Essays on Entrepreneurial Finance

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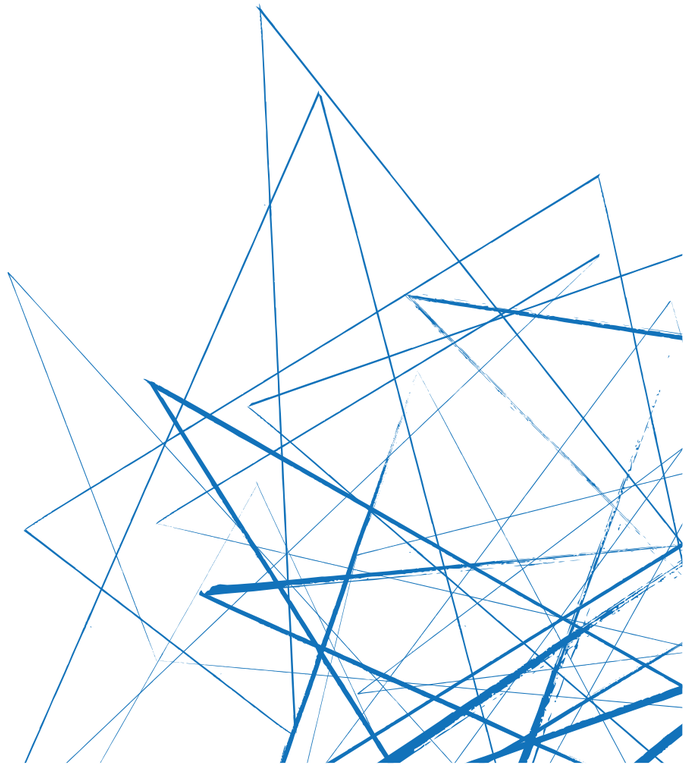
ESSAYS ON ENTREPRENEURIAL FINANCE



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Jacek Piosik

ESSAYS ON ENTREPRENEURIAL FINANCE

Department of Finance

PhD Series 43.2023

CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

Essays on Entrepreneurial Finance

Jacek Piosik

A thesis presented for the degree of Doctor of Philosophy

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Essays on Entrepreneurial Finance

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Abstracts in English

This PhD dissertation is organized in three independent chapters, that address different topics in the field of entrepreneurial finance. The first two chapters consider individual entry into entrepreneurship, and the third chapter considers interactions between founders and angel investors in informal venture capital markets.

Chapter 1. On the Anatomy of Entrepreneurship
(with Damiano Argan and Leonardo Indraccolo)

We investigate the relationship between individuals' skill composition and self-selection into entrepreneurship. Using administrative micro-data from Denmark, we measure analytical skills and communication skills using high school grades in math and native language as proxies. We find that specialized skill sets are rewarded in the labor market, but are negatively related to the probability of becoming an entrepreneur. We also find that for students with high analytical skills, the probability of becoming an entrepreneur is monotonically increasing in communication skills, while the reverse case is not true for students with high communication skills. Motivated by evidence that individuals with high analytical skills run more profitable firms, we propose an identification strategy based on peer effects to estimate the causal effects of skill balance on the probability of entry into entrepreneurship. For the subpopulation of high-performing math students, we use within-school and between-cohort variation in exposure to peers that have parents with a university degree in humanities. We find that the most treated individuals have 20% higher probability of becoming an entrepreneur, compared to the least treated individuals. These findings highlight the importance of improving communication skills of individuals with high analytical proficiency to facilitate the creation of high-performing firms.

Chapter 2. Entrepreneurship, Wealth and Human Capital
(with Leonardo Indraccolo)

How important is the accumulation of human capital versus wealth in explaining selection into entrepreneurship over an individual's life-cycle? To answer this question we construct a new dataset based on Danish administrative data and use it to study the characteristics of individuals that select into entrepreneurship at different stages of their life. We provide new evidence on the fact that entrepreneurs are self-selected along several measures of human capital and skills. We show that entrepreneurs, compared to workers of the same age, on average i) earn higher wages before starting their business ii) experience higher growth rates in wages iii) have more years of education and labor market experience. We show that this self-selection, in terms of human capital, is even stronger across the most productive entrepreneurs. We also show that future entrepreneurs hold slightly higher wealth, compared to workers of the same age, prior to starting the business. We ask whether aspiring entrepreneurs face liquidity constraints and use fathers' wealth as indirect proxy for the

easiness in access to credit. We find that the probability of becoming an entrepreneur is essentially flat along the central part of the family wealth distribution and increasing only at the tails, which is inconsistent with the view that future entrepreneurs face major liquidity constraints. To quantify the relative importance of human capital accumulation versus wealth in affecting individuals' decisions to start a business we propose a quantitative general equilibrium life-cycle model with human capital accumulation, financial frictions and occupational choices. The model is used to disentangle the role of wealth, skills and the quality of the business idea in affecting self-selection into entrepreneurship. Through counterfactual exercises we establish how financial frictions affect the quality of new ventures by distorting individuals' human capital accumulation decisions. Finally, we use the calibrated model to quantify the efficiency and welfare effects of a tax policy aimed at incentivising business creation by young individuals.

Chapter 3. Angels Don't Fall From Heaven
(solo authored)

I investigate the impact of angel investors' human and social capital in informal venture capital markets. I assemble a novel dataset that identifies the population of angel investors in Denmark, and I use prior experience in management and governance related roles to proxy for human and social capital. I find that angel investors with high management experience, relative to founders, obtain equity at discounted valuations, and also observe superior post-investment firm outcomes. The effects are progressive and amplified when experience is acquired in entrepreneurship. In contrast, high governance experience does not affect valuations or outcomes. These findings suggest that managerial human capital generates surplus for investees, and therefore commands an investment premium, while governance-related human capital or overall social capital does not. The findings provide a rationale for targeted rather than generic investment policies.

Abstracts in Danish

Denne PhD afhandling er organiseret i tre uafhængige kapitler, der adresserer forskellige emner inden for iværksætteri og finansiering.

Kapitel 1. Om Entreprenørskabets Anatomi
(med Damiano Argan og Leonardo Indraccolo)

Ved anvendelse af danske administrative data undersøger vi i dette papir, hvordan individers kompetencer påvirker selvselektion ind i iværksætteri. Vi anvender detaljerede data om karakterer fra den almene gymnasieuddannelse inden for matematik og dansk som mål for analytiske og kommunikative færdigheder. Vi finder at højt specialiserede kompetencesæt belønnes på arbejdsmarkedet i form af højere lønninger, men er negativt relateret til sandsynligheden for at blive iværksætter. Vi finder også, at for studerende med høje analytiske kompetencer er sandsynligheden for at starte en virksomhed monotont stigende med deres kommunikative kompetencer, mens dette ikke er tilfældet for resten af befolkningen. Motiveret af resultater der viser at studerende med høje analytiske kompetencer, i gennemsnit driver mere rentable og større virksomheder, foreslår vi en identifikationsstrategi for kausal estimation af effekten af en øgning af kompetencer inden for kommunikation på sandsynligheden for at blive iværksætter. For populationen af individer med høje analytiske kompetencer, anveder vi information om forældres uddannelse og udnytter variationer i studerendes eksponering for jævnaldrende, hvis far har en universitetsgrad i humaniora. Vi finder at en øgning af kommunkative kompetencer for disse individer øger sandsynligheden for at blive iværksætter med op til 20%. Dette studie fremhæver vigtigheden af at forbedre kommunikationsfærdighederne hos individer med høje analytiske evner, i sammenhæng med iværksætteri.

Kapitel 2. Iværksætteri, Formue og Humankapital
(med Leonardo Indraccolo)

Hvor vigtig er akkumuleringen af humankapital i forhold til finansiel kapital i forhold til at forklare individers selektion ind til iværksætteri set over den samlede livscyklus? For at besvare dette spørgsmål konstruerer vi et nyt datasæt, baseret på danske administrative data, og anvender det til at undersøge karakteristika der gør sig gældende for individer, der vælger iværksætteri, vis a vis individer der forbliver på arbejdmarkedet. Vi tilvejebringer ny dokumentation for at nye iværksættere, sammenlignet med lønmodtagere på samme alder, i gennemsnit i) har højere lønninger inden de starter deres første virksomhed ii) oplever højere vækst i lønninger inden de starter deres første virksomhed iii) har sammenlagt flere års uddannelse og arbejdsmarkedserfaring. Vi viser endvidere, at denne selvselektion i form af humankapital er endnu stærkere blandt de mest produktive iværksættere. Vi viser også, at nye iværksættere har marginalt højere formue sammenlignet med lønarbejdere i samme alder, umiddelbart inden de starter deres første virksomhed. Vi undersøger om prospektive iværksættere står overfor likviditetsbegrænsninger og anvender forældres formue som proxy

for adgangen til likviditet eller kredit. Vi finder at sandsynligheden for at blive iværksætter i det væsentlige er flad langs den centrale del af formuedistributionen og kun stigende i halerne, hvilket er inkonsistent med at nye iværksættere står over for markante likviditetsbegrænsninger. For at kvantificere den relative betydning af opsparing af henholdsvis finansiel og humankapital, i forhold til individers beslutninger om at starte en virksomhed, udbygger vi en kvantitativ generel ligevægtsmodel der tager højde for akkumulering af humankapital, finansielle friktioner og erhvervsvalg over individets livscyklus. Vi anvender modellen til at separere effekterne af opsparet formue, opsparet humankapital og kvaliteten af forretningsidéen i forhold til at påvirke selvselektion ind til iværksætteri. Gennem kontrafaktiske øvelser fastslår vi, hvordan finansielle friktioner påvirker kvaliteten af nye virksomheder ved at tilskynde individers beslutninger om akkumulering af mere humankapital. Vi anvender den kalibrerede model til at kvantificere efficiens- og velfærdseffekterne af en skattepolitik rettet mod at incitivere iværksætteri blandt unge.

Kapitel 3. Engle Falder Ikke Ned fra Himlen
(solo forfattet)

Jeg undersøger hvilken rolle investorers virksomhedserfaring spiller i markedet for angel investeringer. Jeg bygger et unikt datasæt, der identificerer populationen af business angels i Danmark. Idet der kontrolleres for uobserveret virksomhedskvalitet og assortativ matching, finder jeg at business angels med højere ledelseserfaring, i forhold til iværksættere, erhverver egenkapital til signifikant lavere værdiansættelser. Denne rabat forstærkes, når den relative erfaring er høj, og når ledelseserfaringen er erhvervet inden for iværksætteri. Højere bestyrelses- og investeringserfaring påvirker imidlertid ikke værdiansættelser. Ledelsesrabatten afspejles i forbedrede virksomhedsresultater efter investeringstidspunktet, og de faktorer, der forstærker rabatten, forstærker også denne positive effekt på virksomhedsresultater. Disse analyseresultater indikerer at ledelseserfaring genererer velfærdsoverskud inden for angel investeringer, som derfor kræver en investeringspræmie. Disse resultaterne rationaliserer en målrettet investeringspolitik, snarere end en generisk investeringspolitik.

Contents

Capa

This PhD thesis examines the role of financial capital, as well as human and social capital in the entrepreneurial economy. Entrepreneurship is a primary component of economic growth, job creation, and innovation, and against this backdrop, policy-makers are inclined to stimulate entrepreneurial activity. Much of the policy dialogue and most policy initiatives are concerned with alleviating the financial constraints of young firms and potential entrepreneurs. The financial constraints of entrepreneurs are well-understood, and routinely attributed to high risk, low collateral, asymmetric information and moral hazard. But entrepreneurs and young firms are also faced with other constraints, primarily in terms of human and social capital, that play a crucial role in the survival and performance of organizations. These constraints are likely to co-determine supply and demand forces in the entrepreneurial economy, and, in turn, affect the effectiveness of any policy measures. The research presented here aims to increase our understanding of human and social capital in individuals' decisions to enter into entrepreneurship, as well as in markets for informal early-stage investments, which are the two most central areas of entrepreneurship research and policy.

The dissertation is organized in three independent chapters, that empirically investigate different topics in entrepreneurial finance. The first chapter studies the role of skill composition in individuals' entry into entrepreneurship. The second chapter studies the relationship between human and financial capital in individuals' entry into entrepreneurship. The third chapter studies the effects of angel investors' human and social capital on firm outcomes and investment premiums. The empirical frameworks of all three chapters leverage unique datasets on firms and individuals in Denmark, that are assembled from multiple sources of administrative data. The data provide comprehensive coverage of firms and individuals over their respective life-cycles, and allow for identification of entrepreneurs and external investors in the Danish population, and detailed accounts of their individual characteristics.

The first chapter, "On the Origin of Entrepreneurship" (co-authored with Damiano Argan and Leonardo Indraccolo), investigates the role of individuals' skill composition in self-selection into entrepreneurship, and the subsequent performance of their businesses. The study relates to the seminal theory proposed in Lazear (2004), often referred to as "jack-of-all-trades theory", arguing that employment rewards skill specialization, while entrepreneurship rewards balanced skills. The theoretical implication is that individuals self-select into these respective occupations based on their skill composition, which has given rise to a growing

body of literature on entrepreneurial skills. This literature has examined the number of prior jobs and roles, the number of academic courses, the type of occupations, as well as exposure to entrepreneurial environments and entrepreneurship education, as potential determinants of entry into entrepreneurship (J. Wagner (2003), Lazear (2004), Lazear (2005), Joachim Wagner (2006), Silva (2007), Levine and Rubinstein (2017), Michelacci and Schivardi (2020), Guiso, Pistaferri, and Schivardi (2021), Queiró (2022), Mertz, Ronchi, and Salvestrini (2023)).

This study exploits register data on Danish firms and individuals, covering a period of 25 years, to investigate how analytical skills and communication skills relate to the entry decisions and performance of entrepreneurs. The primary contribution of this research is the leverage of detailed data on high school grades to provide a more granular understanding of entrepreneurial skills in relation to extant literature.

The main findings are the following. Individuals who exhibit high specialization in either analytical or communication skills are rewarded in terms of higher labor market wages, but are also less inclined to become entrepreneurs. On the other hand, the notion of balanced skills seems to depart from high levels of analytical skills. Specifically, for individuals with high proficiency in analytical skills, the propensity to become an entrepreneur is monotonically increasing in the level of communication skills, while this is not the case for the remaining population. In addition, high proficiency in both analytical and communication skills is associated with higher entrepreneurial performance. Motivated by these findings, the causal effect of increasing communication skills of individuals with high levels of analytical skills is estimated using instrumental variables (IV). The identification strategy builds on peer effects, exploiting within-school and across-cohort variation in parents' field of education. The estimated effects imply that increasing the communication skills of individuals with high analytical skills is associated with up to 20% higher propensity of entry into entrepreneurship. These findings suggest that policy initiatives encouraging development of balanced skills can have a sizable impact on fostering successful entrepreneurship. Specifically, educational strategies aimed at enhancing communicative proficiency can be a tool in nurturing future entrepreneurs.

The second chapter, "Entrepreneurship, Wealth and Human Capital" (co-authored with Leonardo Indraccolo), examines the relationship between human and financial capital in the entry of individuals into entrepreneurship, and the subsequent performance of these individuals as entrepreneurs. Aiming to explain the relatively late entry of individuals into entrepreneurship (Azoulay et al. (2020)), the study leverages detailed data on firms and individuals in Denmark, to provide stylized facts on nascent entrepreneurs and their counterparts that remain labor market employees. These empirical facts highlight that entrepreneurs exhibit higher ex-ante wages and more ex-ante educational and labor market training, relative to their same-age counterparts. Conditional on entry, entrepreneurs that earn higher wages or have more educational or labor market training also exhibit higher performance as entrepreneurs. While these data also document that entrepreneurs hold slightly higher wealth, these initial results suggest that human capital accumulation is an important determinant of entry into entrepreneurship.

The study relates to prior literature that emphasizes financial constraints as a mechanism for postponed entry, formalized in the canonical occupation choice model proposed by Cagetti and De Nardi (2006). The theoretical model builds on the assumption that borrowing constraints prevent prospective entrepreneurs from operating at efficient scales, and imply that entrepreneurs postpone entry to accumulate financial capital in the labor market, which is supported by a number of empirical studies (Holtz-Eakin, Joulfaian, and Rosen (1994), Hurst and Lusardi (2004)). Meanwhile, this study investigates if the underlying mechanism behind postponed entry is related to prior accumulation of either financial or human capital, and finds that human capital is more important in predicting entry into entrepreneurship, as well as subsequent survival and performance of firms. We develop a life-cycle occupational choice model that accounts for individuals' accumulation of both human and financial capital in the labor market prior to entry. We simulate the model using Danish population data, and show that policies which alleviate financial constraints of young entrepreneurs may decrease entry into entrepreneurship, while increasing productivity conditional on entry. This perhaps surprising result occurs because such policies primarily benefit prospective entrepreneurs with high levels of human capital, thus enabling higher productivity, and simultaneously increasing the labor market wages of marginal entrepreneurs with low human capital. The study contributes to a growing body of entrepreneurship literature, that emphasizes the role of entrepreneurs' individual characteristics (Levine and Rubinstein (2017), Bhandari and McGrattan (2020), Queiró (2022), Bhandari, Kass, and Schulz (2022), Gendron-Carrier (2023)), and demonstrates the importance of accounting for human capital accumulation in policy considerations.

The third chapter, "Angels Don't Fall From Heaven" (solo-authored), studies the role of business angels' human and social capital in informal venture capital markets, a.k.a. angel markets. Angel investors are the primary source of external financing of early-stage firms, and their importance in financing economic growth, job-creation and innovation is well-understood and supported by investment policies in the US, EU and elsewhere. However, as angel investments are private and informal in nature, there is little systematic knowledge about angel investors, or the supply and demand characteristics of angel markets. While the extant literature, relying mainly on survey data, consistently documents a disproportional presence of experienced founders, CEOs and other executives in these markets, the role of their experience is not well-understood and remains empirically understudied.

This study investigates the role of angel investors' executive experience in determining both equity valuations and ex-post firm outcomes, aiming to expand our understanding of the potential value-creation by these active investors. The study leverages a novel dataset, that identifies the population of angel investors in Denmark, as well as the accumulated executive experience of individuals in the roles of founders, managers, directors or investors, which is aggregated into three composite factors; management factor, governance factor, and an overall enterprise factor. The empirical framework consists of two parts. The first part examines the effects of executive experience on equity valuations in investment deals, and the second part examines the effects on ex-post firm outcomes. This serves the identification

of a relationship between investment premiums and enhanced firm outcomes.

The main findings are the following. Angel investors with superior management experience, relative to founders, are consistently associated with lower valuations, while superior governance experience does not affect valuations. The conjecture is, that, the human capital acquired in management experience is more valuable to investees, than human or social capital acquired in governance experience. The management discount is amplified when relative experience between founders and angel investors is high, and when management experience is acquired in entrepreneurship. On the other hand, superior management experience is related to consistently higher firm outcomes. The relationship between valuation discounts and ex-post outcomes is further supported by the fact, that the factors that amplify valuation discounts also amplify the positive effect on outcomes. Overall the findings suggest that angel investors with superior management experience generate surplus in angel markets, and therefore extract a premium at the time of investment.

This study relates to an emerging literature on angel investment, and is closely related to a few other studies that exploit administrative micro-data to identify and study angel investors in population data (Andersson and Lodefalk (2020), Kisseleva, Mjøs, and Robinson (2022), Bach, Baghai, Stromberg, et al. (2023)). It also contributes to a broader literature on angel investment, that emphasizes the unique characteristics of angel investors (Mason and Harrison (2002), Mason and Harrison (2008), Wong, Bhatia, and Freeman (2009), Bach, Baghai, Stromberg, et al. (2023)), and a strand of this literature that proposes a positive relationship between angel investors' human and social capital and enhanced firm outcomes, attributed to value-adding activities such as mentoring, strategic guidance, monitoring and resource acquisition (Politis (2008)). It also relates to a more mature literature on venture capital funds, that studies the matching characteristics in these markets, as well as the relationship between investors' abilities and firm outcomes (Hsu (2002), Sørensen (2007), Bottazzi, Hellmann, and Rin (2008)).

Chapter 1
On the Origin of Entrepreneurship

We investigate the relationship between individuals' skill composition and self-selection into entrepreneurship. Using administrative micro-data from Denmark, we measure analytical skills and communication skills using high school grades in math and native language as proxies. We find that specialized skill sets are rewarded in the labor market, but are negatively related to the probability of becoming an entrepreneur. We also find that for students with high analytical skills, the probability of becoming an entrepreneur is monotonically increasing in communication skills, while the reverse case is not true for students with high communication skills. Motivated by evidence that individuals with high analytical skills run more profitable firms, we propose an identification strategy based on peer effects to estimate the causal effects of skill balance on the probability of entry into entrepreneurship. For the subpopulation of high-performing math students, we use within-school and between-cohort variation in exposure to peers that have parents with a university degree in humanities. We find that the most treated individuals have 20% higher probability of becoming an entrepreneur, compared to the least treated individuals. These findings highlight the importance of improving communication skills of individuals with high analytical proficiency to facilitate the creation of high-performing firms.

1 Introduction

Entrepreneurial firms are responsible for a big share of economic growth and job creation in modern economies.[1] While the importance of entrepreneurship for innovation, job-creation and economic growth is well-understood, understanding the determinants of self-selection into entrepreneurship remains an important topic. Which skills characterize individuals that select into entrepreneurship, and how do they differ from the working population? Departing from the seminal contribution by Lazear (2004), a number of studies have investigated the role of human capital and skill compositions in determining successful entrepreneurship.

[1] For example, Decker et al. (2014) show that in the US start-ups are responsible for around 20% of gross job creation.

However, due to low availability of detailed data on entrepreneurs and their individual characteristics, the question remains largely unanswered.[2]

Our contribution is to use danish education registry data, combined with other administrative data sources, to quantify and casually estimate the effect of the complementarity between analytical and communication skills on the probability of self-selecting into entrepreneurship. We have access to a rich and detailed dataset that combines multiple administrative data sources to generate a unique dataset that contains all firm ownership in Denmark between 1996 and 2019. Our dataset allows us to follow individuals over their life-cycle and observe their characteristics before they start a business, during their entrepreneurial spell and after. We also observe the same information for paid employed workers, which enables us to study differences in skill set compositions between workers and future entrepreneurs. Motivated by the theory of Lazear (2004), we use high school grades in math and danish language in the last year of high school to measure communication and analytical skills. We start by providing observational evidence on the complementarity vs substitutability of these skills on the labor market and for selection into entrepreneurship. We find that individuals with more specialized skill sets earn higher wages, but are less likely to start a business compared to individuals with more balanced skill sets. We also show that for the group of individuals who were very good in math during high school the probability of becoming entrepreneurs is monotonically increasing in their oral grade in danish, while the same does not apply for the rest of the population of students. Additionally, we find that entrepreneurs who performed well in math during high school run on average more profitable and successful firms.

Understanding how policymakers can incentivise the creation of new successful businesses motivates us to casually estimate the effect of improving communication skills of students with high mathematical grades in high school. Being able to precisely quantify the increase in the number of new businesses created by individuals with high analytical abilities when these are taught better communication skills, is crucial when designing effective training and education programs aimed at spurring the creation of high performing firms.

Our identification strategy draws from the literature on peer effects and uses information on parents' human capital. We exploit within school, across cohort variation in the share of schoolmates parents' with an academic background in humanities. Motivated by the fact that human capital and skills get transmitted across generations, we instrument communication skills of high performing math students with the human capital composition of parents' peers students. For the cohorts of students graduated between 1997 and 2004, the estimated effect of increasing the share of fathers' peers with a university diploma in humanities by 3.5% - corresponding to the difference between the most and the least treated individual in our sample- increases the probability of selecting into entrepreneurship by 1.1 percentage points. The effect is economically significant if one considers that the share of individuals who ever become entrepreneurs in the economy for the 1997-2004 cohort is 4.8%. The effect corresponds to an increase of 20% in the overall share of entrepreneurs.

[2] Queiró (2022) uses Portuguese administrative data to show that more educated entrepreneurs run bigger businesses which display higher growth rates at the beginning of their life-cycle. Michelacci and Schivardi (2020) use data from the SCF to calculate the returns to education for entrepreneurs.

Other findings by Guiso, Pistaferri, and Schivardi (2021) have highlighted the importance of exposing aspiring entrepreneurs to entrepreneurial environments to stimulate the birth of new successful ventures. To put our results into perspective, we show that the estimated effect of improving communication skills of highly talented math students on the creation of new businesses is comparable in magnitude to increasing students exposure to a higher share of peer students whose fathers are graduated in business. The rest of the paper is organized as follows. The next section discusses our contribution in relation to other work on entrepreneurship. The third section describes our dataset in detail. The fourth and fifth section provide observational evidence on the role of gpa and high school grades on labor market outcomes and selection into entrepreneurship. The fifth section provides evidence on the complementarity between communication and analytical skills in self-selection into entrepreneurship. The sixth section discusses how high ability math students run on average more profitable businesses. Section seven introduces the identification strategy, section eigth discusses the results and the final section concludes.

2 Related Literature

This paper contributes to different strands of the literature. We contribute to the empirical literature on the role of human capital and skills for the understanding of selection into entrepreneurship (Lazear (2004), Lazear (2005), J. Wagner (2003), Joachim Wagner (2006), Silva (2007), Levine and Rubinstein (2017), Michelacci and Schivardi (2020)) and to empirical studies investigating whether skills relevant to entrepreneurship can be learned (Guiso, Pistaferri, and Schivardi (2021), Liang, Wang, and Lazear (2018)).

Prior work has been concerned with bringing empirical evidence to the model of entrepreneurship developed by Lazear (2004). The model predicts that individuals selecting into entrepreneurship must have a more balanced skill set compared to workers (entrepreneurs are jack-of-all traits individuals). The result stems from the assumption that entrepreneurs are required to perform very different task using a variety of skills, while workers only need to perform very specialized tasks. Lazear 2004 tests the theory empirically exploiting the Stanford MBA alumni register. He shows that students with less specialized course tracks, namely individuals who took more courses outside of their track of specialization, are more likely to become entrepreneurs in the future. Additionally, Lazear (2005) uses the same dataset to show how MBA alumni who had a higher number of different occupations as workers are more likely to become entrepreneurs later in life. Along similar lines, J. Wagner 2003 uses a representative sample of the German population and shows that individuals with more professional training in life, or who changed their profession more often, are more likely to become self-employed later in life. Joachim Wagner (2006) uses German data on nascent entrepreneurs (*Regional Entrepreneurship Monitor REM Germany*) to show that individuals who reported to have been active in many different professional fields are more likely to be observed as nascent entrepreneurs. Finally Silva (2007), using the Longitudinal Survey of

Italian Families (ILFI, 1997) and exploiting the panel dimension of the data, shows that while the total number of occupations an individual had in his career is positively associated with the probability of being self-employment later in life, the relationship disappears once accounting for the endogeneity by means of fixed effects .

Our research contributes to this literature along several dimensions. First, by using Danish administrative data we define an entrepreneur as the owner of an incorporated business that is economically active. Moreover, we work with the universe of Danish entrepreneurs. This represents an improvement in the quality of the data used to study the determinants of entrepreneurship. Prior work, as Lazear (2004) and Lazear (2005), used survey data not representative of the general population. On the other side, J. Wagner (2003) does not distinguish between entrepreneurship and self-employment, while later work by Levine and Rubinstein (2017)) has shown how this is critical, as the two groups have very different characteristics. Second, using education registries we have a clear measure of skills, namely grades in math for analytical skills and grade in oral Danish examinations for communication skills. Previous literature used very imprecise proxies for the measurement of skills, such as the number of courses taken outside the field of specialization (Lazear (2004)) or the number of different prior occupations (Lazear (2005), or the number of professional degrees (J. Wagner (2003)). Finally, we address the problem of endogeneity in the relationship between multidimensional skill sets and the decision to become an entrepreneur, which so far has only been addressed by Silva (2007) using panel fixed effects.

The literature studying the human capital determinants of entrepreneurship and firm performance has found patterns of complementarity between skills affecting both self selection into entrepreneurship and firms outcomes. In particular, Levine and Rubinstein (2017) show how having high levels of cognitive ability coupled with the tendency to perform illicit activities when young is a very strong predictor for selection into entrepreneurship. The authors interpret this finding as the existence of complementarity between cognitive skills and the tendency to break established rules. Michelacci and Schivardi (2020) show that the education-labor experience complementarity is associated with higher returns from entrepreneurship and interpret this finding as the existence of complementarity between theoretical knowledge acquired during formal studies and practical skills acquired on the job. We add to these findings by showing evidence of complementarity between analytical and communication skills.

Finally, we add to the literature on the acquisition of entrepreneurial skills. Liang, Wang, and Lazear (2018) build a model where individuals learn business skills while working in high paid occupations as workers and show evidence that indirectly confirms the model predictions. Guiso, Pistaferri, and Schivardi (2021) show how individuals that grew up in areas with a high density of firms acquire skills useful to run a business. Similarly, we show that individuals who in their last high school year, while being good in math, were exposed to an environment where they could better learn communication skills acquired abilities useful to entrepreneurship.

The paper most close in spirit to ours is Mertz, Ronchi, and Salvestrini (2023). Mertz,

Ronchi, and Salvestrini (2023) study the effect of early exposure to entrepreneurship on reducing the gap in self-selection into entrepreneurship between men and women. While asking a different research question than the one we address here, their identification strategy and data are similar. Mertz, Ronchi, and Salvestrini (2023) use within school across cohort variations in the share of female peers' parents that are entrepreneurs or C level managers to study the impact of early exposure to entrepreneurial environments for incentivizing entrepreneurship among women. Our identification strategy also exploits within school across cohort variation, but we use the share of peers' parents graduated in humanities as treatment. Mertz, Ronchi, and Salvestrini (2023) also have access to danish administrative data, but while they define entrepreneurs as owners of unnicorporated businesses, we define an entrepreneur as the owner of an incorporated business which is active.

3 The Data

Our analysis is based on the full population administrative data from Denmark, covering the years from 1996 to 2019. The final dataset is composed of two underlying blocks: the entrepreneurial and the education data set. In the next two sections we describe how we construct these two datasets in detail.

3.1 The Entrepreneurial Dataset

The entrepreneurial dataset combines multiple administrative data sources to generate a unique dataset that contains all firm ownership in Denmark between 1996 and 2019. Specifically, by combining individual level characteristics from Statistic Denmark Research Database (DST) with firm level data from the Danish Central Business Register (CVR) and the commercially available KOB database (KOB) from Experian Denmark, we are able to link individual level information to entrepreneurial spells and subsequent business outcomes. The data contained in Statistics Denmark is provided and updated regularly by relevant Danish authorities, including the Ministry of Taxation, the Ministry of Education and the Ministry of Employment. The database contains general information on individuals such as gender, age, education, wealth and income composition. In addition, detailed employment registers provide all current and previous employment relationships (employer-employee), with corresponding salaries, hours worked, and occupational codes (isco 08) that are used to characterize individual labor market histories, as well as firm-level employment. However, the DST does not contain data on incorporated firms (limited liability companies), but only data on unincorporated firms (sole proprietorship and partnership). As shown by Levine and Rubinstein (2017), when studying entrepreneurship it is key to separate between owners of sole proprietorships and owners of limited liability companies, as they display very different characteristics. To this end, we add the CVR database to the DST dataset, where the former contains information on all firms registered in Denmark since 1980. The CVR also contains detailed ownership records of sole proprietorships, partnerships and corporations

and provides the timing, identity and ownership shares of all direct owners. As ownership records referring to incorporated businesses are limited to the period after 2014, we combine the CVR database with data from the commercially available KOB database, published by Experian Denmark, that contains hand-collected ownership information, which completes missing ownership in the early data years of the CVR database. The KOB database also contains detailed accounting records of corporations. All firms in the resulting dataset are identified by unique CVR-numbers, and all individuals are identified by unique PNR-numbers, which can be matched directly to other data sources.

After combining all these datasets we obtain the entrepreneurial dataset, in which the unit of observation is an individual. For every individual and annually for every year between 1996-2019 the final dataset contains information on individuals' income, net wealth, labor market status, hours worked, occupation, whether an individual owns a sole proprietorship, a partnership or a limited liability company and if so the corresponding business outcomes for each year in which the business exits: revenues, assets, number of employees, turnover, dividends and industry in which the business operates. Concerning years before 1996, the dataset contains, in addition to a variable on accumulated labor market experience, individuals' education level (the highest educational attainment) and her type of education. In addition, for each individual the dataset reports demographic characteristics, the place of birth and the place of living. Finally, we are also able to link individuals with their parents and their siblings through the PNR number, if alive.

We define an entrepreneur as the shareholder of a limited liability company that display at least one employee hired, at least once positive revenue and at least once positive asset. This definition embodies the findings of Levine et al. as separate owner of incorporate company from self-employed and as we use administrative data ensure entrepreneur are not owner of empty legal boxes.

To this aim we link individuals in the Statistic Denmark Research Database (DST, henceforth) to firm data in Danish Central Business Register (CVR, henceforth) and the commercially available KOB database (KOB henceforth), published by Experian Denmark. The DST is provided and updated regularly by relevant Danish authorities, including the Ministry of Taxation, the Ministry of Education and the Ministry of Employment. The database contains general data on individuals, such as gender, age, education, wealth and income composition. In addition, detailed employment registers provide all the current and previous employment relationships (employer-employee), with corresponding salaries, hours worked and occupational codes (isco 08), that are used to characterize individual labor market histories, as well as firm-level employment. However, the DST does not contain data on incorporated firm (limited liability company, henceforth llc) but only data on unincorporated firms (sole proprietorship and partnership). As shown by Levine and Rubinstein 2017, it is key to disentangle self-employed from entrepreneurs. Thus, we add to the DST the CVR database that contains historical and real-time information on all firms registered in Denmark since 1980. The CVR also contains detailed ownership records of proprietorships, partnerships and corporations, providing the timing, identity and ownership shares of all direct owners. As

ownership records referring to corporations are limited to the period after 2014, we combine the CVR database with data from the commercially available KOB database, published by Experian Denmark, that contains hand-collected ownership information, which completes missing ownership in the early data years of the CVR database. The KOB database also contains detailed accounting records of corporations. All firms in the resulting dataset are identified by unique CVR-numbers, and all individuals are identified by unique PNR-numbers, which can be matched directly to other data sources.
The dataset displays, for each Danish individual, annually for every year from 1996 to 2019, his income and wealth, the labor market history, the number of hours worked (if any), the occupation, the firm and the sector of occupation, and in case of self employment whether he has a sole proprietorship, a partnership or a limited liability company and the corresponding firm data for each year: industry, revenues, assets, number of employees, turnover, dividends. As we discussed earlier the unit of analysis in the dataset is the individual. Concerning years before 1996, the dataset contains, in addition to accumulated experience, the full folder of individuals' education history, reporting both the education level (the highest educational attainment) and the type of education. In addition, for each individual the dataset reports demographic characteristics, place of birth, place of living etc. It also allows us to link individuals with their parents and their siblings, if alive.

3.2 The Education Dataset

The second building block of the final dataset, which we use in our analysis, is the education dataset. Statistics Denmark provides education registries for all cohorts graduating after 1996. Specifically, for every high school graduate the registries contain information on students' grade point average in the last year of high school. In addition, for all subjects attended by a student, the registries report the grades students have achieved in every examination, as well as in every written and oral assessment and take-home project.
The Danish education system was majorly reformed in 2005. In the interest of working with a homogeneous sample in which grades are comparable, we only keep the cohorts born between 1997 to 2004. Up to 2004, the Danish high school system was characterized by two main tracks students could choose from: a mathematical and a linguistic one. A third track existed, the so called higher preparatory examination (HF), which was designed for young adults who had left the educational system.
In our analysis we focus only on students enrolled in the mathematical high school track. The reason for this is that up to 2004, students in Danish high schools could choose to take subjects at three different levels, corresponding to different difficulties and a different number of hours per subject.[3]. Clearly, grades obtained in the same subject but at different levels are not comparable as the difficulty of the classes is very different. While all students in both the mathematical and linguistic track take Danish classes at the highest level (level A),

[3] The three different levels were level A (level I), level B (level II) and C (level III). We refer the reader to the appendix for a detailed overview of the Danish high school system.

this is not the case for math classes. Only in math orineted high schools students take math classes at the highest level[4]. In order to have skill measures that are as homogeneous as possible, we select only students enrolled in math-track high schools. In this way for every student we observe the grades he obtained both in danish and math classes, taken at the highest, and thus comparable, level.
In the next section we provide an overview of the main descriptive statistics of our sample.

4 Descriptive Statistics

We define an entrepreneur as a business owner of a limited liability company, who over the sample period has hired at least one employee and whose business displays positive revenues and assets. Whenever the individual is the owner of multiple businesses we multiply firm level outcomes (revenues, employment etc.) with the equity shares he holds in the business and apply the same definition. Following the work by Levine and Rubinstein (2017) we define entrepreneurs as owners of incorporated businesses and assure that we do not define as entrepreneur an individual who owns businesses which are empty legal boxes with no economic activity.
Table 1.1 shows some first descriptive statistics for our sample. In the upper part we report statistics for the general Danish population of men who are older that eighteen in 2019. We see that entrepreneurship is an infrequent career choice. According to our definition of entrepreneurship, slightly less than 4% of the population become entrepreneurs in their life. Those individuals who become entrepreneurs, have on average more years of education (12.8 years against 12.2), and earned higher wages on the labor market, with a difference of around 19 percentage points.

[4] In Denmark between 1997-2004, 80% of students enrolled in math high schools took math classes at the highest level.

Table 1.1. Summary Statistics A

This table reports summary statistics of the data used in the analysis.

	Danish entrepreneurs	Rest of the population
Men older than 18		
Absolute number	110,356	2,745,731
Share	3.86%	96.14%
Average years of Education	12.78	12.15
	(.007)	(.001)
Log wage	5.50	5.31
	(.0006)	(.0000)
Year of birth 1979-1986		
Absolute number	11162	285267
Share	3.77 %	96.23%
Average years of Education	12.86	13.20
	(.02)	(.005)
Average log wage	5.08	5.10
	(.001)	(.0002)
Mathematical HS Students:Year of Graduation 1997-2004		
Absolute number	1885	37,385
Share	4.8%	95.2%
Average Years of Education	15.21	15.71
	(.05)	(.01)
Average log wages	5.24	5.23
	(.004)	(.000)
Average log GPA	4.18	4.20
	(.009)	(.002)
Average grade in Danish	8.52	8.60
	(.05)	(.01)
Average grade in Written Danish	8.31	8.41
	(.05)	(.01)
Average Grade in Oral Danish	8.77	8.81
	(.06)	(.01)
Average Grade in Math	7.82	8.12
	(.08)	(.019)

Table 1.2. Summary Statistics B

This table reports summary statistics of the data used in the analysis.

	Gymnasiale Graduates	Non Gymnasiale Graduates
Year of birth 1979-1986		
Number	106,960	189,469
Share	36.08%	63.92%
Share of Entrepreneurs	4.15%	3.55%
Average Years of Education	14.7	12.3
	(.007)	(.006)
Average log wage	5.13	5.09
	(.000)	(.000)

Table 1.3. Summary Statistics C

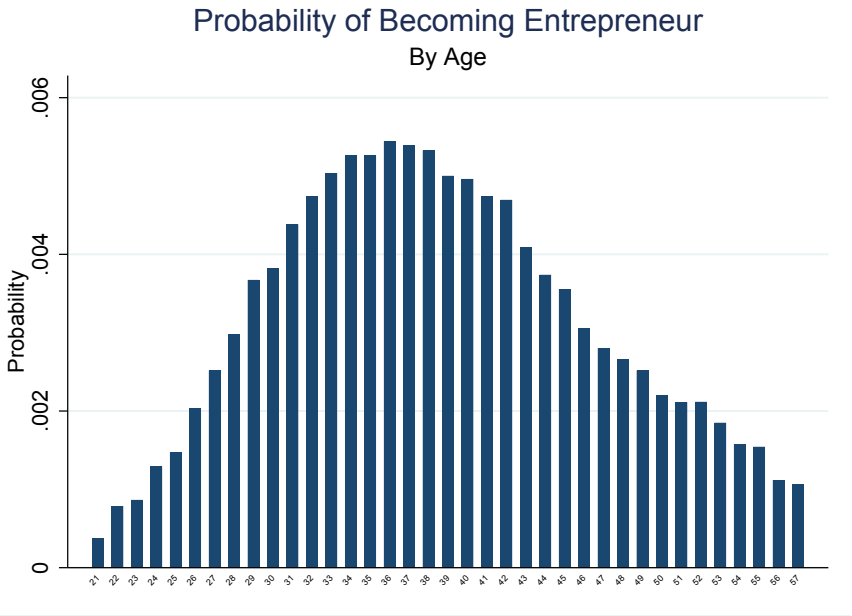
This table reports summary statistics of the data used in the analysis.

	Mathematical HS	Linguistic HS	HF
Entire population			
Absolute number	39,270	12,827	8,939
Shares	64%	21%	15%
Gender ratio(male)	0.50	0.22	0.30
Average Years of Education	15.69	15.04	14.08
	(.01)	(.02)	(.02)
Average log wage	5.23	5.15	5.14
	(0.00)	(.001)	(.001)
Average log GPA	4.20	4.14	3.99
	(.002)	(.003)	(.005)
Share Level A Danish	100%	100%	100%
Share Level A Math	80%	0.0%	7%

Selection into entrepreneurship does not happen with the same frequency at different stages of the life-cycle. In Figure 1.1 we plot the probability of becoming an entrepreneur by age for the cohorts born between 1961 to 1975. We see that the probability of becoming an entrepreneur is hump-shaped in age, with a peak around age 38. These life-cycle patterns reveal that we ought to be able to follow individuals for long time periods over their life to study the drivers of selection into entrepreneurship.

Figure 1.1. Probability of becoming entrepreneur by age

Share of individuals that become entrepreneurs at a given age in the Danish population of men for the cohorts 1961-1975. The data starts in 1996 and ends in 2019.



The second block of Table 1.1, with the heading year of birth 1979-1986, shows descriptive statistics for the cohorts for which we observe the high school grades, as described in the previous section. In fact, individuals that graduated from high school between 1997 and 2004 belong to the 1979-1986 cohorts. For this subsample, the share of individuals that become entrepreneurs is the same as for the general population, around 4%. However, we do not find the positive selection in terms of education and wages, which we observed in the general population. Part of the explanation is that entrepreneurship is a career choice undertaken late in life, as shown in Figure 1.1. This implies that individuals of cohorts 1979-1986 who are pursuing university degrees, have not yet had the time to actually become entrepreneurs. This explains why in the subsample 1979-1986, future entrepreneurs are slightly less educated. Similarly, the negative selection of future entrepreneurs in terms of wages likely stems from the fact that we are comparing wages of future entrepreneurs when they are relatively young, with wages of individuals who always remain workers and thus are older on average[5]. Given that wages increase on over the life-cycle, this explains why on

[5] By definition wages are only observed for paid employed workers.

average future entrepreneurs display lower earnings than always workers.
Of the 1979-1986 cohorts, 37% have a high school degree (gymnasiale uddanelser), while the rest do not. Individuals who have a high school diploma are likelier to become entrepreneurs (4.15% against 3.55%) and unsurprisingly have more years of education and earn more. This can be seen in Table 1.2.
We further provide statistics for the subsample of individuals who completed their high school degree (gymnasiale uddanelser) between the years 1997 and 2004 in Table 1.3. Among the 61 036 men completing high school during these years, 64% of them completed a mathematical high-school program (39 270 individuals), 21% of them a linguistic one (12 827 individuals) and15% of them the higher preparatory examination high school (8 939 individuals). The absolute number of individuals enrolled in the different high school tracks, with respect to the overall number of high school graduates, is the result of different gender ratios in the three tracks. The mathematical high school program is gender balanced with a 50% of men and women, the linguistic program is female dominated with only 22% of men, and similarly for the higher preparatory examination school with a ratio of men to women of 0.3. Mathematical high school students dominate the other students in terms of years of education, gpa and wages when working. A clear hierarchy emerges where mathematical high school students are more skilled than linguistic high school ones, which in turn are more skilled than higher preparatory examination graduates.
The final block of Table 1.1 displays descriptive statistics for the sample we work with, namely the universe of danish male individuals who graduated from a mathematical high school track between 1997 and 2004. Their average age in 2019 - the last year of the sample - is 38.3 and the median individual is born in 1981. Approximately 4.8% of individuals become entrepreneurs, 1885 out of the 39 270 individuals in total. In this subsample entrepreneurs are slightly less educated in terms of years of education and earned on average 1 percentage point higher wages compared to individuals who never start a business. When compared at the same age, future entrepreneurs earned 10 percentage points higher wages compared to always workers. Regarding educational outcomes we find that entrepreneurs have on average slightly lower gpa (2 p.p less) and also display slightly lower grades in all the different types of danish examinations. In math, future entrepreneurs report an average grade which is about 5% less than the average math grade of individuals who never start a business. In the next section, we examine the relationship between schooling, labor market outcomes and selection into entrepreneurship.

5 Balanced skills and labor market outcomes

Motivated by the theory of Lazear (2004), in this section we study how different compositions of skill sets translate into labor market outcomes for paid employed workers and how they relate to selection into entrepreneurship. We use high school grades individuals obtained in danish to capture communication skills, grades obtained in math classes to measure analytical

skills and their interaction to capture skill multidimensionality. In the first subsection we provide simple correlational evidence on the association between high school performance and labor market outcomes and on the relationship between schooling and entrepreneurship. We then move to the role of complementarity in skills.

5.1 Returns to schooling on the labor market

In Table 1.4 we report the returns on the labor market to the average grade in math and danish for the sample of mathematical high school students graduated between 1997 and 2004. As we can see, a one standard deviation increase in log gpa increases expected real wages on the labor market by 4.4 percentage points, or, otherwise said, a 1% higher gpa predicts a 0.12 % higher real wage. When looking at the grades in math and danish we find that mathematical skills are more rewarded. A one standard deviation higher average grade in math predicts an expected real wage of 4.1 percentage points higher, while the same increases in the average grade in danish is only associated with 0.8 percentage points higher wages. The same patterns holds true if we look at grades in only the oral examinations of danish.

In column 5 of Table 1.4, we interact math and danish grades to explore whether individuals with more balanced skill sets receive a premium on the labor market as paid employed workers. We find that the coefficient for the interaction term is negative, suggesting that the labor market seems to favor individuals with specialized, rather than balanced skills. Specifically, for given grade in math and danish oral examination, we find that a one standard deviation higher product of the math and danish oral grade, predicts a 0.8 percentage points lower and statistically significant wage on the labor market. This evidence seems to suggest that more multidimensional individuals earn less than unbalanced ones, showing how the labor market rewards skill specialization.

Table 1.4. High school grades and labor market outcomes

Sample of Mathematical high school students (HS) that graduate from HS between 1997 to 2004 and attended level A math courses. Log-wage is the logarithm of real-wage. bStDX stands for the variation in the expected value of the outcome variable for a standard deviation variation in the explanatory variable.

	(2)	(3)	(4)	(5)
	Log-wage	Log-wage	Log-wage	Log-wage
log_gpa	0.120***			
	(0.00199)			
bStdX	0.044			
Danish		0.00354***		
		(0.000369)		
bStdX		0.008		
Math		0.0113***	0.0117***	0.0131***
		(0.000223)	(0.000216)	(0.000639)
bStdX		0.041	0.042	0.048
Danish Oral			0.00206***	0.00368***
			(0.000287)	(0.000716)
bStdX			0.006	0.010
Danish_Oral#Math				-0.000169*
				(0.0000681)
				-0.008
Constant	4.731***	5.114***	5.123***	5.109***
	(0.00845)	(0.00298)	(0.00261)	(0.00612)
N	561674	563904	563904	563904

5.2 High school grades and selection into entrepreneurship

So far we have established a positive association between average school performance, as measured by log gpa, and future wages as paid employed workers. Moreover, we have established that the labor market rewards specialized workers more than multidimensional ones.

In this section we ask how school outcomes and the complementarity between different skills relate to the probability of selection into entrepreneurship. We start by asking how average schooling ability, as measure by log gpa, is associated with the decision to start a business. We find that log gpa is negatively correlated with the probability of selecting into entrepreneurship. In the first column of Table 1.5 we see that a one standard deviation higher log gpa decreases the probability of becoming entrepreneur by 0.4 percentage points, which is 10% of the average share of entrepreneurs in the sample. Next, we study how communication and analytical skills and their complementarity are associated with the probability of becoming an entrepreneur. As before, we use grades obtained in danish and math to measure the two different skills. In Table 1.5 we report the results of running the following regression:

$$Ent_i = \alpha + \beta_1 \times Math_i + \beta_2 \times Danish_i + \beta_3 \times (Math_i \times Danish_i) + \sum_{y=1997}^{2004} \gamma_y * Year + \epsilon_i \quad (1)$$

where *Ent* is 1 if an individual ever becomes an entrepreneur over the sample period and 0 otherwise. $Math$ and $Danish$ are the average grades of all the math and danish grades received by the individual during the last year of high school and $Year$ are year fixed effects for the year in which the individual received the grades. This specification describes the association between the grades in danish and math received in high school by the student, and their interaction, given the year in which students graduate. The year fixed effects control for the fact that later cohorts have less time to become entrepreneurs in their life as the sample period ends in 2019. They also control for possible "grade inflation" that can affect the grading system across cohorts. We cluster standard errors at the year-school level. The table shows three different specifications. In the first column of Table 1.5 *Danish* is the average of every grade obtained across all types of examinations in danish. In column (2) we only use grades obtained in oral danish exams, while in column (3) we only use grades obtained in written evaluations of danish. The grade in $Math$, instead, is always the mean across all types of examination in math, both written and oral. The first specification shows that: i) there is a negative, but not significant, association between the probability of ever becoming an entrepreneur and the average grade in danish ii) a negative and significant association between ever becoming an entrepreneur and the average grade in math iii) a positive, but slightly insignificant association between the interaction term and the probability of becoming an entrepreneur. Specifications (2) and (3) help us understand whether oral or written danish skills drive the above relationship. We see that further splitting performances in danish into

oral and written skills changes our results. Specifically, once we consider only oral danish evaluations the association between the probability of selecting into entrepreneurship and the interaction term becomes more significant. When, instead, we only consider written evaluations in danish, as in specification (3), the interaction term goes down to zero and becomes insignificant. This suggests that oral danish skills, interacted with math skills, are the ones predicting selection into entrepreneurship. The magnitudes of these associations are sizable. From specification (2) we see that a one standard deviation increase in math is associated with a decrease in the probability of becoming an entrepreneur of 1.3 percentage points and a one standard deviation increase in the interaction term between oral and math skills increases the probability of becoming an entrepreneur by 1.3 percentage points. These numbers are economically relevant if we consider that the overall share of entrepreneurs in the sample is 4.9%.

To further gain understanding of the magnitudes of the coefficients let us consider two different individuals who have very different skill set compositions. Let us consider a first individual with a perfectly balanced skill set, who has grade 8 both in danish and math and a second individual who has an extremely specialized set of skills with grade 15 in math and 1 in danish[6]. Using the estimated coefficients from specification (2) this would imply that the individual with a specialized skill set- grade 15 in math and 1 in danish- has a probability of selecting into entrepreneurship of 3.7%, while the individual with a balanced skill set- grade 8 both in math and danish- has almost a double probability of 6.7%.

Together, this provides observational evidence that multidimensional skill sets predict selection into entrepreneurship and that different compositions of skills have meaningful economic significance to understand the decision to start a business. Moreover, our evidence shows that the oral examinations in danish seem to best capture communication skills.

5.3 Teach the nerds to give a pitch: Oral skills and Very Good Math students

In this section we further deepen our understanding of the relationship between skill complementarity and selection into entrepreneurship. We do this by grouping students into three categories based on their performance in danish and math. Specifically, using official definition of grades from the Danish Ministry of Higher Education and Science we define three grade categories and assign individuals based on their mean grade in each subject, computed over all the grades in a given subject obtained in the last year of high school. [7] The categories are the same for danish and math and are: *Bad*, *Average* and *Very Good*. Category *Bad* contains all students with a mean grade that is less than 4 (8 according to our scale). These are students that are in between meeting only the minimum requirement and a fair performance. The category *Average* contains all individuals with an average grade

[6] The Danish grading system goes from -3 to 12. We converted it to a 1-16 scale to facilitate the interpretation. A grade of 8 is considered a fair grade, 15 is considered an excellent grade while 1 is unacceptable. The appendix contains detailed information on the danish high school grading system.

[7] We refer the reader to the appendix for an extended definition of grades in Denmark. The source for the Danish Grading system can be found at: https://ufm.dk/en/education/the-danish-education-system/grading-system

Table 1.5. High school grades and selection into entrepreneurship

The table reports OLS coefficients of the regression of the probability of being an entrepreneur on log-gpa and HS school grades in math, danish, and their interaction. The sample is the universe of male Danish Mathematical high school students in their last HS school year that attended were enrolled in the last high school year between 1997 to 2004. The outcome variable *Entrepreneur* is 1 if an individual has ever been an entrepreneur in his life. The explanatory variable *Danish* is in specification (1) the average of the grades received in Danish, in (2) the average grades received in solely the oral evaluation of Danish, while in (3) the average grades received solely in the written evaluation of Danish. The explanatory variable *Math* is the average of the grades received in math courses. Grades in Danish and Math are all for level A course. The regression contains additional controls for graduation year f.e.. Standard errors are clustered at school-year-programme in parentheses: # 1113calendar year.

		(1)	(2)	(3)
	Entrepreneur	Entrepreneur	Entrepreneur	Entrepreneur
log_gpa	-.0099***			
	(.003)			
bStdX	-0.004			
Danish		-0.00224	-0.00207	-0.000903
		(0.00166)	(0.00138)	(0.00149)
bStdX		-0.005	-0.006	-0.002
Math		-0.00337**	-0.00370***	-0.00202
		(0.00135)	(0.00116)	(0.00123)
bStdX		-0.012	-0.013	-0.007
Danish×Math		0.000237	0.000257**	0.0000863
		(0.000150)	(0.000126)	(0.000138)
bStdX		0.011	0.013	0.004
Graduation year f.e.		✓	✓	✓
N		31293	31293	31292

Table 1.6. Probability of becoming entrepreneur by skills

This table reports OLS coefficients of the regression of the probability of being an entrepreneur on HS school grades in Danish Oral examination for different levels of the grades in math. The sample is the universe of male Danish Mathematical high school students in their last HS school year attended between 1997 and 2004 . Specification (1) displays the difference in the share of entrepreneurs by average grade in oral Danish for students that have a bad average grade in Math. Specification (2) displays the difference in the share of entrepreneurs by average grade in oral Danish for students that have an average average in Math. Specification (3) displays the difference in the share of entrepreneurs by average grade in oral Danish for students that have a very good average grade in Math. The baseline is the average share of entrepreneurs for students that have a Bad average grade in Danish Oral. Grades in Danish and Math are all for level A course. The regression contains additional controls for graduation year f.e. Standard errors are clustered at school-year-programme in parentheses: (1) # 1104, (2) #1090, (3) 1070.

	Average Grade in Math		
	Bad	Average	Very Good
	Entrepreneur	Entrepreneur	Entrepreneur
Oral Danish Average	-0.00540	-0.00330	0.0182**
	(0.00475)	(0.00618)	(0.00821)
Oral Danish Very Good	-0.00307	0.000737	0.0259***
	(0.00956)	(0.00733)	(0.00882)
Constant	0.0679***	0.0593***	0.0447***
	(0.00752)	(0.00741)	(0.00972)
N	11790	12345	7158

greater or equal than 4 (8 according to our scale) and less or equal than 7 (11 according to our scale). These are students whose performance is fair, between fair and good, and good. The final category *Very Good* is composed of all students with an average grade higher than 7 (11 according to our scale), who are students with a performance that is more than good, very good or excellent.

Dividing students into these categories helps us gauge more insights on the role of skill complementarity. We do this by running the following regression:

$$Ent_i = \alpha + \beta_1 \times Average_i + \beta_2 \times VeryGood_i + \sum_{y=1997}^{2004} \gamma_y * Year + \epsilon_i \tag{2}$$

Where *Average* and *Very Good* are dummies taking value 1 when an individual has a mean grade falling into one of these categories. The variable $Year$ are year fixed effects for the year in which the individual was graded. We cluster standard errors at the year-school level. With this specification *Average* and *Very Good* read as the difference in the share of entrepreneurs in those categories with respect to the base category *Bad*.

In table 1.6 we report the regression coefficients of equation 2. In column (1) of Table 1.6 we subset for the individuals that are *Bad* in math and check how the probability of becoming an entrepreneur changes as we move along the categories of the danish grades, from *Bad* to *Very Good*. We see that there are no significant differences in the share of entrepreneurs as we move from the group of *Bad* (the baseline) students to the group of *Very Good* in the oral danish exams. We observe the same qualitative pattern in column (2) where we subset for the students that belong to the *Average* category in math.

On the contrary, when we look at the effect that higher danish oral skills have on the probability of selection into entrepreneurship for students that are very good in math, we observe an increasing pattern as we move along the different categories of danish oral exams. Very good math students who score *Average* in danish oral have a 1.8 percentage points higher probability of becoming an entrepreneur compared to the baseline of *Bad* students. In turn, very good math students who belong to the *Very Good* group in oral danish exams have 2.6 percentage points higher probability of ever becoming entrepreneurs compared to the baseline category. Considering that for the baseline group of *Bad* students the probability of becoming entrepreneurs is 4.5%, it means that high ability math students scoring very well in danish oral exams have a 60% higher probability of transitioning into entrepreneurship compared to talented math students that score poorly on danish.

In Table 1.7 below we report the shares of entrepreneurs for the different combinations of groups (9 combinations in total), without controlling for the high school year of graduation (standard error in parenthesis). From the table we observe another couple of facts. As already found with regression 2, for students who are very good in math the share of individuals that become entrepreneurs is strongly increasing in the oral score in danish. This pattern, however, is not present for students who are bad or average in math. Second, the share of entrepreneurs is decreasing with higher grades in math (column I), but not with higher grades in the oral exam of danish. Third, the highest share of entrepreneurs is among the students that are bad both in oral danish exams and math.

This last two findings align with evidence from the previous sections. In particular, the last finding is in accordance with log gpa being negatively associated with selection into entrepreneurship, while the fact that the share of entrepreneurs is decreasing with higher grades in math can be explained considering that individuals with highly specialized mathematical skills are highly rewarded on the labor market as paid employed workers.

The most interesting correlational evidence is that the probability of selecting into entrepreneurship for high skilled math students is strongly increasing in oral danish abilities. This finding can be rationalized through models of entrepreneurship that build on the intuition initially proposed by Lazear (2004), for which individuals that start businesses need to

be able to perform a variety of different tasks and must thus be multidimensional in their skill set. More recent research by Choi et al. (2019), who analyze the human capital composition of founding teams in start-ups, seem to give similar importance to the multidimensionality of human capital for the understanding of business outcomes.

Table 1.7. Share of entrepreneurs by group of grades

The table reports the share of entrepreneurs by group of grades without any additional controls.

	Math grade		
	Bad	Average	Very good
Danish grade			
Bad	0.057	0.052	0.023
	(0.004)	(0.006)	(0.008)
Average	0.052	0.048	0.039
	(0.002)	(0.002)	(0.003)
Very good	0.054	0.051	0.046
	(0.009)	(0.005)	(0.004)

6 Entrepreneurial outcomes of math skilled students

In this section we study the performance of businesses owned by individuals who attended a mathematical high school and took math classes at the highest level. We are motivated by our previous findings that for the group of talented math students the share of entrepreneurs increases as their communication skills improve. We now want to know whether firms owned by individuals with high mathematical skills on average also generate more revenues, more employment and are more profitable. If this is the case, then asking how we can incentivize entrepreneurship among students with high analytical skills becomes a policy relevant question to investigate.

To simply the analysis of this section, whenever in our data we have individuals who are owners of multiple businesses we only keep the outcomes of the firm in which the individual holds the highest share. This helps us create a more direct link between individuals and firm performance[8]. We start by running a simple regression in which we study the association between attending a mathematical high school - and taking level A math classes- and firm performance. We run the following regression:

$$Out_{it} = \alpha + \beta_1 * MathHS_i + \sum_{y=1997}^{2004} \gamma_y * Yearbirth + \sum_g \theta_g * year + \epsilon_{it} \quad (3)$$

where Out_{it} is firm outcome in year t, for the firm owned by individual i, $MathHS_i$ is a dummy taking value one if the entrepreneur attended a mathematical high school and $Yearbirth$ and $year$ are respectively the year of birth of the individual and year fixed effects. The coefficient $MathHS$ displays the average difference in firms outcome with respect to

[8] In our data the median share is around 68%

the general population of firms, for firms that are owned by an individual who attended a mathematical high school and took math courses at the highest level (level A). [9] We control for the year of birth of the owner to control for the longer period older individuals have to open and manage a firm, and we control for year fixed effects to account for aggregate economic conditions. The unit of observation is the firm-year outcome.
Table 1.8 reports the coefficients of regression 3. Starting from the upper left column we see that firms owned by individuals who attended mathematical high schools have: i) a higher number of employees- 1 more employee with respect to the average of the general population which is approximately 8, that is 12,5% higher number of employees compared to the baseline; ii) almost 7 percentage points higher revenue; iii) 17 percentage points higher value added; iv) 26 percentage points higher assets; v) 32 percentage points higher earnings before interests and taxes (Ebit); vi) 35 percentage points higher net income; viii) 34 percentage points higher value of equity. To sum up, these means that an entrepreneur who attended a mathematical high school on average holds bigger firms (in terms of employment, revenues and assets) and more profitable firms (ebit and net income), compared to entrepreneurs who did not attend a mathematical high school.

Table 1.8. Firm outcomes of mathematical high school students

This table reports OLS coefficient of the regression of firm outcomes on having been in Mathematical HS. The coefficient Math HS measures the average difference in firms outcomes owned by students who attended a mathematical high school, compared to outcomes of firms owned by students who attended other high schools. An individual is considered attending a Mathematical HS if she attended Mathematical HS and took level A math classes (80% of the sample). The sample is the universe of all limited liability companies having at least one employee owned by an individual born between 1979 and 1986. The regression contains additional controls for year of birth of the owner and year fixed effect. All outcome variables are defined as in the Danish Authority accounting standards, apart from employment they all log, and they are all trimmed at the 1st and 99th percentile. In terms of entrepreneurs the sample is composed by 11162 entrepreneurs, of which 1392 are mathematical HS.

	Employees	Log revenues	Log value added	Log assets	Log Ebit	Log net income	Log equity
Math HS	1.092^{***}	0.0692^{***}	0.175^{***}	0.269^{***}	0.337^{***}	0.361^{***}	0.351^{***}
	(0.124)	(0.0160)	(0.0154)	(0.0179)	(0.0241)	(0.0254)	(0.0223)
Constant	7.477^{**}	8.335^{***}	7.827^{***}	8.469^{***}	6.286^{***}	5.338^{***}	7.397^{***}
	(2.883)	(0.369)	(0.330)	(0.390)	(0.561)	(0.538)	(0.451)
N	45741	45274	44752	45104	36623	35004	39768

In Table 1.9 we report the coefficients of running the same regression as before, but in which we split individuals according to our three categories of *Bad*, *Average* and *Very Good* math skills.[10] Thus the coefficients *Bad Math*, *Average Math*, *Very Good Math* show the difference in average firm outcomes of individuals that attended a math high school with an average math grade being either *Bad*, *Average* or *Very Good*, with respect to the general population of entrepreneurs as defined in Table IV. We find that the better an individual was in math at high school, the bigger and the more profitable his firm is. In terms of profitability, an entrepreneur who belonged to the *Very Good* math group in high school owns firms that have an ebit of 54 percentage points higher than the general population, while entrepreneurs who belong to the *Bad* math category have businesses with an ebit

[9] The set of observations is composed of all firm outcomes of businesses owned by individuals born between 1979 and 1985 in order to be comparable to firm outcomes of firms owned by individuals who attended a mathematical high school, as the education dataset is available for cohorts graduated between1997 and 2004

[10] The three categories are defined as in the previous section.

which is only 22 percentage points higher than the baseline. Similarly for net income, where *Very Good* math business owners have firms which display net income that is 55 percentage points higher than the general population, while for the *Bad* group it is only 24 percentage points higher. Also in terms of revenues and employment we see that i) individuals who belong to the *Very Good* category in math skills own firms that have 2 employees more than the rest the population (25% more), while individuals who belong to the *Bad* group own firms that have the same amount of employees as the general population; ii) *Very Good* math entrepreneurs also have firms that on average have 16 percentage points higher revenue, while *Bad* math entrepreneurs only 5 percentage points higher. These findings hold true also for the other firm performance measures as can be seen in Table ...

Table 1.9. High school grades and firm outcomes

This table reports OLS coefficient of the regression of firm outcomes on having been in a mathematical HS and having a Bad, Average, very Good grade average in Math. An individual is considered attending Mathematical HS if she attended Mathematical HS and took level A math (80% of the sample).The sample is the universe of all limited liability companies having at least one employee owned by an individual born between 1979 and 1986. The regression contains additional controls for year of birth of the owner and year fixed effect. All outcome variables are defined as in the Danish Authority accounting standards, apart from employment they all log, and they are all trimmed at the 1st and 99th percentile. In terms of entrepreneurs the sample we have 11162 entrepreneurs, of which 1392 are mathematical HS, 471 are Bad_Math, 446 are Average_Math, and 210 Very_Good_Math.

	Employees	Log revenues	Log value added	Log assets	Log Ebit	Log net income	Log equity
Bad_Math	0.311	0.0525*	0.0508*	0.180***	0.242***	0.252***	0.215***
	(0.190)	(0.0243)	(0.0233)	(0.0273)	(0.0369)	(0.0390)	(0.0341)
Average_Math	1.442***	0.0428	0.218***	0.255***	0.334***	0.378***	0.337***
	(0.188)	(0.0244)	(0.0234)	(0.0273)	(0.0363)	(0.0382)	(0.0338)
Very_Good_Math	1.957***	0.159***	0.348***	0.482***	0.540***	0.549***	0.649***
	(0.267)	(0.0348)	(0.0334)	(0.0386)	(0.0524)	(0.0550)	(0.0474)
_cons	7.531**	8.341***	7.836***	8.481***	6.288***	5.352***	7.415***
	(2.883)	(0.369)	(0.329)	(0.390)	(0.560)	(0.538)	(0.451)
N	45741	45274	44752	45104	36623	35004	39768

To sum up, this evidence shows that individuals who attended a mathematical high school program own firms that are bigger and more profitable compared to the rest of the population and that both firm size and profitability is increasing with analytical skills, as measured by math grades in high school. While suggestive, these findings point towards the idea that quantifying the role of complementarity between communication and analytical skills in driving self-selection into entrepreneurship for the group of high skilled math students is a policy relevant question to explore in light of the above average quality of firms that math skilled entrepreneurs run. This leads us to the next section in which we propose an identification strategy to casually estimate and quantify the effect of increasing communication skills for mathematical high school students on the probability of starting a business.

7 Identification Strategy

So far we have provided compelling observational evidence on the relationship between individuals' skill set composition and selection into entrepreneurship. On a correlational level we observe that i) individuals who were good at math in high school run more successful and

profitable businesses ii) the share of good math high school students who start a business is increasing in their communication skills. In this section we want to do an additional step and casually estimate the effect of improving communication skills of high ability math students on the probability that they will become entrepreneurs. Quantifying the effect of this treatment for the population of high skilled math students is crucial if policymakers want to design training programs or other policy interventions to incentivize the creation of high performing firms.

To causally estimate the effect of communication skills on selection into entrepreneurship for the population of high skilled mathematical high school students, we draw from the literature on peer effects. The general idea of this literature is that individuals learn from each others and that skills get transferred across students in the same school. We use information on parental education and exploit within school, across cohort variation in the share of parents peer students' with an academic background in humanities (Mertz, Ronchi, and Salvestrini 2023). Motivated by the fact that human capital and skills get transmitted across generations, the basic idea is to instrument individual communication skills with the human capital composition of parents peers' classmates. In particular, for every individual who attended a math high school and took level A math classes we compute the share of his parents schoolmates' who have a university degree in the field of humanities[11]. We then regress a dummy that takes value one if an individual ever becomes an entrepreneur in our sample on the share of fathers peer students' graduated in humanities, controlling for school fixed effects and school fixed effects interacted with a variables that measures the share of the parents of the peer students across the different possible education levels[12]. In other words, for the seven cohorts (1997-2004) of students graduated in mathematical high schools we compare individuals who in their last year of high school were in the same school, in two different cohorts - but exposed to the same share of fathers peers' at every education level- where for one student the fathers of his peers are more frequently graduated in humanities than other fields. We additionally control for the education level and the area of education of the father of every individual as we adopt a leave one out strategy. [13]. The specification is:

$$Ent_i = \alpha + \beta_3 * Hum_{J-i,i} + \sum_{sc=n,edccs=k}^{sc=N,edcs=K} \Gamma_{n,k} * Sc_n * edcs_k + \theta * C_i + \epsilon_i \tag{4}$$

Where Ent_i is a dummy taking value one if the individual ever becomes an entrepreneur in our sample, $Hum_{J-i,i}$ is the share of fathers peers' graduated in humanities during the last high school year of the individual,$Sc_n * edcs_k$ is the cross product between a school fixed effect and the share of maximal education level of fathers' peers, C_i contains the individual's father education level and field of graduation as well as municipality fixed effects. So for two individuals in the final year of high school, who attended the same mathematical high

[11] We consider university degrees that take 5 years to be completed (so BSc + Msc).

[12] This means that the variable measures the share of parents peers' that have 9,12,15,17 or 20 years of education, corresponding to an education level of less than high school, high school, BSc, MSc and PhD.

[13] The share is computed for each individual, leaving his father out when computing the share.

school in different years, whose parents peers' however have the same educational structure (same share of fathers peers' with 9,12,14,15,17,20 years of education), we estimate the difference in the share of entrepreneurs for the individual that was exposed to a higher share of peer students with parents graduated in humanities. This identification strategy has two key assumptions. First, we assume that individuals did not strategically self-select into school programs with schoolmates that were more frequently sons of fathers with university degrees in humanities. The second identifying assumption is that sons of fathers graduated in humanities are on average better in communication skills and that these skills transfer to peer students. This last assumption is testable. We discuss this assumption in the next section.

7.1 Variability in treatment

In the literature on peer effects, a common concern with our type of identification strategy is whether there is enough variation in peer characteristics. In our setting, this means asking if across cohorts of students that graduated from the same mathematical high school during the years 1997-2004 and who have the same number of fathers with a university degree, we observe enough variation in the share of fathers peers' with a humanistic degree.
We address this concern in Table 1.10 where we display the mean, standard deviation, 10th and 90th percentile of the share of fathers graduated across different fields and the residuals from the regression of the share of fathers graduated in different fields on school fixed effects and school fixed effects interacted with the shares of maximum education of the fathers of peer students (colum *residualized*). In the column *plain*, we see that on average a mathematical high school student in her last year of school has 2% of fathers peers' graduated in humanities, with a standard deviation of 0.026. To obtain a sense of the variability in the share of fathers peers' graduated in humanities across difference school-years cells, we show the 10th and 90th percentile of the share of fathers peers' humanities graduates[14]. The least *treated* students, meaning individuals exposed to the 10th percentile of the share of peers with fathers graduated in humanities, have a 0% share. That is, in their school-year cell, nobody is the son of a father graduated in humanities. The very *treated* individuals are students exposed to the 90th percentile of the share of fathers peers' graduated in humanities and have a 6.3% share of peer students with fathers graduated in humanities in their school-year cell. We additionally display the same moments for the other relevant fields of study: business, engineering, and natural sciences. In general, the share of fathers peers' graduates across the different disciplines can be thought as the different probability to meet a peer student in the school that has higher abilities in the field of his father's university subject and represents for the other students a source of accumulation of field-specific human capital through peer interactions and learning spillovers. Our identification strategy relies on exploiting different exposures of students to the accumulation of specific skills that arise from the human capital of fathers peers' students. In the main regression 4 we control for the overall level of fathers

[14] For privacy policies when using the data we cannot show percentiles of distributions, but show instead averages around these percentiles.

with a university degree. This makes sure that we do not use variation in the share of fathers peers' with humanities degrees that only come from school-years cells having a higher overall number of fathers with a university degree. For this reason, Table 1.10 in column *residualized* shows the moments of the share of fathers peers' graduated across different disciplines after controlling for school fixed effects and school fixed effects interacted with the shares of maximum education of the fathers of peer students. The standard deviation is around 0.016 and the difference between the least and the most treated individual is about a 3.5% to 4% difference in the share of peers with fathers graduated in humanities.

Table 1.10. Variability in treatment

The table reports mean, St. Dev, mean 9-11 percentile, mean 89-91 percentile of the share of peers' fathers graduated in humanities and residuals of a regression of the share of peers' fathers graduated in humanities on school f.e. and school f.e. interacted with the education share of peers parents (Residualized), for Mathetimatical HS students in their last year belonging to the cohort 1997-2004.

	Plain				Residualized			
	Mean	St. Dev	mean 9-11 pc	mean 89-91 pc	Mean	St. Dev	mean 9-11 pc	mean 89-91 pc
Humanities	0.025	.030	0	0.063	0	.016	-0.017	0.017
Business	0.029	0.033	0	0.072	0	.016	-0.017	0.018
Engineering	.039	0.043	0	0.11	0	.018	-0.021	0.020
Natural sciences	0.025	0.028	0	0.065	0	0.015	-0.016	0.017

7.2 Father field of graduation and their son performance

Given that our empirical strategy relies on using human capitaI of fathers peer students' as an instrument for the communication skills of an individual, in this section we provide evidence on the intergenerational transmission of human capital and skills between fathers and sons. Specifically, in Table 1.11 we show the average grade in math and danish, high school gpa and the probability of becoming an entrepreneur of high school students, for the different disciplines in which their fathers obtained a university degrees. The sample is made of all high school students graduated in a mathematical high school between 1997 and 2004, who have fathers with a university degree. The averages in the table are computed with respect to a reference made of the averages of sons with fathers graduated in other disciplines: education, social science, information, agriculture, welfare, service and unknown. In column (1) we show that the average grade in danish for students whose father is graduated in humanities is significantly higher than the average of students who have fathers graduated in other disciplines (almost 7% higher than the reference). In particular, the grade is higher than the one obtained by sons of graduates in business, natural sciences and engineering who all have lower than reference average grades. The same pattern applies when we consider oral and written examinations separately, with a greater positive difference between the grades in oral than written exams (column (2) and (3)). When we move to the grade in math (column (4)) we see that sons of humanity graduates have a higher average grade also in math, but the positive difference with respect to the reference category is smaller, while significant (2.8% higher grade). Sons of business graduates do not have a significant different average grade compared to the reference category, while the sons of graduates in natural sciences have a significant higher grade in math (6.7% higher). Somehow surprisingly, sons

of engineers have lower than average grade in math, and also lower than the average math grade of sons of humanity graduates.
In Column (5) we display the average gpa in the last year of high school by father field of graduation. Students with fathers graduated in humanities are those with the highest gpa. Finally, in column (6) we show the average share of entrepreneurs by the field of graduation of the father. The son of humanity graduates have on average a 1,2 percentage point lower share of entrepreneurs than the reference category, but the difference is not significant. On the other hand, as expected, sons of business graduates have a 2.5 percentage points higher share of entrepreneurs compared to the baseline (which is more than the half of the average share of entrepreneurs in the sample).
In light of the evidence in Table 1.11, we showed that indeed the son of a graduate in humanities has better communication skills, as proxied by the grade in the oral danish exams, than sons of graduates in other disciplines. This evidence is suggestive of the fact that human capital is transmitted across generations and supports our empirical approach. Second, sons of humanity graduates do not become more frequently entrepreneurs, as is the case instead for sons of business graduates. This is important as it implies that there are no other factors pushing sons of humanity graduates to select into entrepreneurship. Finally, the literature on intergenerational skill transmission usually thinks of human capital being transmitted between father and sons as a bundle of skills. While it is true that sons of humanity graduates have higher gpa on average, we know from the previous sections that high school gpa is negatively associated with the probability of becoming an entrepreneur. This means that individuals graduated in humanities likely transmit a bundle of skills to their sons, but predominately so they transmit better communication skills.

Table 1.11. Father field of graduation and son high school grades

This table reports OLS coefficients of the regression of the average grade in the final year of high school (for student of Mathematical HS) in (1) Danish, (2)Oral Danish, (3) Written Danish, (4) Math, (5) probability of becoming an entrepreneur and (6) log-gpa on a dummy for the father of an individual being graduated in humanities, business, Natural Science, Engineering. The coefficients display the difference in the variable of interest of the mean of every field with respect to the rest of the group of fields that are: education, social sciences, information, agriculture, welfare, service, uknown. An individual is considered attending Mathematical HS if she attended Mathematical HS and took level A math (80% of the sample of mathematical HS students). The sample is the universe of all Mathematical HS students having a father that has a university education. Standard errors are clustered at school year level. Cluster #: 1053 all specification.

	(1) Danish	(2) Danish Oral	(3) Danish Written	(4) Math	(5) log-gpa	(6) Entrepreneur
Humanities	0.643***	0.641***	0.577***	0.267***	0.0437***	-0.0119
	(0.111)	(0.132)	(0.117)	(0.146)	(0.0134)	(0.00728)
Business	-0.169*	-0.116	-0.192**	-0.0971	-0.0141	0.0248**
	(0.0901)	(0.113)	(0.0890)	(0.145)	(0.0126)	(0.00931)
Natural Science	-0.246***	-0.305**	-0.185**	0.635***	0.00958	0.00484
	(0.0902)	(0.114)	(0.0900)	(0.143)	(0.0123)	(0.00851)
Engineering	-0.487***	-0.475***	-0.478***	-0.245**	-0.0717***	0.0172**
	(0.0776)	(0.0976)	(0.0792)	(0.122)	(0.0116)	(0.00741)
_cons	9.307***	9.565***	9.056***	9.450***	4.355***	0.0431***
	(0.0435)	(0.0534)	(0.0453)	(0.0692)	(0.00583)	(0.00376)
N	7050	7050	7050	7050	7050	7050

8 Second stage

In this section we analyze the effect of being exposed to a higher share of peers whose father is graduated in humanities on the probability to become an entrepreneur. If the two identifying assumptions hold, then equation 4 captures the casual effect of increasing communication skills of mathematical high school students on the probability to start a business and become entrepreneurs.

In Table 1.12, we report the estimated regression coefficients of equation 4. We display the coefficients estimated on subsamples of different cohorts: in (1) cohorts from 1997 to 2004, in (2) from 1997 to 2003, in (3) from 1997 to 2002 and in (4) from 1997 to 2001. The reason for this goes back to our initial findings that the majority of individuals open a business relatively late in life, implying that later cohorts might not have had the time yet to become entrepreneurs. When we consider the cohorts 1997 to 2004 in column (1), the effect of increasing the share of fathers peers' with a university diploma in humanities from 0% to 100% increases the probability to become an entrepreneur by 7.4 percentage points, but is not significantly different from zero. When we start to remove later cohorts- columns (2) to (4)- we see that the effect increases up to 31 percentage points (column (4)). If we assume that the estimated effect for the cohorts 1997-2001 is close to the true one if we could have followed individuals of these cohorts over their entire life-cycle, this implies that individuals being exposed to peers with all fathers graduated in humanities compared to none, increases the probability of ever becoming an entrepreneur by 31.5 percentage points. One has to consider, however, that the difference between the least and the most treated individual in our dataset -the difference between the 90th and 10th percentile - is 3.5 percentage points. Thus the difference in the probability of becoming an entrepreneur between an individual who is the least and the most treated is 1.1 percentage points. To put this into context, this corresponds to 20% of the overall share of entrepreneurs in the economy for the 1997-2001 cohort. This is an economically significant effect.

In the second row of Table 1.12, we report the regression coefficients of equation 4 in which we use the share of fathers peers' with a degree in business- instead of humanities- for different cohorts. We do this as an indirect test of our identification strategy, because as shown by Mertz, Ronchi, and Salvestrini (2023) sons of business graduates are likelier to start a business. This also helps us to have a benchmark against which to compare the estimated coefficients for humanities. In column (1) we see that increasing the share of fathers peers' with a university diploma in business from 0% to 100% increases the probability to become an entrepreneur by 16 percentage points, which becomes 19 percentage points for cohorts 1997-2003 (column (2)). Comparing for the same cohorts the effect of increasing the share of fathers peers' with humanities or business degrees has similar effects in magnitude. This means that improving the communication skills of students who are good at math or providing more early exposure of students to an entrepreneurial environment has a quantitative comparable effect on spurring new business creation.

Table 1.12. Second stage regression

This table reports the OLS coefficients of the regressing the probability of ever becoming an entrepreneur on the share of peers whose father is graduated in humanities, controlling for school f.e., school f.e. interacted with share of education of peers' fathers, father year of education interacted with field of education and high school municipality f.e. In column (1) the sample contains cohort from 1997 to 2004, column (2) cohorts from 1997 to 2003, column (3) cohorts 1997 to 2003, and column (4) cohorts 1997 to 2002. In the second, third and fourth row we report the same OLS coefficients where instead of using the share of peers' fathers with a degree in humanities we use those with a degree in business, natural sciences and engineering respectively. The sample is the universe of male Danish Mathematical high school students in their last HS school year. *Entrepreneur* is 1 if an individual has ever been an entrepreneur in her life. Standard errors are clustered at year-school level and are: # (1) 1,109, (2) 969, (3) 829, (4) 691

	1997-2004	1997-2003	1997-2002	1997-2001
	(1)	(2)	(3)	(4)
	Entrepreneur	Entrepreneur	Entrepreneur	Entrepreneur
1) Share_humanities	0.0737	0.165**	0.249**	0.316**
	(0.0649)	(0.0771)	(0.102)	(0.148)
2) Share_business	0.154**	0.190**	0.0184	0.161
	(0.0717)	(0.0872)	(0.132)	(0.157)
3) Share_natural_sciences	-0.0606	-0.0772	-0.0586	-0.0928
	(0.0727)	(0.0858)	(0.115)	(0.170)
4) Share_engineering	0.0509	0.0428	0.0728	0.223
	(0.0647)	(0.0764)	(0.107)	(0.151)
School f.e.	✓	✓	✓	✓
School f.e.×Share_HS+9	✓	✓	✓	✓
School f.e.×Share_HS+12	✓	✓	✓	✓
School f.e.×Share_HS+14	✓	✓	✓	✓
School f.e.×Share_HS+15	✓	✓	✓	✓
School f.e.×Share_HS+17	✓	✓	✓	✓
School f.e.×Share_HS+20	✓	✓	✓	✓
Father_year_of_education×education_area	✓	✓	✓	✓
High school municipality f.e.	✓	✓	✓	✓
N	29642	26291	23051	19668

Finally, in the second and third row of Table 1.12 we show the same results but changing fathers' university degree to natural sciences and engineering respectively. We see that being expose to a higher share of students with fathers graduated in natural sciences has a negative effect, even if statistically not different from zero, on the probability of becoming an entrepreneur. This alines with our findings in section 7.2 that fathers graduated in natural sciences on average transmit higher mathematical skills to their sons, which alone negatively relate to self-selection into entrepreneurship. For fathers graduated in engineering the effect on the probability of ever becoming an entrepreneur is positive, but again not statistically significant.

Taken together, this evidence shows that mathematical high school students in their last year of school, who were exposed to a higher share of peers with fathers graduated in humanities - for a given school and given overall number of fathers with university diploma - have a significantly higher probability of becoming entrepreneurs compared to the rest of the population. The effect is sizable, being around 20% of the share of entrepreneurs in the economy for the 1997-2021 cohorts. The effect is also comparable, in terms of magnitudes, to exposing students to more entrepreneurial environments as measured by the share of fathers peer students' graduated in business.

9 Conclusion

In this paper we use Danish administrative data to provide new findings on the role of skill multi-dimensionality in explaining self-selection into entrepreneurship. We use detailed high school grades obtained by students in math and danish to measure analytical and communication skills. Observational evidence shows that individuals with specialized skills earn higher wages on the labor market, but are less likely to become entrepreneurs. For high talented math students in high school, the probability of starting a business is increasing in their communication skills. These students are also the ones owning the most profitable and successful businesses if they become entrepreneurs. To casually estimate the effect of improving communication skills of individuals with good analytical skills, we propose an identification strategy that exploits information on parents' human capital. Our findings show that teaching better communication skill to students who are very good at math in high school spurs business creation and that the effects are sizable. Our findings contribute to growing evidence on the role of human capital for entrepreneurial outcomes and inform the policy debate on the importance of education and training programs to incentivise the birth of successful entrepreneurs.

10 Appendix

The table below provides an overview of the structure of the Danish high school system up to 2004.

Figure 1.2. Overview class structure in mathematical high school program

General upper secondary education (gymnasium): distribution by subject of the total number of lessons per year (prior to the reform of 2005)

Subject	Number of lessons per year in each form		
	I	II	III
1. *Languages*:			
Beginner language	105	108	–
Visual arts	–	–	51
Biology	79	–	–
Danish language	79	81	102
English	105	108	–
Continuation language	105	108	–
Geography	–	81	–
History and civics	79	81	76
Physical education and sport	53	54	51
Latin	79	–	–
Music	79	–	–
Science	79	108	–
Classical studies	–	–	76
Religious studies	–	–	76
2. *Mathematics*:			
Beginner/continuation language	105	108	–
Visual arts	–	–	51
Biology	79	–	–
Danish language	79	81	102
English	79	108	–
Physics	79	81	–
Geography	–	81	–
History and civics	79	81	76
Physical education and sport	53	54	51
Chemistry	79	–	–
Mathematics	132	135	–
Music	79	–	–
Classical studies	–	–	76
Religious studies	–	–	76
3. *Optional subjects at advanced level*:			
Beginner language	–	–	127
Biology	–	135	127
English	–	–	127
Continuation language	–	–	127
Physics	–	–	127
Greek	–	135	203
Chemistry	–	135	127
Latin	–	135	127
Mathematics, mathematics stream	–	–	127
Mathematics, language stream	–	135	127
Music	–	135	127
Social studies	–	135	127

Source: Danish Eurydice Unit, 2005. Optional subjects are offered at an advanced and intermediate level. Concerning physical education and visual arts as optional subjects, the number of lessons may be combined with the lessons allocated to compulsory subjects. There must be 32 weekly lessons (each lasting 45 minutes) in the first year, and 31-32 in the second and third years. In the first year the 32 lessons are spent on compulsory subjects (27 in the second and 17 lessons in the third year).

Figure 1.3. Danish Grading System 7-point grading scale

Grade	Description	ECTS	Old scale (00-13)
12	For an excellent performance displaying a high level of command of all aspects of the relevant material, with no or only a few minor weaknesses	A	13 11
10	For a very good performance displaying a high level of command of most aspects of the relevant material, with only minor weaknesses	B	10
7	For a good performance displaying good command of the relevant material but also some weaknesses	C	9 8
4	For a fair performance displaying some command of the relevant material but also some major weaknesses	D	7
02	For a performance meeting only the minimum requirements for acceptance	E	6
00	For a performance which does not meet the minimum requirements for acceptance	Fx	5 03
-3	For a performance which is unacceptable in all respects	F	00

Chapter 2
Entrepreneurship, Wealth & Human Capital

How important is the accumulation of human capital versus wealth in explaining selection into entrepreneurship over an individual's life-cycle? To answer this question we construct a new dataset based on Danish administrative data and use it to study the characteristics of individuals that select into entrepreneurship at different stages of their life. We provide new evidence on the fact that entrepreneurs are self-selected along several measures of human capital and skills. We show that entrepreneurs, compared to workers of the same age, on average i) earn higher wages before starting their business ii) experience higher growth rates in wages iii) have more years of education and labor market experience. We show that this self-selection, in terms of human capital, is even stronger across the most productive entrepreneurs. We also show that future entrepreneurs hold slightly higher wealth, compared to workers of the same age, prior to starting the business. We ask whether aspiring entrepreneurs face liquidity constraints and use fathers' wealth as indirect proxy for the easiness in access to credit. We find that the probability of becoming an entrepreneur is essentially flat along the central part of the family wealth distribution and increasing only at the tails, which is inconsistent with the view that future entrepreneurs face major liquidity constraints. To quantify the relative importance of human capital accumulation versus wealth in affecting individuals' decisions to start a business we propose a quantitative general equilibrium life-cycle model with human capital accumulation, financial frictions and occupational choices. The model is used to disentangle the role of wealth, skills and the quality of the business idea in affecting self-selection into entrepreneurship. Through counterfactual exercises we establish how financial frictions affect the quality of new ventures by distorting individuals' human capital accumulation decisions. Finally, we use the calibrated model to quantify the efficiency and welfare effects of a tax policy aimed at incentivising business creation by young individuals.

1 Introduction

In this paper we study and quantify the relative importance of human capital accumulation versus wealth in explaining selection into entrepreneurship.

Numerous anecdotes suggest that entrepreneurs, especially successful ones, are young individuals with great business ideas who open a start-up early in life. While this might be true for some founders, it does not reflect the average entrepreneur. As Azoulay et al. (2020) document, the average age at founding of US business owners over the period 2007-2014 is 41.9 years. When considering only high-growth sectors, the average age at founding is 45 years. Earlier contributions have explored the relationship between age and business foundation, with an emphasize on the role of wealth in affecting the propensity to become an entrepreneur.[1] If financial markets work imperfectly and aspiring entrepreneurs face collateral constraints, as in David S. Evans and Jovanovic (1989), then part of the observed life-cycle patterns can simply be explained by the fact that individuals need time to accumulate enough wealth to start their business at a profitable scale. However, empirical studies by Hurst and Lusardi (2004) have found a weak relationship between wealth and selection into entrepreneurship.

On the other side, recent evidence is starting to show how entrepreneurial human capital, defined as all those learnable factors embodied in the business owner (organizational kills, management abilities, social contacts etc.) is crucial in explaining business success [2]. Still little is known, however, on how the the accumulation of human capital and skills affects the decision to start a business. How does the accumulation of human capital interact with the accumulation of wealth and how does it ultimately affect business entry? Are human capital and wealth substitutes in entrepreneurial activity? Which is more important in driving selection into entrepreneurship over an individual's life-cycle? To answer these questions we construct a novel dataset combining multiple administrative data sources from Denmark and provide new evidence on the relationship between human capital accumulation, wealth and selection into entrepreneurship. We have access to a rich and detailed panel data set on the universe of Danish firms created between 1996 and 2019. By identifying the ultimate owners of these firms we are able to match firm level data with individual level information on business owners' characteristics. We observe individuals both before and after their transition into entrepreneurship, which enables us to provide new facts on entry into entrepreneurship over the life-cycle.

Similarly to Azoulay et al. (2020), we find that the age distribution at founding is hump-shaped, although the average age at business foundation is slightly younger in Denmark, being 38 years on average. Next, we turn to the role of human capital and selection into entrepreneurship. We show that entrepreneurs are self-selected in terms of

[1] Holtz-Eakin, Joulfaian, and Rosen (1994) use US inheritance data to show that the propensity to start a business and the initial size of the business is increasing with the amount of the inheritance, which they interpret as a sign of the presence of liquidity constraints.

[2] Smith et al. (2019) use US tax data to show that on average around three quarters of pass-through business profits represent returns to owners human capital, rather than compensation for holding productive financial wealth. Queiró (2022) uses Portuguese administrative data to show that firms started by more educated entrepreneurs start bigger and display higher growth rates.

different measures of human capital and skills. Specifically, we document that entrepreneurs, compared to workers of the same age, on average i) earned higher wages before starting their business ii) experienced higher growth rates in wages iii) have more years of education and labor market experience. We also ask how workers and entrepreneurs differ in terms of unobserved earnings ability, as measured by the residuals of a Mincerian wage regression. We find that Danish entrepreneurs are positively selected also in terms of residuals from the earnings regressions. These results show that entrepreneurs are positively selected from the pool of workers and that understanding the dynamics of entrepreneurial human capital accumulation is key to shed light on the process of business formation.

We then move to the role of wealth as a barrier to entrepreneurship. Prior work has highlighted that if financial markets work imperfectly, aspiring entrepreneurs need to have enough wealth to overcome collateral constraints and run their firms at a profitable scale. Additionally, higher wealth holdings can also serve as a source of insurance against negative business outcomes. We investigate the relationship between wealth and selection into entrepreneurship in our data by showing that future entrepreneurs hold slightly higher wealth, compared to workers of the same age, before starting their business. To try to isolate the role of wealth held to overcome collateral constraints, we use information on fathers' wealth to indirectly proxy for the presence of liquidity constraints. If the latter were the main reason holding back individuals from entrepreneurial activity we would expect the propensity of becoming an entrepreneur to increase as borrowing constraints become looser. We find that the probability of becoming an entrepreneur is essentially flat along most of the family wealth distribution and only increasing in the tails. We additionally show that entrepreneurs coming from wealthier families do not seem to start businesses earlier in life compared to the rest of the population. While not conclusive, our suggestive evidence confirms the findings by Hurst and Lusardi (2004) and Bhandari, Kass, and Schulz (2022) that aspiring entrepreneurs do not seem to face major liquidity constraints as previous theoretical work was suggesting.

To disentangle and quantify the relative importance of human capital, skills and entrepreneurial ideas in affecting the decision to start a business we propose a general equilibrium life-cycle model with financial frictions, human capital accumulation and occupational choices. The model is based on previous work by Cagetti and De Nardi (2006), but is extended to include a realistic life-cycle dimension and human capital accumulation. Specifically, we consider a small open economy in which individuals are endowed with a learning ability which determines the speed at which they accumulate human capital. In each period they make an occupational choice between being a worker or an entrepreneur. In both occupations individuals accumulate entrepreneurial skills, through a learning-by-doing technology. The stock of accumulated human capital has two effects. On one side it fully determines labor income if individuals become paid employed workers, on the other it affects the productivity of the business if individuals decide to start a firm. The overall productivity of the business is the product of an exogenous shock which captures the quality of the business idea and the level of the entrepreneur's human capital. Entrepreneurs face collateral constraints, in the sense that they can only borrow up to a multiple of their wealth. These

model ingredients generate a non-trivial sorting of individuals across occupations depending on their asset holdings, business ideas and accumulated stock of human capital. Finally, there is a government that collects income taxes and uses them to fund pension benefits and wasteful government spending.

The model is brought to the data through a simulated method of moments procedure, by targeting data moments which are informative about the underlying structural parameters. Importantly, our model is able to replicate several untargeted moments, as well as the main selection mechanisms into entrepreneurship observed in the data. We use the model to study the interplay between human capital accumulation, wealth and quality of the business idea in affecting transitions into entrepreneurship. The model shows how the average productivity of entrepreneurs increases with age, mainly because of the higher accumulated stock of human capital. The model also reveals that young entrepreneurs substitute lower human capital with higher than average quality of business ideas, while individuals that open businesses later in life tend to have more skills but worse business ideas.

Through counterfactual exercises we establish the effects that financial frictions have on aggregate entrepreneurial activity in the economy, on the life-cycle dynamics of entrepreneurship and on the productivity of the businesses that are started. We separate the effects into partial and general equilibrium responses and show how eliminating financial frictions in general equilibrium reduces the share of entrepreneurs in the economy, but increases their average quality. While the absence of collateral constraints makes entrepreneurship more attractive in partial equilibrium, the indirect increase in the wage pushes low-quality aspiring entrepreneurs back to paid employed jobs. Financial frictions affect the quality of new ventures on the extensive and intensive margin. On the extensive margin, eliminating financial frictions lowers the average quality of new entrepreneurs as individuals can start a business without the need of accumulating wealth, which correlates with the accumulation of human capital. On the intensive margin, however, eliminating financial frictions improves firm productivity as entrepreneurs can borrow more for the same productivity levels and thus produce more output. We find that both in partial, and more so in general equilibrium, the intensive margin effect dominates and that aggregate TFP increases when financial frictions are eliminated.

Finally, we study the welfare properties of a tax reform aimed at incentivising business creation by young individuals. Specifically, we consider a new tax regime in which entrepreneurs under the age of 30 are exempted from paying income taxes. We find that such a tax reform is self-financing, meaning it can be implemented by keeping the budget balanced without having to increase taxes for other categories. We show that this is the case because the tax reform helps to partly undo the negative efficiency effects of financial frictions. While the tax reform is efficient, we discuss how not everybody would be in favor of it. We measure the welfare effects of the policy using the consumption-equivalent measure (CEV) and trace out who wins and who looses from the reform. The next section discusses our contributions to the extant literature.

2 Related Literature

This paper relates to several strands of literature. The decision to start a business and become an entrepreneur is an infrequent career choice [3]. Until recently, data limitations have forced the literature to sidestep several aspects that contribute to our understanding of the process of business formation[4]. On the empirical side, we contribute to recent work studying the characteristics of individuals that select into entrepreneurship using administrative data. Queiró (2022) uses Portuguese administrative data to analyze the relationship between education and entrepreneurial outcomes, while Gendron-Carrier (2023) uses Canadian admin data to show that individuals who previously worked in high-wage firms tend to do better as future entrepreneurs. Using US administrative data sources Bhandari, Kass, and Schulz (2022) compare the average life-time incomes of self and paid employed individuals to draw new conclusions on the returns to entrepreneurship. We contribute to this growing literature by constructing a new dataset based on the full Danish administrative data and are able to distinguish between owners of sole proprietorships, partnerships and limited liability companies, which has been shown by Levine and Rubinstein (2017), to be crucial for the correct measurement of entrepreneurship. We provide new evidence emphasizing the importance of skills and human capital accumulation for the understanding of selection into entrepreneurship over an individual's life-cycle. We also provide new observations on the relationship between wealth and selection into entrepreneurship, leveraging information on prior family wealth to have a better proxy for the presence of liquidity constraints, which have often been advocated as a barrier to aspiring entrepreneurs (David S. Evans and Jovanovic (1989) and David S Evans and Leighton (1989)).

On the theory side, we propose a new simple quantitative macroeconomic model that extends the canonical model of entrepreneurship by Cagetti and De Nardi (2006), allowing for a realistic life-cycle structure and human capital accumulation. Our work connects to papers that use models of entrepreneurship to understand macroeconomic outcomes, such as Allub and Erosa (2019) who build an occupational choice model that distinguishes between self-employed and entrepreneurs to quantify the effects of financial frictions on GDP and inequality, Wellschmied and Yurdagul (2021) who argue on the importance of accounting for endogenous hours worked to understand the wealth distribution among entrepreneurs and Kozeniauskas (2018), Salgado (2020) who propose a model of entrepreneurship with technological change to account for the decline in the share of entrepreneurs in the US economy. Our paper also relates to the strand of research that incorporates entrepreneurs in otherwise standard incomplete-market models to evaluate efficiency and welfare properties of tax reforms. Example of such recent works are Bruggemann (2021) and Guvenen et al. (2023). A paper close in spirit to ours is Bhandari and McGrattan (2020). The authors highlight the importance of accounting for entrepreneurs' sweat equity when designing business and

[3] The share of individuals who ever become entrepreneurs in our sample is 7.4%.

[4] Most past work on entrepreneurship was based on survey data, see for example David S Evans and Leighton (1989), Hurst and Lusardi (2004), De Nardi, Doctor, and Krane (2007) and Poschke (2013).

corporate taxes. The concept of sweat equity and human capital share some similarities but differ in two major respects. In Bhandari and McGrattan (2020) entrepreneurs can invest time in creating sweat equity which increases the firm's productivity. Typical activities that would rise sweat equity are marketing and networking activities that build customer bases and client lists. In this sense the notion of sweat equity is closer to the concept of intangible capital and is firm specific, rather than individual specific as human capital. Second, the authors do not investigate the role of sweat equity for business creation nor study how it affects transitions into entrepreneurship, which is the focus here.

We show how allowing for human capital accumulation allows to draw new conclusions on the type of individuals that open a business at different stages of their life and how our framework can be used to reevaluate the effects of financial frictions on aggregate entrepreneurial activity and on the productivity of new ventures that are created by different types of individuals. Finally, our work also relates to papers that use structural econometric models as Hincapié (2020), Catherine (2022) and Gendron-Carrier (2023) to disentangle the role of different economic forces, from cognitive to non-cognitive abilities, non-pecuniary benefits, labor market experience and risk aversion in driving selection into entrepreneurship.

The reminder of the paper is organized as follows. Section 2 describes the data, while section 3 provides empirical evidence on the role of wealth and human capital for selection into entrepreneurship. Section 4 introduces the model and section 5 discusses how we bring it to the data. Section 6 is dedicated to the study of the model properties and counterfactual exercises. Section 7 analyses the policy reform and the final section concludes.

3 Data

Our analysis is based on administrative data for the entire Danish population. We combine multiple administrative data sources to construct a unique dataset, that maps all firm ownership in the Danish economy between 1996-2019. This includes direct and indirect ownership of both incorporated firms (ltd. corporations)[5], and of unincorporated firms (proprietorships, partnerships), the timing of ownership relations, and the allocation of ownership shares in cases with multiple owners.

Our primary interest lies in identifying individuals that transition into entrepreneurship for the first time, their main characteristics at the time of transition, and the subsequent performance of their firms. We characterize individual entrepreneurs using detailed records of labor market histories, education, wealth, income, age, gender and we measure firm performance using annualized data on employment, revenue and value-added.

The primary unit of observation is an individual. We start by restricting the sample to all men born between 1962 and 1976, implying that individuals are aged 20-57 in the sample[6].

[5] There are three types of limited corporations in Denmark, relevant to the data period: A/S, ApS and IvS, that differ mainly in terms of capital requirements. As per 2020, A/S has a capital requirement of 250.000 dkk, ApS has a capital requirement of 40.000 dkk, and IvS has a capital requirement of 1 dkk. The capital requirement of ApS was reduced from 125.000 dkk to 80.000 dkk in 2010, and then reduced further to 50.000 dkk in 2014, and 40.000 in 2020. IvS was introduced in 2014 and discontinued in 2019.

[6] We do not observe firm ownership for cohorts born before 1962.

All firm related variables, for example revenues, value-added and employment, are weighted by the ownership shares of the individual. We define an individual as an entrepreneur if at any given moment in time in our sample, the individual is the owner of a limited liability firm with positive revenues, positive assets and who has hired at least one employee over the entrepreneurial spell. We define the start of the entrepreneurial spell with the year in which the individual started owning shares of the limited liability firm.

We further restrict the sample such that we can divide individuals in two types: workers and entrepreneurs. Workers are individuals with paid-employed jobs who have worked at least part-time in the last year. We drop individuals that are and remain self-employed during the time period of the dataset. Finally, we keep only entrepreneurs for which we observe the transition into entrepreneurship. This leaves us with 8,620,260 observations for a total of 400,930 individuals. Of these, 7.4% are entrepreneurs at some point in time, while the rest are workers.

4 Empirical Evidence

Table 2.1 reports summary statistics for our sample[7]. In the upper part of the table, we present a simple measure of standardized hourly wages that adjust for differences in age and calendar year. This measure is obtained by dividing each individual's wage by the average wage of people with the same age, in the same year. For entrepreneurs we use the wages they were earning before transitioning into the entrepreneurial spell. We see that future entrepreneurs earn on average around 20% higher standardized wages compared to workers. We further construct a measure of the average annual real wage growth for workers and entrepreneurs[8]. Aspiring entrepreneurs are not only positively selected in terms of levels of prior earnings, but also in terms of annual growth rates, experiencing an average increase in wages of 3.4% against a 1.3% of workers. The last block of the table provides the distribution of the highest education achieved by the two groups. Interestingly, among entrepreneurs we observe a high share of individuals where the highest level of completed education is high school or vocational training, whereas among the workers we have a higher share of individuals at the extreme of the education distribution. That is, they exhibit a higher fraction of people that only completed comprehensive school and a higher fraction that completed a PhD or equivalent.

Next, we turn to the life-cycle dynamics of entrepreneurship in Denmark. Figure 2.1 shows the regression coefficients of the probability of becoming an entrepreneur on age. We see that the age distribution at founding is hump-shaped, with an average age at founding of 38. The qualitative patterns of the age distribution at founding in Denmark are similar to the ones found by Azoulay et al. (2020) for the US, even if Danish entrepreneurs are slightly younger at business start. In the following two sections we provide suggestive evidence on

[7] Throughout our work median and percentiles in the data are computed as averages around percentiles to comply with Danish data privacy policies.

[8] This growth rate is computed as $g_{it} = \frac{w_{i,t} - w_{i,t-1}}{0.5*(w_{i,t} + w_{i,t-1})}$.

the potential mechanisms behind this pattern.

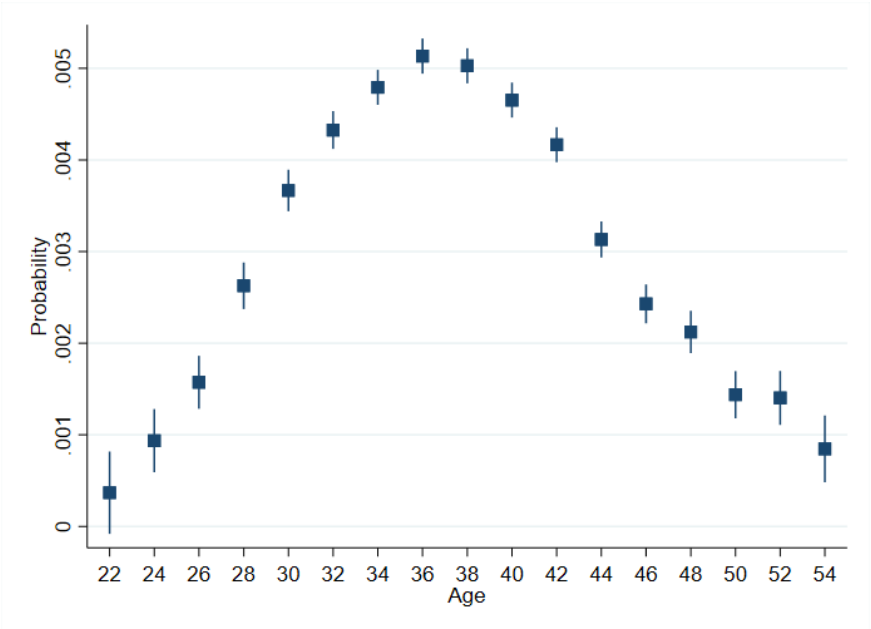
Table 2.1. Summary Statistics

Standardized wages are computed dividing each individual's wage by the average wage of individuals of the same age and in the same calendar year.

	Workers	Entrepreneurs
Observations	7,923,893	696,367
Standardized wage		
Average	1.0	1.2
Median	0.9	1.1
Wage growth		
Average	1.3%	3.4%
Median	1.2%	2.7%
Education		
Comprehensive school	19.0%	10.5%
High school	47.2%	53.5%
Vocational school	7.6%	10.7%
Bachelor or equivalent	13.9%	13.2%
Master or equivalent	10.6%	11.2%
Doctorate or equivalent	1.7%	0.9%

Figure 2.1. Age distribution at founding

The table reports the OLS coefficients of the regression of the probability of becoming an entrepreneur on age, without a constant. The sample is the universe of danish men born between 1962 and 1976.



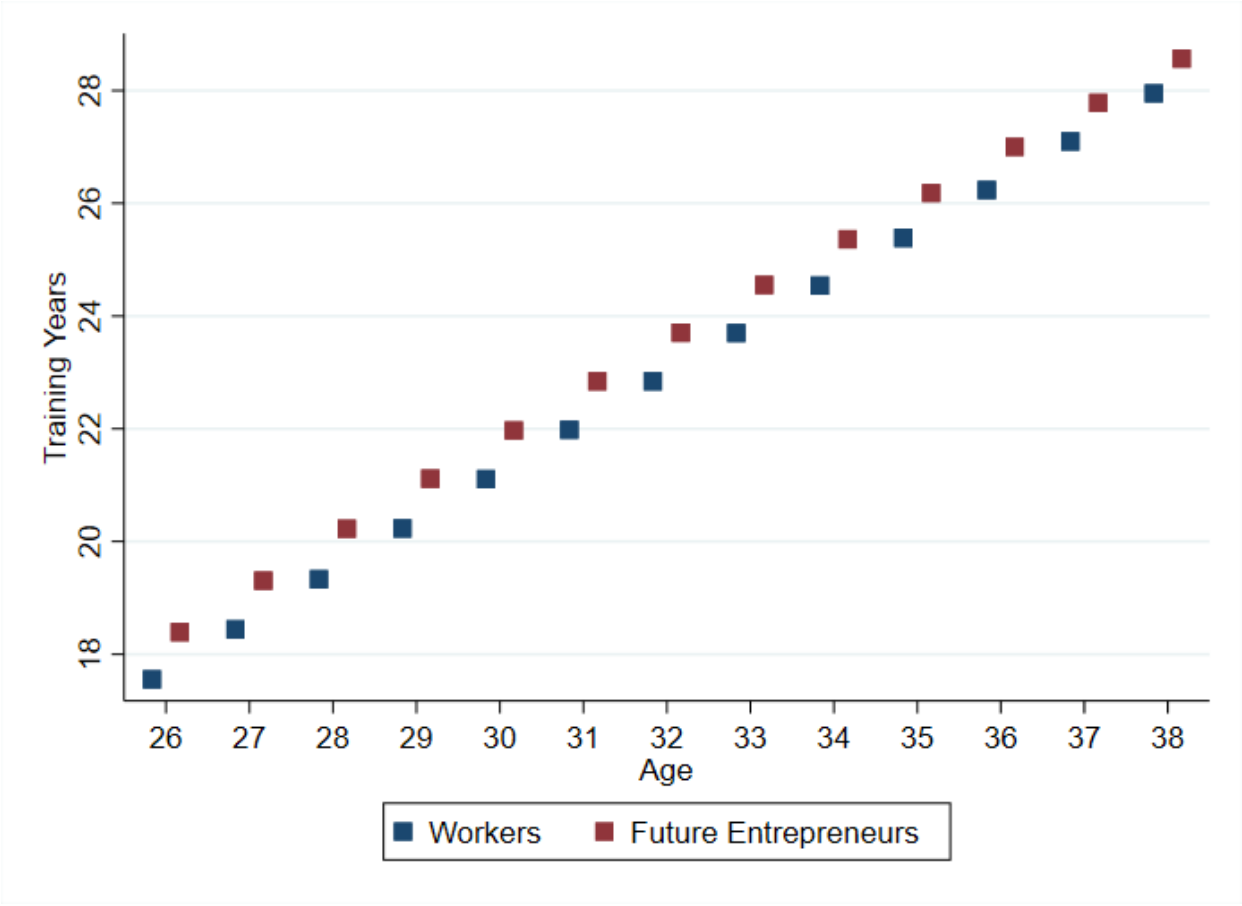
4.1 Selection in terms of human capital

Founding and running a firm is a complex activity. Among other skills, it requires management abilities, a good notion of the market in which to start the business and the capacity of organizing complex tasks. Part of these skills can be acquired through formal education, while others can be learnt on the job. In both cases, accumulating human capital is a slow process. This section presents evidence on the fact that entrepreneurs are positively selected along different measures of human capital usually used in the literature.[9]

We start by measuring human capital in terms of education and labor market experience. For each individual in the data set we construct the variable training years as the sum of years of education and labor market experience at any given point in time. In Figure 2.2 we plot the average training years by age for workers and future entrepreneurs, before they transition into entrepreneurship. We plot the average training years up to age 38, which is the average age at business start.

Figure 2.2. Human capital as average training years

Training years are defined as the sum of years of education and labor market experience at any given moment in time.



We see that future entrepreneurs on average have more training years compared to

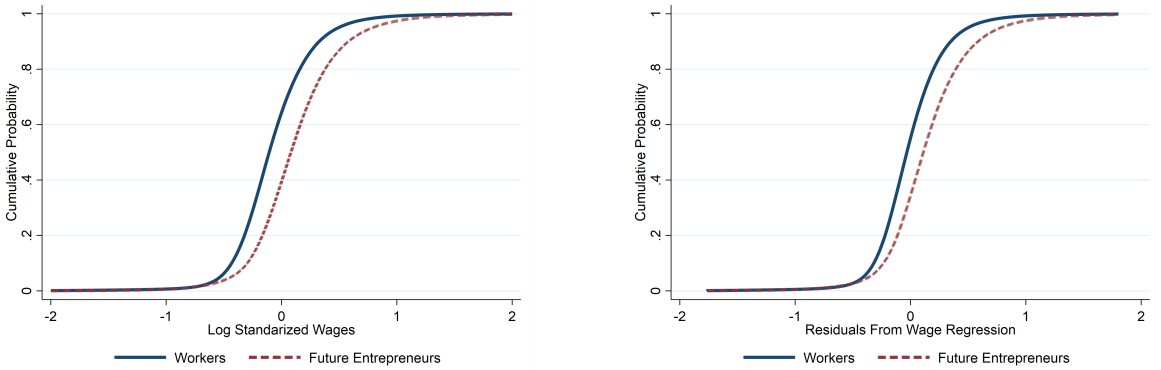
[9] For example, wages and residuals from earnings regressions are used in Borjas, Kauppinen, and Poutvaara (2019) to study positive self-selection in terms of skills of migrants vs non-migrants.

workers of the same age. These differences are statistically significant at the 5% significance level and are also economically relevant. For example, at age 30 aspiring entrepreneurs have on average almost one additional year of training, which reflects both education choices and actual labor market experience. Given that we are conditioning on age this implies that future entrepreneurs have spent more time working or acquiring skills in education, ultimately building up a higher stock of human capital.

A second measure often used to proxy for individuals' human capital are hourly wages. To the extent that markets are competitive, wages reflect individuals' true productivity on the job. Our analysis consists in constructing a measure of standardized hourly wages for each individual and to compare cumulative distributions of standardized wages between future entrepreneurs and workers. We standardize hourly wages by dividing each individual's wage by the average wage earned by people with the same age, in the same year. This procedure helps to account for differences in wages that simply come from life-cycle dynamics and aggregate economic conditions. For future entrepreneurs, we use the hourly wages they were earning before the entrepreneurial spell. By plotting the cumulative distribution function we do not impose any functional form restriction on the data and one can see that the positive selection of aspiring entrepreneurs in terms of prior wages not only holds on average, but along the entire distribution. This means that for any value of standardized wages in the danish economy, the fraction of future entrepreneurs earning lower than that wage is smaller than the fraction of workers. Panel (a) of figure 2.3 illustrates the cumulative distribution function for the two groups.

Figure 2.3. Self-selection of entrepreneurs in terms of observed and unobserved charateristics

Panel (a) shows the cdf of standardized wages. Panel (b) plots the cdf of residuals from a wage regression.



(a) Selection in terms of prior standardized wages.

(b) Selection in terms of residuals of wage regressions.

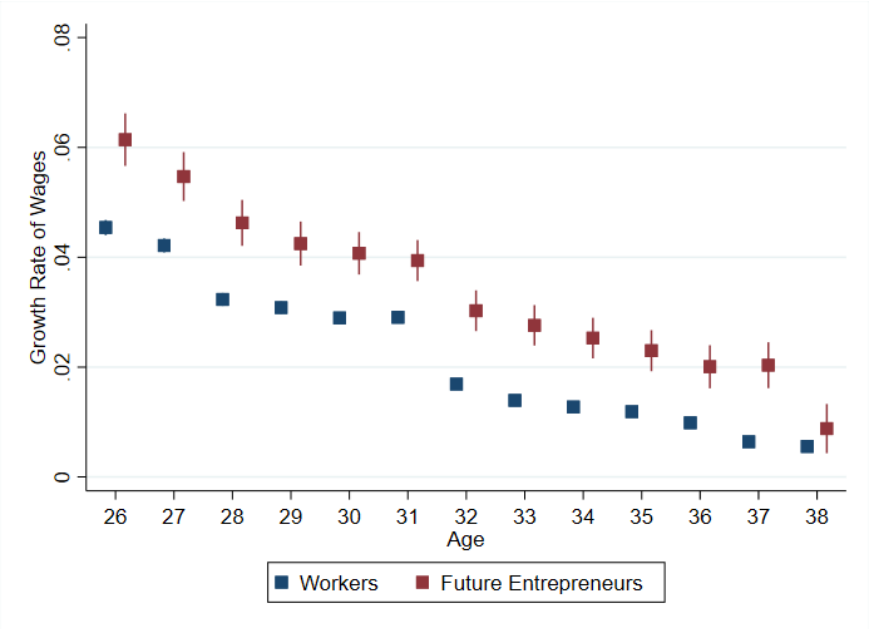
Differences in wages partly reflect differences in observables and one can wonder how the two groups differ in terms of unobserved characteristics. To this end, we run simple Mincerian regressions for the two groups in which we regress wages on education, age and year dummies and examine how the residuals differ between the two groups. Goal of the exercise

is to establish whether the observed differences in panel (a) Figure 2.3 only reflect different education choices or whether workers and future entrepreneurs also differ along unobserved abilities. Panel (b) of Figure 2.3 shows that the two groups also differ in terms of unobserved characteristics, with future entrepreneurs being positively selected. By construction, panel (b) of Figure 2.3 tells us that workers and entrepreneurs differ in terms of characteristics which are not explained by education and age.

The final piece of evidence we produce to demonstrate that entrepreneurs are positively selected in terms of human capital, is to check how the two groups differ between experienced wage growth. While differences in wages inform us on the stock of accumulated human capital, changes in wages mostly reflect increases in individual's productivity that may stem from different learning abilities on the job. In Figure 2.4 we show that future entrepreneurs were experiencing higher growth in wages, compared to workers of the same age, before starting a business.

These statistics - while observational- reveal us an important dimension of the data to take into account when modeling selection into entrepreneurship. In the next section we explore the relationship between wealth and entrepreneurship.

Figure 2.4. Wage growth of future entrepreneurs and workers.



4.2 Selection in terms of wealth

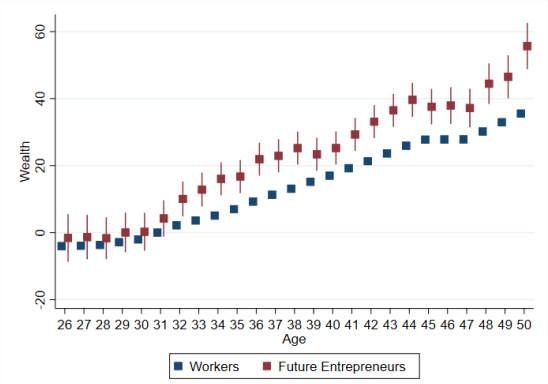
In this section we revisit the relationship between wealth and selection into entrepreneurship. Standard theories of entrepreneurship like in David S. Evans and Jovanovic (1989), would predict that if financial markets work imperfectly, then aspiring entrepreneurs save to overcome collateral constraints. This would imply that future entrepreneurs hold higher wealth compared to workers with observationally similar characteristics. Additionally, if

markets are incomplete and entrepreneurs are risk-averse, then future entrepreneurs also hold wealth to insure themselves against adverse business outcomes.

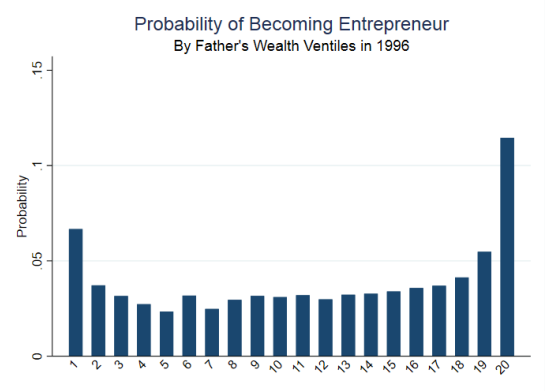
In panel (a) of Figure 2.5 we plot net wealth holdings of workers and future entrepreneurs conditional on age. We see that future entrepreneurs hold higher wealth at almost every age, compared to workers. The difference in wealth holdings is statistically significant.

Figure 2.5. Wealth and selection into entrepreneurship

Panel (a) shows net wealth holdings of workers and future entrepreneurs. Net wealth is measured as the sum of financial wealth and housing, minus outstanding debt. Panel (b) plots the share of individuals who ever become entrepreneurs by the ventiles of their father's wealth measured at the beginning of the sample (1996).



(a) Net wealth holdings of workers and future entrepreneurs.



(b) Share of entrepreneurs by family wealth

Given that savings decisions are the result of individuals' choices, we cannot tell whether the differences in wealth holdings stem from the presence of liquidity constraints or from other reasons[10]. To get closer at understanding the role of wealth held to overcome collateral constraints, we use information on fathers' wealth in 1996 - the beginning of the sample - as a proxy for liquidity constraints. If indeed borrowing constraints were holding individuals back from entrepreneurship, we would expect the fraction of individuals that become entrepreneurs to increase as borrowing constraints get looser. The underlying assumption is that as we move along the family wealth distribution, individuals are less and less borrowing constraint either because they can directly get resources from their family or because they can pledge part of their family assets' as collateral to obtain bank credits[11]. Panel (b) of Figure 2.6 shows that the probability of becoming an entrepreneur is not monotonically increasing with family wealth. The relationship between family wealth and selection into entrepreneurship is essentially flat along most of the central part of the distribution and only increasing in the first and last ventile. Part of this can be explained by the fact that entrepreneurs are over represented in the tails of the wealth distribution and are likely to pass over the family business. We further ask whether better access to

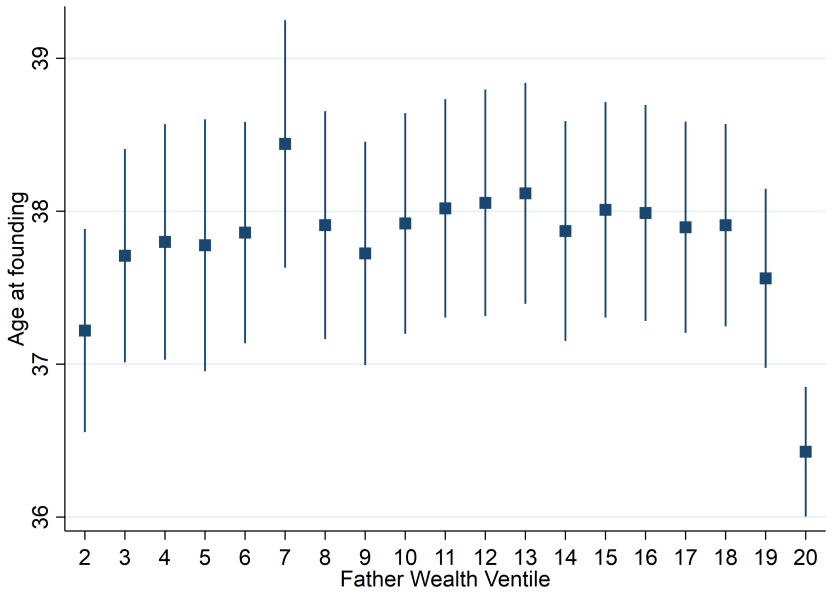
[10] For example, higher wealth holdings can arise mechanically from higher incomes or from differences in patience between future entrepreneurs and workers.

[11] Of course family wealth also captures other aspects, like transferable entrepreneurial knowledge (or the business itself) between parents and children. But if anything, this should reinforce the positive relationship between family wealth and the propensity of becoming an entrepreneur.

credit impacts the life-cycle dynamics of entrepreneurship by regressing the age at business start on the ventiles of father wealth. As can be seen in Figure 2.6, on average entrepreneurs that come from richer families do not start their business earlier in life, with the exception of individuals who come from very rich backgrounds who start their firm about 1.5 years younger on average. This indicates that the need of accumulating wealth is likely not the only driver of the life-cycle patterns of selection into entrepreneurship.

Figure 2.6. Age at founding by father wealth

The figure plot the OLS regression coefficients of the age at business start on the ventiles of father wealth in 1996, without a constant.



4.3 Complementarity between human capital and wealth

We further explore to which extent human capital and wealth are substitutes or complements in entrepreneurial activity. Are entrepreneurs coming from richer families still positively selected in terms of human capital or less so because they can substitute wealth for skills? We check for evidence of substitutability by reporting the average log standardized wage of workers and future entrepreneurs conditional on family wealth. If human capital can be substituted with wealth we expect the differences in log standardized wages between workers and future entrepreneurs to become smaller as we move along the family wealth distribution[12]. Table 2.2 shows that the differences in log standardized wages between future entrepreneurs and workers do not change as we move along the family wealth distribution. Regardless of the family background, future entrepreneurs earn on average between 16%-19% more than workers and this difference remains constant throughout the family wealth distribution. This evidence, while suggestive, indicates that human capital and wealth cannot be really substituted and that both are needed, although to different degrees, in entrepreneurial activity.

Table 2.2. Complementarity vs substitutability of human capital and wealth

The table shows differences in percentiles and statistics of log standardized wages between future entrepreneurs and workers conditional on family wealth.

Fathers' Wealth Decile in 1996	Average Log Standardized Wages		
	Entrepreneurs	Workers	Difference
First decile	0.087	-0.075	0.162
Second decile	0.097	-0.062	0.159
Third decile	0.111	-0.061	0.172
Fourth decile	0.115	-0.064	0.179
Fifth decile	0.111	-0.065	0.176
Sixth decile	0.108	-0.065	0.173
Seventh decile	0.112	-0.067	0.179
Eight decile	0.108	-0.067	0.175
Ninth decile	0.09	-0.074	0.164
Tenth decile	0.089	-0.099	0.188

[12] An example of why this can be the case is that entrepreneurs coming from richer families might be better able to hire people to work for them whenever they do not have the right skills to do the activities themselves.

4.4 Entrepreneurial outcomes and human capital

Up to now we have established that aspiring entrepreneurs are positively selected in terms of human capital with respect to workers. In this section we explore how our measures of human capital relate to business productivity. We classify entrepreneurs in our sample as ex-post high and low productive. For every entrepreneur we compute a measure of his average productivity over the first five years of business (conditional on survival), computed as the ratio between real revenues and employment. We then define an entrepreneur as high productive if he belongs to the top decile of the productivity distribution. Table 2.3 below provides a set of summary statistics on ex-post high and low productive entrepreneurs.

Table 2.3. Summary Statistics

This table reports summary statistics for high and low productive entrepreneurs. Standardized wages are computed dividing each individual's wage by the average wage of individuals of the same age and in the same calendar year.

	Low Productive Entrepreneurs	High Productive Entrepreneurs
Observations	625,497	69,494
Standardized wages		
Average	1.2	1.4
Median	1.1	1.2
Wage growth		
Average	3.3%	4.2%
Median	2.6%	3.4%
Age at founding		
Average	37.8	37.8
Median	38	37
Real net wealth prior to business start		
Average	18,144 €	38,715 €
Median	1,459 €	13,915 €
Father's net wealth in 1996		
Average	150,602 €	208,255 €
Median	43,899 €	54,826 €
Education		
Comprehensive school	10.9%	7.2%
High school	54.3%	46.4%
Vocational school	10.6%	10.8%
Bachelor or equivalent	12.6%	18.4%
Master or equivalent	10.7%	15.8%
Doctorate or equivalent	0.9%	1.4%

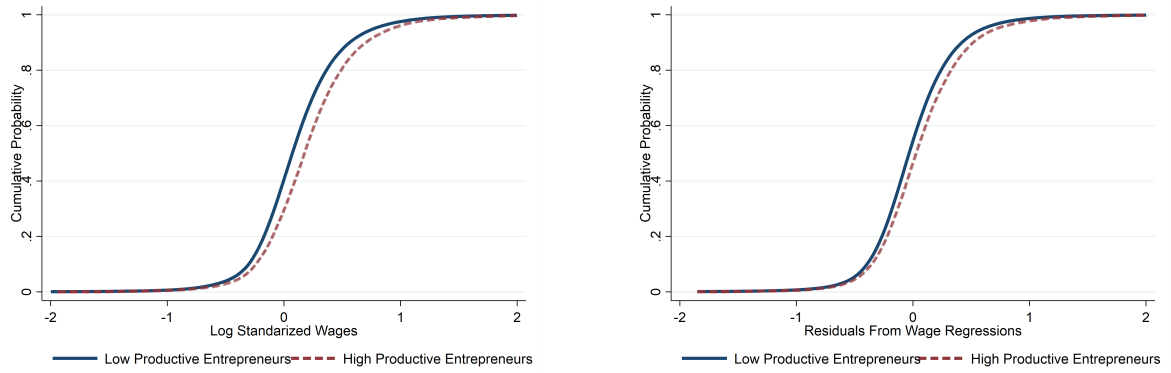
The summary statistics show that high productive entrepreneurs, compared to low productive ones, are positively selected in terms of our measures of human capital. High productive entrepreneurs display higher average and median standardized wages and experienced higher wage growth before starting their firm. In terms of educational attainment, high productive entrepreneurs also seem more educated as the fraction of entrepreneurs with at least a bachelor degree is higher. We also see that ex-post high productive entrepreneurs seem to hold more net wealth at business start and come from richer families as captured by father's net wealth in 1996. Interestingly, we do not see any demographic differences between the two groups as they are both on average 38 years old at business start.

We reproduce the figures showing self-selection in terms of observable and unobservable characteristics for high and low productive entrepreneurs. Figure 2.7 below shows the two cumulative distribution functions for prior standardized wages and residuals of wage

regressions. Compared to Figure 2.3 - showing the differences between future entrepreneurs and workers - we see that the magnitude of the selection in terms of prior standardized earnings is lower, but still present. Also, the cdf of residuals of wage regressions for the group of high productive entrepreneurs first order stochastically dominates the cdf for the group of low-productive entrepreneurs. Our findings suggest that human capital is not only related to selection into entrepreneurship, but it also positively associated with future firm performance.

Figure 2.7. Selection of high vs low productive entrepreneurs in terms of observed and unobserved characteristics

Panel (a) shows the cdf of standardized wages. Panel (b) plots the cdf of residuals from a wage regression.



(a) Selection in terms of prior wages.

(b) Selection in terms of residuals of wage regressions.

To sum up, our empirical evidence shows that i) future entrepreneurs earn higher wages compared to workers of the same age and experience higher wage growth before opening their business ii) future entrepreneurs are positive selected also in terms of unobserved characteristics as measured by the residuals of wage regressions iii) higher levels of human capital at business start are associated with higher firm productivity measures. We additionally find that future entrepreneurs on average hold more wealth compared to workers, but that the probability of becoming an entrepreneur is essentially flat along the central part of the family wealth distribution, which is inconsistent with the view that aspiring entrepreneurs face major liquidity constraints.

While observational, our findings suggest that human capital accumulation is an important dimension to take into account to understand selection into entrepreneurship. Disentangling the role of wealth, skills and business ideas in driving the process of business creation from the data is challenging without a credible source of exogenous variation. To this end, we build a quantitative model where both human capital, wealth and good ideas are needed to start a business and use our structural framework to rationalize the empirical findings. The next section introduces the model economy.

5 The model economy

We consider a small open economy with a realistic life-cycle structure and overlapping generations in which in every period individuals have to decide whether to start a business and become entrepreneurs or work as paid employed workers. To become entrepreneurs individuals need wealth, a good business idea and human capital. The latter can be accumulated both while being a worker and while being an entrepreneur with a learning by doing technology. Human capital is transferable across occupations. The process by which individuals accumulate human capital is the same across occupations and depends on a learning ability term which is individual specific. Human capital has two effects. On one side it determines total labor income as a worker, on the other it affects business productivity and hence entrepreneurial profits. Entrepreneurs face collateral constraints and every period have to decide how much capital and labor to hire. The presence of collateral constraints give rise to financial frictions and the need for prospective entrepreneurs to save enough wealth to pledge as collateral in order to borrow the optimal amount of capital to use in the production process. Markets are assumed to be incomplete so agents save to self-insure against idiosyncratic risk. Individuals pay progressive labor income taxes and retire at an exogenous age J_r with pension benefits b. Government revenues are used to finance the retirement system and wasteful government spending G.

Demographic structure

The economy is populated by overlapping generations in which in each period a continuum of agents are born. Time is discrete and agents can live up to a maximal age J. The demographic patterns are assumed to be stable in the sense that at any point in time agents of age j make up a constant fraction μ_j of the population. Agents retire at age J_r with social security benefit b, which is independent of their labor market history.

Endowments

In every period individuals are endowed with a business idea and a learning ability. The quality of the business idea, θ, affects overall business productivity if the individual decides to become an entrepreneur and start a business. The term θ is assumed to follow an AR(1) process with Gaussian innovations. The learning ability, ξ, is a fixed personal trait that determines the speed at which human capital is accumulated and is drawn from an exogenous distribution at age $j = 1$.

Human capital

Human capital is accumulated according to the following law of motion:

$$h_{j+1} = h_j + \xi_i h_j$$

where ξ_i stands for the individual's learning capacity and is time-constant. Workers and entrepreneurs share the same human capital accumulation technology.

Production technology
Entrepreneurs decide how much capital k and external labor units n to hire, while being endowed with the following production technology:

$$y = \theta_j h_j \left(k_j^{\gamma}(n_j)^{1-\gamma}\right)^{v}, \; v \in [0,1)$$

The parameter $v < 1$ implies that entrepreneurs face decreasing returns to scale. The term θ, which stands for the quality of the business idea, directly affects business productivity together with the stock of accumulated human capital h_j. The parameter γ determines the share of income accruing to the variable factors of production, namely capital and labor.

Preferences
All agents have identical preferences and choose consumption to maximize the following objective function:

$$\mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} u(c_j)\right] \tag{1}$$

where the period utility function $u(c)$ is assumed to be of the CRRA class.

Market arrangements
Markets are incomplete in the sense that agents cannot fully insure themselves against idiosyncratic sources of risk by trading state-contingent assets.
Workers are not allowed to borrow, but can save in a risk-free asset. Entrepreneurs can borrow capital within a period to invest in their firm. However, they face collateral constraints, meaning they can only borrow up to a fraction λ of their wealth: $k \leq \lambda a$. The collateral constraint faced by entrepreneurs is motivated by the fact that financial markets are assumed to work imperfectly, due to non perfectly enforceable contracts.

5.1 The individual problem

At the beginning of every period individuals have to decide whether to become entrepreneurs or workers. Individuals know their learning capacity ξ, their stock of accumulated human capital h, they observe the quality of the business idea θ and form expectations about future ability levels. Occupational choices are made at the beginning of every period, after the business idea shock has realized. Workers then choose consumption and savings, while entrepreneurs also decide how much external capital and labor to hire. Each individual at beginning of life is endowed with some positive level of human capital stock.
We write the household problem in recursive form. Let $\mathbf{x}_j = (a, \theta, h, \xi)$ be the individual state vector at age j, where a stands for asset holdings, θ is the business idea, h is the stock

of human capital, and ξ represents the learning ability. The value function of a household at age j is $V_j(\mathbf{x}_j) = \max\left\{V_j^w(\mathbf{x}_j), V_j^e(\mathbf{x}_j)\right\}$ where $V_j^w(\mathbf{x}_j)$ and $V_j^e(\mathbf{x}_j)$ represent the value of being a worker and an entrepreneur at age j respectively.
Consider a household of age $j < J_r$. If $V_j^e(\mathbf{x}_j) \geq V_j^w(\mathbf{x}_j)$ he decides to become an entrepreneur and solves the following dynamic problem:

$$V_j^e(\mathbf{x}_j) = \max_{c_j, a_{j+1}, k_j, n_j} \left\{u(c_j) + \beta \mathbb{E}\left[V_{j+1}(\mathbf{x}_{j+1})\right]\right\} \tag{2}$$

s.t

$$c_j + a_{j+1} = y_j + a_j - T_y(y_j) \tag{3}$$

$$y_j = \pi(h_j, \theta_j, k_j, n_j) + r a_j \tag{4}$$

$$k_j \leq \lambda a_j \tag{5}$$

$$a_{j+1} \geq 0 \tag{6}$$

$$n_j \geq 0 \tag{7}$$

$$h_{j+1} = h_j + \xi_i(h_j) \tag{8}$$

where $\pi(h_j, \theta_j, k_j, n_j)$ stands for entrepreneurial profits. Business profits depend on the entrepreneur's human capital stock, his business idea, his investment into physical capital k_j and the amount of external labor inputs hired n_j. The entrepreneur chooses capital and external labor to maximize profits:

$$\pi = \max_{k_j, n_j} \left\{\theta_j h_j \left(k_j^\gamma (n_j)^{1-\gamma}\right)^v - (r+\delta)k_j - w n_j\right\} \tag{9}$$

s.t

$$k_j \leq \lambda a_j \tag{10}$$

$$n_j \geq 0 \tag{11}$$

where F captures fixed production costs. If $V_j^w(\mathbf{x}_j) > V_j^e(\mathbf{x}_j)$ the agent becomes a worker and his dynamic problem reads:

$$V_j^w(\mathbf{x}_j) = \max_{c_j, a_{j+1}} \left\{u(c_j) + \beta \mathbb{E}\left[V_{j+1}(\mathbf{x}_{j+1})\right]\right\} \tag{12}$$

s.t

$$c_j + a_{j+1} = y + a_j - T_y(y_j) \tag{13}$$

$$y_j = w h_j + r a_j \tag{14}$$

$$a_{j+1} \geq 0 \tag{15}$$

$$h_{j+1} = h_j + \xi_i h_j \tag{16}$$

Workers and entrepreneurs pay progressive labor income taxes. At age J^r agents retire and they all solve the same problem:

$$W_j(\mathbf{x}_j) = \max_{c_j, a_{j+1}} \{u(c_j) + s_{j+1}\beta \mathbb{E}\left[W_{j+1}(\mathbf{x}_{j+1})\right]\} \tag{17}$$

s.t

$$c_j + a_{j+1} = b_j + (1+r)a_j \tag{18}$$

$$a_{j+1} \geq 0 \tag{19}$$

The transfer b_j is independent of the individual labor income history.

5.2 Government

The government collect taxes from labor and entrepreneurial income and finances pension benefits b as well as wasteful resources G. I adopt the tax function of Heathcote, Storesletten, and Violante (2017):

$$T_y(y) = y - \tau_y y^{(1-\psi)} \tag{20}$$

The parameter τ_y governs the average level of income taxes, while ψ captures the degree of tax progressivety.

5.3 Equilibrium

Let $\mathbf{x}_j = (a, \theta, h, \xi)$ be the individual state vector at age j. Denote by $\Gamma(\mathbf{x}_j, j)$ the stationary distribution of individuals over states and ages. We can then define a competitive equilibrium for this economy.

A stationary recursive competitive equilibrium for this economy is defined as value functions $V_j(\mathbf{x}_j)$,$V_j^e(\mathbf{x}_j)$, $V_j^w(\mathbf{x}_j)$, *policy functions* $c_j(\mathbf{x}_j), a_j(\mathbf{x}_j), n_j(\mathbf{x}_j), k_j(\mathbf{x}_j), \mathbb{I}_e(\mathbf{x}_j), \mathbb{I}_w(\mathbf{x}_j)$, *prices* (r, w) *and a stationary distribution* $\Gamma(\mathbf{x}_j)$ *such that*:

1. *Given prices* (r, w) *the value functions and associated policy functions solve the individual problem described above.*

2. *The labor market clears:*

$$\sum_{j=1}^{J_r-1} \psi_j \int_{\mathbf{x_j}} h_j(\mathbf{x_j}) \mathbb{I}_w(\mathbf{x}_j)\, d\Gamma(\mathbf{x}_j) = \sum_{j=1}^{J_r-1} \psi_j \int_{\mathbf{x_j}} n_j(\mathbf{x}_j) \mathbb{I}_e(\mathbf{x}_j)\, d\Gamma(\mathbf{x}_j)$$

where $\mathbb{I}_w(\mathbf{x}_j) = 1$ when an individual is a worker and $\mathbb{I}_e(\mathbf{x}_j) = 1$ when an individual is an entrepreneur.

3. *The Government budget constraint clears:*

$$\sum_{j=1}^{J_r-1} \psi_j \left[T_y(y) w \int_{\mathbf{x_j}} h_j \mathbb{I}_w(\mathbf{x}_j)\, d\Gamma(\mathbf{x}_j) \right] + \sum_{j=1}^{J_r-1} \psi_j \left[T_y(y) \int_{\mathbf{x_j}} \pi_j(\mathbf{x}_j) \mathbb{I}_e(\mathbf{x}_j)\, d\Gamma(\mathbf{x}_j) \right] = \sum_{j=J_r}^{J} \psi_j \left[b \int_{\mathbf{x}_j} \mathbb{I}_r(\mathbf{x}_j)\, d\Gamma(\mathbf{x}_j) \right] + G$$

where $\mathbb{I}_r(\mathbf{x}_j) = 1$ when an individual is retired.

4. *The invariant probability measure $\Gamma(\mathbf{x}_j)$ is consistent with the population structure, the exogenous processes and individual behavior.*

Under the assumption of a small open economy, the interest rate r is fixed and there is no need of an additional asset market clearing condition.

6 Mapping the Model into Data

In this section we describe how we map the model to the data. The model is solved in general equilibrium and brought to the data through a simulated method of moments procedure. Agents enter the economy at age $j = 1$, real age 20 and retire at age $J_r = 45$, real age 65. All agents die at age $J = 71$, real age 91. Some parameters are calibrated using external evidence, while the remaining ones are calibrated internally.

Externally calibrated parameters

The preference parameters σ and β are taken from Bruggemann (2021). Specifically, we set the coefficient of risk aversion in the utility function σ to 1.5 and the discount factor β to 0.96. The values τ_y and ψ of the tax function are taken from Holter, Krueger, and Stepanchuk (2019) who estimate equation 20 for Denmark. The value for τ_y is 0.69, while ψ is set to 0.22. Lastly, we set the depreciation rate $\delta = 0.04$ and the interest rate to 1%.

Internally calibrated parameters

We are left with seven parameters to calibrate internally and we do so by targeting seven different data moments. The business quality shock θ_j follows an AR(1) process of the type:

$$\theta_{it} = \zeta \theta_{it-1} + v_{it} \tag{21}$$

where the innovations are drawn from a Normal distribution $v_{it} \sim \mathcal{N}(0, \sigma_\theta)$. The learning ability ξ is drawn from a log-normal distribution $\xi \sim \mathcal{LN}(\mu_\xi, \sigma_\xi)$.
Under these functional form assumptions the parameters to calibrate are

$[\mu_\xi, \sigma_\xi, v, \gamma, \lambda, \zeta, \sigma_\theta]$. The first two parameters govern the average and standard deviation of the log-normal distribution from which the learning ability ξ is drawn. The term v is the return to scale parameter in the entrepreneurial production technology and γ is the parameter affecting the share of income accruing to capital and labor in the production function. The parameter λ defines the severity of the collateral constraint, while the last two parameters ζ, σ_θ determine the stochastic process for the entrepreneurial business quality shock.

These parameters are calibrated by targeting seven different data moments which are informative about the underlying structural parameters. The calibration procedure follows a standard simulated method of moments approach. For a set of candidate parameter values we solve the household problem, we find the stationary equilibrium and compute model moments from a panel of $N = 100,000$ individuals. The simulated method of moments approach consists in selecting parameter values such that the squared distance between data and model moments is minimized. The solution to the minimization problem is a vector $\hat{X}$ of parameter values such that the following objective function is minimized:

$$L(X) = \min_X (\hat{\Omega} - \Omega(X))' W (\hat{\Omega} - \Omega(X)) \tag{22}$$

where $\Omega(X)$ are the moments computed from the simulated data, $\hat{\Omega}$ are the empirical moments and $W = I$. The minimization is performed by generating random Sobol sequences inside reasonable parameter spaces and selecting the combination of parameters that minimizes equation 22. In the next section we discuss which moments we target to separately identify the human capital accumulation process, from the collateral constraint parameter and the business quality shock.

6.1 Identification

Given the complexity and non-linearity of the model, all moments are jointly affected by all parameters in equilibrium. However, some moments are more informative than others for certain parameters. In this section we provide intuitive arguments regarding identification. The key challenge in mapping the model to the data is to select data moments that are informative about the underlying structural parameters. We choose moments that separately identify the three main mechanisms that affect selection into entrepreneurship in the model economy: the human capital accumulation process, financial frictions and the quality of the business idea.

We use moments from wage data of all individuals in our sample to inform the human capital accumulation process. To the extent that markets are competitive, wages are informative about the stock of human capital accumulated by individuals[13]

[13] Many papers in the literature on human capital accumulation and macroeconomic outcomes use wage data to calibrate the human capital accumulation process. See Huggett, Ventura, and Yaron (2011) and Huggett, Ventura, and Yaron (2006) for an example.

Human capital accumulation process

Specifically, we target the average growth rate of wages of individuals of age 25-30 to calibrate the mean of the learning ability μ_ξ, while we target a measure of dispersion in wages -the ratio of the 75th to 25th percentile of the wage distribution at age 40- to calibrate the standard deviation of the learning ability σ_ξ. Lower levels of the average learning ability imply lower growth rate in wages and higher values of the standard deviation in the learning ability imply higher dispersion in wages for a given age. By calibrating the human capital accumulation process by using wage data and not statistics related to life-cycle patterns of entry into entrepreneurship helps us to cleanly separate this channel from the others.

Business quality shock

To calibrate the two parameters defining the stochastic process of the business quality shock (ρ and σ_θ) we target the share of entrepreneurs that fail within the first five years and the magnitude of selection in terms of prior wages between future entrepreneurs and workers. The first moment is naturally linked to ρ. In fact, higher shares of failure within the first five years mean that the business quality shock is less persistent and bad shocks can hit individuals after short time periods since they started their business. The standard deviation of the business quality shock is informed by the degree of selection in terms of prior wages between aspiring entrepreneurs and workers. The intuitive reason is that the bigger the difference in prior wages between entrepreneurs and workers, the more important is the role of human capital in entrepreneurship and less so the quality of the business idea. In this sense, a small variance of the business quality shock implies that individuals have business ideas which are very similar in quality and what drives some individuals into entrepreneurship while others not, are differences in accumulated human capital and wealth. On the other side, a big variability in the quality of the business idea leads to the fact that entrepreneurs are individuals who are observationally similar to workers, who however happened to be lucky and get a good draw of θ. We calibrate σ_θ to match the difference in average prior standardized wages between future entrepreneurs and workers, which is our measure of selection.

Financial frictions

To discipline the severity of the collateral constraint λ we use the average ratio between initial total firm assets and the owner's wealth. Whenever collateral constraints are binding, λ exactly pins down the ratio $\frac{k}{a}$, which is the model equivalent of firm assets to individual's wealth. Importantly, the bigger this ratio, the bigger the value of λ, meaning the lower are collateral constraints as aspiring entrepreneurs can access external finances easily. By targeting the average of this ratio, our value of λ reflects the fact that some individuals may not be constrained.

Remaining parametrs

Finally, we target the overall share of entrepreneurs in the economy and the median number of employees at business start to inform the two parameters of the production function v and

γ. Table 2.4 provides an overview of the moments we target and how close we get in matching them. We see that we match all moments relatively well. The model understates initial firm size, while overstating slightly the average selection in terms of prior wages. However, as we show in more detail in the next section, the model is able to replicate fairly well the overall selection in terms of human capital between workers and future entrepreneurs.

Table 2.4. Targeted moments

Moment	Data	Model
Average growth rate wages age 25-30	3.8%	3.8%
Ratio p75/p25 wages age 40	2.6	2.6
Share of entrepreneurs	7.4%	7.3%
Share entrepreneurs that fail within first 5 years	46.3%	48.1%
Difference in average standardized wages	0.24	0.30
Ratio average firm assets to owner's wealth at business start	3.3	3.2
Median number of employees at business start	2.9	3.4

Table 2.5. Internally calibrated parameters

Parameter	Value
Average learning ability μ_ξ	-3.5
Standard deviation learning ability std_ξ	0.85
Returns to scale parameter v	0.54
AR(1) coefficient ρ	0.899
Standard deviation of the innovation sd_θ	0.20
Collateral constrain parameter λ	3.3
Production function parameter γ	0.523

7 Model Validation and Properties

In this section we discuss how the model performs in matching moments and data profiles which were not explicitly targeted in the calibration procedure. Specifically, goal of this section is to describe how the model is able to generate the same selection mechanisms into entrepreneurship observed in the data. This is a useful model validation exercise which ensures that our structural framework can be used as a laboratory to study counterfactual scenarios and the effectiveness of policy interventions.
Second, in this section we explore the main model mechanisms and shed light on the interplay between human capital accumulation, the business quality idea and financial frictions in explaining selection into entrepreneurship over the life-cycle, the productivity of new entrepreneurs and resource misallocation.

Model validation: untargeted data moments

Table 2.6 below provides an overview of life-cycle moments of entry into entrepreneurship, which were not explicitly targeted in the calibration procedure. Interestingly, the model is able to come close in matching the two central moments of the age distribution at founding even if it does so by generating a bit too many young and old entrepreneurs and less entrepreneurs in their mid forties, compared to the data. The median age at business start in the model is 36, against 38 in the data and a higher fraction of individuals start a firm already in young ages in the real data, while less so in the model. This can be seen from the first decile of the age distribution at founding being 26 in the data and 29 in the model.

Table 2.6. Untargeted moments: Age distribution at founding

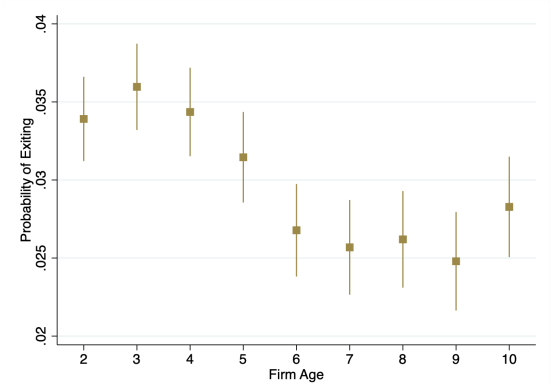
Moment	Data	Model
Average age at founding	38	35
Std age at founding	6.4	8.2
Median age at founding	38	36
First decile age at founding	29	26
Ninth decile age at founding	46	45

The model is able to capture fairly well both qualitatively and quantitatively the exit dynamics from entrepreneurship. In Figure 2.8 we plot the OLS coefficients of regressing a dummy variable taking value one when an entrepreneur goes back to a paid employed job on the years spent in entrepreneurship (firm age). The same regression is run on real and simulated data. We see that the model captures the qualitative decreasing pattern of the probability of exiting from entrepreneurship by firm age, even if it predicts slightly higher probabilities of exit at older firm ages, compared to the data. The probability of exiting from entrepreneurship for an individual who has already spent 9 years as entrepreneur is around 2.5% in the model, but only 1.2% in the data.

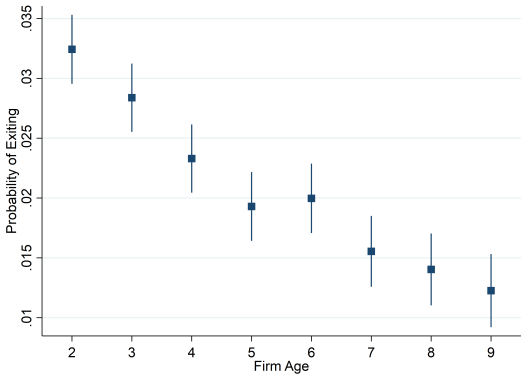
We provide evidence on the main selection mechanisms into entrepreneurship that operate in our model economy and compare them to the data. One main result of the empirical section was that aspiring entrepreneurs are positively selected along different measures of human capital and skills. Below we show that our model generates the same patterns. We compute measures of standardized wages in the model by dividing labor income of workers and future entrepreneurs by the average labor income of individuals with the same age. As in the data, wages of future entrepreneurs are the wages they were earning as workers before starting the business. To see how selected future entrepreneurs are in the model economy, we replicate the cumulative distribution function of prior standardized wages computed on the data in the empirical evidence section. In Figure 2.9 we se that, both in the real and simulated data, future entrepreneurs are positively selected in terms of prior wages. While the average difference in prior wages was targeted, the model is able to reproduce the first order stochastic dominance property of the distribution of standardized

Figure 2.8. Probability of exiting by firm age: model vs data

This figure reports the OLS coefficients of regressing the probability of exiting from entrperenurship on the years spent in entrepreneurship (firm age). The same regression is run on real and simulated data.



(a) **Model**: Exit probabilities from entrepreneurship by firm age

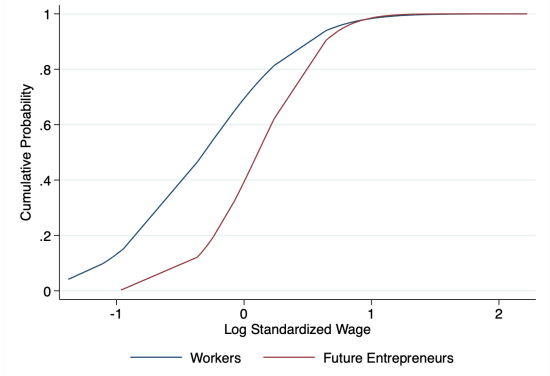


(b) **Data**: Exit probabilities from entrepreneurship by firm age

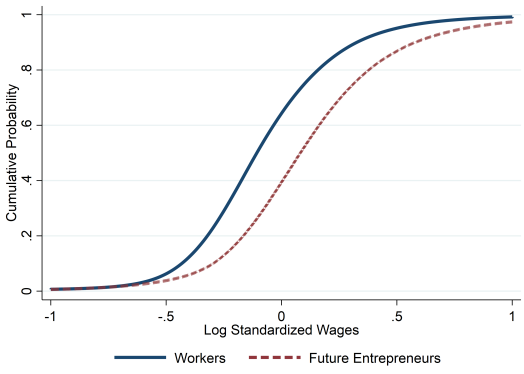
wages observed in the data. This is an important property of the model, given the new evidence we provide on the relationship between human capital accumulation and selection into entrepreneurship in the data. In the next subsections we use the model to explore some of its properties through counterfactual exercises.

Figure 2.9. Self-selection of entrepreneurs in terms of observed characteristics: model vs data

Panel (a) shows the cdf of standardized prior wages in the model. Panel (b) shows the same plot in the data using simulated data.



(a) **Model**: selection in terms of prior standardized wages.



(b) **Data**: selection in terms of prior standardized wages.

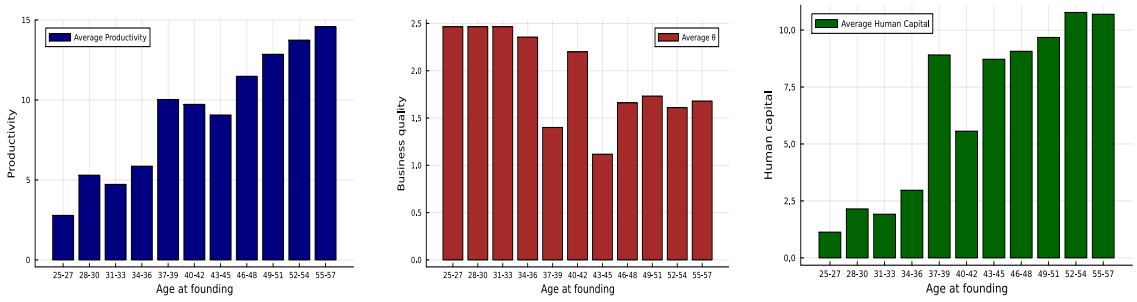
Model properties: human capital vs business idea

To shed light on the interchangeability of skills vs ideas in driving selection into entrepreneurship at different stages of the life-cycle, we plot the average productivity of new businesses by age at founding. We measure productivity, in the model, with the product of $\theta_j h_j$. From

Figure 2.10 we see that business productivity is increasing in the age at founding, mostly because of the higher stock of human capital that on average individuals have accumulated. We quantify how much of the business productivity is driven by the quality of the idea and how much by the accumulated stock of human capital by plotting the average value of θ and h separately by founding age. On average aspiring entrepreneurs substitute low skills with good business ideas and vice-versa. Individuals who open a business early in life have business ideas of high potential, to compensate for having relatively low human capital. In fact, in the first three age bins only individuals with the best θ draw start a firm. As individuals get older, the average quality of the business idea gets lower (θ goes down), but the average skill of the entrepreneur increases such that overall productivity is actually increasing in age at founding. The substitutability between human capital and θ is evident in the spike in human capital at age $37-39$. This is the first age range in which individuals find it optimal to start a business even if they do not have the best business idea. These individuals are the ones with the highest learning ability ξ who in the age range 37-39 have enough human capital and wealth to compensate for an average θ, that it becomes optimal for them to switch to entrepreneurship rather than stay workers.

Figure 2.10. Business productivity over the life-cycle

The three panels show the average level of overall productivity (θh), of human capital and quality of the business idea by age at founding of the entrepreneurs.



(a) Overall productivity **(b)** Business quality **(c)** Human capital

The different patterns of human capital and quality of the business idea over the life-cycle show one potential source of technological inefficiency in the model. In fact, the model assumes that aspiring entrepreneurs need both θ and h to run a business, even if with some degree of substitutability. Higher overall productivity of new businesses could be achieved if individuals with high skills (high h) could meet with individuals with good business ideas. Our model points out that studying the characteristics of a market for ideas and one for managerial skills and its underlying potential frictions can be an avenue to understand the productivity dynamics of new enterprises.

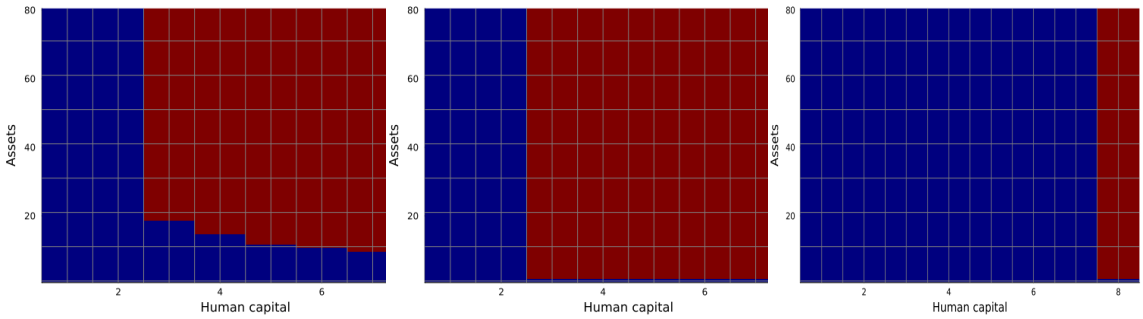
Model properties: the role of financial frictions

Collateral constraints represent a source of friction in the model. These constraints create inefficiencies on the extensive margin by keeping out from entrepreneurship individuals with high productivity θh, but who have not enough wealth to be able to run the business at a profitable scale. Financial frictions also generate inefficiencies on the intensive margin. In fact, conditional on entry, productive entrepreneurs are limited in the size of the business they can manage by a multiple λ of their wealth holdings.
In this section we quantify the effects that financial frictions have on the productivity of newly created businesses (extensive margin) and on mis-allocation on the intensive margin. We do so by simulating an economy with no financial frictions - where aspiring entrepreneurs can borrow without limits - in partial equilibrium (with fixed prices) and in general equilibrium in which prices (the wage) is allowed to adjust.
Separating the partial equilibrium from the general equilibrium response is instructive to isolate the pure role that collateral constraints have on individual choices from the feedback effect that happens in response to these choices captured by an increase in the equilibrium wage. Figure 2.11 shows the discrete policy function for becoming an entrepreneur for different combinations of human capital and wealth, at a fixed age and fixed shock θ. The red area represents combinations of the state-space in which individuals decide to become entrepreneurs. The figure shows the same policy function in the baseline economy, in an economy with no financial frictions in which prices are held fixed (PE) and in a an economy with no financial frictions but where prices are allowed to adjust (GE). When the collateral constraint is removed in partial equilibrium, the combinations of human capital and wealth for which agents start a business increase. Specifically, all individuals with high enough human capital - above 2.5 - but with low wealth find it now optimal to start a business as they can borrow capital to operate at a big enough scale and generate profits. This was not the case in the baseline economy. In general equilibrium, however, the individual response is different. The threshold level of human capital at which individuals want to start a business increases and the overall red area shrinks. This is the effect of the wage, which in general equilibrium has to increase to clear the labor market in response to the fact that many more individuals have decided to become entrepreneurs and demand external labor. The higher wage makes the labor costs higher, but more importantly, makes the outside option of being a worker more attractive, reducing the overall number of entrepreneurs in the economy.

Table 2.7 summarizes the effects of removing financial frictions. In partial equilibrium, the share of entrepreneurs in the economy doubles and the median age at founding drops from 35 to 33. This is the result of the fact that individuals now only need to have high enough human capital and a good θ to start a business, but do not need any wealth. When the wage increases to restore equilibrium on the labor market, the share of entrepreneurs in the economy is actually lower than in the baseline economy and business owners are on average older. This happens because individuals wait to acquire high enough skills to

Figure 2.11. Discrete policy functions

The three panels display the discrete policy function for the choice of becoming an entrepreneur. The policy function is shown for a given age (the average age) and given θ. Red areas represent combinations of the state-space for which the individual wants to become an entrepreneur. Panel (a) shows the policy function under the baseline case, panel (b) for an economy with no financial frictions in partial equilibrium and panel (c) for an economy with no financial frictions in general equilibrium.



Baseline case PE response GE response

generate profits that go beyond their labor market earnings.

Financial frictions have an effect on how efficiently resources are allocated. In partial equilibrium, the absence of financial frictions implies that conditional on entry, every entrepreneur can reach its optimal firm size and is not constraint anymore. This clearly increases efficiency. On the other side, however, when collateral constraints are removed, the cutoff productivity level for entry into entrepreneurship goes down with a consequent inflow of low-productive entrepreneurs in the economy. This has an opposite effect on efficiency. The table shows that in partial equilibrium the first effect prevails and that aggregate TFP increases compared to the baseline economy.[14] In general equilibrium the effect on efficiency is even higher with aggregate TFP that increases by approximately 16% compared to the baseline. This is mostly the result of the fact that a higher wage discourages low-productive entrepreneurs to start a business, reinforcing the positive effect on the intensive margin.

Table 2.7. Eliminating financial frictions

The table displays average statistics of the baseline economy and an economy with no collateral constraints. It does so by splitting the effect of removing financial frictions into a partial and general equilibrium response.

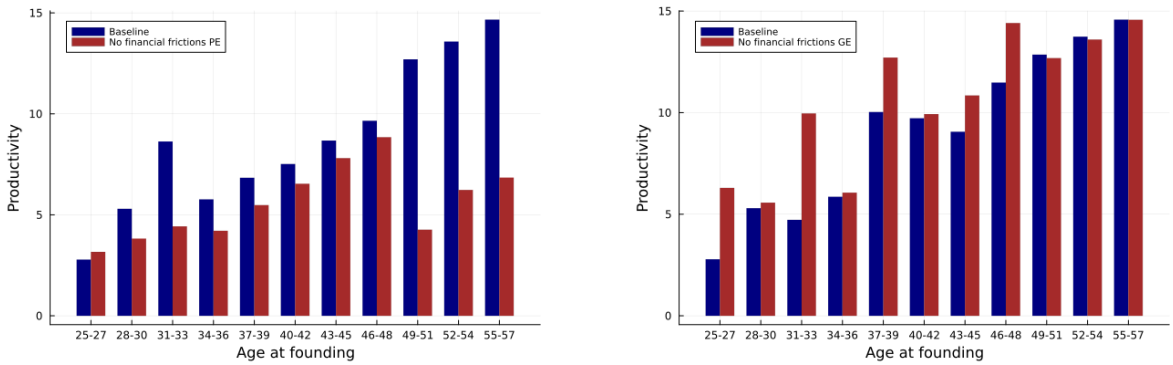
	Baseline	PE response	GE response
Age at founding			
Average	35	33	40
Share entrepreneurs			
Average	7.4%	14.9%	4.0%
Aggregate TFP			
	.	+7.9%	16.4%
Correlation tfp-size			
	0.84	0.98	0.98

[14] Aggregate tfp is compute by summing revenues, capital and labor of all entrepreneurs of a given age and dividing aggregate revenues by $(K^{\gamma}L^{1-\gamma})^{v}$, where K and L are aggregate capital and labor for entrepreneurs of a given age. The final tfp value is then obtained by aggregating over the ages.

The effects that financial frictions have on the productivity of entrepreneurs at business start can be seen from Figure 2.12. In partial equilibrium, at every age at founding, entrepreneurs are of lower productivity in the counterfactual economy compared to the baseline. In general equilibrium this is not true anymore, with the productivity of aspiring entrepreneurs being higher in younger and middle ages and almost the same after age 50. Most of the productivity gains come from the fact that young and middle-aged individuals start businesses with higher levels of human capital. This effect tappers off after age 50 in which even in the presence of collateral constraints high skilled individuals were making high enough profits to prefer starting a business than stay workers. Consequently, while the collateral constraint is still binding on the intensive margin for old entrepreneurs, it does not affect the threshold level of human capital on the extensive margin at which old agents decide to start a business.
Figure 2.13 compares the average level of human capital and θ at business start in the two economies to understand the sources of the increase in overall productivity when financial frictions are removed. We see most of the increase in productivity comes from the fact that individuals start with higher levels of human capital, which implies that high skilled individuals can start bigger and more profitable firms. This effect explains the overall increase in business productivity at start.

Figure 2.12. Average entrepreneur's productivity at business start by age at founding

The two panels compare the average entrepreneur's productivity measured as the product θh for different ages at founding. Panel a) compares the baseline economy with an economy with no financial frictions in partial equilibrium while panel b) compares the baseline to an economy with no financial frictions in general equilibrium.



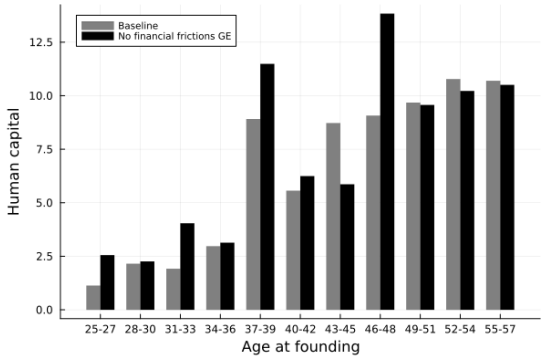
(a) Baseline vs no financial frictions in PE

(b) Baseline vs no financial frictions in GE

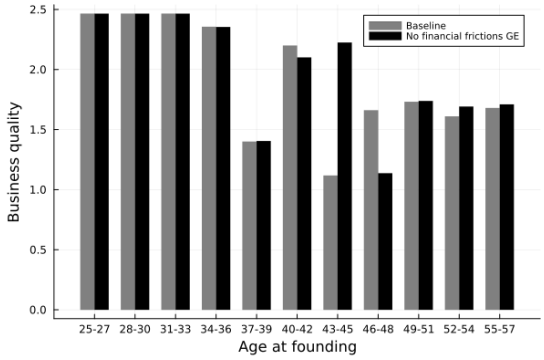
The effect that collateral constraints have on firm size (distortion on the intensive margin) is captured by Figure 2.14. The figure plots the association between the entrepreneur's initial productivity - θh - and his initial number of employees at business start. In an economy with no financial frictions, firm size is pinned down by productivity. In fact, in panel b) of Figure 2.14 we see that for every level of productivity there is only one optimal level of employment. In the presence of financial frictions, however, there are multiple possible initial firm sizes for a given level of productivity which depend upon the entrepreneur's wealth.

Figure 2.13. Disentangling the sources of productivity

The two panels show the average entrepreneur's human capital at business start under the baseline and no frictions economy. Panel (b) does the same of the quality of the business idea.



(a) Human capital



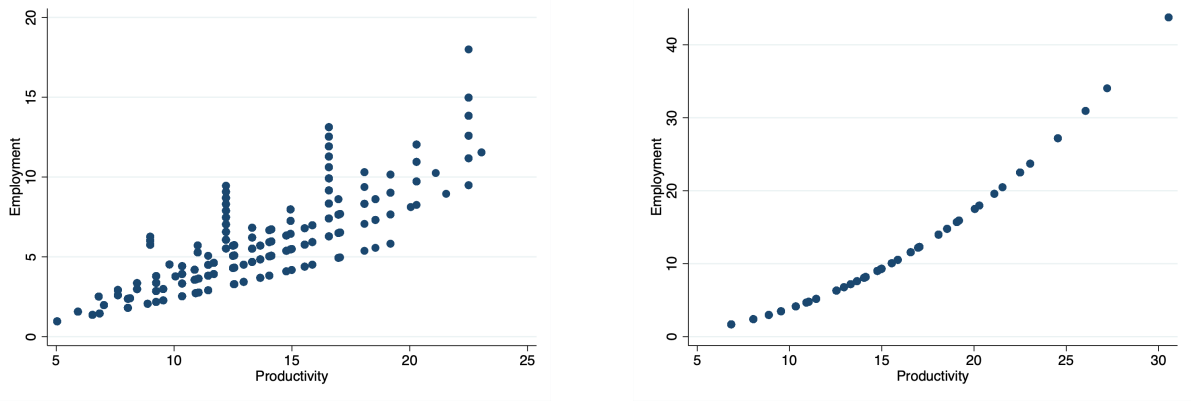
(b) Quality of business idea

Given that aspiring entrepreneurs can have the same productivity levels but different wealth holdings, either because they accumulate human capital at different speeds or because they are hit by a good business idea in different moments of the life-cycle, we get dispersion in initial firm size every time the borrowing constraint is binding. Even at high productivity levels, collateral constraints can be binding as the optimal firm size is increasing in overall business productivity. Getting rid of these frictions implies that firms are started bigger and produce more output for the same productivity level, with clear efficiency gains.

To sum up, most efficiency gains of eliminating financial frictions come from the intensive margin, meaning that high productive entrepreneurs can operate at a bigger scale. On the extensive margin, the higher wage that results in general equilibrium acts as an additional selection mechanism on the type of businesses that are created since it pushes up the threshold level of human capital at which agents want to become entrepreneurs, improving resource allocation in the economy.

Figure 2.14. Scatter log-size on log-tfp

Panel (a) displays a scatter plot between initial productivity ($h\theta$) and initial size measured by employment under the baseline economy. Panel (b) shows the same scatter plot for the economy with no financial frictions in general equilibrium.



(a) Baseline

(b) No financial frictions

8 Policy Reform

In this section we use the calibrated model to evaluate the efficiency and welfare properties of a tax reform, which in policy settings is often advocated as a mean to incentivize entrepreneurship and business creation by young people. We consider a tax policy reform in which we eliminate income taxes for young entrepreneurs below the age of 30. We first ask if and by how how much the average tax rate τ_y has to increase to keep the budget balanced and how the reform affects efficiency. Second, we compare welfare in the two different steady states using the consumption-equivalent variation (CEV) measure to trace out who wins and who looses from the policy reform.

8.1 Efficiency of the policy reform

The first question we ask is whether eliminating taxes for young business owners is a sustainable policy for the government or whether taxes have to be raised for other categories to maintain the budget balanced. There are two different forces at play when taxes are removed. On one side the government gives up the revenues it was collecting from young entrepreneurs, which negatively affects the government budget. On the other side, however, eliminating taxes increases the value of entrepreneurship in young ages as individuals can earn higher net profits than before. This entails that more individuals will find it optimal to start a business, although this effect is in part mitigated in general equilibrium as wages have to increase to clear the labor market. A third positive effect for the government budget is that by eliminating taxes for young entrepreneurs, individuals that create firms in young ages can generate more profits for the same amount of inputs and accumulate more wealth. This in turn means that individuals who started a business between the age of 20 and 30 will have more resources to pledge as collateral and will on average run bigger businesses

even in older ages. Running bigger businesses also means that profits are higher and that tax revenues for the government increase compared to the status quo.
We find that under our calibration eliminating taxes for young entrepreneurs is a self-financing policy in which the government can eliminate taxes for young entrepreneurs below the age of 30 without having to increase taxes for others. This finding is explained by the fact that the second and especially the third effect described above dominate. Table 2.8 shows that the policy reform increases aggregate TFP by 2.2%, mainly because eliminating taxes helps young entrepreneurs to relax the borrowing constraint and generate more output for the same productivity level, improving resource allocation on the intensive margin. In this sense, the policy reform helps to in part undo the negative role of financial frictions in the economy.

Table 2.8. Policy reform

The table displays statistics of the baseline economy and the new economy under the policy reform.

	Baseline	Policy Reform
Share entrepreneurs	7.4%	10.0%
Aggregate TFP	.	+2.2%
Equilibrium wage	.	+24%

8.2 Welfare effects

The fact that the policy reform is self-financing does not mean that everyone would be in favor of it. To measure how much individuals would gain or loose from the policy reform we use the consumption-equivalent variation (CEV) welfare measure. This statistic measures how much consumption growth an individual in a given state would be willing to accept or give-up to make him indifferent between the status quo and the reform. The CEV is thus a function of the state-space and one can show that under CRRA utility it can be computed as:

$$\omega(a,\theta,h,\xi) = \left[\frac{V_0(a,\theta,h,\xi)}{V^*(a,\theta,h,\xi)}\right]^{(\frac{1}{1-\sigma})} - 1 \tag{23}$$

where $V^*(a,\theta,h,\xi)$ is the value function under the baseline steady-state and $V_0(a,\theta,h,\xi)$ is the value function under the policy-reform.
Given that not all areas of the state-space are populated by the same mass of individuals, we compute the CEV for each individual in the simulated data generated under the policy reform. Panel a) of Figure 2.15 shows the average CEV for workers and entrepreneurs at different ages computed on the simulated data. We see that for workers the CEV is always positive, meaning that they would require positive consumption growth under the status

quo in order to be indifferent with the reform. The main benefit that accrues to workers under the new tax regime is that wages are higher, implying they earn more labor income for the same level of human capital. The CEV is decreasing over age as part of the welfare gains under the new tax regime stem from the fact that the value of entrepreneurship has increased, particularly so up to the age of 30. This in turn has a positive effect also for individuals who are currently workers but who might become entrepreneurs in the future, as it increases their continuation value.

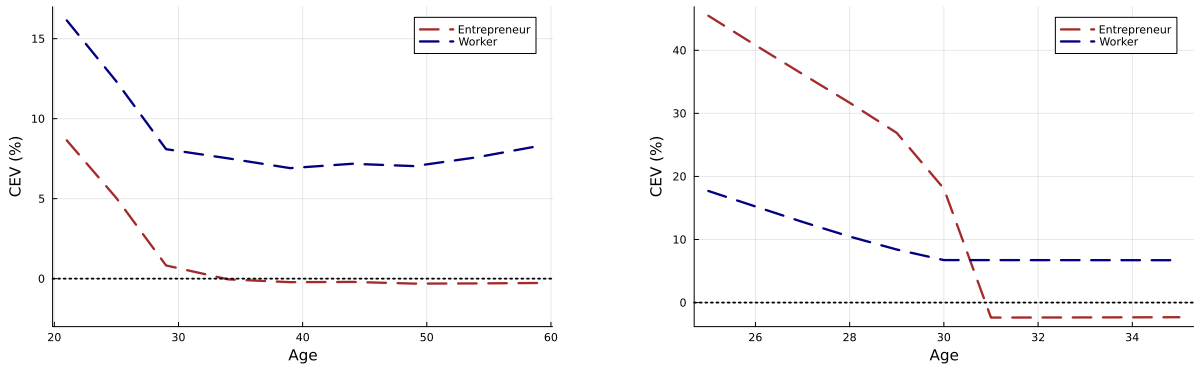
For entrepreneurs the average CEV is also positive up to age 30 but becomes negative after that. This means that entrepreneurs who are above 30 would actually vote against the reform as they would on average be willing to give up around 2.6% of consumption growth in the status quo to avoid the reform. The reason is that under the new tax regime entrepreneurs above 30 face higher labor costs without any benefits.

The fact that the average CEV is higher for workers than entrepreneurs, even if entrepreneurs are the ones exempted from paying taxes, comes from the fact that the highest welfare gains of the reform go to entrepreneurs with high human capital, good business ideas and high wealth. However, these individuals are very few, especially in the age range 20-30, such that actually the highest welfare gains on average accrue to the workers.

In panel b) of Figure 2.15 we plot the CEV for high human capital and high wealth individuals. In this case we see that entrepreneurs require up to almost 50% of consumption growth in the status quo to be indifferent with the reform. The reason for this is that the tax system in the status quo is highly progressive, which implies that high skilled and high wealth entrepreneurs are the ones paying the highest taxes in the baseline. Consequently, when taxes are removed, they are the ones who benefit the most in terms of disposable income and thus consumption under the new regime.

Figure 2.15. Welfare analysis

Panel (a) displays the average CEV of workers and entrepreneurs at different ages using the simulated data to take into account the distribution of individuals over the state-space. Panel b) shows the CEV for workers and entrepreneurs for a given combination of values of the state-space.



(a) CEV from simulated data

(b) CEV over state-space

As a final note, we want to point out that our analysis is based on comparing two

steady states, while a full welfare analysis would require taking into account the transition towards the new equilibrium. The third effect described above and induced by the reform, namely that firms would be bigger and generate more profits, would not happen immediately but would take time. This in turn might imply that in some periods along the transition the government would run a negative deficit. Still, if the government had access to debt it could run a balanced budget period by period and repay the debt back in the new steady state. If, however, access to debt is not possible, then the government would have to raise taxes for some categories in the first years along the transition, with potentially more ambiguous welfare effects.

9 Conclusion

In this paper we use Danish administrative data to provide new evidence on the fact that entrepreneurs are positively selected in terms of different measures of human capital and skills. Second, we use our data to revisit the question about the relationship between wealth and selection into entrepreneurship. We find that the probability of selection into entrepreneurship is flat along most of the family wealth distribution. While suggestive, our findings go against the traditional view that liquidity constraints are a main impediment to aspiring entrepreneurs. To disentangle the role of human capital accumulation, wealth and business ideas in driving selection into entrepreneurship at different stages of individuals' life-cycle, we propose a general equilibrium life-cycle model with human capital accumulation, occupational choices and financial frictions. A key property of the model is that good business ideas are critical in making individuals select into entrepreneurship at young ages, while skills are more important as individuals get older. Removing financial frictions, which are a source of inefficiency in our model, decreases the share of entrepreneurs in the economy, but increases their average productivity. This result is a consequence of better resource allocation on the intensive margin and on a higher threshold level of human capital required to become an entrepreneur on the extensive margin. We evaluate the efficiency and welfare effects of a reform that eliminates income taxes for young entrepreneurs, which in policy settings is often advocated a mean to incentivize business creation. We find that exempting young entrepreneurs up to the age of 30 to pay income taxes is a self-financing and efficient policy under our calibration. The major efficiency gains come from the fact that lower income taxes help to partly undo the negative effects of financial frictions and allow a better use of productive resources.

Our paper makes two main contributions. On the empirical side, we highlight the importance of studying the process of entrepreneurial human capital accumulation for the understanding of the determinants of business formation, which in prior work has been largely unexplored and neglected. On the theory side, we make the point that future theoretical work on entrepreneurship cannot abstract from the role that human capital plays as key factor driving individuals' decisions and that accounting for it has implications for the way we evaluate fiscal

policy reforms and the effects of financial frictions in the economy. We see different fruitful avenues for future research. On one side we need to deepen our understanding of which skills entrepreneurial human capital is composed of, how individuals accumulate it and how the skill set of workers differs from the one of entrepreneurs. Accessing detailed data on the career trajectories of entrepreneurs and on their educational backgrounds can help addressing these issues. A second interesting line of research is to further explore how individuals with good business ideas can meet with individuals with high management abilities and which frictions may prevent the existence of markets for ideas and for managers. Understanding how these market work and whether there is scope for government intervention is critical for a better understanding of the drivers of productivity dynamics of young businesses.

Chapter 3
Angels Don't Fall From Heaven

I investigate the impact of angel investors' human and social capital in informal venture capital markets. I assemble a novel dataset that identifies the population of angel investors in Denmark, and I use prior experience in management and governance related roles to proxy for human and social capital. I find that angel investors with high management experience, relative to founders, obtain equity at discounted valuations, and also observe superior post-investment firm outcomes. The effects are progressive and amplified when experience is acquired in entrepreneurship. In contrast, high governance experience does not affect valuations or outcomes. These findings suggest that managerial human capital generates surplus for investees, and therefore commands an investment premium, while governance-related human capital or overall social capital does not. The findings provide a rationale for targeted rather than generic investment policies.

1 Introduction

Angel investors are informal venture capitalists, who invest their own wealth directly into private firms, and subsequently provide them with active support (Wetzel (1983), Lerner (1998), Prowse (1998), Mason and Harrison (2002), Wong, Bhatia, and Freeman (2009)). They constitute the primary source of external financing of early-stage firms, and account for investment volumes that are comparable to those of venture capital funds (Wilson (2011)). The importance of angel investors in financing entrepreneurship, innovation, and job-creation is well-understood, and supported by investment policies worldwide (Lerner (2009), Hellmann and Thiele (2019), Hellmann, Schure, and Vo (2021)). Yet, there is limited knowledge about this segment of equity investment, because of the inherently private and opaque nature of angel markets (Tenca, Croce, and Ughetto (2018)). Despite the consistently documented presence of experienced founders, CEOs, board members and private investors in these markets, the precise role of their experience has not been clearly established (White and Dumay (2017)). In particular, the perceived relationship between angel investors' executive experience and enhanced firm outcomes remains largely anecdotal and empirically

understudied (Becker-Blease and Sohl (2007), Mason and Harrison (2008), Shane (2008), Kerr, Nanda, and Rhodes-Kropf (2014)). Moreover, the aspect of how this experience influences investment returns has not been examined in the finance literature.

In this study, I investigate the relationship between angel investors' executive experience, investment valuations, and firm outcomes. I ask the pertinent question: Is the human and/or social capital derived from executive experience valued in investment deals, and does this purported value translate to superior post-investment outcomes? I study these questions using a novel dataset, that identifies the population of angel investors in Denmark.

An extensive literature has covered the topic of resource dependence among early-stage firms (Aldrich and Auster (1986), Cassar (2004)), paying considerable attention to the role of financial constraints (Chan (1983), Ueda (2004), Winston & Yeramilli (2008), Hellmann, Lindsey & Puri (2008)), as well as human and social capital constraints (Becker (1964), Coleman (1988), Hite and Hesterly (2001), Davidsson and Honig (2003)), emphasizing their impact on the long-term survival and performance of young organizations. A strand of this literature points to the emergence of private equity markets with specialized investors, such as angel investors and venture capital funds, that provide equity financing, and undertake screening, monitoring and value-adding activities to gain advantage (Gompers and Lerner (2001), Denis (2011)). The characteristics of these markets have been documented extensively in the context of venture capital funds (Metrick and Yasuda (2010)). These studies emphasize investor heterogeneity (Gompers and Lerner (2005), Hochberg, Ljungqvist, and Lu (2007)), value-adding activities (Bottazzi, Hellmann, and Rin (2008)), two-sided preferences (Sørensen (2007)), utility transfers (Hsu (2002)), and performance persistence of experienced investors (Kaplan and Schoar (2005), Korteweg and Sorensen (2015)). Angel investors have received considerably less attention in this literature, due to a lack of systematic data.

This study draws on the main insights from the venture capital literature, while acknowledging fundamental differences between venture capital funds and angel investors. In particular, angel investors invest in earlier stages of the firm life-cycle, and their active involvement is often more hands-on, extending to activities like mentoring, strategic guidance, monitoring and resource provisioning (Politis (2008)). Heterogeneity is also more pronounced among angel investors, and angel investors are not subject to fiduciary duties, fixed investment horizons or other constraints that characterize professionally managed funds (Wong, Bhatia, and Freeman (2009)).

I assemble a novel dataset, that identifies the population of angel investors in Denmark. The dataset combines multiple sources of administrative register data, that I use to map all shareholders, CEOs, directors, employees and family relations in limited liability corporations (LLCs). The comprehensive information is used to identify the owners of each firm and classify them as either founders or investors. Angel investors are specifically identified under the definition, that, they are: i) not active in the operations of portfolio firms, ii) not related to founders, iii) manage their own investments, iv) invest in minority shares, and v) invest at least 100,000 DKK (15,000 USD) at the time of entry. The definition is consistent with extant literature, that generally emphasizes these primary characteristics of angel investors

(Wetzel (1983), Lerner (1998), Prowse (1998), Mason and Harrison (2002), Wong, Bhatia, and Freeman (2009))[1]. I delineate a sample of 2,711 unique investment deals, between 2000-2021, that I use to analyse the effects of angel investors' executive experience on equity valuations, as well as on ex-post firm outcomes, which serves the identification of a relationship between outcomes and investment premiums.

Using Principal Component Analysis (PCA), I construct three composite measures of accumulated executive experience, that I refer to as management factor, governance factor and overall enterprise factor. These factors are based on comprehensive data on founders, CEOs, private investors and directors, encompassing the universe of firms (not limited to LLCs), and account for the duration and scale of individuals' experience in each role. Management factor pertains to roles as founder or CEO, governance factor pertains to roles as investor or professional director, and enterprise factor encompasses all roles. This segmentation of experience serves an examination of differences between human capital acquired in management and governance related roles, while the overall enterprise factor implies substitutability between different types of experience and acts as a proxy for social capital.

To examine the effects of angel investors' executive experience on valuation, I set up a regression model, that explains variability in premoney valuation in the cross-section of investment deals, controlling for year and industry fixed effects (FE) and a comprehensive battery of deal, firm and founder characteristics, that are likely to influence firm value. I interact the valuation model with variables that indicate if investors hold superior experience, relative to founders, as indicated by higher management, governance or enterprise factors.

The primary identification concern in the basic regression setup lies in the feature of unobserved firm quality, that is not captured by regression controls, as well as non-random matching that drives the pairing between more experienced investors and high-quality firms along these unobserved dimensions. Such matching behaviour may potentially bias the coefficient of interest downwards, and underestimate the valuation effect of executive experience. To address these concerns, I exploit the subsamples of firms with repeat investments (558 out of 2,711 observations), and of investors with repeat investments (798 out of 2,711 observations), to control for unobserved firm quality and matching characteristics in the data. I estimate a series of regression models that test the valuation effects of various combinations of superior executive experience, embedded in the management, governance and enterprise factors. Next, I estimate the effects of superior experience on a number of post-investment outcomes.

The main findings are as follows. Investment deals where angel investors hold superior management experience, relative to founders, are robustly associated with significantly discounted equity valuations. On the other hand, superior governance experience as well as overall enterprise experience (assuming substitutability between experience domains) do not affect valuations. The baseline effect of superior management experience amounts to 10%

[1] Some recent studies, including Bach, Baghai, Stromberg, et al. (2023), which is closely related to this work, emphasize repeat investment in the definition of angel investors. I consider the subsample of repeat investors in detail in the analysis section.

lower premoney valuation, on average, and 25% when controlling for firm and investor fixed effects (FE), underscoring the importance of assortative matching in the data. These results are robust to unobserved matching characteristics, and a range of alternative valuation metrics, such as postmoney valuation, price-to-book ratio and price-to-sales ratio. The finding that superior governance or overall enterprise experience have no effect on valuation, indicate that the human capital derived from management experience is uniquely valued in angel investments. Conversely, the human capital derived from governance experience, or social capital derived from overall enterprise experience is not valued. These findings relate to Politis (2012), who identifies the four main value-adding activities of angel investors as mentoring, strategic guidance, monitoring and resource provisioning. The conjecture is, that, the capacity for mentoring and strategic guidance is more valuable to investees than the capacity for monitoring and resource provisioning.

Expanding from this main result, I investigate channels that amplify or diminish the observed management discount. Specifically, I find that the management discount is amplified in the segment of deals, where founders have low endowments of management experience, increasing the baseline effect to 14%, and to 26% in the subsamples with repeat investments. The results indicate that the resources embedded in superior management experience exhibit declining marginal utility to founders, but may also reflect higher risk or higher effort associated with this segment of deals. I also investigate variation in the management discount, associated with the relative distance in experience between founders and angel investors. I find that high relative distance substantially amplifies the valuation discount, increasing to more than 40% when controlling for investor fixed effects (FE). Given that this effect captures the management discounts enjoyed by the most experienced angel investors in the sample, the result evidences substantial utility transfers in the matching process of angel markets, which stands in contrast to prior to literature on matching in venture capital markets (Sørensen (2007), Hsu (2002)). Lastly, I examine the nature of investors' management experience, and variation in the management discount. I find that higher founder experience is associated with progressively higher discounts. I also find that broad and narrow industry similarity is related to progressively higher discounts.

I compare these findings with post-investment firm outcomes, to establish if the mechanism behind valuation discounts is consistent with value-creation. I use the same metric of superior management experience, that is associated with discounted equity valuations, and I interact it in regression models where I estimate variation in survival rates, revenue growth rates, employment growth rates, as well patenting rates. I find that superior management experience is robustly associated with higher post-investment outcomes across all these measures. Moreover, the main factors that amplify valuation discounts also consistently amplify the positive effect on outcomes. The exception is broad and narrow industry similarity, which is consistently and progressively related to lower effects on ex-post outcomes. The later result may be suggestive of inefficiencies stemming from a lack of diversification in human capital.

The overall findings suggest a robust relationship between angel investors' management

experience, equity valuations and post-investment outcomes of portfolio firms. The main interpretation is, that, the human and social capital acquired in management experience generates surplus in angel markets, and therefore commands an investment premium. It follows arithmetically that angel investors with high management experience earn significantly higher returns than other investors in angel markets, providing an empirical explanation of the consistent entry of seasoned executives into these markets. The findings also provide a rationale for targeted rather than generic investment policies, as they highlight the differences in socioeconomic impact of investors with different backgrounds.

This study contributes to an emerging literature on angel investments. It is closely related to a few other studies that exploit administrative micro-data to identify angel investments in population data. Andersson and Lodefalk (2020) use Swedish register data to identify 156 firms that are likely financed by angel investors, with identification relying on the entry of wealthy board members, absent any information about investments or equity ownership. Bach, Baghai, Strömberg, et al. (2023) use Swedish register data to identify 720 angel investors, applying a similar procedure to the one used in this study, while restricting the definition of angel investors to repeat investors with at least two investment deals in the data. The study documents the primary characteristics of angel investors, and highlights the disproportionate entry of experienced executives into angel markets. Kisseleva, Mjøs, and Robinson (2022) study the returns to early-stage investment using Norwegian register data, and find that firms exhibit increased performance after the entry of angel investors. The present study is the first to empirically investigate the relationship between angel investors' executive experience, investment valuations and post-investment firm outcomes.

This work also contributes to a more general literature on venture capital investment, studying the role of active investors and their human and social capital in these markets. It is most closely related to Sørensen (2007), who studies the role of two-sided preferences in matching outcomes and subsequent performance of firms, and Hsu (2002), who documents the prevalence of utility transfers in the matching process, to compensate more valuable investors. This study documents similar market characteristics in informal venture capital markets, and highlights the specific role of managerial and entrepreneurial human capital in the matching, valuation and performance outcomes in these markets.

2 Data

The starting point of the analysis is to identify the population of angel investments in Denmark and characterize all firms, founders, investors and investment deals in detail. The main agenda is to investigate the effects of investors' human and social capital (HSC) on the pricing of investment deals and on post-investment firm performance. I construct a novel dataset that is well-suited to address these research questions.

I combine multiple sources of administrative data on firms and individuals, to generate a comprehensive mapping of all direct and indirect shareholders, board members, CEOs

and employees of private limited liability corporations (LLCs) that are active between 1995-2021. I also account for family relations between individuals in the data. Exploiting this information set, I identify the owners of each firm and I classify them as either founders or external investors. Specifically, I identify angel investors under the definition that they are not related to any founders, not involved in the management or operations of the firm, manage their own investments, and invest at least 100,000 DKK (15,000 USD) at the time of entry. Following this definition, I identify 2,714 unique investment deals in the data, along with detailed information about each transaction.

To obtain relevant measures of individuals' HSC related to enterprise experience, which are key to the purpose of this study, I exploit the comprehensive mapping of founders, managers, investors and directors in all private and public firms since 1995 (not limited to LLCs), and I summarize the careers of all individuals in each of these roles. I aggregate this information using Principal Component Analysis (PCA) to obtain composite measures of management experience, governance experience, as well as an overall measure of enterprise experience.

In this section I describe the main data sources used for the construction of the data set. I describe the structure of the data, the measurement of economic variables, and the algorithm that I use to identify angel investments. I also provides summary statistics of the main sample used in the analysis.

2.1 Data Sources

The main data sources used for construction of the dataset are the Danish Central Business Register, Experian Denmark, and Statistics Denmark.

Administered and published by the Danish Business Authority, the Central Business Register serves as a main information repository for Danish firms. It comprises both current and historical information on all registered firms, and encompasses all legal forms, including Limited Liability Corporations (LLCs), Limited Partnerships (LPs), Unlimited Partnerships (UPs), Sole Proprietorships (SPs), and the range of institutional legal forms. In the case of LLCs, the register specifically details the identities, as well as the timing of entry and exit, of all board members, CEOs, and direct shareholders owning more than 5% equity, including their respective equity shares. I use shareholder information to identify the ultimate owners of each firm and the vehicles through which they own equity shares. The comprehensive information about CEOs and board members is then used to classify the owners that are involved in the management and governance of each firm, as well as owners who are not involved.

Furthermore, the CVR register includes comprehensive information on all primary market transactions registered in LLCs at least since 1990. These data cover the number of shares issued, the price per share, and the transaction mode (i.e. cash, debt, assets, equity). This information provides direct measures of investment amounts, equity shares, and equity valuations in each investment deal, which is crucial to the analysis of investment deals.

The dataset is further supplemented with firm-specific data from the commercial database Experian. These data contain detailed income statements and balance sheets of Danish LLCs, collated from mandatory annual reports submitted between 1995 and 2021. It includes data on assets, equity and earnings (EBIT), which I use to track the financial characteristics and performance of LLCs in the data. The Experian database also includes manually collected information about shareholders in LLCs, which complements and enhances the information available in the Central Business Register. I combine the firm data with information on patent registrations submitted by Danish firms during the data period, which are kindly provided by the Danish Patent and Trademark Organization.

The data on firms and individuals are then integrated with register data from Statistics Denmark. These registers are sourced directly from relevant authorities, such as the Tax Authority, that are authorized to collect and retain private information about firms and residents in Denmark, which ensures universal coverage of these populations.

Statistics Denmark's registers contains comprehensive demographic information about individuals. This includes primary characteristics such as gender, age, income and wealth. It also includes links between parents, children and spouses, that I expand to account for all siblings, grandparents, cousins, uncles/aunts and in-laws as well. Information about family relations is used to identify investors that are related to founders, which is a key criterion for exclusion of angel investments (reference). I combine the primary demographic information with detailed education data, that include the level and field of education, and the GPA score in secondary school. I code the education level in terms of equivalent years of schooling, ranging over the values 9, 12, 15, 17 and 20, that correspond to primary school, secondary school, BSc degree, MSc degree, and PhD degree, respectively.

The register also includes universal labor market data that is sourced from income tax statements reported by employers. These data offer comprehensive links between all employers and employees between 1995 and 2021, and include detailed information such as salaries, hours and occupational codes. I use this information to identify any shareholders that are also employees of a given firm, which is another key criterion for exclusion of angel investments, as well as for identification of founders. The labor market data is also used to account for the real employment level of all firms in the data, excluding any salaries that are paid to owners. I code firm employment in terms of full-time equivalents (FTE), which amounts to 1924 hours during a year by Danish standards.

Furthermore, Statistics Denmark provides comprehensive revenue data of all firms that are subject to VAT collection. This applies to essentially all LLCs in the data, as well as most other legal forms, with some few exceptions in the health and education sectors. The data is obtained from mandatory VAT statements reported to the Tax Authority. The comprehensive revenue data, as well as firm-level employment data, are used to supplement the financial information on LLCs in the main sample of angel investments, and to account in detail for firm characteristics (not limited to LLCs) in the classification of individuals' experience records from enterprise activities.

2.2 Identification of Angel Investments

I develop an algorithm, that identifies angel investors within the larger population of individual shareholders in privately owned LLCs. While the ownership structures of LLCs can be complex and involve multiple levels of intermediate ownership, such as holding or investment vehicles, ultimate shareholders are per definition either individuals or institutions. I refer to ultimate shareholders as owners. I identify all owners with respect to each firm, and I classify an eligible subset of them as angel investors.

The starting point is 588,784 LLCs that are active between 1995-2021, with all direct shareholders recorded over the life-cycle, including their respective equity shares. I derive the owners of each LLC, as well as any vehicles that lie between them, by recursively tracking shareholder information through all levels of upstream and downstream ownership. This process generates a comprehensive and time consistent mapping between LLCs that emerge in the bottom levels, any number of intermediate vehicles, and the owners that emerge in the top level. All owners are identified as either individuals, institutions, or foreign direct investors, and in some few cases they remain unclassified in the data. The mapping of ownership across the network of LLCs allows for identification of any investment or acquisition events that occur in the data, as well as the vehicles and owners that participate in these transactions.

The population of firms, that I consider as investment targets of angel investors, are all operating firms, that are either organized in a single LLC, with no downstream investments, or in a closed-circuit enterprise structure, that is characterized by a parent LLC that wholly owns one or more subsidiaries. In the later case, the level of investment is the parent LLC. In keeping with prior literature, I exclude firms in the financial and real estate sectors. I also exclude professional service firms in the fields of consulting, law and accounting (reference).

I classify individual owners of each firm as either founders or external investors under the main assumption that external investors are not active in the management or operations of their portfolio firms. This classification extends to the level of the investment vehicle, where applicable. In practice I classify all owners that hold a CEO position or receive salary from the firm as founders. In addition, I consider as 'founders' (or friends, family and fools) any relatives of founders, as well as any shareholders that enter at the time of incorporation when all shares are issued at par value, or in a single security class. I consider seed stage investments in cases with multiple security classes issued during the year.

I identify investment events by corresponding changes in direct shareholder composition with coinciding primary market transactions. If there are no primary market transactions, the event is classified as a (partial) acquisition. I assume that investors enter by means of cash or debt conversion, and I disregard any share issues at par value. When there are multiple securities issued during the year (which affects few cases), I rank them by the highest share price and allocate issued shares according to quoted equity ownership in the shareholder register. I classify investors at the level of vehicle, where relevant, by the ownership composition and involvement of owners. Vehicles that are owned primarily by institutions or foreign direct investors are classified as 'private equity funds'. I classify as

angel investors any vehicles (or direct investors), that are primarily owned by individuals, and are actively managed by their owners. The later restriction excludes professionally managed investments and corporate investments, that are also classified as 'private equity funds' for simplicity.

Focusing on investments between 2000-2021, that involve between 5% and 50% of share capital and a minimum investment amount of 100,000 DKK (15,000 USD), I identify all deals with participation of angel investors. With the research question in mind, I exclude deals that are co-invested with private equity funds. I also exclude deals with no active founders in the target firm (i.e. professionally managed firms). These criteria result in a main sample of 2,711 unique investment deals, that involve 2,414 firms, 5,639 investors and 6,414 founders.

Using the transaction data from the Central Business Register I record the investment amount, the amount of shares issued and the total amount of share capital relevant to each transaction. These metrics are used to calculate postmoney valuation, which is defined as the market capitalization at the issued share price, as well as premoney valuation, which is defined as postmoney valuation excluding the investment amount.

2.3 Measurement of Human and Social Capital

To quantify the human and social capital acquired in previous enterprise experience, which is central to this study, I summarize the accumulated experience of all individuals in the roles of founders, managers, investors, and directors. I use all available data, at least since 1995, and I consider any experience acquired within firms that have at least one regular employee. I include all eligible LLCs, Sole Proprietorships, Limited and Unlimited Partnerships, Institutions, Foundations, and Public Organizations. I assign one main role for each individual-firm relation over time, such that the 4 experience categories are mutually exclusive and collectively exhaustive.[2]

I consolidate all experience records, where I consider the number of years and firms associated with each role, the average and maximum firm size in terms of employment, as well as the average and maximum total employment in cases that involve the same role in multiple firms. I also document the primary industry for each role, and the average equity shares held in each role (by construction managers and directors own no significant equity shares). These metrics are grouped into three main categories: management, governance, and enterprise. Management refers to roles as founder or manager, governance refers to roles as investor or director, and enterprise encompasses all roles. By design, management and governance are mutually exclusive categories, and enterprise is a composite of the two categories. The distinction between management and governance captures the fundamentally different activities that are associated with actively managing or actively monitoring firms,

[2] Conceptually, founders are defined as shareholders that either receive salary or hold a management position in the firm, and conversely, investors are shareholders that neither receive salary nor hold management positions in the firm. Professional managers and directors are defined as executives that may receive salary, but are not shareholders in the firm. Regular employees receive salary but are neither managers, directors, nor shareholders.

which are likely to engender different specializations in human capital, that may in turn have different impact in the context of angel investments. The composite category, enterprise experience, captures the aggregate human and social capital acquired in all prior roles, without regard for differences in human capital specialization, and is a useful starting point for analysing the impact of investors' experience.

To capture the intensity and scope of each type of experience, I use Principal Component Analysis (PCA) to generate a composite index for each category. I estimate three separate PCA models, each using the same set of variables and their interactions. I focus on average and maximum firm employment, as well as total employment, that accounts for simultaneous roles in multiple firms. I do not interact the models with experience duration to mitigate the influence of data censoring in 1995. All input variables are winsorized to the 99. percentile and normalized to reduce the influence of extreme outliers and scale discrepancies. Only individuals with positive experience are included in the estimates. I retain the first principal component for each model. Table 3.14 in the appendix reports the eigenvalues, explained variance and factor loadings for the three PCA models. The first principal component in each model has an eigenvalue greater than 4, explains more than 80% of variance, and all input variables exhibit positive factor loadings greater than 0.80, which ensures a robust correspondence between input criteria and predicted factor scores.

The log-normalized factor scores of individuals are used as proxies for the level of HSC associated with each experience category. To provide a meaningful segmentation of individuals based on these factor scores, I use a clustering algorithm to group individuals into 10 factor tiers, that minimize within-group variance in factor scores, while maximizing between-group variance. This method generates an unequal distribution of individuals across tiers, but allows for a more clear interpretation of the data. In particular, belonging to a higher tier is associated with substantially higher experience. The results presented in this study are however robust to other grouping mechanisms for capturing differences between individual factor scores, such as quintiles, or even discrete differences in predicted scores.

I introduce the ordinal variables MANAGEMENT, GOVERNANCE, and ENTERPRISE, each spanning a scale from 0 to 10, that present a distinct hierarchical structure of individuals within each experience domain, which applies to both investors and founders in the data. Table 3.1 provides a breakdown of mean experience records across these divisions. The lowest tier consists of individuals with no recorded experience, while the subsequent tiers are consistently associated with elevated mean values of the input criteria. For example, belonging to the highest management tier, is associated with managing 1,150 employees in the the record year, and 14.6 years of experience on average. I refer to these variables as management factor, governance factor and enterprise factor, respectively.

2.4 Summary Statistics

This section presents summary statistics of the main sample used in the analysis. The sample contains 2,711 unique investment deals that involve 2,414 firms, 6,414 founders and 5,639

Table 3.1. Average Experience Records in Each Factor Category and Factor Tier

The table reports the mean experience records and number of observations across factor categories management, governance and enterprise, and across tiers within each category, ranging between 0 and 10. Individuals in tier 0 have no recorded experience in the relevant category. The variables n years and n firms denote the total number of years and firms that an individual has held in the roles relevant to each category. Peak employment denotes the record number of employees (measured in FTEs) across all firms associated with each category in a given year. Equity is a composite index, ranging between 0 and 1, which measures the mean ownership share associated with each factor category.

FACTOR TIER	0	1	2	3	4	5	6	7	8	9	10
MANAGEMENT											
EMPLOYMENT RECORD	0.0	1.7	4.6	10.8	19.4	26.3	40.2	65.7	117.2	299.6	1150
N YEARS	0.0	2.9	6.5	9.4	10.6	11.1	12.7	13.8	14.3	14.8	14.6
N FIRMS	0.0	1.2	1.5	2.0	2.3	2.5	3.1	2.9	3.7	4.4	4.2
EQUITY (PCT)	0.0	0.46	0.43	0.35	0.35	0.35	0.33	0.29	0.25	0.21	0.10
GOVERNANCE											
EMPLOYMENT RECORD	0.0	1.9	4.6	9.3	15.3	22.3	35.2	71.3	149.6	349.8	2189
N YEARS	0.0	2.4	3.8	5.1	5.6	6.4	7.7	8.9	10.3	11.8	13.6
N FIRMS	0.0	1.2	1.7	2.3	2.9	3.7	4.3	6.4	9.3	15.0	24.5
EQUITY (PCT)	0.0	0.17	0.16	0.14	0.12	0.13	0.13	0.10	0.09	0.09	0.07
ENTERPRISE											
EMPLOYMENT RECORD	0.0	2.1	4.4	6.8	11.8	22.7	43.3	81.2	165.7	480.3	2631
N YEARS	0.0	3.1	5.3	7.5	9.0	10.1	12.0	13.5	14.8	15.6	16.1
N FIRMS	0.0	1.3	1.7	2.1	2.6	3.6	5.2	6.7	9.5	16.2	25.8
EQUITY (PCT)	0.0	0.42	0.39	0.39	0.35	0.30	0.27	0.22	0.19	0.14	0.09

investors. In order to characterize the interactions between founders' and investors' factors at the level of investment deals, I consider the highest factor among each founder team and investor syndicate. I also define the binary variables ENTERPRISE$^+$ and ENTERPRISE$^-$, that indicate if investors belong to a higher factor tier than founders, or to a lower (or similar) factor tier. Similar variables are defined for management and governance factors.

Table 3.2 present the main characteristics of firms, founders, investors and investment deals in the sample, segmented between deals where investors have higher or lower enterprise factors, compared to founders. The breakdown of variables reveals that differences in characteristics, unrelated to HSC, are generally small across the divisions ENTERPRISE$^+$ and ENTERPRISE$^-$. Significant differences amount to higher revenue and employment, as well as larger and older founder teams in the segment of ENTERPRISE$^+$ deals. The most notable differences are however present investors' factor levels, which are substantial. On average, investors lie 3.68 factor tiers higher in terms of enterprise factor, and 3.53 in terms of management factor in ENTERPRISE$^+$ deals. The main focus of the analysis is on the relationship between investors' higher experience factors, and the pricing of investment deals. The table shows insignificant differences in pricing metrics premoney valuations, price-to-book, and price-to-sales ratios across the two segments, but all measures these measures are generally higher for the reference group. However, investors in the ENTERPRISE$^+$ group may either have higher management factor, higher governance factor, or both.

Two-sided matching preferences are a general feature of angel markets, which is also evident in the main sample data. Table 3.8 and Table show the average matching outcomes of

founders an investors in the sample, for observations in each factor tier. These figures display a tendency of both founders and investors to match with more experienced counter-parties, as they become increasingly more experienced, evidencing assortative matching patterns in the market.

Table 3.2. Main Characteristics: Firms, Founders, Investors and Investment Deals

The table presents main characteristics of firms, founders, investors and investment deals in the main sample, containing 2,714 unique deals. The sample is segmented between deals where founders have respectively 'low' or 'high' enterprise factors, which corresponds to factor tiers 1, 2 and factor tiers higher than 2. Each subsample is also split between deals with superior enterprise factors, ENTERPRISE$^+$, and deals with inferior (or similar) enterprise factors, ENTERPRISE$^+$. The table reports sample means and difference in means. Management, governance and enterprise refers to the maximum factor in each category across founder and investor teams. Premoney valuation is defined as market capitalization at the issued share price, excluding the investment. Price-to-book and price-to-sales are defined as premoney valuation divided by book assets and revenue respectively, and are only defined for firms with non-zero assets or revenue. Seed stage refers to deals that occur during the year of incorporation, and debt conversion is an indicator for use of debt securities in the transaction. P-values of difference-in-means tests are not reported, (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

	ALL DEALS		ENTERPRISE$^-$		ENTERPRISE$^+$		DIFFERENCE
	MEAN	SD	MEAN	SD	MEAN	SD	(-) - (+)
FIRMS:							
AGE	3.59	4.86	3.77	4.76	3.47	4.93	0.29
ASSETS (M DKK)	6.50	13.19	7.45	15.34	5.87	11.46	1.58**
REVENUE (M DKK)	7.50	24.24	7.83	27.39	7.28	21.85	0.55
EMPLOYEES (FTES)	3.81	9.54	4.45	12.44	3.38	6.89	1.07**
PATENTS (YES = 1)	0.09	0.28	0.10	0.30	0.08	0.27	0.02
POSITIVE EBIT (YES = 1)	0.44	0.50	0.44	0.50	0.44	0.50	0.00
FOUNDERS:							
AGE	43.67	9.29	45.55	9.15	42.39	9.17	3.15***
TEAM SIZE	2.37	1.32	2.74	1.43	2.11	1.17	0.63***
MALE (YES = 1)	0.87	0.27	0.88	0.23	0.85	0.29	0.028**
EDUCATION (YEARS)	14.08	2.24	14.02	2.08	14.11	2.34	−0.09
MANAGEMENT FACTOR	3.90	3.17	5.45	3.44	2.85	2.48	2.60***
GOVERNANCE FACTOR	3.06	2.99	4.46	3.46	2.11	2.15	2.34***
ENTERPRISE FACTOR	4.09	3.15	5.80	3.29	2.94	2.45	2.86***
INVESTORS:							
MANAGEMENT FACTOR	5.68	3.40	3.57	3.05	7.11	2.84	−3.53 ***
GOVERNANCE FACTOR	4.73	3.40	2.98	2.75	5.92	3.28	−2.94 ***
ENTERPRISE FACTOR	6.03	3.17	3.83	2.96	7.52	2.33	−3.68 ***
DEALS:							
INVESTMENT (M DKK)	1.87	3.20	1.86	3.27	1.89	3.15	−0.03
PREMONEY	8.84	14.97	9.45	16.27	8.42	14.00	1.02
P/B	4.36	8.82	4.58	9.53	4.22	8.31	0.36
P/S	12.91	37.32	13.51	36.24	12.51	38.03	1.00
DEAL ROUND (1, 2+)	1.17	0.37	1.22	0.42	1.13	0.33	0.10***
SEED STAGE	0.20	0.40	0.18	0.38	0.21	0.41	−0.04 *
DEBT SECURITIES	0.19	0.40	0.20	0.40	0.19	0.39	0.15
OBSERVATIONS	2,711	2,711	1,095	1,095	1,616	1,616	

Figure 3.1. Founders' Experience Levels and Counter-party Matching Outcomes

The figure shows average counter-party matching outcomes in the main sample (y-axis), conditional on the factor tier of founders (x-axis). The factor categories enterprise and management are represented in the left and right panels respectively. The panels show the average factor level of matched investors for each tier of founders, compared to the average factor level of investors in the sample (denoted random match). All matching outcomes are averaged across sample years and weighted by the number of observations in each year.

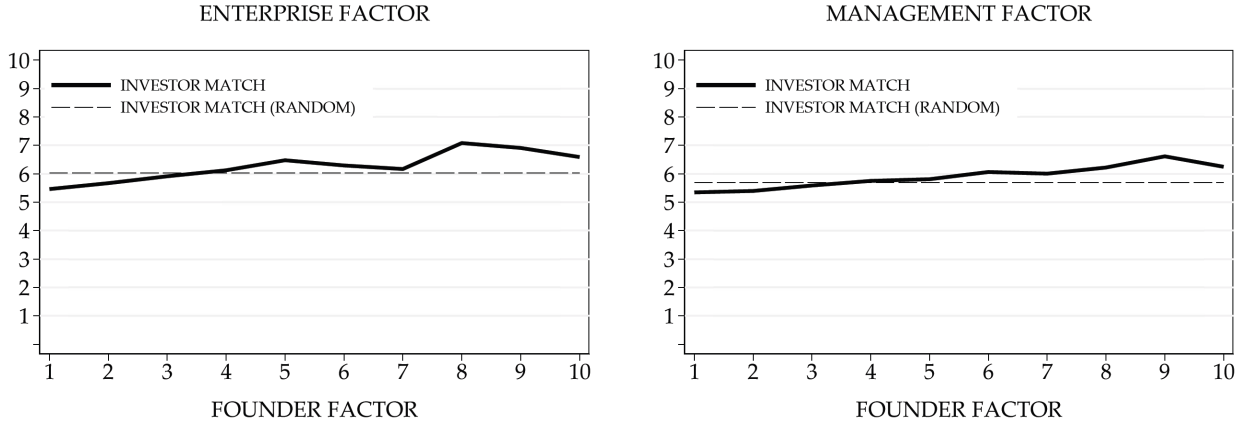
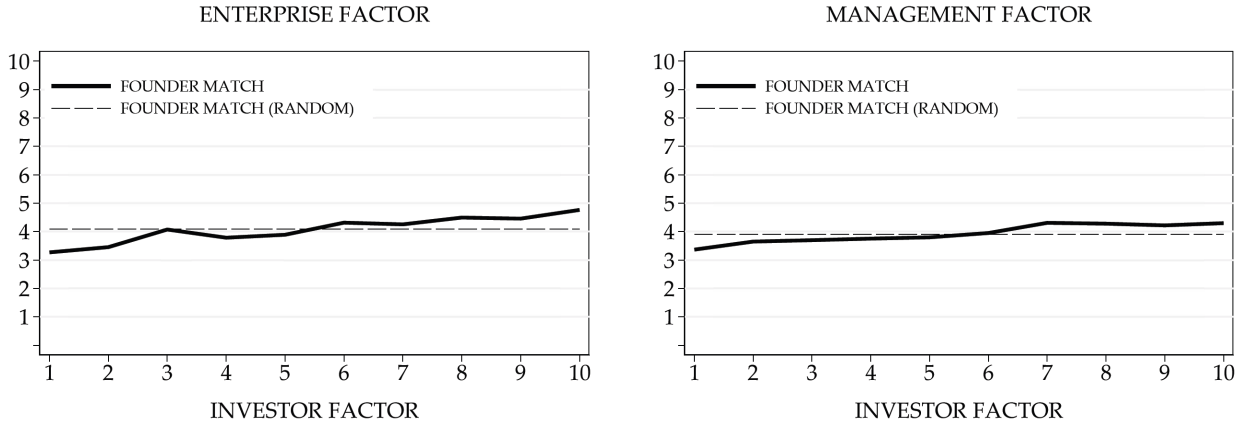


Figure 3.2. Investors' Experience Levels and Counter-party Matching Outcomes

The figure shows average counter-party matching outcomes in the main sample (y-axis), conditional on the factor tier of investors (x-axis). The factor categories enterprise and management are represented in the left and right panels respectively. The panels show the average factor level of matched founders for each tier of investors, compared to the average factor level of founders in the sample (denoted random match). All matching outcomes are averaged across sample years and weighted by the number of observations in each year.



3 Analysis

This section provides an empirical analysis of the hypotheses outlined in the introduction. In the first part I present evidence that investors with superior enterprise factors invest at discounted equity valuation. I analyse the components of the enterprise factor in detail and demonstrate that the valuation discount is entirely attributed to superior management factor, after controlling for factor correlations. Expanding from this key finding, I examine moderating effects of other characteristics related to the matching of founders and investors. In particular, I show that the valuation discount is amplified when founders have low management factor, and when the relative magnitude of investors' management factor is high. The discount is also amplified when investors' management factor is acquired in a founder role, or within the industry of the target firm. In the second part of the analysis, I demonstrate that superior management factor is related to higher ex-post firm performance, thus reciprocating the effects on equity valuation. I also show that the moderating factors identified in the valuation analysis amplify the positive effects of superior management factor on firm performance, except for industry congruence that shows opposite effects.

3.1 Part 1: Investment Valuation

The first step of the analysis is to create a regression model that explains equity valuation based on observable characteristics of the economic environment, firms, founders, and investment deals. This will be used as a benchmark model for estimating any additional effects of investors' HSC. In practice I estimate these effects by including a binary variable that indicates if investors have higher factors than founders, which provides for a direct comparison between investors' HSC in the cross section of investment deal. I use the following regression formulation to analyse investment valuation throughout this section (subscripts omitted):

$$\textsc{log(premoney)} = \beta_0 + \beta_1 \textsc{enterprise}^{+} + \beta_2 \mathrm{X} + \mathrm{F} + \mathrm{I} + \mu + \varepsilon \tag{1}$$

The dependent variable LOG(PREMONEY) denotes logged premoney valuation in the investment deal. This is an absolute measure of firm value, which is generally preferred in the context of entrepreneurial finance, as comparative metrics like assets, revenue, or earnings can be particularly volatile and sensitive to accounting deficits in the early stages of the firm's life cycle. However, I test the robustness of the main estimates using other pricing metrics below. The main explanatory variable, ENTERPRISE^{+}, indicates if investors have higher enterprise factor than founders. X is a vector of control variables, F denotes firm fixed effects (FE), I denotes investor fixed effects (FE), and μ contains fixed effects (FE) by industry and year. ε is an error term. Three main sets of control variables are included, which take into account characteristics of the investment deal, the firm, and the founder team, that are likely to influence the firm's equity valuation. Deal controls include the logged investment amount

and its square and its square. They also include an indicator of seed stage, defined as the year of incorporation, the financing round number (coded as 1 or 2+), an interaction term that measures logged investment from previous rounds, and a binary variable that indicates if shares are issued by means of debt conversion. Firm controls include firm age and logged revenue, assets and employment. They also include the leverage ratio, the revenue growth rate, an indicator of positive EBIT, and an indicator of patent holdings. Founder controls include the main characteristics of all founders, including any inside investors from previous rounds. These include team size (capped at 5), gender composition, mean age and education, as well as the highest factors in each respective category, management, governance and enterprise, that are included as linear terms. They also include an indicator of foreign or institutional minority interests. In order to avoid multicollinearity issues that could distort the estimated effects, investor characteristics are not included in the model. These are likely to serve as 'bad controls' in a context where focus is primarily on the effects of superior enterprise experience.

I include firm fixed effects (FE) and investor fixed effects (FE) in the model to control for unobserved time-invariant firm and investor characteristics that might simultaneously influence matching and equity valuation. I exploit the subsamples with repeat investments within firms (558 out of 2,711 observations) and within investors (798 out of 2,711 observations) to include these estimators, while acknowledging the potential attrition bias in the respective subsamples. In particular, firms with repeat investments are likely to be of higher quality, and serial investors are on average more experienced. However, given that matching is non-random in angel markets, the primary identification concern is that unobserved firm quality and assortative matching with more experienced investors along this dimension may bias the coefficient of interest downwards. Firm fixed effects (FE) and investor fixed effects (FE) are particularly useful in addressing these concerns. I discuss some issues related to the inclusion of these estimators and their interpretation below.

The results of regression model (1) are presented in Table 3.3. The table shows 7 successive regressions, that each incorporate progressively more controls. The initial results show that ENTERPRISE^{+} is robustly associated with lower equity valuation, when controlling for industry and year FE (2), deal characteristics (3), firm characteristics (4) and founder characteristics (5), with a positive and significant coefficient of -0.0860***, implying that investors with higher enterprise factor obtain equity at lower prices, relative to investors without. However, when accounting for firm fixed effects (FE) in model (6), the significance diminishes, and when including investor fixed effects (FE) in model (7) the coefficient becomes positive. The valuation discount associated with higher enterprise factor is evidently not robust to controlling for unobserved, time-invariant firm or investor characteristics, suggesting that the initially observed effects are driven by other factors. These last results might also be attributed to limited variation in the explanatory variable within firms and investors. Either way, this initial finding paves the way for a more in-depth analysis, focusing on the two main components of the enterprise factor, which are management and governance factors.

Table 3.3. Primary Effects of Superior Enterprise Factor on Equity Valuation

The table presents OLS regression results, with dependent variable log(premv), that measures the logged premoney valuation of investment deals, regressed on the explanatory variable, ENTERPRISE^{+}, that indicates if investors are superior in enterprise factor and a comprehensive set of controls. Each model includes progressively more controls. Year and industry fixed effects (FE) are included first. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures logged investment from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. The last two models include firm fixed effects (FE) and investor fixed effects (FE) respectively. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ENTERPRISE^{+}	-0.0951*	-0.0966*	-0.120***	-0.114***	-0.0860***	-0.0893	0.0501
	(0.0509)	(0.0505)	(0.0289)	(0.0286)	(0.0317)	(0.0860)	(0.110)
YEAR FE		+	+	+	+	+	+
INDUSTRY FE		+	+	+	+	+	+
CONTROLS DEAL			+	+	+	+	+
CONTROLS FIRM				+	+	+	+
CONTROLS FOUNDER					+	+	+
FIRM FE						+	
INVESTOR FE							+
R^2	0.00129	0.0317	0.691	0.702	0.714	0.671	0.731
OBSERVATIONS	2,711	2,711	2,711	2,711	2,711	2,711	2,711
PANELS						2,414	2,216

The initial results indicate that a superior enterprise factor is related to discounted valuations. As this factor is a composite of management and governance experience, the next regressions dissects this factor into its primary components, to examine more closely the specific drivers behind the observed effect. Given the intrinsic correlation between these three factors, a 'horse race' regression framework is employed to assess each factor's contribution to the observed discount, by incorporating them in various combinations. The regression model in (1) is adapted to include the indicator variables GOVERNANCE^{+} and MANAGEMENT^{+}. The model is estimated including the full set of controls and the additional variables are introduced in combination to assess their relative significance.

Table 3.4 presents the main results of the regression analysis. The table presents six regressions, where the first three models include one indicator at the time, and the subsequent three models incorporate all three simultaneously, with the last two also including firm fixed effects (FE) and investor fixed effects (FE), respectively. The results indicate that, when included individually, all three factors are associated with negative and significant effects on equity valuation, where superior management factor exerts the largest effect, with the coefficient -0.103*** representing a substantial economic effect, that amounts to approximately 10% lower valuation on average. Interestingly, when all three factors are included simultaneously in model (4), the coefficients of enterprise and governance factors, which were previously negative and significant, become insignificant, while the coefficient on management factor is largely unaffected. Including firm fixed effects (FE) and investor fixed

effects (FE) in models (5) and (6), the negative valuation effect of MANAGEMENT$^+$ increases to -0.251** and -0.250**, respectively, implying substantially larger effects when controlling for unobserved firm and investor characteristics in the data. The coefficient estimates of MANAGEMENT$^+$ are remarkably similar in the two subsamples, and are likely attributable to unobserved firm quality, as well as assortative matching on this dimension, that drives the pairing of more valuable firms with more experienced investors. This feature of the data leads to a downward bias in the baseline coefficient estimate when firm or investor fixed effects (FE) are not included. Interpretation and generalization of the results in the last two models requires some caution however, as they pertain to within-firm and within-investor variation in the explanatory variables across smaller subsamples, that are characterized by potentially higher firm quality and investors with higher factor scores.

The results imply that, after accounting for the valuation effect of superior management factor, higher governance or enterprise factors, that are per construction mainly related to investment and director experience, do not entail any valuation discount. Table 3.15 in the appendix reports additional regression results where the three factors are evaluated pairwise. These results confirm that only MANAGEMENT$^+$ remains significant when included with the other factors, which leads to the conclusion that their effects are primarily driven by correlation with superior management factor.

Relating these findings to prior literature, Politis (2008) identifies the four main value-adding activities of angel investors as mentoring, strategic guidance, monitoring and resource provisioning, relating by varying degree to the human and social capital of investors. One interpretation of the regression results is, that, founders attach more value to the mentoring and strategic guidance that an investor with higher management factor might provide, beyond the monitoring capacity and resource provisioning of investors that are primarily experienced in governance roles, and connect to larger networks than founders. Evidently the human and/or social capital embedded in higher governance or higher enterprise factors does not affect valuations.

In order to evaluate the robustness and generality of these key findings, I estimate the same regression models where I include as dependent variable the four main pricing metrics used in the finance literature, which are postmoney valuation, price-to-book ratio, price-to-assets ratio and price-to-earnings ratio. The relative metrics are only applicable to firms that have positive values of the denominator, resulting in a varying number of observations across specifications. Table 3.5 displays the main results with the full set of controls across all these measures, which confirm the robustness of the main findings. The results from the previous analysis are robust across all pricing metrics, all though not significant in the case of price-to-earnings ratio. In all cases, when controlling for the presence of higher management factor, investors with higher governance or enterprise factors are not associated with valuation effects. These results also hold in the subsamples with firm fixed effects (FE) and investor fixed effects (FE), which are not reported.

Overall, these results confirm that investors with higher management factor invest at substantially lower equity valuations, compared to investors without. They suggest that

the human capital specialization of investors is more important than their social capital (proxied by higher governance and enterprise factors), and imply human capital cultivated in management roles is uniquely valued. These key findings are central contributions of this study, that demonstrate the importance of management experience in angel markets, and contribute to our understanding of the role of investors' human and social capital. In particular they provide a first order rationale for the disproportionate entry of experienced founders and managers into angel markets.

Table 3.4. Joint Significance of Enterprise, Governance and Management Factors

The table presents OLS regression results, with dependent variable log(premv), that measures the logged premoney valuation of investment deals, regressed on explanatory variables ENTERPRISE^{+}, GOVERNANCE^{+} and MANAGEMENT^{+}, that indicate if investors are superior in each respective factor and a set of controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures logged investment from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. The last two models include firm fixed effects (FE) and investor fixed effects (FE) respectively. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)	(4)	(5)	(6)
ENTERPRISE^{+}	-0.0860***			0.0132	0.0534	0.170
	(0.0317)			(0.0528)	(0.124)	(0.131)
GOVERNANCE^{+}		-0.742**		-0.0466	0.0403	0.118
		(0.0297)		(0.0366)	(0.0956)	(0.106)
MANAGEMENT^{+}			-0.103***	-0.0935**	-0.251**	-0.250**
			(0.0308)	(0.0454)	(0.110)	(0.124)
YEAR FE	+	+	+	+	+	+
INDUSTRY FE	+	+	+	+	+	+
CONTROLS DEAL	+	+	+	+	+	+
CONTROLS FIRM	+	+	+	+	+	+
CONTROLS FOUNDER	+	+	+	+	+	+
FIRM FE					+	
INVESTOR FE						+
R^2	0.714	0.714	0.714	0.715	0.677	0.728
OBSERVATIONS	2,711	2,711	2,711	2,711	2,711	2,711
PANELS					2,414	2,216

Table 3.5. Robustness of Main Valuation Effects under Alternative Pricing Metrics

This table presents the results of ordinary least squares (OLS) regressions with five different outcome variables regressed on explanatory variables ENTERPRISE$^+$, GOVERNANCE$^+$, MANAGEMENT$^+$, that indicate if investors are superior in each respective factor and a comprehensive set of controls. The outcome variables log(premv) and log(postmv) measure the logged premoney and postmoney valuations of investment deals, while LOG(P/B), LOG(P/S) and LOG(P/E) measure the logged ratios of premoney valuation divided by book assets, revenue and earnings (EBIT), respectively. The fraction metrics are only applicable to firms positive positive values of the numerator. All models are estimated using the same set of controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures logged investment from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)
	LOG(PREMONEY)	LOG(POSTMONEY)	LOG(P/B)	LOG(P/S)	LOG(P/E)
ENTERPRISE$^+$	0.0132	0.0156	0.00713	0.0738	0.0143
	(0.0528)	(0.0420)	(0.0550)	(0.0600)	(0.135)
GOVERNANCE$^+$	-0.0466	-0.0368	-0.0388	-0.0557	0.0908
	(0.0366)	(0.0291)	(0.0381)	(0.0415)	(0.0946)
MANAGEMENT$^+$	-0.935**	-0.0769**	-0.110**	-0.141***	-0.0953
	(0.0454)	(0.0361)	(0.0473)	(0.0516)	(0.117)
YEAR FE	+	+	+	+	+
INDUSTRY FE	+	+	+	+	+
CONTROLS DEAL	+	+	+	+	+
CONTROLS FIRM	+	+	+	+	+
CONTROLS FOUNDER	+	+	+	+	+
R^2	0.708	0.796	0.695	0.839	0.437
OBSERVATIONS	2,711	2,711	2,660	2,413	1,201

3.2 Moderating Factors of the Management Discount

The findings above show that superior management experience is associated with significantly discounted equity valuations. Expanding from this result, I examine channels that might attenuate or amplify the main effects.

I first test the moderating effects of founders' management factors, denoted FOUNDER_M. This relates to the endowment hypothesis, discussed in the introduction, arguing that the HSC of investors is more valuable to inexperienced founders, potentially leading to larger discounts in this segment. In order to test the hypothesis, I segment founder teams into two categories, denoted FOUNDER_M_L and FOUNDER_M_H, that pertain to factor tiers 0, 1, 2, and tiers higher than 2, respectively. The division corresponds roughly to the sample median among founder teams. I interact these variables in turn with the main explanatory variable, MANAGEMENT$^+$, to evaluate any changes in the observed discount.

Table 3.6 reports the regression results, using the full set of controls in all specifications, and including firm fixed effects (FE) and investor fixed effects (FE) in the last two models. Panels (1) and (2) show that the negative coefficient on MANAGEMENT$^+$ changes from -0.103*** to -0.158*** when including an interaction with the linear term, FOUNDER_M, denoting founders' management tier. The higher coefficient on MANAGEMENT$^+$ now represents the baseline effect when the interaction term is zero, i.e. when founders belong to the lowest tier. Evidently, the least experienced founders encounter the largest discounts. In models (3), (4) and (5) I partition MANAGEMENT$^+$ into interactions with FOUNDER_M_L and FOUNDER_M_H to highlight the differences between inexperienced and experienced founders. The results in panel (3) show that inexperienced founders are associated with discounts that are approximately twice the magnitude of experienced founders, comparing coefficients -0.141*** and -0.0707*. Adding firm fixed effects (FE) and investor fixed effects (FE) in models (5) and (6) increases the effects across both groups, but the relative difference in coefficients is largely preserved, which implies that the moderating effects of founders' experience are robust to unobserved firm and investor characteristics. These findings demonstrate that the discount effect of MANAGEMENT$^+$ is more pronounced in deals with inexperienced founders, consistent with the endowment hypothesis.

Table 3.6. Moderating Effects of Founder Teams' Management Factor Endowment

The table presents output from OLS regressions, where the dependent variable, log(premv), that measures the logged premoney valuation of investment deals, is regressed on the main explanatory variable MANAGEMENT^{+}, interaction variables, and a set of controls. MANAGEMENT^{+} indicates if investors are superior in management factor, compared to founders and the variable FOUNDER_M measures the maximum management factor of founders, and ranges between 1 and 10. FOUNDER_M$_{L}$ indicates 'low' factors, pertaining to tiers 1 and 2, while FOUNDER_M$_{H}$ indicates 'high' factors, pertaining to all tiers between 3 and 10. All five models are estimated using the same set of basic controls, and the last two models also include firm fixed effects (FE) and investor fixed effects (FE), respectively. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures the logged investment amount from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. The last two models include firm fixed effects (FE) and investor fixed effects (FE) respectively. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)	(4)	(5)
MANAGEMENT^{+}	-0.103***	-0.158***			
	(0.0308)	(0.0480)			
MANAGEMENT^{+} · FOUNDER_M		0.0145			
		(0.00974)			
MANAGEMENT^{+} · FOUNDER_M$_{L}$			-0.141***	-0.263**	-0.264*
			(0.0392)	(0.116)	(0.150)
MANAGEMENT^{+} · FOUNDER_M$_{H}$			-0.0707*	-0.180**	-0.162
			(0.0370)	(0.0895)	(0.108)
YEAR FE	+	+	+	+	+
INDUSTRY FE	+	+	+	+	+
CONTROLS DEAL	+	+	+	+	+
CONTROLS FIRM	+	+	+	+	+
CONTROLS FOUNDER	+	+	+	+	+
FIRM FE				+	
INVESTOR FE					+
R^2	0.714	0.715	0.715	0.677	0.726
OBSERVATIONS	2,711	2,711	2,711	2,711	2,711
PANELS				2,416	2,216

Investigating the role of relative distance between founders' and investors' management factors, I estimate a regression model that explores how valuation discounts fluctuate based on this metric. I use the log-normal factor scores of founders and investors to obtain a metric of relative distance, and I define the variables D_L and D_H, that denote relative distance below and above the sample median. These variables are integrated into the main regression model and interacted with the MANAGEMENT^+ variable.

Table 3.7 presents the results of the regression analysis. The initial regressions in panels (1) and (2) show little invariance in effects between low-distance and high-distance investors, a theoretically surprising outcome. However, incorporating firm fixed effects (FE) and investor fixed effects (FE) in panels (3) and (4) alters this result and presents substantially larger discounts in favor of the most experienced investors, reaching more than 40% relative to the reference category. This shift is potentially due to assortative matching where highly experienced investors, represented by the term, D_H, pair with high-quality firms along dimensions that are unobserved in the data. As this is not captured by regression controls, the coefficient adjusts when including investor fixed effects (FE). Panels (5), (6), (7) partition the sample further between founders with low and high experience, revealing similar coefficient adjustments across both founder groups when including firm and investor fixed effects (FE), and confirming discounts of more than 40% when investors' experience is relatively high.

Overall the results suggest that the relative scale of investors' experience substantially amplifies the management discount. Interpretation of these results does requires some caution, as they rely on a smaller sample of repeat investors. However, the coefficient adjustments are consistent with a large body of literature emphasizing the role of assortative matching in early-stage investments (Sorensen (2007)), which is likely more pronounced in angel markets, given the inherent heterogeneity of investors and the informal nature of the matching process. When highly experienced investors invest in relatively inexperienced founders, these founders are likely to run more valuable firms.

Table 3.7. Moderating Effects of the Relative Distance of Management Factors

The table presents output from OLS regressions, where the dependent variable, log(premv), that measures the logged premoney valuation of investment deals, is regressed on the main explanatory variable MANAGEMENT$^+$, interaction variables, and a set of controls. MANAGEMENT$^+$ indicates if investors are superior in management factor, compared to founders. FOUNDER_M$_L$ and FOUNDER_M$_H$ indicate 'low' and 'high' management factors of founders, respectively, where L pertains to factor tiers 1 and 2, and H pertains to factors tiers between 3 and 10. The variables D$_L$ and D$_H$ indicate the relative distance in factor scores between investors and founders, where L and H indicate values below and above the sample median, respectively. All models are estimated using the same set of basic controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures the logged investment amount from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. Models (3) and (5) include firm fixed effects (FE) and models (4) and (6) include investor fixed effects (FE). (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MANAGEMENT$^+$	-0.103***						
	(0.0308)						
MANAGEMENT$^+$ · D$_L$		-0.102***	-0.193**	-0.194*			
		(0.0343)	(0.0906)	(0.108)			
MANAGEMENT$^+$ · D$_H$		-0.104***	-0.225*	-0.424**			
		(0.0381)	(0.113)	(0.159)			
MANAGEMENT$^+$ · FOUNDER_M$_L$ · D$_L$					-0.157***	-0.321**	-0.235
					(0.0486)	(0.137)	(0.167)
MANAGEMENT$^+$ · FOUNDER_M$_L$ · D$_H$					-0.136***	-0.233*	-0.454**
					(0.0435)	(0.138)	(0.177)
MANAGEMENT$^+$ · FOUNDER_M$_H$ · D$_L$					-0.0673	-0.137	-0.194*
					(0.0412)	(0.0994)	(0.117)
MANAGEMENT$^+$ · FOUNDER_M$_H$ · D$_H$					-0.0786	-0.296**	-0.412**
					(0.0609)	(0.147)	(0.163)
YEAR FE	+	+	+	+	+	+	+
INDUSTRY FE	+	+	+	+	+	+	+
CONTROLS DEAL	+	+	+	+	+	+	+
CONTROLS FIRM	+	+	+	+	+	+	+
CONTROLS FOUNDER	+	+	+	+	+	+	+
FIRM FE			+			+	
INVESTOR FE				+			+
R^2	0.714	0.714	0.677	0.728	0.715	0.669	0.728
OBSERVATIONS	2,711	2,711	2,711	2,711	2,711	2,711	2,711
PANELS			2,414	2,216		2,414	2,216

Proceeding to an examination of the composition of management factor, I construct a founder index, using a composite measure of equity ownership associated with previous management roles, that ranges between 0 and 1, and is denoted INVESTOR_F. The measure represents the degree of founder experience embedded in investors' management factor. I also define indicator variables, INVESTOR_F_0, INVESTOR_F_L, INVESTOR_F_H, that indicate zero, below median and above median founder experience, as implied by the index. I integrate these variables in the main regression specification with MANAGEMENT^+ to test the moderating effects founder experience on management discounts. I do not include investor fixed effects (FE), due to limited variation in these metrics within investors.

Table 3.8 presents the results of the regression analysis. Including the linear interaction term INVESTOR_F in panel (2) decreases the coefficient on MANAGEMENT^+, implying that low values of the founder index are associated with lower discounts. In panels (3) and (4) I include the 3 categorical indicators, showing that founder experience is related to progressively higher discounts, displaying coefficients -0.0898** and -0.121*** on the interactions with categories L and H. Including firm fixed effects (FE) in model (4) concentrates the discount among investors with highest founder experience, implied by the coefficient -0.369***. One interpretation of the results is, that, founders acquire unique dimensions of human capital in the risky process of establishing and growing a business, which are valued in angel markets, but not available to professional managers. Relating these findings to the value-adding activities of angel investors discussed in the introduction, founders are likely to possess higher mentoring capacity than other managers (Politis (2008)).

The last moderating effect I test is similarity in human and social capital. I use the indicators denoted SECTOR^+ and SECTOR^- to indicate if investors' management experience is acquired primarily in the same (broad) sector as the target firm, or not. I define similar indicators for (narrow) industries, INDUSTRY^+ and INDUSTRY^-.[3] These variables act as proxies for the similarity (or congruence) in human and social capital between investors and investees, and are integrated with the main explanatory variable, MANAGEMENT^+, to test the moderating effects of these characteristics on the management discount. I do not include firm fixed effects (FE) or investor fixed effects (FE), because of limited variation in these variables within firms and investors.

Table 3.9 shows the results of the regression analysis. The results in panel (2) and (3) show that the management discount increases to -0.140*** when investors' experience is acquired in the target sector, and increases further to -0.190*** when acquired in the target industry. These findings suggest that similarity is associated with progressively larger discounts, which is potentially due to reduced asymmetric information associated with these investments.

[3] Sector is defined by NACE nomenclature at one-digit level, corresponding to an aggregation into 10 sectors. Narrow industry is defined by NACE nomenclature at two-digit level, corresponding to aggregation into 88 industries.

Table 3.8. Moderating Effects of Founder Experience within Management Factor

The table presents output from OLS regressions, where the dependent variable, log(premv), that measures the logged premoney valuation of investment deals, is regressed on the main explanatory variable MANAGEMENT$^+$, interaction variables, and a set of controls. MANAGEMENT$^+$ indicates if investors have a superior factor, compared to founders. The variable INVESTOR_F is a composite ownership index, ranging between 0 and 1, that measures equity ownership associated with prior management experience. The variables INVESTOR_F$_0$, INVESTOR_F$_L$, INVESTOR_F$_H$ indicate if the ownership index is 'zero', 'low' or 'high', respectively, corresponding to zero, below median and above median values. All models are estimated using the same set of basic controls. The logged ownership index is included in controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures the logged investment amount from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. The last model includes firm fixed effects (FE). (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)	(4)
MANAGEMENT$^+$	-0.103***	-0.0871**		
	(0.0308)	(0.0392)		
MANAGEMENT$^+$ · INVESTOR_F		-0.0535		
		(0.122)		
MANAGEMENT$^+$ · INVESTOR_F$_0$			-0.0728	-0.226
			(0.0530)	(0.196)
MANAGEMENT$^+$ · INVESTOR_F$_L$			-0.0898**	-0.190
			(0.0375)	(0.133)
MANAGEMENT$^+$ · INVESTOR_F$_H$			-0.121***	-0.369***
			(0.0426)	(0.124)
YEAR FE	+	+	+	+
INDUSTRY FE	+	+	+	+
CONTROLS DEAL	+	+	+	+
CONTROLS FIRM	+	+	+	+
CONTROLS FOUNDERS	+	+	+	+
FIRM FE				+
R^2	0.715	0.715	0.715	0.682
OBSERVATIONS	2,711	2,711	2,711	2,711
PANELS				2,414

Table 3.9. Moderating Effects of Industry Similarity within Management Factor

The table presents output from OLS regressions, where the dependent variable, log(premv), that measures the logged premoney valuation of investment deals, is regressed on the main explanatory variable MANAGEMENT$^+$, interaction variables, and a set of controls. MANAGEMENT$^+$ indicates if investors have superior factor, compared to founders. The variables SECTOR$^+$ and SECTOR_ indicate if investors' management factor is primarily acquired in the target firm's (broad) sector (+) or in other sectors (-). The variables INDUSTRY$^+$ and INDUSTRY_ indicate if investors' management factor is primarily acquired in the target firm's (narrow) industry (+) or in other industries (-). All models are estimated using the same set of basic controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures the logged investment amount from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(PREMONEY)	(1)	(2)	(3)
MANAGEMENT$^+$	-0.103***		
	(0.0308)		
MANAGEMENT$^+$ · SECTOR$^-$		-0.0858***	
		(0.0332)	
MANAGEMENT$^+$ · SECTOR$^+$		-0.140***	
		(0.0410)	
MANAGEMENT$^+$ · INDUSTRY$^-$			-0.0893***
			(0.0316)
MANAGEMENT$^+$ · INDUSTRY$^+$			-0.190***
			(0.0556)
YEAR FE	+	+	+
INDUSTRY FE	+	+	+
CONTROLS DEAL	+	+	+
CONTROLS FIRM	+	+	+
CONTROLS FOUNDER	+	+	+
R^2	0.715	0.715	0.715
OBSERVATIONS	2,711	2,711	2,711

3.3 Part II. Firm Performance

This part of the analysis examines post-investment outcomes, focusing on the effects of management factor, MANAGEMENT$^+$, compared to the reference category. I specifically analyse if the same measures that predict valuation discounts are related to ex-post firm performance. I present evidence that MANAGEMENT$^+$ deals exhibit significantly higher performance in terms of survival rates, revenue growth, employment growth, and in terms of patent registrations, a frequently used measure of innovation growth. I show that the first three moderating factors identified in the previous analysis, inexperienced founders, relative distance, and founder experience, consistently amplify the positive effects on ex-post performance. I also show that congruence in HSC is consistently and progressively associated with lower ex-post performance.

The most common outcome measures used in the entrepreneurial finance literature are liquidation (failure), exit through acquisition or IPO, or achievement of milestones like subsequent funding rounds or investment from venture capital funds. These are all tangible

indicators of failure and success in settings where real returns are rarely observed, and often subject to observational bias. In keeping with the literature, I identify four binary outcomes in the data within a time-frame of five years from each investment deal; liquidation, acquisition, external funding and venture capital funding. Liquidation events are reported directly in the Central Business Register. Acquisition events are identified in the data as the entry of investors that control at least 90% equity. External funding is identified as the entry of new investors and a minimum investment of 100,000 DKK (15,000 USD). Venture capital funding is identified as the entry of private equity funds and a minimum investment of 1,000,000 DKK (150,000 USD).

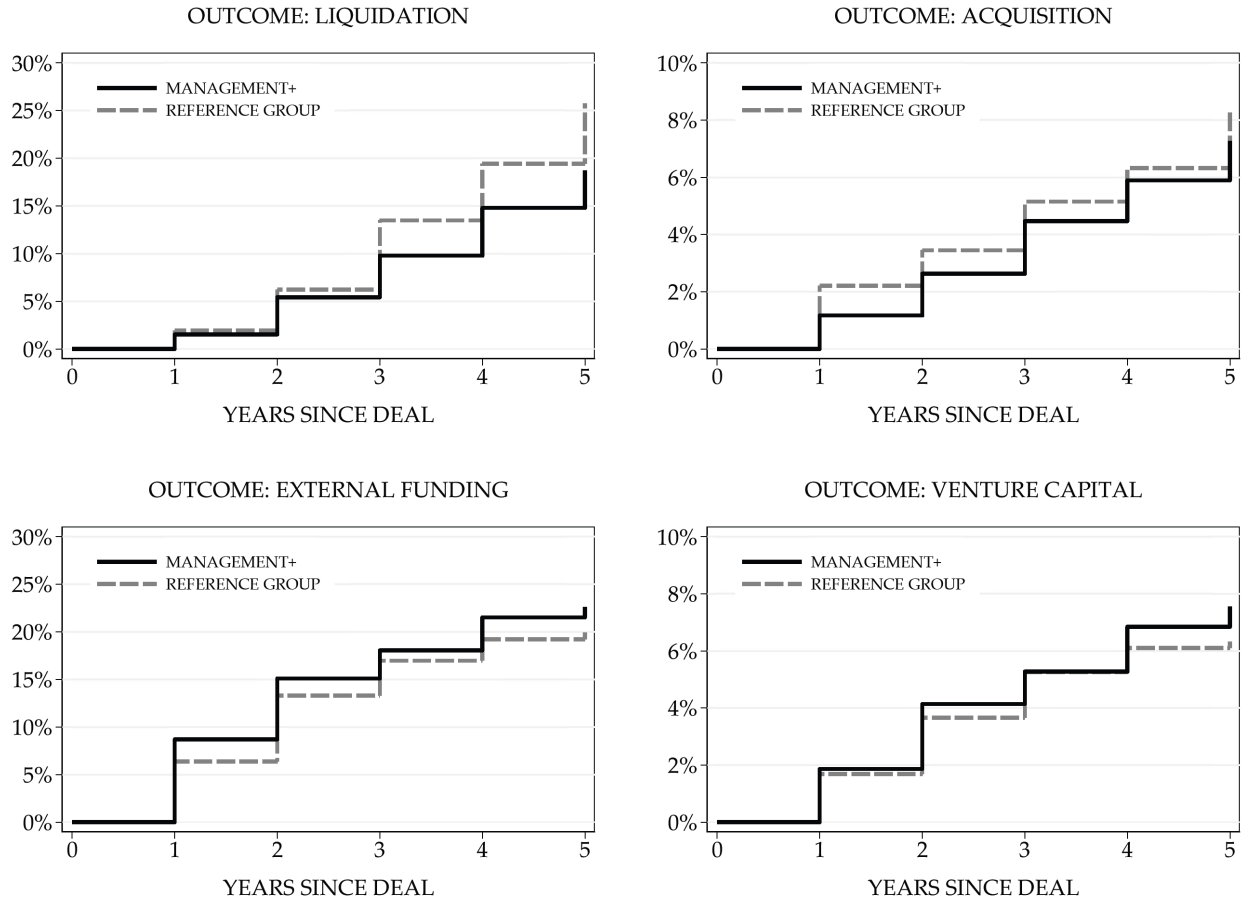
Figure 3.3 presents the incidence of these four outcomes during the first five years that proceed each deal. The results are presented in Kaplan-Maier survival diagrams that are used to illustrate differences in event rates between MANAGEMENT$^+$ and the reference category, while controlling for data censoring. The figure displays that the MANAGEMENT$^+$ category performs better during all five years in terms of survival, external funding and venture capital funding. The reference group performs better in terms of acquisitions. In the case of acquisition, external funding and venture capital funding, the differences in outcome rates are relatively small and statistically insignificant. In the case of liquidation rates, differences in outcome rates are both statistically and economically significant. After five years the MANAGEMENT$^+$ category has a failure rate of approximately 19%. Compared to the reference category (26%), this amounts to a 27% lower liquidation rate, and represents a substantial economic effect. While this analysis does not control for differences in confounders between groups, results with matched samples generally indicate similar findings, and are not reported for brevity.

Focusing on the differences in liquidation rates, I estimate hazard ratios using Cox Proportional Hazards regressions, that leverage the same basic controls from the valuation analysis, under which a higher management factor is robustly associated with valuation discounts. In these regressions I quantify the impact of MANAGEMENT$^+$ and its moderators on failure rates, while controlling for confounders.

Table 3.10 provides the main results of the analysis. Panel (1) reports hazard ratios using the full set of controls, corresponding to the valuation model. The hazard ratio of MANAGEMENT$^+$ is 0.756**, indicating that investors with higher management factor experience significantly lower propensity for failure. Panel (2) presents an interaction between the MANAGEMENT$^+$ indicator and variables pointing to inexperienced and experienced founders, FOUNDER_M$_\text{L}$ and FOUNDER_M$_\text{H}$. The hazard ratio reduces to 0.602*** in the case of inexperienced founders, whereas the effect dissipates in the case of experienced founders. Panel (4) highlights the interaction of superior factor with indicators D$_\text{L}$ and D$_\text{H}$, that indicate low and high distance in management factor between founders and investors. Both interactions show hazard ratios below one, with a more pronounced effect for the high-distance group which is lower than the baseline effect. Panel (5) examines the interaction of management factor with founder experience. The hazard ratio is only significant for the segment with high founder experience, which also stands below the baseline estimate. The

Figure 3.3. Post-investment Binary Outcomes: Failure and Success Probabilities

The figures show the results of survival analysis represented in Kaplan-Maier diagrams. The main outcome variables are liquidation (failure), acquisition, external funding and venture capital. Liquidation is defined as the dissolution of the firm's legal status, which occurs in the process of bankruptcy, or in voluntary liquidation when there are no creditor claims. Acquisition is defined as the entry of external shareholders that control more than 90% of equity at entry. External funding is defined as a subsequent investment event of at least 100,000 DKK (15,000 USD) with the entry of new external investors. Venture capital is defined as an investment event of at least 1,000,000 DKK (150,000 USD), where the majority of limited shareholders are institutions or foreign direct investors. Observations are tracked for up to five years from the time of investment deals, and any outcome information after the fifth year is censored. The Kaplan-Maier diagrams show realized outcomes over time in proportion to the number of subjects at risk in each period. The results are presented for treatment and control group respectively. The treatment group includes investment deals where investors have higher management factor than founders ($\text{MANAGEMENT}^{+} = 1$), and the control group comprises investment deals where investors have similar or lower management factor ($\text{MANAGEMENT}^{+} = 0$). The analysis is conducted with the full sample of investment deals and includes 2,714 observations (1,529 treatment, 1,185 controls).



last two panels show how hazard ratios are moderated by sector and industry similarity. The perhaps surprising results indicate lower hazard ratios in the case of no similarity, SECTOR$^-$ and INDUSTRY$^-$. Interestingly, the hazard ratio increases to above one in the case of INDUSTRY$^+$, implying a progressively negative effect of similarity in HSC on liquidation outcomes.

Overall, the results suggest that MANAGEMENT$^+$ diminishes the likelihood of liquidation, which is a positive outcome that reciprocates the previously identified management discount. The three main factors that amplify this positive effect on liquidation, inexperienced founders, relative distance, and founder experience, also echo their negative on the management discount. These findings demonstrate a robust relationship between the effects that MANAGEMENT$^+$ exerts on valuation, and on subsequent firm outcomes, suggesting that these investors generate added value for their investment targets, and obtain lower equity valuations in expectation of these effects.

The data allows for tracking of post-investment outcomes in terms of revenue and employment growth, as well as growth in patent registrations. Figure 3.4 illustrates the trajectories of revenue and employment between MANAGEMENT$^+$ deals and the reference group, where values are indexed to 100 at the time of investment, and averaged across firms and years. The indication is higher growth rates in both revenue and employment associated with higher management factor. To further quantify the effects on these outcomes, I employ OLS regressions with firm fixed effects (FE) that account for firm-level performance up to 5 years before and after investment deals. In these regressions, the dependent variables are logged revenue, logged employment, and patent registrations. I include the indicator MANAGEMENT$^+$ interacted with a post-investment indicator, denoted POST, and I include interactions with the moderators identified in the valuation analysis, which serve to examine variation in outcomes within these groups.

The results of these analyses are presented in Tables 3.11, 3.12, and 3.13. The effects observed in all three performance measures are remarkably similar and align with the positive effects of MANAGEMENT$^+$, as well as its moderators, previously identified in relation to liquidation rates. Specifically, the baseline effects on logged revenue, logged employment and patent registrations are 0.216***, 0.310***, and 0.0254**, respectively. These coefficients represent substantial economic effects, translating to approximately 20% higher revenue growth, 30% higher employment growth, as well as a 7% higher patent registration, on average. Furthermore, the effects are markedly more pronounced in all models for inexperienced founders and deals where relative distance in experience is high. The moderating effects of founder experience are also evident, showing heightened effects in the categories L and H, relative to investors with no founder experience. The most significant effects are however located in the middle group, denoted L, which indicates below-median founder index. The moderating variables that indicate sector and industry similarity, SECTOR$^+$ and INDUSTRY$^+$ are consistently related to lower performance relative to their reference categories, i.e. no similarity, and INDUSTRY$^+$ is consistently associated with lower performance than SECTOR$^+$, suggesting that similarity in HSC is progressively detrimental to investees.

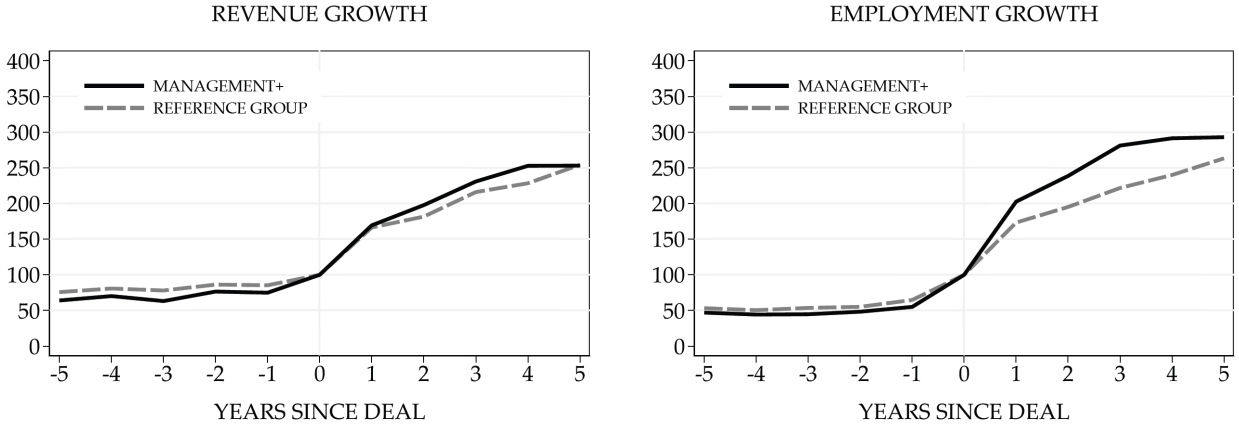
Table 3.10. Effects of Superior Management Experience and Moderators on Failures

The table presents output from Cox Proportional Hazard regressions, where the outcome variable, that indicates liquidation events, is regressed on the main explanatory variable, MANAGEMENT^{+}, interactions, and a set of controls. MANAGEMENT^{+} indicates if investors have superior factor, compared to founders. FOUNDER_M$_{L}$ and FOUNDER_M$_{H}$ indicate if founders have 'low' or 'high' management factors, respectively, where L pertains to tiers 1 and 2, and H pertains to tiers between 3 and 10. d_{L} and d_{H} indicate the relative distance in factor scores between investors and founders, where L and H indicate values below and above the sample median, respectively. INVESTOR_F$_{0}$, INVESTOR_F$_{L}$, INVESTOR_F$_{H}$ indicate the share of ownership associated with investors' management experience, where 0 indicates no ownership, and L and H indicate shares below and above the sample median, respectively. All models are estimated using the same set of basic controls. Year and industry fixed effects (FE) are included. Deal controls include the logged investment amount and its square, the financing round number (coded 1 or 2+), and an interaction term that measures the logged investment amount from previous rounds. Deal controls also include an indicator for seed stage, defined as investment during the initial year of incorporation, and an indicator for debt securities used in the transaction. Firm controls account for firm age and logged values of revenue, assets and employees. They also include the debt ratio, revenue growth rate, and indicators of positive EBIT and patent holdings. Founder controls include the main characteristics of all founders, including any informal investors from previous financing rounds. These include team size (1-5), mean age, gender, years of education, and indicators of institutional or foreign minority interests. They also include the highest values of enterprise, governance and management factors (tiers) across the founder team. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

EVENT: LIQUIDATION	(1)	(2)	(3)	(4)	(5)	(6)
MANAGEMENT^{+}	0.756**					
	(0.0841)					
MANAGEMENT^{+} · FOUNDER_M$_{L}$		0.602***				
		(0.0822)				
MANAGEMENT^{+} · FOUNDER_M$_{H}$		0.965				
		(0.131)				
MANAGEMENT^{+} · d_{L}			0.793*			
			(0.0996)			
MANAGEMENT^{+} · d_{H}			0.705***			
			(0.101)			
MANAGEMENT^{+} · INVESTOR_F$_{0}$				0.858		
				(0.159)		
MANAGEMENT^{+} · INVESTOR_F$_{L}$				0.830		
				(0.113)		
MANAGEMENT^{+} · INVESTOR_F$_{H}$				0.646***		
				(0.0965)		
MANAGEMENT^{+} · SECTOR^{-}					0.696***	
					(0.0854)	
MANAGEMENT^{+} · SECTOR^{+}					0.898	
					(0.134)	
MANAGEMENT^{+} · INDUSTRY^{-}						0.688***
						(0.0802)
MANAGEMENT^{+} · INDUSTRY^{+}						1.206
						(0.218)
YEAR FE		+	+	+	+	+
INDUSTRY FE		+	+	+	+	+
CONTROLS DEAL		+	+	+	+	+
CONTROLS FIRM		+	+	+	+	+
CONTROLS FOUNDER		+	+	+	+	+
OBSERVATIONS	2,579	2,579	2,579	2,579	2,579	2,579
OUTCOMES	385	385	385	385	385	385

Figure 3.4. Post-investment Outcomes: Growth Rates in Revenue and Employment

The figure shows the average changes in revenue and employment 5 years before and after investment deals (year = 0), in the subsets of investment deals, MANAGEMENT$^+$ = 1, and MANAGEMENT$^+$ = 0, where investors have respectively higher management factor than founders, or similar or lower factor (reference group). Employment and revenue is indexed at the time of the investment deal, and only firms with more than 0.1M DKK in revenue or 0.1 FTE are included. Firms' indices winsorized at the 5. and 95. percentiles, and averaged over each time period, where data is available. The figures do not account for industry or time differences across the sample.



In conclusion, the results show a strong and robust relationship between MANAGEMENT$^+$ and post-investment firm performance. The converging tendencies of the main effects, as well as the three moderating factors, which echo their effects on valuation discounts, substantiate the intrinsic link between investment valuation and firm performance. These findings suggest that the observed discount is related to expected value creation from the influence of investors' superior HSC, represented by the MANAGEMENT$^+$ category. It follows arithmetically that these investors generate surplus in angel markets, and also earn substantially higher returns than other investors. The finding that industry similarity commands progressively larger valuation discounts, while being related to consistently worse outcomes, are indicative of inefficiencies or systematically lower firm quality related to these investments, that warrant additional exploration.

Table 3.11. Effects of Management Factor and Moderators on Revenue Growth

The table presents output from OLS regressions with firm fixed effects (FE), where the dependent variable log(revenue), is regressed on a post-investment period indicator (post), and its interaction with the main explanatory variable, MANAGEMENT^{+}, interactions, and a set of controls. The time period used in the estimation spans up to 5 years before and 5 years after investment deals, and all firms in the main sample are included. MANAGEMENT^{+} indicates if investors have superior factor, compared to founders. FOUNDER_M$_{L}$ and FOUNDER_M$_{H}$ indicate if founders have 'low' or 'high' management factors, respectively, where L pertains to tiers 1 and 2, and H pertains to tiers between 3 and 10. d$_{L}$ and d$_{H}$ indicate the relative distance in factor scores between investors and founders, where L and H indicate values below and above the sample median, respectively. INVESTOR_F$_{0}$, INVESTOR_F$_{L}$, INVESTOR_F$_{H}$ indicate the share of ownership associated with investors' management experience, where 0 indicates no ownership, and L and H indicate shares below and above the sample median, respectively. All models are estimated with firm and year FE. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(REVENUE)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
P (POST)	0.140***	0.0192	0.0134	0.0182	0.0187	0.0189	0.0198
	(0.0323)	(0.0389)	(0.0389)	(0.0389)	(0.0389)	(0.0389)	(0.0389)
P · MANAGEMENT^{+}		0.217***					
		(0.0388)					
P · MANAGEMENT^{+} · FOUNDER_M$_{L}$			0.314***				
			(0.0445)				
P · MANAGEMENT^{+} · FOUNDER_M$_{H}$			0.0788				
			(0.0497)				
P · MANAGEMENT^{+} · D$_{L}$				0.182***			
				(0.0459)			
P · MANAGEMENT^{+} · D$_{H}$				0.256***			
				(0.0475)			
P · MANAGEMENT^{+} · INVESTOR_F$_{0}$					0.129*		
					(0.0703)		
P · MANAGEMENT^{+} · INVESTOR_F$_{L}$					0.325***		
					(0.0496)		
P · MANAGEMENT^{+} · INVESTOR_F$_{H}$					0.145***		
					(0.0492)		
P · MANAGEMENT^{+} · SECTOR^{-}						0.251***	
						(0.0426)	
P · MANAGEMENT^{+} · SECTOR^{+}						0.141***	
						(0.0546)	
P · MANAGEMENT^{+} · INDUSTRY^{-}							0.238***
							(0.0401)
P · MANAGEMENT^{+} · INDUSTRY^{+}							0.0724
							(0.0781)
YEAR FE	+	+	+	+	+	+	+
FIRM FE	+	+	+	+	+	+	+
R^2	0.099	0.101	0.102	0.101	0.101	0.101	0.101
OBSERVATIONS	18,137	18,137	18,137	18,137	18,137	18,137	18,137
PANELS	2,711	2,711	2,711	2,711	2,711	2,711	2,711

Table 3.12. Effects of Management Factor and Moderators on Employment Growth

The table presents output from OLS regressions with firm fixed effects (FE), where the dependent variable log(employment), is regressed on a post-investment period indicator (post), and its interaction with the main explanatory variable, MANAGEMENT^{+}, interactions, and a set of controls. The time period used in the estimation spans up to 5 years before and 5 years after investment deals, and all firms in the main sample are included. MANAGEMENT^{+} indicates if investors have superior factor, compared to founders. FOUNDER_M$_{L}$ and FOUNDER_M$_{H}$ indicate if founders have 'low' or 'high' management factors, respectively, where L pertains to tiers 1 and 2, and H pertains to tiers between 3 and 10. d_{L} and d_{H} indicate the relative distance in factor scores between investors and founders, where L and H indicate values below and above the sample median, respectively. INVESTOR_F$_{0}$, INVESTOR_F$_{L}$, INVESTOR_F$_{H}$ indicate the share of ownership associated with investors' management experience, where 0 indicates no ownership, and L and H indicate shares below and above the sample median, respectively. All models are estimated with firm and year FE. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

LOG(EMPLOYMENT)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
P (POST)	0.213***	0.0391	0.0341	0.0376	0.0386	0.0387	0.0399
	(0.0315)	(0.0378)	(0.0378)	(0.0378)	(0.0378)	(0.0378)	(0.0378)
P · MANAGEMENT^{+}		0.311***					
		(0.0377)					
P · MANAGEMENT^{+} · FOUNDER_M$_{L}$			0.393***				
			(0.0433)				
P · MANAGEMENT^{+} · FOUNDER_M$_{H}$			0.192***				
			(0.0483)				
P · MANAGEMENT^{+} · D_{L}				0.259***			
				(0.0446)			
P · MANAGEMENT^{+} · D_{H}				0.368***			
				(0.0462)			
P · MANAGEMENT^{+} · INVESTOR_F$_{0}$					0.232***		
					(0.0684)		
P · MANAGEMENT^{+} · INVESTOR_F$_{L}$					0.423***		
					(0.0482)		
P · MANAGEMENT^{+} · INVESTOR_F$_{H}$					0.232***		
					(0.0478)		
P · MANAGEMENT^{+} · SECTOR^{-}						0.360***	
						(0.0414)	
P · MANAGEMENT^{+} · SECTOR^{+}						0.202***	
						(0.0531)	
P · MANAGEMENT^{+} · INDUSTRY^{-}							0.338***
							(0.0389)
P · MANAGEMENT^{+} · INDUSTRY^{+}							0.124
							(0.0760)
YEAR FE	+	+	+	+	+	+	+
FIRM FE	+	+	+	+	+	+	+
R^{2}	0.131	0.135	0.135	0.135	0.135	0.135	0.135
OBSERVATIONS	18,137	18,137	18,137	18,137	18,137	18,137	18,137
PANELS	2,711	2,711	2,711	2,711	2,711	2,711	2,711

Table 3.13. Effects of Management Factor and Moderators on Patent Registration

The table presents output from OLS regressions with firm fixed effects (FE), where the dependent variable, patents, is regressed on a post-investment period indicator (post), and its interaction with the main explanatory variable, MANAGEMENT^{+}, interactions, and a set of controls. The time period used in the estimation spans up to 5 years before and 5 years after investment deals, and all firms in the main sample are included. MANAGEMENT^{+} indicates if investors have superior factor, compared to founders. FOUNDER_M$_{L}$ and FOUNDER_M$_{H}$ indicate if founders have 'low' or 'high' management factors, respectively, where L pertains to tiers 1 and 2, and H pertains to tiers between 3 and 10. d$_{L}$ and d$_{H}$ indicate the relative distance in factor scores between investors and founders, where L and H indicate values below and above the sample median, respectively. INVESTOR_F$_{0}$, INVESTOR_F$_{L}$, INVESTOR_F$_{H}$ indicate the share of ownership associated with investors' management experience, where 0 indicates no ownership, and L and H indicate shares below and above the sample median, respectively. All models are estimated with firm and year FE. (*), (**) and (***) indicate statistical significance at the 10%, 5% and 1% level, respectively.

PATENTS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
P (POST)	0.00337	-0.00922	-0.00903	-0.0101	-0.00942	-0.00936	-0.00889
	(0.00991)	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0119)
P · MANAGEMENT^{+}		0.0225*					
		(0.0119)					
P · MANAGEMENT^{+} · FOUNDER_M$_{L}$			0.0194				
			(0.0137)				
P · MANAGEMENT^{+} · FOUNDER_M$_{H}$			0.0271*				
			(0.0153)				
P · MANAGEMENT^{+} · D$_{L}$				-0.00714			
				(0.0141)			
P · MANAGEMENT^{+} · D$_{H}$				0.0557***			
				(0.0146)			
P · MANAGEMENT^{+} · INVESTOR_F$_{0}$					-0.0175		
					(0.0216)		
P · MANAGEMENT^{+} · INVESTOR_F$_{L}$					0.0668***		
					(0.0152)		
P · MANAGEMENT^{+} · INVESTOR_F$_{H}$					-0.00507		
					(0.0151)		
P · MANAGEMENT^{+} · SECTOR^{-}						0.0426***	
						(0.0131)	
P · MANAGEMENT^{+} · SECTOR^{+}						-0.0216	
						(0.0168)	
P · MANAGEMENT^{+} · INDUSTRY^{-}							0.0338***
							(0.0123)
P · MANAGEMENT^{+} · INDUSTRY^{+}							-0.0542**
							(0.0240)
YEAR FE	+	+	+	+	+	+	+
FIRM FE	+	+	+	+	+	+	+
R^2	0.131	0.135	0.135	0.135	0.135	0.135	0.135
OBSERVATIONS	18,137	18,137	18,137	18,137	18,137	18,137	18,137
PANELS	2,711	2,711	2,711	2,711	2,711	2,711	2,711

4 Conclusion

I investigate the role of investors' executive experience in angel markets. I use comprehensive data on shareholders, CEOs, directors, employees and family relations in private corporations, to identify the population of angel investors in Denmark. I analyse a sample containing 2,711 unique investment deals, and comprehensive data on firms, founders, investors, and deal transactions. I find that angel investors with higher management experience, relative to founders, obtain equity at significantly lower valuation, 10% on average, and 40% when relative experience is high. Higher governance experience, related to previous director or investor activities, however, does not affect valuations. The management discount is amplified when founders have low experience, and when angel investors' experience is acquired in founder roles, or within the industry of the target firm. I test the effects of management experience on post-investment outcomes, and find that the management discount is reciprocated in higher ex-post survival, growth and innovation rates, suggesting that management experience generates surplus in angel markets, and commands a premium at the time of investment. The three main channels that amplify valuation discounts also amplify the positive effects of management experience on firm outcomes, which serves to establish the robustness of the main results. Overall, the results suggest that the human and social capital of investors' with higher management experience is valuable in angel markets. The findings provide an explanation for the disproportionate entry of experienced executives into angel markets. These findings also suggests that investment policies that aim to maximise socioeconomic welfare, might be more effective if targeted at investors with demonstrated management experience.

5 Appendix

Table 3.14. Principal Components: Eigenvalues, Explained Variance and Loadings

This table presents the principal component analysis (PCA) results for the experience categories ENTERPRISE, GOVERNANCE, and MANAGEMENT. The variables firm employment (mean) and (peak) denotes the average and maximum employment per firm (measured in FTEs). Total employment (mean) and (peak) denotes average and maximum employment across multiple firms within a reference year. All measures are computed using the records available since 1995. The reported eigenvalues reflect the total variance captured by the respective principal component. A higher eigenvalue indicates greater explanatory power. The proportion of variance explained designates the share of total variation explained by the principal component relative to the input data.

PCA MODEL	ENTERPRISE	GOVERNANCE	MANAGEMENT
FIRM EMPLOYMENT (PEAK)	0.942	0.925	0.988
FIRM EMPLOYMENT (MEAN)	0.848	0.831	0.959
FIRM EMPLOYMENT (MEAN) · FIRM EMPLOYMENT (PEAK)	0.892	0.875	0.942
TOTAL EMPLOYMENT (PEAK)	0.943	0.934	0.972
TOTAL EMPLOYMENT (MEAN)	0.959	0.953	0.972
TOTAL EMPLOYMENT (MEAN) · TOTAL EMPLOYMENT (PEAK)	0.890	0.888	0.953
EIGENVALUE	5.00	4.88	5.55
VARIANCE EXPLAINED	0.83	0.81	0.92

Table 3.15. Paired Significance of Enterprise, Governance and Management Factors

The table presents OLS regression results, with dependent variable Ln(PREMV), that measures logged premoney valuation of investment deals, regressed on explanatory variables ENTERPRISE$^+$, GOVERNANCE$^+$ and MANAGEMENT$^+$, that indicate if investors are superior in each respective factor and a set of controls. Year and industry fixed effects (FE) are included in all models. Deal controls include the logged investment amount and its square, and the financing round (coded 1, 2, 3+), and an interaction term that measures previous investment in the case of later rounds. They also include an indicator for post-seed stage (with reference category seed stage), and whether the transaction includes debt conversion. Firm controls account for firm age and logged values of revenue, assets and employees. They also include debt-to-assets ratio, revenue growth rate, and it's interaction with firm revenue, an indicator of positive earnings (EBIT), and it's interaction with ROA, as well as indicators for patent holdings and firms with zero assets. Team controls include the main characteristics of all founders, including informal investors from previous financing rounds. These include team size, mean age, gender distribution, education, and indicators of foreign or institutional minority shares,, and they include the founder team's enterprise, governance and management factors, respectively. The last two models include firm fixed effects (FE) and investor fixed effects (FE).

LOG(PREMV)	(1)	(2)	(3)	(4)	(5)	(6)
ENTERPRISE$^+$	-0.0604	-0.0186		0.0132	0.0534	0.170
	(0.0389)	(0.0465)		(0.0528)	(0.124)	(0.131)
GOVERNANCE$^+$	-0.0414		-0.0423	-0.0466	0.0403	0.118
	(0.0365)		(0.0322)	(0.0366)	(0.0956)	(0.106)
MANAGEMENT$^+$		-0.0895**	-0.858**	-0.0935**	-0.251**	-0.250**
		(0.0454)	(0.0334)	(0.0454)	(0.110)	(0.124)
YEAR FE	+	+	+	+	+	+
INDUSTRY FE	+	+	+	+	+	+
CONTROLS DEAL	+	+	+	+	+	+
CONTROLS FIRM	+	+	+	+	+	+
CONTROLS FOUNDER	+	+	+	+	+	+
FIRM FE					+	
INVESTOR FE						+
R^2	0.714	0.714	0.715	0.715	0.677	0.728
OBSERVATIONS	2,711	2,711	2,711	2,711	2,711	2,711
PANELS					2,414	2,216

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