias arises. In the empirical part, I use the same measure of trust as Botazzi

et pal. (2016) but pursue a different empirical strategy. Gompers et al. (2016) then provided inspiration and context for the studied topics.

Theoretical part

This chapter aims to set a stage for the empirical part of this paper. As argued in the literature review part, some studies report biases concerning venture capital deals that are impacted by assortative mating (Gompers et al., 2016, Botazzi et al., 2016). To build a foundation for the empirical part, I describe two models that explain the existence of this bias. First, I consider a game theory model to identify equilibria using a conventional game setup and a signaling game. Exogenous beliefs are incorporated into the structure and help build the theoretical prediction that positively sorted deals are picked up with a higher likelihood and that they could underperform. The second model is a constraints model based on Degryse et al. (2022) with one added element - monitoring costs. Equally to the first model, exogenous beliefs are crucial as the empirical prediction is that these beliefs lead to lower monitoring needs and thus underperformance of positively sorted deals.

The matching problem between *Investor* and *Founder* is modeled as an example of a moral hazard problem, which falls into the category of adverse selection. Typically, there are two types of asymmetric information problems – adverse selection and the aforementioned moral hazard. Asymmetric information is demonstrated in the famous market for lemons defined by Nobel laureate George Akerlof, where the buyer is not sure about the quality of a given car. Moral hazard then refers to a situation where agent 1 does not know how will agent 2 behaves. A typical example is insurance markets and bargaining over wages in signaling games. In both following models, I assume that *Investor* is unsure how *Founder* will approach her work and thus fall into the category of moral hazard.

Game theory

Game theory is a convenient framework for drawing theoretical predictions from the *Investor* and *Founder* matching problem since there are two agents, decision-making processes, and uncertainty involved. However, there are many possible directions one can make use of a game theory. For the sake of the gradual development of an argument, I make use of the classification used in Gibbons (1997). I first introduce a simple static game with complete information in a 2x2 matrix à la Prisoner's dilemma. Secondly, I model the given problem as a dynamic game with complete information, where the concept of backward induction is used. Finally, I move to a more complex solution where external beliefs are incorporated, and the problem is modeled as a simple signaling game.

Static game with complete information

In a simple static game with complete information, there are two players with two possible actions in the game – *Founder* and *Investor*, who can shirk or work and invest or not invest respectively. Note that the game involves moral hazard since *Investor* does not know whether *Founder* will work diligently with full effort on her project once money is provided. There are different payoffs for each combination of an outcome that can be thought of as success (e.g. IPO) or failure, that is the firm/startup goes bankrupt. Table 2.1 depicts this simple game in a conventional 2x2 matrix.

Table 2.1 – Conventional 2x2 matrix.

	Founder		
Investor		SHIRK	DO NOT SHIRK
	INVEST	*a,b*	*c,d*
	DO NOT INVEST	*e,f*	*g,h*

Given the relationship between both players and their actions, one can deduce potential payoffs. From the *Investor's* point of view, the payoffs are ranked as followed:

$$c > e > g > a.$$

It is intuitive that if the *Investor* invests and the *Founder* does not shirk (option *c*), the former player has the greatest payoff. Note that here I disregard the explicit probability of success or quality of the project itself, yet I make the implicit and straightforward assumption that if the entrepreneur does not shirk, there is a higher probability for the deal to succeed. On the other side of the spectrum, *a* is the worst option for the *Investor* as she invests in a deal in which the probability of success is diminished due to the shirking of the *Founder*. The middle options *e* and *g* are less intuitive. Here I argue that if *Founder* shirks and the *Investor* does not invest, there is some benefit to the *Investor*, though marginal, as she was correct about the qualities or rather incompetence of the *Founder*. From the *Founder's* point of view, her options are ranked as follows:

$$d > b > f > h.$$

Since d>b, I assume that the private benefit from shirking is slightly less than the implicit higher probability of success of the deal when the entrepreneur works, and the venture capitalist invests. I also argue that making this assumption is crucial – the model needs to be built such that there are incentives for players to engage in cooperation. The latter relationship between the two letters *h* and

f implies that the *Founder* is slightly better off if she shirks, and the *Investor* does not invest. Since the investment is not happening at all, it seems peculiar why this is the case. However, one might argue that if *Founder* does not shirk, her payoff might be negative as even though she was determined to put effort into the deal, the *Investor* decided not to pursue the deal. Analogously to the arguments above, I will relax this assumption later. Assigning arbitrary payoffs, Table 2.2 outlines the game in a 2x2 matrix.

Table 2.2 – Game with payoffs. Red circles denote preferred strategy of each player.

		Founder	
Investor		SHIRK	DO NOT SHIRK
	INVEST	*-100, 45*	*100,50*
	DO NOT INVEST	*100*	*-10,-10*

Note that assigned payoffs are not completely random, since they follow the previously described logic. For instance, 45 is just slightly worse than 50 to depict the trade-off between private benefit from shirking and potential gain from the deal from the *Founder's* perspective. More importantly, solving the game leads to two Nash equilibria – {INVEST, DON'T SHIRK} and {DON'T INVEST, SHIRK} denoted in red circles in Table 2.2. For completeness, Nash equilibrium is found such that a player gives the best response to the strategy of the other player. In other words, a player does not have the incentive to deviate given the strategy of the other player. The top right equilibrium {INVEST, DON'T SHIRK} is then the socially optimal outcome as the sum of payoffs is maximized.

The equilibria are based on some strong assumptions. I will discuss two alternatives and their implications. Firstly, from the *Founder's* point of view, if one assumes that the benefit from shirking equals the outcome when the investment goes through, and *Founder* is working, one comes to the same equilibria as previously described. That is, if a private benefit from shirking also equals 50, it does not have an impact on the outcome. Although I previously argued that this assumption is rational and maybe even fundamental, relaxing it does not alter the outcome. Secondly, and perhaps more importantly, if one assumes that all payoffs from the DON'T INVEST strategy yield 0 for both players, the outcome is again unchanged. Table 2.3 depicts the outcome with altered payoffs.

Table 2.3 - 2x2 payoff with relaxed assumptions.

		Founder	
Investor		SHIRK	DON'T SHIRK
	INVEST	*-100,50*	*100,50*
	DON'T INVEST	*0,0*	*0,0*

Dynamic game with complete information

The previous game assumed that the bargaining between *Founder* and *Investor* is static. However, the decision to shirk or work can be made by *Founder* based on the decision of *Investor*. Therefore, it depends on the perspective whether the game is static or dynamic. One clear advantage of a dynamic game in the bargaining problem is that one can use backward induction to separate Nash equilibria based on non-credible threats (Gibbons, 1997). Figure 2.1 summarizes this dynamic game. *Investor* moves first whereas *Founder* follows with her decision to work or shirk. Therefore, here I assume that *Founder* bases her decision solely on the action of *Investor*. The payoffs are same as in the static game with complete information and thus the Nash equilibrium with non-credible threat is indeed {INVEST, DON'T SHIRK}, which is found by backward induction. *Investor* observes *Founder's* options and thus anticipates what she does and thus either Invest or Don't invest decision is made. Since *Founder* will be always working, when *Investor* invests, it is the Nash equilibrium with non-credible threats and is denoted in bold in Figure 2.1.

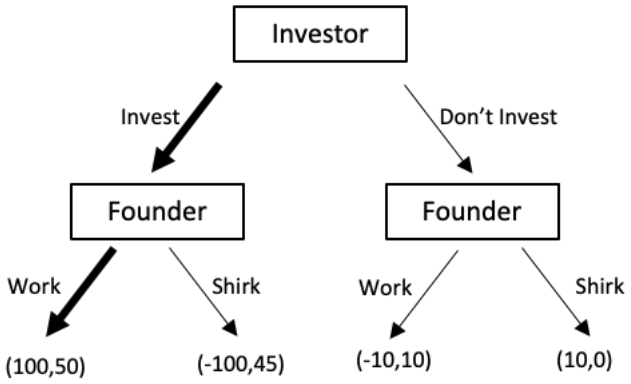

Figure 2.1 - Dynamic game. Adopted source: Gibbons (1997).

Signaling game

Even though the dynamic game yields a single Nash equilibrium, it might not be perfectly suitable for the matching problem between *Investor* and *Founder*. Firstly, the assumption that the problem is a dynamic game is questionable. I argue that some Founders are inherently more productive than others and thus they do not base their decision to work or shirk solely on the strategy of *Investor*. Secondly and more importantly, information about whether *Founder* is working, or shirking is not known to *Investor* and thus it is private. Lastly, to fit the matching problem in the framework of this paper, there is a need to introduce exogenous beliefs on which *Investor* chooses her *Founder*. All three requirements can be summed up in the signaling game whereby *Investor* holds her own beliefs about signaling by *Founder*. A signaling game is a typical example of the moral hazard

problem. Spence (1973) famously described a problem where employers do not know the productivity of workers. However, education can be used as a proxy for a type of workers. Therefore, highly productive workers are willing to pay premium for their education. The idea is that education here serves as a separator or indeed a signal of productivity of workers to employers (Spence, 1973). The matching problem between *Investor* and *Founder* is somehow similar. *Investor* does not know whether *Founder* will shirk or work, however, in her mind, there can be a signal based on exogenous beliefs upon which *Investor* makes the decision to invest. The following signaling game is not based on Spence (1973) but mainly on Cho and Kreps's (1987) beer and quiche signaling game. The idea is that a new concept - perfect Bayesian equilibrium – is introduced, where "beliefs are elevated to the level of importance of strategies in the definition of equilibrium" (Gibbons 1997, p.142). Incorporating beliefs into the setup is crucial as it fits very well with the given problem of bargaining between *Investor* and *Founder*. The following lines closely follow Gibbons's (1997) interpretation of the beer and quiche signaling game. Figure 2.2 depicts the game in full detail. Consider the following assumptions that this game considers. Nature draws a type *t* according to a probability distribution *x(t),* where *t* can be either Work or Shirk, that is *Founder* who works or shirks. This strategy is called a separating strategy if both types send a different message (Gibbons, 1997). Founder of course observes her type. However, before the bargaining is finished *Investor* observes whether there is positive or negative assortative mating of a potential deal. In this context, assortative mating, which is denoted as AM+ and AM- in Figure 2.2 respectively, is considered a signal to *Investor*. Since *Investor* holds *Founder* with positive assortative mating in higher regard, she is more likely to choose her. In other words, *Investor* associates working with positive assortative mating +AM and shirking with negative assortative mating -AM. This is denoted in Figure 2.2, where the left-hand side of the bold line is associated with the outcome. Note that the dashed line refers to the fact that *Investor* does not know whether *Founder* is a Work or Shirk type. Probabilities *p* and *q* then represent the probability that positively sorted type works, and negatively sorted type shirks respectively. It is clear that $p>1-p$ and $q>1-q$ must hold for the logic described. Now, why would *Investor* associates work with +AM? Clearly, those beliefs are exogenous. However, similarly to employers in Spence's (1973) signaling game, there should be some reasoning behind why it is the case. A belief that education is a signal for the productivity of employers might not hold always in individual cases but will arguably hold on average. The reason is the entry barrier to a higher education institution and the amount of work, effort, and skills that are required to graduate. In the matching problem, the reason is more subtle. *Investor* might simply extract utility from cooperating and investing with *Founder* who is from the same country or university and thus decrease the investment hurdle as Gompers et al. (2016) described. After all, as was shown in many examples in the literature review part that people and animals tend to mate and work with similar

mates. The model adds that agents tend to mate and work with similar people despite the fact that there might be a better matching working partner available. Moreover, these exogenous beliefs are costly and might lead to underperformance of the deals in the long run.

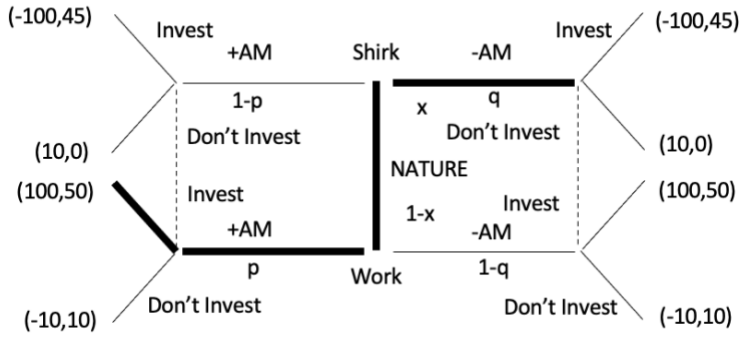

Figure 2.2 - Signaling game.

Updated beliefs

The signaling game predicts that *Investor* is more likely to choose +AM *Founder*. This is exactly what happens in the real world at least according to empirical papers discussed in the Literature review part - Botazzi et al. (2016) and Gompers et al. (2016). Furthermore, according to these studies, homogenous deals tend to underperform in the long run. The signaling game predicts both matching and underperformance based on *Investor's* exogenous beliefs regarding *Founder*. If the game is repeated and thus *Investor* observes some underperformance in positive assortative mating deals, she will simply adjust her beliefs and the game starts from the beginning, thus there is no bias towards nationality or any other trait.

Constraints model

The presented model is based on Degryse et al. (2022), where the only difference being the incorporation of monitoring costs in the second part of the model. The constraints model is included as an alternative and potential extension to the game theory model since it focuses on the same bargaining problem between *Investor* and *Founder*, however the described logic and main tools are different. Furthermore, it also implicitly focuses on the moral hazard issue since monitoring is introduced.

Set up of the model

There are two agents; the *Investor* and *Founder.* The *Founder* is endowed with intangible and tangible assets A, expects return R_F and has a private benefit from shirking B. The *Investor* makes investment I, expects a return of the deal R_I and inquiry cost of monitoring C_M if she desires this option. Based on the *Founder's* actions, there is a probability of high returns p_h and a probability of a low return p_l. Both agents face two constraints – incentive compatibility constraint (IC) and individual rationality constraint (IR). Although the actual paper considers constraints from *Founder*, this setup looks at the *Investor's* constraints. *Investor* faces IC and IR respectively.

IC:

$$R_I - C_m - I \geq p_h R_I - I.$$

$$R_I \geq \frac{C_m}{1-p_h} \quad (1).$$

That is if *Investor* pursues monitoring, she expects to earn at least what she would earn if she "gambles".

IR:

$$R_I p_h \geq I \text{ or } R_I - C_m \geq I \quad (2).$$

$$R_I \geq \frac{I}{p_h} \text{ or } R_I \geq I + C_m \quad (3).$$

That is pursuing the deal is a rational decision. Since there are two options – pursuing monitoring costs or not, there will be two possible outcomes. Due to the length constraint of this paper, I show only the part where the *Investor* decides to monitor, that is equations (1) and (3). Algebra for the alternative can be found in the appendix. If one takes both constraints, it follows that:

$$I + C_m \begin{matrix} > \\ = \\ < \end{matrix} \frac{C_m}{1-p_h}.$$

From the expression above, one can define $\tilde{I}$, where $\tilde{I} = \frac{C_m}{1-p_h} - C_m$ and consider two cases $\mathrm{I} \geq \tilde{\mathrm{I}}\ and\ \mathrm{I} \leq \tilde{\mathrm{I}}$. If $\mathrm{I} \geq \tilde{\mathrm{I}}$, IR constraint binds and it follows that:

$$\frac{C_m}{1-p_h} - C_m \leq I,$$

$$\frac{C_m}{1-p_h} \leq I + C_m,$$

$$\frac{C_m}{1-p_h} \leq R_I.$$

If $\tilde{\mathrm{I}} \leq \mathrm{I}$, IC constraint binds and it follows that:

$$\frac{C_m}{1-p_h} - C_m \geq \mathrm{I},$$

$$R_I - C_m \geq \mathrm{I},$$

$$R_I \geq I + C_m.$$

When IR binds the profits are

$$\pi_I = R_I - I - C_m,$$

$$\pi_I = I + C_m - I - C_m,$$

$$\pi_I = 0.$$

Thus, *Investor* earns 0 profits. However, if IC binds, the profits are higher than 0 if:

$$R_I - I - C_m > 0,$$

$$\frac{C_m}{1-p_h} - I - C_m > 0,$$

$$C_m\left(\frac{1}{1-p_h} - 1\right) > I,$$

$$C_m\left(\frac{p_h}{1-p_h}\right) > I,$$

$$C_m > \frac{I}{\frac{p_h}{1-p_h}} \equiv \bar{C}.$$

The *Investor* pursues the investment if the cost of monitoring is higher than the expression on the right-hand side denoted by $\bar{C}$. Note that an increase in p_h leads to lower monitoring costs. The crucial assumption here is that a higher probability of a successful deal leads to a lower need for monitoring costs.

Assortative mating

To link this model to the matching problem between *Investor* and *Founder*, I introduce assortative mating to the model. Similar to the Game theory model, I set an assumption that *Investor* creates exogenous beliefs on the ability of *Founder* based on same traits – e.g. nationality. Therefore, if positive assortative mating occurs, the *Investor* has less incentive to monitor a fellow national. Let $C_{m(AM)}$ be monitoring costs if positive assortative mating is present. It follows that $C_{m(AM)} < C_m$ and thus from the equalities above the expected profit of the *Investor* is:

$$R_I - C_{m(AM)} - I \; > R_I - C_m - I.$$

Therefore, ceteris paribus lower monitoring costs are better for the *Investor,* and she is more likely to choose this deal. This could explain the observation in the data that positively sorted deals are more likely to choose (Botazzi et al., 2006, Gompers et al., 2006). Another assumption I am making here is that the relationship between p_h and $C_{m(AM)}$ is suppressed. To put it another way, a decrease from C_m to $C_{m(AM)}$ does not affect p_h per se. One can also extent the logic of the model to the underperformance of positively sorted deals. Monitoring is not needed only before the deal is made but also after. Since, by definition, there is less monitoring needed for the homogamy deals, there are more likely to shirk and thus underperform. Note that this theoretical prediction is consistent with findings from Hege at el. (2008), where the author argues that lower performance of the European VC scene is caused by imperfect monitoring skills which might be result from inexperience and lack of foundation.

Remarks on the theoretical framework

Both models offer theoretical predictions that serve as support for the empirical part. The game theory model considered a basic 2x2 setup, dynamic game, and mainly then signaling game with exogenous beliefs of *Investor*. The Nash equilibrium and perfect Bayesian equilibrium respectively were identified in each game. There does not exist one consistent Nash equilibrium as it is changing based on the assumptions of the games. However, the bottom line is that {INVEST, DON'T SHIRK} was identified as the Nash equilibrium with the greatest sum of payoffs for the first two games. Moreover, if indeed exogenous beliefs as defined in the setup exist it was shown that it favors *Founder* that has

a common trait with *Investor* and thus positive assortative mating is more likely. This then could lead to underperformance as better matching for *Investor* might be available. The constraints model was not discussed in great depth due to the length constraint of this work. However, in this model I explicitly introduced monitoring costs to the already defined setup from Degryse et al. (2022). Without the loss of generality, exogenous beliefs were yet again added to the model and the result was that *Founder* with a common trait is not monitored to a large extent and thus this leads to the underperformance defined in the literature. Therefore, both models describe a scenario in which positively sorted deals are more likely to be selected but at the same time underperform. The reason is that both are exogenous beliefs created by *Investor*. Note how are both models connected to the predictions from Gompers et al. (2016). The game theory model implies a decreased hurdle to invest, whilst Degryse et al. (2022) model predict less monitoring for positively sorted deals. Both cases might lead to underperformance of homogenous deals. The limitations of the discussed models are vast and the famous statement "all models are wrong, some are useful" fits perfectly to both scenarios (James Clear, 2018). However, the goal was to model findings in already existing literature using well known concepts such as game theory and prepare the foundation for the empirical part of this paper. The main drawback is that many factors of the model are to some extent arbitrary and exogenous. Predictions of underperformance and matching of *Investor* and *Founder* is based on exogenous beliefs of *Investor*. Generally, with experience the described behavioral biases might attenuate in time if they exist at the first place. However, without going to further speculation, I believe that the main goal of this theoretical part was achieved and the foundation for the empirical part was set adequately.

Empirical part

The theoretical part described how in theory assortative mating between founders and investors can lead to underperformance of their deals. The next step is to validate the proposed theory with adequate empirical analysis. It is not trivial to study this research question empirically. Therefore, I had to assemble a unique dataset with newly constructed controlling variables, independent variables, and most notably instrumental variables. The research question was put under scrutiny including two robustness checks. However, it is the very nature of the research question that brings with it many limitations, which must be borne in mind when contemplating the results.

Data

Because of the originality of the research question, I faced several issues when composing the dataset. Other studies, for instance, Botazzi et al. (2006) handpicked data about VC managers to enrich and strengthen their empirical analysis. However, handpicking data is both time-consuming and in general difficult in a sense of getting the right information. Moreover, a sample selection bias might be a problem as there could be common indicators among VC funds that refuse or accept to report their data in a questionnaire. For my empirical analysis, I have used three main data sources – the Zephyr database, the ORBIS database, and data about the trust measure provided by the European Commission. All data sources but the last are provided within the resources of the library at the Erasmus University of Rotterdam. Zephyr database contains data about deals in the financial world – in a general sense M&A activity, where M&A includes everything from angel investors to massive acquisitions made by Apple or Microsoft. Most of the variables used in my empirical analysis are from this data source and will be discussed thoroughly in the next section. ORBIS database contains a great variety of data about companies – here I used variables such as IPO date and the country of residence to name just a few. The last data source was the Eurobarometer survey from 1996 where the data about trust within the European nations was found. Finally, since the final dataset is a merge of three separate data sources, there was a need to align the type of variables and formatting and create new variables from other external sources. Formatting and aligning variables required data manipulation in Microsoft Excel, for instance joining a deal with an appropriate value of the trust measure. Creating new variables then mainly refers to the distance and GDP log difference between countries, which were included in the Botazzi et al. (2006) paper as well. The distance data were computed with the help of simplemaps.com, whilst the GDP log differences were taken from the FRED database.

Descriptive statistics

Whole sample

For the sake of completeness and understanding of the assembled dataset, I first provide some trivial descriptive statistics about the whole sample. The number of observations in the whole sample is 14 068. Most of the deals (around 94%) are completed, whilst the rest is either rumor-expired or assumed to be completed. The oldest deal in the dataset originates in 1997, whilst the latest in 2022. The deal value ranges from 34 million euros to 1 836 million euros. There are also slight differences between the type of deal financing. Whilst most of the deals (87%) are venture capital, the non-insignificant part, that is around 12%, are different kinds of angel-type investments. The number of deals where either the target company or the acquirer is based in the US is 2 155. An even larger number is then for either target or acquirer residing in Germany, more precisely 2 804. Therefore, the data mostly provided by Zephyr are not aligned with overall trends in the world of venture capital that were outlined in the literature review section. For instance, only for the year 2021, the number of venture capital deals in the US was around 15 500, which is even more than the Zephyr database provides for 25 years and many countries across the globe (Statista, 2022). Moreover, according to Statista, the number of deals in Europe in 2020 was 3 559. As was argued previously, venture capital deals are private matters and companies do not have the obligation to disclose all details. This natural selection bias in a sense is a direct consequence of the originality and difficulty of the research question.

European sample

Since the research questions focus solely on a specific subgroup of European deals, for instance those countries for which the trust measure is not available are excluded, I provide a graphic representation of the sample. Even though many countries especially the US are excluded from this analysis the European sample totals 4 418 observations. Figure 3.1 shows that the number of deals in the sample increased from 11 in 1997 to 500 in 2015. The red line shows the overall trend over the years. Note also how data from the sample are aligned with the seasonality of the venture capital industry. In 2000, right in the middle of the dot com bubble, the number of deals peaked at 468. This value was overcome not sooner than 15 years later in 2015. Note also that the last announced year considered in this sample is 2015. The reason is that some time is needed for the target company to be deemed successful. I did this cut-off arbitrarily and arguably it does not have an impact on the validity of the research question. Moreover, Botazzi et al. (2016) also cut their sample following similar logic.

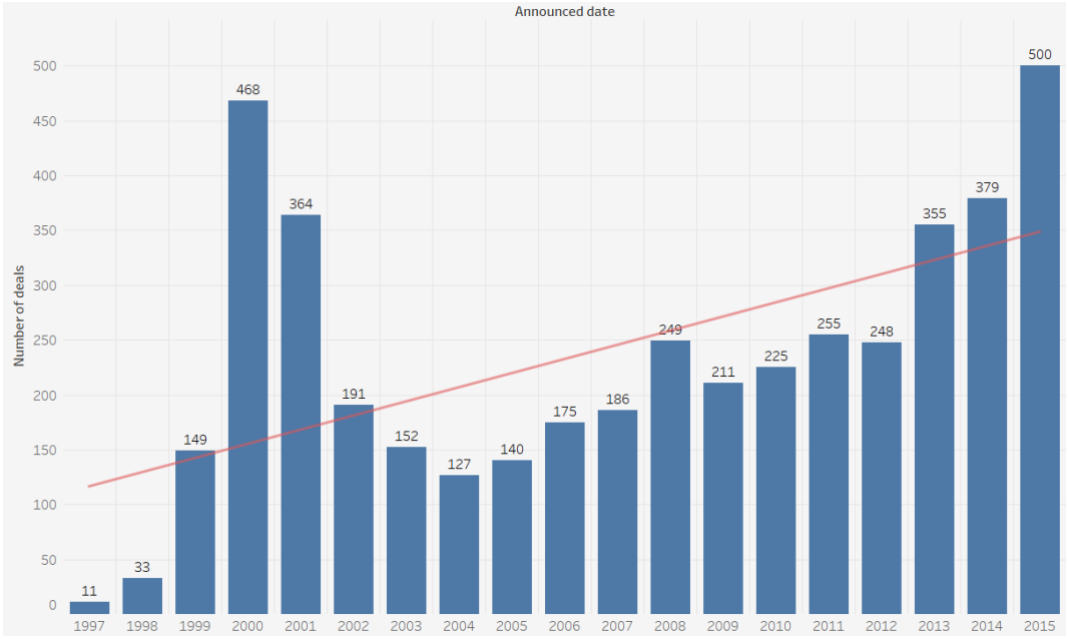

Figure 3.1 - Number of European VC deals over time in the studied sample. Data analysis was conducted in the Tableau software.

It is not surprising that most of the European deals in the sample originate in Germany and France. However, as Figure 3.2 depicts, it is slightly surprising that the number of deals that originated in the UK is just slightly higher than in Italy. More precisely, Figure 3.2 depicts in which country a target resides. Other countries such as Spain, the Netherlands, Ireland, and Sweden are also present with hundreds of deals. Regarding the per capita view, it seems that Sweden with its 10 million inhabitants would top the ranking. This is not surprising given that the most valued European start-up or rather a private company is Klarna and one the biggest and most popular IPOs in the past five years founded in Europe is Spotify. As of 2022, Spotify's market cap is around $17 billion whilst Klarna is valued at around $7b, down from $45b a year prior (Yahoo Finance, 2022). Interestingly, the latter company still has its and headquarters in Stockholm, Sweden (Yahoo Finance, 2022).

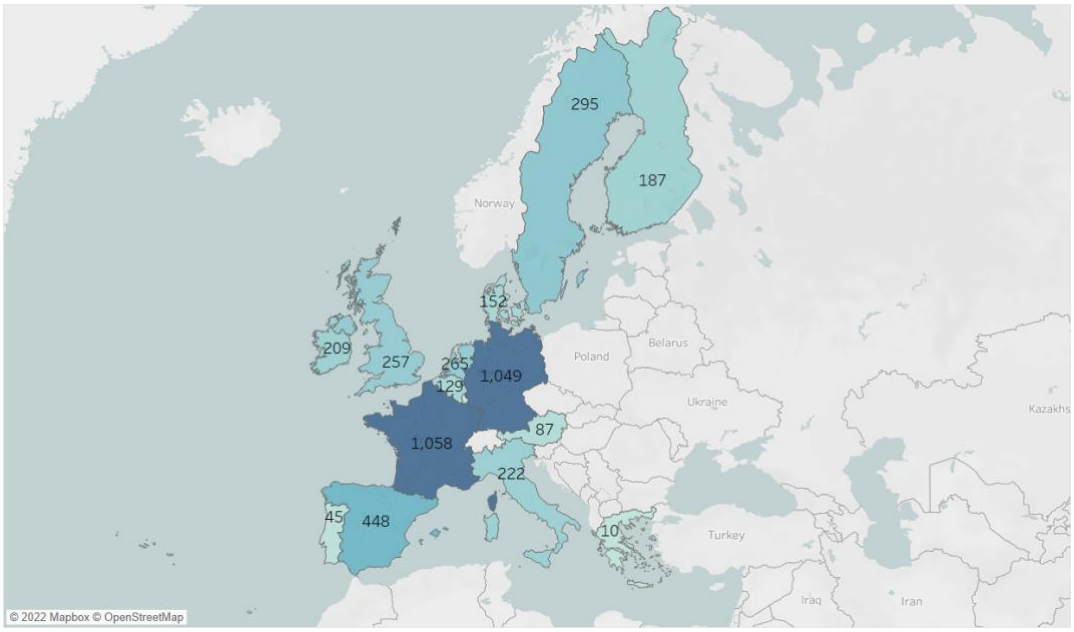

Figure 3.2 - Number of deals per European country. The shades of blue indicate data density. Data analysis was conducted in the Tableau software.

Figure 3.3 graphs a distribution of all deals in the sample by their value. The x axis represents the value of the deal in thousands of euros divided into same sized bins and the y axis gives information about how many deals are present in a given category. This distribution is then compared to the standard normal distribution. As it happens, the deal value of the sample is not normally distributed. Most of the deals are up to € 2 million, but fat tails also exist. The standard normal distribution is almost a magical concept since some types of data such as the height and weight of human beings are almost perfectly normally distributed. However, as Figure 3.3 demonstrates, it is not the case with the value of the deals in the sample. Figure 3.4 then in a trivial way depicts the size of different deals regarding a cross-country combination of targets and acquirers. At the first sight, homogenous combinations prevail, that is a deal with a target and an acquirer from the same country is the most common outcome. However, there are likely to be confounders such as distance or other omitted variables that might have an impact on the result, and thus at this stage, I only describe data observed in the sample without going into the empirical predictions.

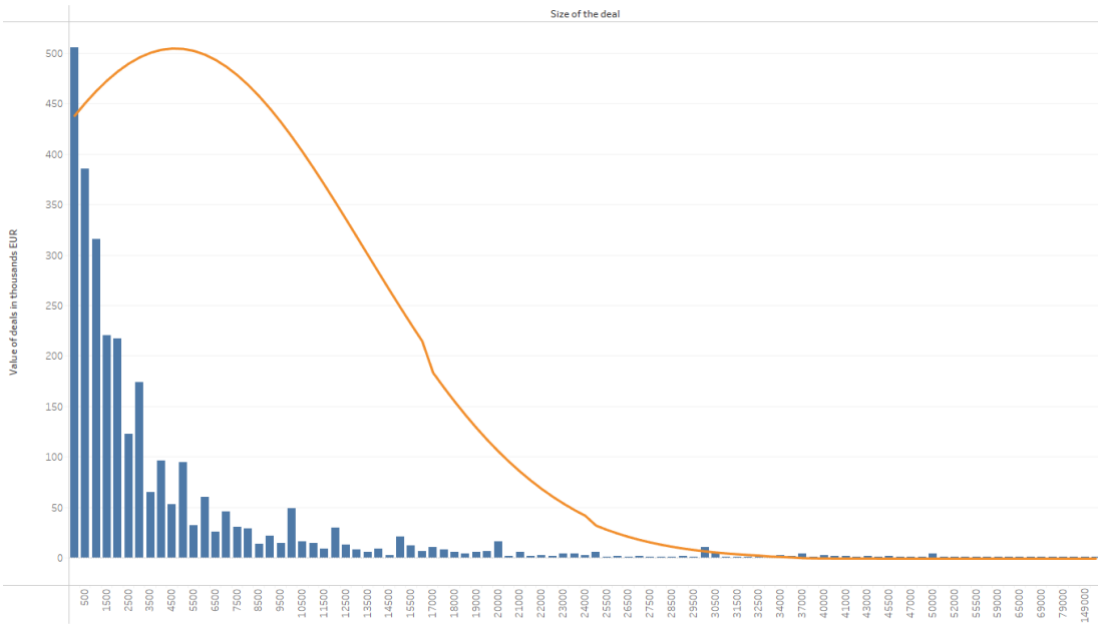

Figure 3.3 - Distribution of value of deals compared to the normal distribution. Data analysis was conducted in the Tableau software.

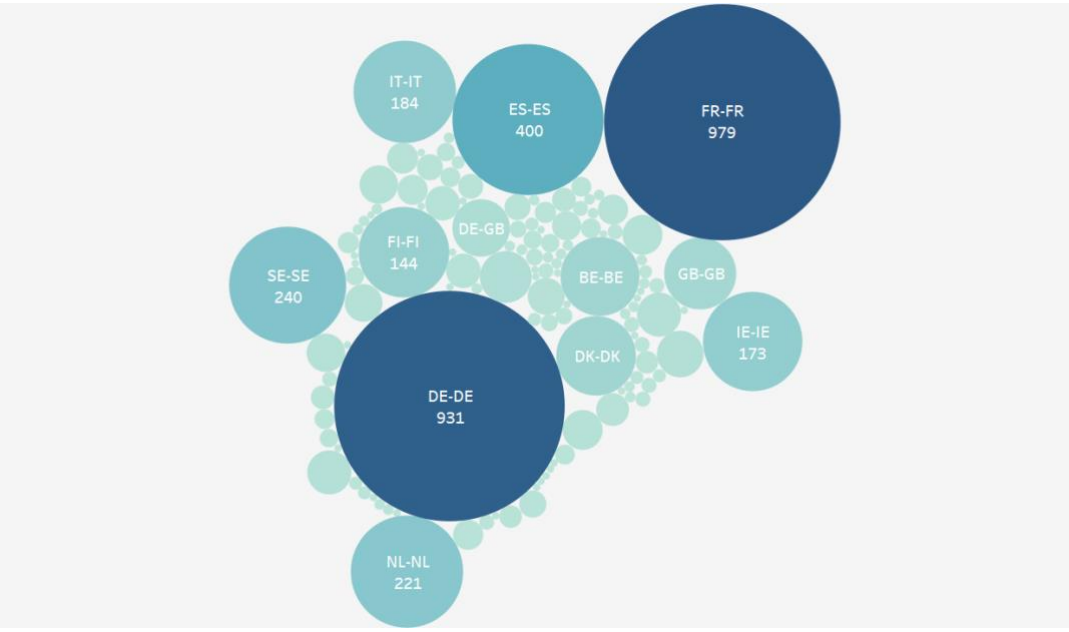

Figure 3.4 - Number of deals by combination between acquirors and targets. Data analysis was conducted in the Tableau software.

Control variables

Since some variables were calculated in addition to the original variables from Zephyr and ORBIS, I divide this section into given variables and custom variables.

Given variables

Deal value

- Estimated value of the deal in thousands of euros. There are many missing values which is not surprising since the deal value does not have to be disclosed with private deals.

Deal financing

- This variable refers to the type of a deal. Most deals in the sample are categorized as VC deals, whilst some angel investments are also included. In numbers, over 90% of the deals are categorized as VC deals by Zephyr and thus the sample selection sticks closely to the research question.

Announced date (YEAR)

- This variable is only a modification of Zephyr's "Announced date" variable since it takes only a year from the date. Thanks to that, I could perform data manipulation more easily in STATA. Interestingly, over 95% of observations share the same "Announced" and "Completed date". This peculiarity might come down to the fact that information about the deal is released all at once and thus both dates are the same.

Post-deal target profit before tax

- This measure provides information about financial condition of target company first available year after the deal. The number is reported in thousands of euros.

Pre-deal target profit before tax

- This measure provides information about financial condition of target company last available year before the deal. The number is reported in thousands of euros.

Target NACE Rev.2 code(s)

- NACE codes categorize businesses according to their activity. The official definition is that "NACE is the acronym used to designate the various statistical classifications of economic activities developed since 1970 in the European Union." (NACE rev. 2, 2008, p.13). Accordingly, this variable was converted from a code to a string. However, NACE Rev.2 codes are often very specific and in essence there exist hundreds of business categories. For simplicity, I used only 38 different categories. For instance, the category "Agriculture, forestry, and fishing" in the report can be further broken down into "Animal production", "Crop production" and many other subcategories. This complex segmentation was thus for purpose of this paper simplified.

Target IPO date

- Issuing shares of a private company is arguably the most desired outcome of venture capitalists. Most of venture investments are for approximately 5 to 10 years as it takes time for a company to develop from a startup or even middle-sized company to an IPO prospect. This variable simply provides date when given IPO occurred.

Target/Acquiror city

- European city where target and acquiror reside.

Custom variables

The following variables were added to the dataset on the top of variables provided by any of the mentioned data sources. The reason is mainly fear for omitted variable bias, which is a common problem in econometric analysis. Therefore, I decided to include what I deem relevant explanatory variables that aim to mitigate this bias.

Distance in km

- Distance is a very important variable regarding the research question. The reason is that assortative mating can be well explained not by the fact that there are sympathies between like people but simply because they are geographically closer to each other. For example, a VC investor from Prague has indeed many options to invest in the whole of Europe, however, given that her office is located in Prague, she might be more likely to invest in Prague-based companies. Including this variable in the regression should mitigate this effect. Regarding the construction of this measure, I generated the longitude and latitude of cities given in the dataset provided by ORBIS

and Zephyr from simplemaps.com. Then I used a formula provided on the internet to generate distance firstly in miles and then in kilometers after simple conversion. Calculated distances were then checked with googlemaps.com values.

GDP log difference

- To control for any differences in economic strength, GDP log difference is also added as an explanatory variable. The data were downloaded from FRED St louis database and then converted to log form in Excel.

AM

- A binary variable that equals 1 if VC deals are positively sorted by country of residence of the VC fund and founders. Therefore, if both investor and investee are from Spain, this variable will equal 1.

Instrumental variables

Trust measures

This measure is gained similarly to Botazzi et al. (2016) and it is the main building block of the empirical strategy. Data about the trust of one nation in another are from a Eurobarometer survey undertaken in 1996 (Eurobarometer 46.0, 1996). As the name suggests, this survey was held within the European Union member states and is indeed published to this day, thus providing an interesting and reliable source of information and mood among European nationals. Thousands of interviews across Europe were held with the total number of respondents being slightly over 200 000 (Eurobarometer 46.0, 1996, p.38). The authors of the survey posed the following question: "I would like to ask you a question about how much trust you have in people from various countries. For each, please tell me whether you have lots of trust, some trust, not very much trust, or no trust at all" (Eurobarometer 46.0, 1996, p.5). Since the survey contains many other questions, I had to extract only this specific question for all countries. I made some aggregation and simplification of the data – for instance joining data from East and West Germany

Having robustness checks in the empirical analysis in mind, I constructed two measures of trust between nations. The first is a fraction of people in a given country that has a lot of trust, that is score 1, towards a different country. The second measure then takes a simple average of the aforementioned options in the survey, whereby 1 = Lot of trust, 2 = Some trust, 3 = Not very much trust and 4 = No trust at all. Therefore, the first measure is a percentage, where a higher number

implies higher trust. The second measure is a number where a lower number means higher trust. Results from the trust measure undoubtedly mirror the characters of the European nations involved as well as pose interesting information about attitudes within the same nationality. For instance, in line with the hypothesis of assortative mating, the top three average scores are matches from Finland, Denmark, and Sweden, that is Finnish people trust most of their fellow nationals compared to all other European countries. In numbers, 72% of Finns reported they have a "lot of trust" in their fellow nationals. Finns are then followed by Danes and Swedes. On the other side of the spectrum are the non-assortative mated pairs, namely Portugal-Greece, Greece-Germany, and Spain-Great Britain. Only 2% of Portuguese reported that they have a "lot of trust" in Greeks. Only 4% of Spaniards then have "a lot of trust" in Britons. Figure 3.5 then shows the score for every pair in the sample, with red being the worst. Green color pairs are often sorted by the same nationality, whilst red fields are in line with heterogamy. In fact, the country with the worst score that follows positive assortative mating is Italy. Only 22% of Italians have a "lot of trust" in their fellow nationals. The least trustful nation is then Portugal as 7 out of 10 worst outcomes in the survey involve Portuguese. Only between 1-8% of Portuguese have a "lot of trust" in Swedes, Belgians, Germans, Finns, the Irish, Austrians, and Greeks. Note that Figure 3.5 does not give information about the exact number of Trust measures and does not display all countries. The objective was rather to provide a graphical illustration of the results of Trust measures across countries.

Figure 3.5 - Trust measure scores by pairs between countries. Data output was conducted in the Tableau software.

Dependent variables

Success1

It is a binary dependent variable that takes on value 1 if the given target company went public. Note that even though in the sample I consider only deals up to 2015, the IPO date is not limited. Therefore, in the extreme case, a deal done in 2015 with IPO in 2022 is included in the sample. That gives even in the extreme case 7 years for the target to issue a public offering. Measuring success in VC deals is a difficult task as not only IPO itself represents a successful deal. For instance, a share acquired by a VC fund can be sold in the future for a higher price, which would also mean a monetary successful deal or a positive net present value of the deal. Yet due to the lack of data and overall complexity of tracking the lifetime of target companies, I decided to pursue the IPO date as an ultimate measure of success of the deal. This strategy was also used by Botazzi et al. (2016). Generally, there is a long way from striking a deal and issuing shares. Indeed, only roughly 1% of all companies from the sample finished in IPO and thus are deemed successful under the definition of Success1 variable.

Success2

Success2 variable is also a binary variable and works as an extension of Success1 variable, where I consider successful deals as those that not only resulted in IPO but also those where the target's profit before tax was higher after the deal compared to before the deal. On one hand, there are more deals deemed as successful according to this measure. On the other hand, measuring success this way can result in inconsistencies. The profits are measured as the last and first available year before and after the deal respectively. Path to a profitable business usually takes longer than a few quarters. Furthermore, even non-profitable businesses with the right business strategies and investments could be deemed successful. This is true, especially for growth industries such as technology, where it is conventional to scale the business at the expense of profitability. These limitations are the reason why Success2 is used as a robustness check variable.

Empirical strategy

Theoretical framework

Primarily due to endogeneity concerns I pursue an empirical strategy based on instrumental variables. Since I want to study the effect of assortative mating on the performance of the European VC deals, the trivial approach would be to run an ordinary least square (OLS) regression of AM binary variable on the dependent variable Success1. However, there are many other factors such as personal preference, experience, or the language of either founders or investors that might affect the binary variable AM. Note that even after controlling for distance in kilometers and GDP log difference, there still are potential variables that are correlated with the binary variable AM but are not included in the regression. This common phenomenon in Econometrics is called the omitted variable bias. Wooldridge (2009) offers an example of the effect of education on wages arguing that one cannot regress education or years of schooling on wages since omitted factors such as ability are potentially correlated with both wage and education. Since ability is difficult to measure, an instrumental variable is an effective way to deal with this endogeneity issue.

In general (and it is no different for this paper), there are two conditions that need to be met when considering the use of the IV. One must find a suitable instrument that is both relevant and exogenous. The relevance condition is simply defined as:

$$Cov(x_i, z_i) \neq 0,$$

where x_i refers to the endogenous variable, AM in this paper, and z_i refers to the instrumental variables *z1* and *z2*, which correspond to the two Trust measures introduced in the previous section. Theoretically, people should trust more their fellow nationals than strangers' nationalities. This, of course, can differ from a person to person and probably also nation to nation. However, intuitively the trend should be a positive correlation. Colorful matching in Figure 3.5 showed evidence that it is indeed the case. Moreover, as Table 3.1 depicts, there is a strong correlation between AM and both instruments. Note that the sign of the correlation is different for *z1* and *z2*. The reason is the way both instruments are defined: for *z1* higher number means lower trust and for *z2* higher number reported means higher trust, which explains why there is a minus sign in front of *z1*. It is worth highlighting the close to a -1 correlation between both instruments, which is not surprising given both variables originate from the same survey.

Table 3.1 - Correlation between instruments and endogenous variable.

	AM
AM	1.00
Instrument 1	0.65
Instrument 2	-0.71

Unfortunately, the exogeneity condition is not as straightforward and easy to validate. Simply one will cannot know for sure whether an instrument is truly exogenous or not. In general, the exogeneity condition is defined as

$$Cov(z_i, u_i) = 0,$$

where u_i refers to the error term. An alternative interpretation of this condition is that z_i should not be in the equation for a dependent variable y_i. A typical instrument often used in literature feels exogenous by nature. For instance, Angrist and Krueger (1991) use a quarter of birth as IV when calculating the effect of education on wage. The assumption that a quarter of birth and wage are not correlated is most likely to be true and thus the exogeneity condition is supposedly fulfilled. Furthermore, in the US the amount of schooling is correlated with quarter of birth as children born in January start school with higher age than those born in December (Angrist and Krueger, 1991). Another example of most likely exogenous instrument is from Bennedsen et al. (2007), where authors aim to study the detrimental effect on a company's profit when CEO successor is from the same family. The authors pick the gender of the first-born child of departing CEOs as IV. The relevance restriction is fulfilled as first-born boys are more likely to become successors than girls. At the same time, there is potentially no effect of children' gender on firms' performance. The instrumental variable used in this study is the previously described trust measure between European nations. Trust is clearly important when choosing a partner in VC matching process, however it should not have any effect on the future performance. In other words, I assume that the only way in which trust affects the future performance of the deal is via positive assortative mating. From the point of view of economic theory, when both founders and venture capitalists arguing about the deal, they should base their decision on maximizing their future utility. Soft traits such as trust among different nationals should not affect it. However, the way the exclusion restriction is built, the IV here trust, can have an impact but only via the endogenous variable. Therefore, trust between European nations per se should not have an impact on the performance of VC deals and thus is exogenous.

Two-stage least squares (2SLS) is a conventional empirical strategy when working with instrumental variables. Following description is based on Wooldridge (2014) and it follows conventional empirical steps:

1st stage

$$AM_i = \alpha_0 + \alpha_1 z_i + \alpha_2 Controls_i + \varepsilon_i$$

where conventional OLS is run $\widehat{AM_i} = \widehat{\gamma_0} + \widehat{\gamma_1} z_i + \widehat{\gamma_2} Controls_i$.

2nd stage

$$Success_i = \beta_0 + \beta_1 \widehat{AM_i} + \beta_2 Controls + \mu_i$$

where again conventional OLS is run and β_1^{2SLS} approximates to true β_1.

Results

Base regression

Table 3.2 depicts the result of the first stage of 2SLS, which incorporates both *z1* and *z2* instruments, as well as control variables and year, deal financing and industry fixed effects. Both instruments are statistically significant at the 1% significance level and therefore fulfilling the relevance condition. Similarly, to the reported correlation in Table 3.1, Instrument 1 (*z1*) has a different sign to Instrument 2 (*z2*), an outcome that is also seen in the first stage of 2SLS. Moreover, including the control variables is justified by the reported statistical significance. The number of observations is 1211 as some deals are drop due to missing observations in the sample.

Table 3.2 - The first stage of 2SLS with both instruments. AM is dependent variable.

	(1) Instrument 1	(2) Instrument 2
z1	1.557***	
	(0.0533)	
Dealvalue	-0.00000308**	-0.00000302**
	(0.00000115)	(0.00000104)
Distance	-0.0000244***	-0.0000191***
	(0.00000614)	(0.00000556)
GDPdifference	-0.590***	-1.113***
	(0.220)	(0.200)
z2		-0.847***
		(0.0234)
_cons	0.403	2.436***
	(0.430)	(0.390)
N	1211	1211
R2	0.505	0.596
Year FE	Yes	Yes
Deal financing FE	Yes	Yes
Industry FE	Yes	Yes

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Table 3.3 depicts results of the second stage 2SLS for both instruments. The coefficients are jointly statistically significant. The most important coefficient is the negative sign of the initial endogenous variable *AM*. If Instrument 1 (*z1*) is used, then the negative coefficient is statistically significant at 5% significance level. In other words, according to the results positive assortative mating has a negative effect on the success of the deal. If Instrument 2 (*z2*) is used, the statistically significance is not confirmed, however, the negative sign persists. *Dealvalue* has a positive coefficient and is statistically significant across both instruments. R-squared of both regressions is comparable – 0.122 and 0.129. This implies that 12% of the variation in *Success1* is explained by included variables. Industries such as agriculture, the manufacture of pharmaceuticals, or scientific research and development have a positive sign and are statistically significant at a 5% level. Moreover, dummies for the years 1997, 1999, 2000, 2006, and 2009 as well as the family office are also statistically significant at a 5 % level[1]. Note that due to the use of binary variables both for the dependent and the endogenous variable, the interpretation of the coefficient is limited. This does not apply solely to the

[1] The output of the whole regressions including dummies for fixed effects can be found in Appendices.

endogenous variable but also to explanatory variables. Therefore, I mainly focus on the sign and statistical significance of the endogenous variable.

Table 3.3 - Dependent variable Success1.

	Instrument 1	Instrument 2
AM	-0.0570**	-0.0297
	(0.0253)	(0.0226)
Dealvalue	0.00000203**	0.00000223***
	(0.000000864)	(0.000000856)
Distance	-0.00000743	-0.00000602
	(0.00000468)	(0.00000462)
GDPdifference	-0.0420	-0.0357
	(0.162)	(0.162)
N	1211	1211
R2	0.122	0.129
Year FE	Yes	Yes
Deal financing FE	Yes	Yes
Industry FE	Yes	Yes

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Robustness checks

To put the results under scrutiny, I run the same regression using a different dependent variable - *Success2*. Recall that *Success2* is an extension of *Success1* variable, where on the top of now public firms, companies whose profit was higher after the deal than before the deal are deemed to be successful as well. Table 3.4 summarizes the results. The number of observations is still the same as well as the joint statistical significance of the regressors. However, the R-squared is much smaller, and therefore less variation in *Success2* is explained by dependent variables. More importantly, for Instrument 1 (*z1*), the coefficient of the endogenous variable is negative and statistically significant at 1% level. Similarly, to outcome of regressions with *Success1* variable, the endogenous variable is not statistically significant with Instrument 2 (*z2*). However, it is still negative. The GDP difference variable is also statistically significant at a 5 % level with a negative sign for both variables.

The second robustness check is to include countries' specific fixed effects. More precisely, check regressions output when controlling for the nationality of the investors and investees. Table 3.4 depicts results of this specification. Coefficients in the regression are jointly statistically significant. Notably however, the endogenous variable is not statistically significant anymore, yet its coefficient is negative across both instruments. The p-value of Instrument 2 (*z2*) is especially close as it is 0.105.

Correspondingly to the original specification, *Dealvalue* coefficients are positive and statistically significant at 1% level. R-squared of the regression slightly improved to 0.142.

Table 3.4 - Dependent variable Success2

	Instrument 1	Instrument 2
AM	-0.126***	-0.0591
	(0.0455)	(0.0404)
Dealvalue	0.000000801	0.00000132
	(0.00000155)	(0.00000153)
Distance	-0.0000146*	-0.0000111
	(0.00000841)	(0.00000827)
GDPdifference	-0.601**	-0.586**
	(0.292)	(0.289)
N	1211	1211
R2	0.050	0.067
Year FE	Yes	Yes
Deal financing FE	Yes	Yes
Industry FE	Yes	Yes

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Table 3.5 - Investor/Investee FE included

	Instrument 1	Instrument 2
AM	-0.0401	-0.0297
	(0.0248)	(0.0226)
Dealvalue	0.00000299***	0.00000301***
	(0.000000878)	(0.00000878)
Distance	0.00000915	-0.00000116
	(0.00000487)	(0.00000486)
N	1209	1209
R2	0.142	0.142
Year FE	Yes	Yes
Deal financing FE	Yes	Yes
Industry FE	Yes	Yes
Investor/Investee FE	Yes	Yes

Standard errors in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

Discussion

There are some interesting results from both base and robustness check regressions. The coefficient on the endogenous variable *AM* is negative in all specifications though not always statistically significant at the crucial 5% level. Since the R-squared is higher in the base regression and Investor/Investee fixed effects specification, I deem results with *Success1* dependent variable as the

most important results. There is some evidence of the variable *AM* having a negative impact on the future success of VC deals. This finding is to some extent consistent with Botazzi et al. (2016) and Gompers et al. (2016). However, across both instruments, only once was negative coefficient statistically significant at 5% level. Therefore, the evidence is not robust.

Since Botazzi et al. (2016) study worked as the primary inspiration for this paper, I will discuss the main similarities and differences. Firstly, I decided to use the same measure of trust between nations for my empirical analysis as the authors did. However, my empirical design uses this measure as an instrument for assortative mating whilst Botazzi et al. (2016) use it only to explain the probability of a deal or indeed a success of a deal. In other words, I aimed to find information about whether assortative mated deals underperform whilst Botazzi et al. (2016) goal was to study the effect of trust on deals' performance. Although not always true, generally it holds that if people are positively sorted, they tend to trust each other and thus this is the reason why both studies are similar. The results of both studies are to some extent also connected since Botazzi et al. (2016) found that higher trust between founders and investors undermines performance. However, Botazzi et al. (2016) go much deeper in the empirical analysis than I did as they also found that trust increases the probability of a deal. Furthermore, thanks to a Heckman selection model with an exclusion restriction and its Mills ratio they conclude that the "negative relationship between trust and success is driven by selection effects." (Botazzi et al. 2016, p.2285). This suggests that higher trust is associated with risk-seeking behavior or lower effort in general from investors. The methodology used in both papers is very much different as this study makes use of regression with an instrumental variable, whilst Botazzi et al. (2016) use a logit model. Therefore, my paper looks at a similar topic through different lens and finds a similar though not robust conclusion as Botazzi et al. (2016).

Regarding empirical strategy of this paper, there are many limitations that could have influenced the results – interpretation of the coefficients, sample selection bias, old data for trust measure, independent variable *Success2*, instrument exogeneity and *AM* variable. I shall discuss these limitations one by one. Firstly, I run the instrumental variable regression with both the instrument as well as the endogenous variable being binary variables. Therefore, the interpretation of the coefficients is not as straightforward as with continuous variables. As a result, I only interpreted the sign and the statistical significance of coefficients, which might be deemed insufficient.

Secondly, there might be a sample selection bias present. This limitation was already discussed to some extent throughout this paper, mainly in regard to hand-picked data from questionnaires. The empirical part relies to a large extent on the dataset provided by Zephyr. However, since details of the

deals do not have to be made public by the parties involved, there is a danger that only companies with some common characteristics make exclusive information such as deal value or companies' profit after a deal available. In other words, the randomization of data, which is always crucial in empirical analysis, might not be perfectly achieved. In general, examples of sample selection bias can be for instance related to wages. Heckman (1972) argues that "One observes market wages for working women whose market wage exceeds their home wage at zero hours of work. Likewise, one observes wages for union members who found their nonunion alternative less desirable." (Heckman, 1972, p.153). These samples do not need to necessarily represent the true population as might be the case with the sample used in this study. In the end, it comes to the difficulty of the research question. Working with data from deals of private companies will always have the danger of the possibility of sample selection bias.

The third limitation of the reported results might be the trust measure variable. Since the data comes from the survey undertaken in 1996, the attitudes of Europeans towards their fellow and other nationals might have simply changed. Geopolitical issue such as Brexit and the war in Ukraine arguably impacts these moods among Europeans to a large extent. However, I would argue that in general, positive assortative mating and trust still go hand in hand as they might be unlikely to change – people will trust more to someone with a common trait, here nationality, rather than a stranger. Another limitation is the specification of the *Success2* variable. As previously described, the *Success2* variable takes on value 1 if a target company went public or reported profits after the deal was higher than before the deal. The issue here might be that Zephyr reports data only in the first available year after the deal. Determination of success in VC deals takes arguably much longer than that. Therefore, companies that are not profitable or less profitable in the first year after the deal might still do very well in the following years. Indeed, the usual lifetime of a VC fund is around 8 to 10 years. This limitation of the *Success2* variable urged me to mostly rely on results with the *Success1* variable, that is a deal is deemed successful if and only if the target company went public.

Another limitation I shall address is the instrument exogeneity condition. The relevance condition is trivial to assess since a simple correlation between an instrument and an endogenous variable is often enough. On the other hand, one cannot be completely sure that the instrument is exogenous. In the context of this study, the level of trust between European nations must affect the success of the deal only via assortative mating. In theory, trust should not matter when it comes to the performance of the deal. However, as previously argued, Botazzi et al. (2016) report a negative effect of trust on the probability of success of VC deals. In this study, I make the assumption that this trust effect is attributed to assortative mating and thus the trust instrument is exogenous. Finally, for

the endogenous variable AM, I do not consider nationality of investor but rather country of residence of VC funds as a source of information. It might be the case that a nationality of a venture capitalist or indeed a founder is not always the same as the country of residence of their respective fund or company. I made this simplification due to data availability.

Apart from the many limitations, I believe that there is an added value in the empirical part of the study. First, I looked at more recent VC deals that have not been covered by Botazzi et al. (2016). However, more importantly, I pursued the instrumental variable approach to deal with potential endogeneity. By doing that one is arguably closer to a desired causal relationship. Both Botazzi et al. (2016) and Gompers et al. (2016) used a probit /logit model in their studies. Thanks to a more detailed dataset they were able to control for many potential omitted variables. However, since I had limited resources when conducting a dataset, I could not rely on many control variables. Furthermore, the instrumental variable strategy is indeed powerful and often used when dealing with endogeneity issues. Therefore, given the theoretical setup and resources, I argue that the instrumental variable strategy was not only the right choice but also offers a novelty when studying the underperformance of VC deals that are formed based on positive assortative mating.

Conclusion

By discussing literature, constructing theoretical models, and analyzing empirical data, this thesis showed that there is some merit to underperformance of deals that suffer from positive assortative mating in VC. I chose an approach where I firstly discussed relevant literature, secondly constructed a theoretical framework, and finally brought some empirical evidence of this bias. Furthermore, both theoretical and empirical part offer space for robustness checks and thus the research question is put under great scrutiny throughout the paper. The expectations from this work were high and even though there are many limitations that have been thoroughly discussed, I can state that the expectations were to some extent met. Yet if the results from the empirical part were more robust, for instance statistically significant across all robustness checks, the output and impact of this thesis would be better and more reliable.

Throughout the paper, I build on existing concept of behavioral bias due to positive assortative mating. Furthermore, similar research question has been addressed in the past. Indeed, the main inspiration for this paper were Becker (1973), Gompers et al. (2016) and Botazzi et al. (2016). However, at the same time I touched at many novelties. First, by using game theory and moral hazard concept, I defined theoretical framework for the bias resulting from positive assortative mating. Secondly, the instrumental variable methodology was not applied by neither Botazzi et al. (2016) not Gompers et al. (2016). Finally, the chosen sample considered only European and mainly more recent deals than that are available in the literature. I deem all the aforementioned points as the main contributions to current literature.

To better understand given problem, there is a space to track how the behaviors of investors and founders will change in time and how it differs across different regions. In general, Europe is more nascent to VC and thus might offer more space for the bias than in the US. At the same time, even the European VC industry is improving every year. The clear disadvantage of the research question is that one is looking at least five years into the past. However, the main improvement are the data. I hope that data from VC deals will be more accessible and more detailed in the future. If it is the case, one can deduct selection bias and other data related issues from limitation of the research.

It seems that opposites do not attract, quite the reverse. Behavioral biases are relevant and present even for bright individuals such as venture capitalists. Despite all the limitations, there is a merit to the argument that positively sorted deals underperform in the long run. Therefore, venture capital funds should be critical to founders that they share a common trait with – one being

nationality. With a little bit of imagination, the observed result could be applied to any other relationship humans engage in and thus picking the right mortgage, car or property can suffer from assortative mating bias.

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Appendices

Game Theory

Unchanged outcome of the game when shirking brings the same payoff to *Founder* as working.

	Founder		
Investor		SHIRK	DON'T SHIRK
	INVEST	-100,50	100,50
	DON'T INVEST	0,0	-10,-10

If the payoffs are 0 when investment does not happen.

	Founder		
Investor		SHIRK	DON'T SHIRK
	INVEST	-100,50	100,50
	DON'T INVEST	0,0	0,0

Constraints model

Founder faces IC since it follows that:

$$p_h R_F \geq p_l R_F + B$$

$$R_F \geq \frac{B}{\Delta p}$$

In words, there is incentive to work for *Founder.* Note that this is similar to benefit of shirking being less than actual reward when investment happens, and *Founder* works defined in the game theory set up. *Founder's* IR is as follows:

$$p_h R_F \geq A$$

$$R_F \geq \frac{A}{p_H}$$

That is, it must be rational decision for *Founder* to not keep status quo and enjoy her assets.

Empirical results

	Instrument 1	Instrument 2
AM	-0.0570**	-0.0297
	(0.0253)	(0.0226)
Dealvalue	0.00000203**	0.00000223***
	(0.000000864)	(0.000000856)
Distance	-0.00000743	-0.00000602
	(0.00000468)	(0.00000462)
GDPdifference	-0.0420	-0.0357
	(0.162)	(0.162)
Agriculture	0.491***	0.487***
	(0.154)	(0.154)
Manufacturing in pharmaceuticals	0.118***	0.120***
	(0.0352)	(0.0351)
Mining	0.952***	0.952***
	(0.218)	(0.217)
Scientific research and development	0.103***	0.105***
	(0.0374)	(0.0372)
1997	0.887***	0.881***
	(0.271)	(0.216)
1999	0.118***	0.123***
	(0.0444)	(0.0442)
2006	0.0782**	0.0814**
	(0.0324)	(0.0322)
2009	0.119***	0.115***
	(0.0349)	(0.0347)
Family office	0.0742**	0.0729**
	(0.0358)	(0.0356)
	0.272**	0.275**
	(0.126)	(0.125)
N	1211	1211
R2	0.122	0.129
Year FE	Yes	Yes
Deal financing FE	Yes	Yes
Industry FE	Yes	Yes

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01