Risky Entrepreneurship and Wealth

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Abstract

This paper studies the relationship between entrepreneurial risk-taking and wealth. I use the Kauffman Firm Survey to document facts about the risks new entrepreneurs take and the sources of their initial financing. Based on these facts, I build a model of occupational choice, where agents choose to become workers or entrepreneurs, and endogenous risk choice, where entrepreneurs choose from a menu of risky projects, with riskier projects earning higher expected returns. The model features two frictions. First, a missing market for entrepreneurial risk that prevents entrepreneurs from insuring themselves against entrepreneurial income risk and the risk of business failure. Second, borrowing constraints that prevent entrepreneurs from investing in a capital stock larger than a certain multiple of their personal net worth. As a consequence of both of these frictions, agents select into entrepreneurship based on their entrepreneurial ability and their personal wealth. I calibrate the model to match the firm dynamics of new privately held US firms and use it to measure the quantitative importance of these two frictions in generating the observed relationship between wealth and entrepreneurship. Removing either friction increases output, productivity, and wages in the economy, and removing both reveals important interaction effects. I then examine how the endogenous choice of risk can help explain the high concentration of wealth we observe in the US.

Keywords: Entrepreneurship, Risk-Taking, Financial Frictions, Aggregate Productivity, Wealth Inequality

JEL Codes: D31, G32, J24, L26

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1 Introduction

Entrepreneurs are disproportionately important for the distributions of income and wealth. In the Survey of Consumer Finances (2004), 11% of households contain at least one entrepreneur, defined as someone who both owns and actively manages a business. These households earn 25% of aggregate income and own 40% of aggregate wealth. Despite their high levels of income and wealth, entrepreneurs in the US receive favourable tax treatment and direct government support in the form of loans and grants. For example, in 2017 the US Small Business Administration, a US Federal Government agency, had an outstanding loan portfolio to small and medium sized businesses of more than $131 billion dollars (US Small Business Administration, 2017). Why does the US government give favourable tax treatment and direct government support to those who are already wealthy? Presumably, these benefits are conferred on entrepreneurs in order to both encourage individuals to become entrepreneurs and to encourage existing entrepreneurs to increase their investments. Understanding precisely why individuals become entrepreneurs and their incentives to invest thus is vital for the design of public policy.

In this paper, I study how entrepreneurial risk impacts the relationship between entrepreneurship and wealth. It is well known that entrepreneurship is risky. Many new businesses fail (Decker et al., 2016) and entrepreneurial income is far more volatile than labour income (DeBacker et al., 2018). Given the risks involved, wealthier people may be more likely to start a business if they are better able to smooth their consumption when a business fails or when entrepreneurial income is particularly low. By contrast, if a poor entrepreneur's business fails, or if they earn low income, their consumption may have to be greatly curtailed. These considerations mean that when two equally able individuals are deciding whether to become entrepreneurs, and becoming an entrepreneur is associated with a great deal of risk, the wealthier individual should be more likely to become an entrepreneur. Of course, at the same time, financial constraints on the amount entrepreneurs can borrow may also make wealthier individuals more likely to start a business. If wealth poor individuals cannot afford to pay initial fixed costs or cannot rent a sufficient amount of capital, wealthier individuals should again be more likely to become entrepreneurs, even conditional on ability.

Using the confidential version of the Kauffman Firm Survey (KFS), a panel of 4,928 new US firms, I document facts about the risks new entrepreneurs face and how they fund their businesses. Motivated by these facts, I then build a quantitative model where agents choose whether to become entrepreneurs or worker, and conditional on being an entrepreneur choose from a menu of project types. These types differ in the level of risk and reward they offer. The model has two key frictions, a missing market for entrepreneurial risk and borrowing constraints. I use this model to quantify the relative importance of these two frictions in explaining the relationship between wealth and entrepreneurship. I also study the extent to which the endogenous choice of risk can help explain the high concentration of wealth at the top of the distribution.

In the Kauffman Firm Survey data, I show that firm exit is common across industries and for both high-investment and low-investment firms. Exit is disproportionately driven by firms that earn cumulative negative profits over the sample period. This suggests that idiosyncratic risk is an essential feature of entrepreneurship. These unsuccessful entrepreneurs experience real financial losses both from irreversible financial investments and from forgone labour earnings. The combination of uncertainty about entrepreneurial success and these real losses motivate studying entrepreneurship as a risky gamble. About half of the entrepreneurs raise some debt, mostly in the form of personal loans rather than business loans.

Motivated by these facts, I build a model of occupational selection and endogenous risk choice. Agents are endowed with two types of skill, entrepreneurial and worker. Each period, they choose to be entrepreneurs or workers, and conditional on being an entrepreneur choose how risky a business to operate. Higher risk businesses earn higher rewards in expectation. Two frictions prevent the efficient selection of agents, based solely on relative ability, into entrepreneurship.First, a missing market for entrepreneurial risk prevents entrepreneurs from insuring the substantial income risk and capital investment risk they face. Second, financial frictions, in the form of a collateral constraint, limit the amount of capital an entrepreneur can invest in. Wealth helps agents overcome both frictions, because wealthier agents are better able to self-insure themselves against fluctuations in entrepreneurial income, and at the same time are able to invest in a larger capital stock. As a consequence, selection into entrepreneurship is based on both ability and wealth.

Using the model, I measure the quantitative importance of these two frictions in generating the strong relationship between entrepreneurship and wealth observed in the data. I calibrate this model to match moments about new firms in the Kauffman Firm Survey. Within the calibrated model, I first shut down the effects of the missing market for entrepreneurial risk on selection intro entrepreneurship by considering the case where all agents are risk-neutral. Second, I relax the borrowing constraint by allowing entrepreneurs to invest in any amount of capital regardless of their wealth. Finally, I shut down both frictions and compare the resulting equilibria. Removing either friction raises output, wages, and productivity in the economy. Removing both has a much larger impact than either of them in isolation, suggesting the interaction of the two frictions is strong.

The endogenous choice of risk within the model also has implications for the cross-sectional distribution of wealth. Since entrepreneurs endogenously choose their business type, higher wealth agents choose higher risk projects. As a consequence, wealthy entrepreneurs earn higher returns on average than wealth poor entrepreneurs. These higher returns increase the concentration of wealth at the top right tail. I quantify the contribution of endogenous risk choice to generating dispersion in wealth by contrasting the benchmark economy, with an endogenous choice of project type, to an exogenous risk economy, where projects are randomly allocated to entrepreneurs.

Related Literature

There is a large literature studying the decision to become an entrepreneur. Since at least Evans and Jovanovic (1989), much of the literature has focused on the importance of personal wealth in overcoming borrowing constraints. If financial frictions prevent wealth-poor individuals from borrowing, they will be unable to pay fixed set up costs or invest in a large capital stock. This will discourage or prevent them from entering entrepreneurship. Empirically, it is well known that entrepreneurship is highly correlated with wealth. For example, Gentry and Hubbard (2004) show that in the Survey of Consumer Finances, entrepreneurial households hold a disproportionate amount of wealth and that their wealth-to-income ratios are significantly higher than non-entrepreneurial households. Hurst and Lusardi (2004) present a more mixed picture. They document that in the Panel Study of Income Dynamics (PSID), the probability of selecting into entrepreneurship is only increasing in wealth for the top 5% of the wealth distribution. They find that both prior and future bequests predict individuals becoming entrepreneurs, suggesting this relationship between wealth and entrepreneurship is not solely driven by liquidity constraints.

An alternative mechanism that determines entrepreneurial selection, originally proposed by Kihlstrom and Laffont (1979), is uninsurable entrepreneurial risk. In their model, heterogeneity in risk-aversion drives more risk-averse individuals to be workers while more risk-tolerant individuals become entrepreneurs. Cressy (2000) argues that this uninsurable entrepreneurial risk can also generate a relationship between wealth and entrepreneurship. As long as agents' preferences exhibit decreasing absolute relative risk aversion, wealthier individuals will be more likely to take on a risky entrepreneurial venture. When entrepreneurial income is low, wealth-poor individuals may have to substantially curtail income, leading to large losses in utility, while wealthy entrepreneurs will be better able to self-insure their consumption using their wealth.

There is certainty substantial evidence that entrepreneurs face a high degree of idiosyncratic risk. Decker et al. (2016) calculate that US firm exit rates are consistently 8%-10% per year. Even conditional on survival, DeBacker et al. (2018) document that entrepreneurial income volatility is substantially higher than employment income using IRS data. While both exit and entrepreneurial income volatility may be correlated with the business cycle, much of this risk is idiosyncratic. Studying US manufacturing firms, Castro et al. (2015) shows that 80% of unexplained revenue TFP volatility is due to idiosyncratic shocks rather than aggregate shocks. A large and growing empirical literature finds that social programs that provides some insurance against some of the risks entrepreneurs faces can significantly increase the number of people who become entrepreneurs. Examples include Bianchi and Bobba (2013),Hombert et al. (2014) , Olds (2016), and Gottlieb et al. (2018).

The first contribution of this paper is to estimate the degree to which both borrowing constraints and the missing market for entrepreneurial risk each induce selection into entrepreneurship based on wealth. To do so, I build upon Cagetti and De Nardi (2006). Like in their model, agents have two types of ability, worker and entrepreneurial, and make an occupational choice decision in each period. Unlike in their model, the occupational choice in this paper is risky. While both types of ability are partially persistent, agents must choose their current period's occupation before knowing the realization of their abilities. Since entrepreneurial income is riskier than labour income, the occupational choice here involves not just the chose between the level of income but also the variance. In addition, a one-time fixed set up cost of starting a business makes the initial decision to become an entrepreneur introduces an element of capital risk. If the business is successful for many periods, the fixed cost is worth paying, if the business turns out to be unsuccessful, the loss of that wealth will be felt acutely.

One natural consequence of borrowing constraints is the misallocation of talent. Buera (2009) shows that financial frictions induces low-ability wealthy individuals to become entrepreneurs at the expense of high-ability poor individuals. This misallocation in talent can substantially reduce aggregate productivity. While people may be able to save out of these constraints over time, Moll (2014) finds that the short run transition dynamics can still be important. Papers such as Buera and Shin (2011), Midrigan and Xu (2014), and Castro and Ševčík (2017) provide evidence that financial frictions can have large impacts on aggregate productivity and help explain large cross-country differences in TFP.

The second contribution of this paper is then to document how the missing market for entrepreneurial risk can also reduce aggregate productivity. It does so through two channels. First, like borrowing constraints, the missing market for entrepreneurial risk distorts occupational choice decisions. Second, since higher-risk higher-reward projects have higher expected productivity, there are aggregate productivity losses from entrepreneurs choosing lower-risk lower-reward projects.

By studying this endogenous choice of entrepreneurial risk, this paper is also related to a number of papers on how entrepreneurs choose risk. A closely related paper is Choi (2017). He uses US Census Bureau data to show that individuals who had higher paying jobs prior to starting a business take larger risks, as measured by higher exit rates, more dispersion in growth, and faster average growth conditional on survival. Relative to his contribution this paper considers how wealth, rather than labour market opportunities, encourages more risk taking by entrepreneurs. Vereshchagina and Hopenhayn (2009) study a similar question, looking at how wealth impacts both the choice to become an entrepreneur and the endogenous choice of risk. In their three period model, wealth-poor entrepreneurs take larger risks in the hopes of being able to be entrepreneurs in the future. This result contrasts with the results in this paper, where wealthier individuals choose larger risks.

Panousi and Papanikolaou (2012) study risk taking in publicly traded firms. Using Compustat data, they document that firm investment falls as firm-specific risk rises and that this effect is stronger when managers own more of the firm. Their result provides micro evidence that aversion to firm-specific risk shifts investment decisions. By contrast, this paper considers how entrepreneurs choose what type of business to start, when given a choice between different risk-reward types. This channel is likely to be more important for private firms, which are the focus of this paper. More broadly, Gabler and Poschke (2013) also considers how less risk-taking leads to aggregate productivity losses. The mechanisms however differ, as they consider a framework with risk-neutral firms facing distortions to allocative efficiency, while I consider risk-averse entrepreneurs facing a missing market for entrepreneurial risk.

Finally, this paper is also related to a literature that aims to explain the cross-sectional distribution of wealth observed in the data. Quadrini (1999) argues that financial frictions give rise to strong savings motives for entrepreneurs. Cagetti and De Nardi (2006) show that a model of entrepreneurship with both endogenous borrowing constraints and a strong bequest motive can well approximate the observed distribution of wealth. More recently, empirical evidence from Scandinavian countries, Bach et al. (2018) and Fagereng et al. (2018), show that wealthier individuals earn persistently higher rates of return on their assets. This paper contributes to this literature by considering a model with both borrowing constraints and rate of return heterogeneity. Specifically, the endogenous choice of risk means that wealthier individuals choose the higher-risk higher reward project and so on average earn higher returns than wealth-poor entrepreneurs. The third contribution of this paper is to examine how much additional wealth concentration this mechanism can generate.

In section 2, I illustrate the two key mechanisms, a missing market for entrepreneurial risk and borrowing constraints in a simple two-period model. Section 3 provides some descriptive evidence on the importance of these mechanisms using data from the Kauffman Firm Survey. Motivated by these facts, I extend the two-period model into a perpetual youth model in section 4. I explain the calibration strategy for this model in section 5 and report the results of the quantitative analysis in section 6. Section 7 concludes.

2 Two Period Model

In this section, I construct a simple two-period model to illustrate the key mechanisms explored in this paper.

2.1 Environment

Agents live for two periods and have Epstein-Zin preferences over consumption in the two periods, given by:

$$U = \frac{c_1^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} + \beta \frac{\left(\mathbb{E}\left[c_2^{1-\sigma}\right]\right)^{\frac{1-\frac{1}{\theta}}{1-\sigma}}}{1-\frac{1}{\theta}} \tag{1}$$

where $\theta > 0$ is the elasticity of intertemporal substitution and $\sigma > 0$ is the coefficient of relative risk aversion.

At the start of the first period, agents have an endowment of initial wealth $(e) \in [0, \infty)$ and a known entrepreneurial ability $z \in [\underline{z}, \bar{z}]$. Based on these initial states, each agent must choose to be a worker or an entrepreneur and make a consumption savings decision. In the second period, entrepreneurs produce after hiring labour.

All agents have identical productivity as a worker. If an agent chooses to be a worker, they will earn a wage of w with certainty in the second period.

Agents that choose to be an entrepreneur must choose a risky project type $x \in \{x_1, x_2, ..., x_{n_x}\}$. Higher project types deliver higher expected productivity, but at the cost of more disperse productivity. With probability p, the entrepreneur's risk succeeds, and their productivity is boosted by ψx. With the complementary probability the risk fails and their productivity is cut by x. In the second period entrepreneur's realized productivity is given by $\tilde{z}$:

$$\tilde{z} = \begin{cases} z + \psi x & \text{with probability} \quad p \\ z - x & \text{with probability} \quad 1-p \end{cases} \tag{2}$$

where $\psi > \frac{1-p}{p}$, so that the expected value of $\tilde{z}$ increases with x.

There are two assets, capital (k) and a risk-free financial asset (a). Any agent can save in the risk-free financial asset, while only agents who choose to be entrepreneurs can invest in capital. Workers can only save in the financial asset. Entrepreneurs can save or borrow in the financial asset by pledging capital as collateral according to:

$$-a \leq \phi k \tag{3}$$

Note how when $\phi = 1$, the collateral constraint does not bind, and entrepreneurs can invest in any amount of capital regardless of their savings.

In the second period, entrepreneurs who have a realized productivity of $\tilde{z}$ and have invested in capital k will hire labour n and produce output according to:

$$y = \tilde{z}^{1-\gamma}(k^{\alpha}n^{1-\alpha})^{\gamma} \tag{4}$$

2.2 Agent's Problems

Depending on their initial endowments of wealth (e) and entrepreneurial productivity (z), agents make an occupational choice decision between being workers and entrepreneurs according to:

$$V_1(z,e) = \max\{V_1^E(z,e), V_1^W(e)\} \tag{5}$$

Worker's Problem

Based on their initial endowment of wealth (e), workers make a simple consumption-savings decision between two periods. They face no uncertainty, as they will earn w with certainty in the second period.

$$V_1^W(e) = \max_{c_1,a} \frac{c_1^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} + \beta\left[\mathbb{E}\left(V_2^W(a)^{\frac{1-\sigma}{1-\frac{1}{\theta}}}\right)\right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}} \tag{6}$$

s.t.

$$c_1 + a = e$$

In the second period, workers consume all of their resources.

$$V_2^W(a) = \frac{c_2^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} \tag{7}$$

where

$$c_2 = a(1+r) + w$$

Entrepreneur's Problem

Based on their initial endowment of wealth (e, z), entrepreneurs choose how much to consume today (c_1), how risky a business to start $x \in \{x_1, x_2, ..., x_{n_x}\}$, the amount of capital to invest in (k), and the amount of financial asset (a) to borrow or save.

$$V_1^E(e) = \max_{c_1,x,k,a} \frac{c_1^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} + \beta\left[\mathbb{E}\left(V_2^E(\tilde{z},k,a)^{\frac{1-\sigma}{1-\frac{1}{\theta}}}\right)\right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}}$$

s.t.

$$
\begin{aligned}
c_1 + a + k &= e \\
-a &\leq \phi k \\
\tilde{z} &= \begin{cases} z + \psi x & \text{with probability} \quad p \\ z - x & \text{with probability} \quad 1-p \end{cases}
\end{aligned}
$$

where $\psi > \frac{1-p}{p}$ and $\phi \in [0, 1]$.

In the second period, the entrepreneur chooses how much labour to hire after the realization of the shock to their productivity:

$$V_2^E(\tilde{z}, k, a) = \max_n \frac{c_2^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}}$$

s.t.

$$c_2 = \tilde{z}^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma - wn + (1-\delta)k + a(1+r)$$

2.3 Model Predictions

Prediction 1: Risk means agents will select into entrepreneurship based on both ability and wealth

When there are no borrowing constraints ($\phi = 1$), both entrepreneurial ability and wealth increase the value of becoming an entrepreneur relative to a worker. Higher entrepreneurial ability z strictly increases realized productivity $\tilde{z}$ and so increases the income agents will receive if they are entrepreneurs. Wealth increases the value of entrepreneurship because of the risky nature of entrepreneurship. If their entrepreneurial risk fails, entrepreneurs earn less than when their risk succeeds. For wealthy individuals, this loss of earnings may not make a big difference, as their consumption is primarily determined by their wealth. By contrast, wealth-poor individuals consume mainly out of their income. Since agents are risk averse, even if the expected entrepreneurial income is higher than income as a worker, wealth-poor agents choose to be workers because the loss of utility in the unsuccessful low-consumption state is enough to outweigh the higher utility in the successful high-consumption state.

Figure 1 shows selection in the model with no borrowing constraints ($\phi = 1$). This pattern of selection misallocates some entrepreneurial talent. Output would strictly increase if some of the high-wealth low-ability entrepreneurs would switch occupations with the low-wealth high-entrepreneurial-ability workers.

Prediction 2: Wealthier agents choose higher risk projects

Figure 1: Occupational selection by entrepreneurial ability z and endowed wealth e

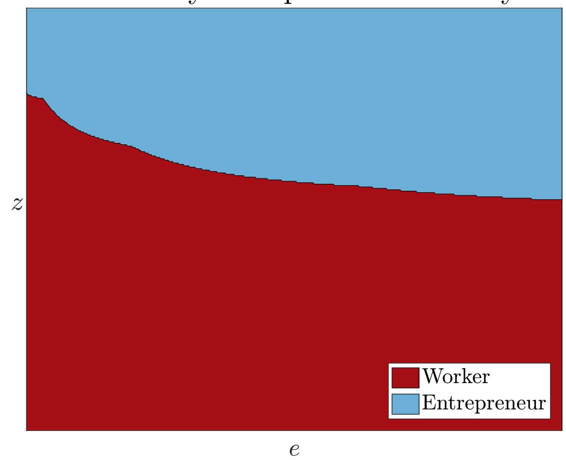
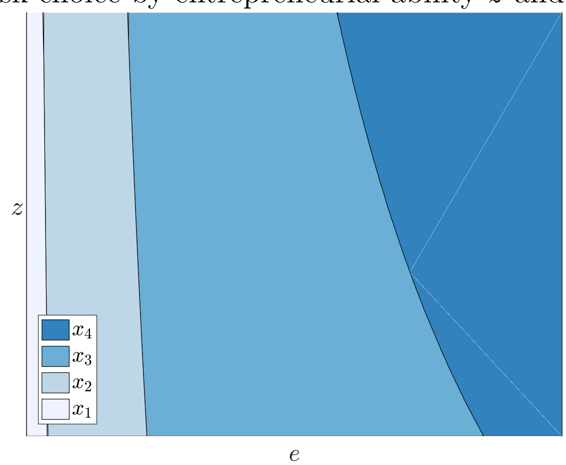


Figure 2: Endogenous risk choice by entrepreneurial ability z and initial endowed wealth e

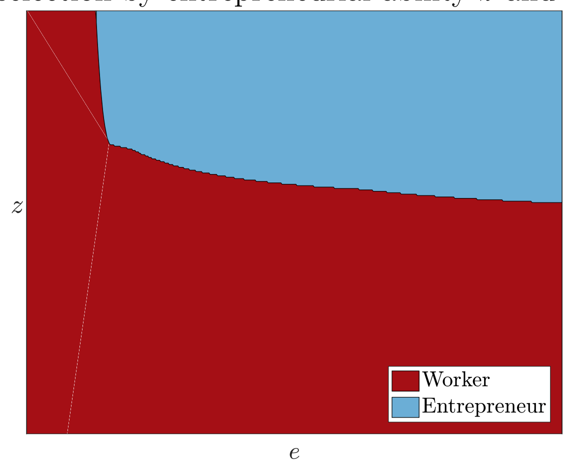


The consumption of wealthy agents is primarily determined by their initial endowments of wealth. They are willing to take large risks because even when their entrepreneurial risk is unsuccessful, their consumption is high and so the difference in marginal utility of income between the good and bad state is small. As a consequence, they choose higher risk projects with higher expected productivity than wealth-poor agents.

Prediction 3: Borrowing constraints increase the selection into entrepreneurship on wealth

Imposing a borrowing constraint ($\phi < 1$) limits the amount of capital entrepreneurs can invest in based on their initial endowment of wealth. If entrepreneurs cannot invest in sufficient capital to operate at their optimal scale, this will lower their entrepreneurial income regardless of the success of the business. As figure 3 shows, more high ability agents with little wealth choose to become workers. Despite their high ability, the restriction on their size limits their entrepreneurial income so much that they would prefer to be workers.

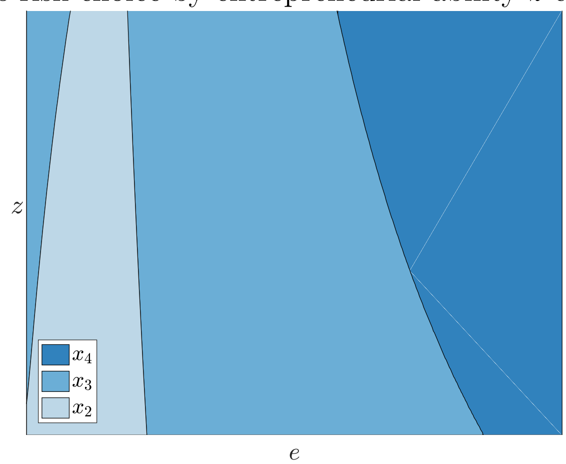
Figure 3: Occupational selection by entrepreneurial ability z and initial endowed wealth e.



Prediction 4: Borrowing constraints distort the endogenous choice of risk

Borrowing constraints ($\phi < 1$) alter entrepreneur's incentive for taking risks. As borrowing constraints limit their income, entrepreneurs respond by choosing a higher level of endogenous risk x than they would if they were unconstrained. This happens because the risks of a higher x and a larger scale are substitutes. Higher x increases the entrepreneur's income in the good state and reduces it in the bad state. Conditional on the amount saved, the amount invested in k (and therefore the amount borrowed in a) increases the entrepreneur's income in the good state and reduces net income (profits minus debt repayment) in the bad state. In the two period model, this leads to an increase in endogenous risk for the constrained individuals relative to the case where they were unconstrained. In the full perpetual youth model in 4, the impact of borrowing constraints on the endogenous choice of risk becomes ambiguous due to dynamic considerations.

Figure 4: Endogenous risk choice by entrepreneurial ability z and endowed wealth e.



3 Stylized Facts

In this section I document three key facts about new firms from the confidential version of the Kauffman Firm Survey: These facts motivate features of the model of both the two period model in section 2 and the full dynamic model in section 4.

1. Entrepreneurs face substantial exit risk, across industries and investment levels.
2. Entrepreneurs that invest more of their own money in their business earn more dispersed cumulative profits.
3. Entrepreneurs that invest more of their own money in their business also raise more external funds.

These three facts motivate the modelling choices in this paper. In particular, the first fact motivates studying how the the missing market for entrepreneurial risk affects selection into entrepreneurship. The second fact motivates the inclusion of an endogenous choice of risk that entrepreneurs face. The final fact motivates the inclusion of borrowing constraints in the model.

3.1 Kauffman Firm Survey Data

The Kauffman Firm Survey is a single cohort panel of 4,928 new US firms. All firms are founded in the year 2004, and the survey follows them until they exit or until 2011. It was designed to provide a representative sample of all new businesses started in 2004[1]. The firms include businesses that were independently founded, purchased from an existing business or purchased as a franchise and exclude any inherited businesses, any non-profits, and businesses that were started as a branch or subsidiary of an existing business. For each firm, information about up to 10 owners is provided.

These firms are highly heterogeneous. As table 1 shows, the majority of firms are non-employers in the first year, though many go on to hire at least one worker later. More firms are owned and operated by a single entrepreneur, though a small proportion have multiple owners. The distribution of total is highly skewed with the mean investment almost twice as large as the median investment.

[1]The sampling frame is taken from the Dun and Bradstreet US Business database.

Table 1: Summary Statistics

	Mean	p10	p50	p90	n Firms
Employment (Year 1)	2.0	0	0	5	4,823
Employment (Year 8)	5.2	0	1	10	2,000
Entrepreneurs	1.4	1	1	2	4,928
Total Investment (Years 1-8)	480.5	67	277	762	3,488

Total investment is in thousands of US dollars and included funding from both equity and debt. The number of firms in each row varies depending on data availability.

3.2 The Missing Market for Entrepreneurial Risk

The model in section 2 shows how a missing market for entrepreneurial risk can generate selection into entrepreneurship based on wealth. If this missing market is quantitatively important for who selects into entrepreneurship, two things must be true. First, entrepreneurs must face a significant degree of uncertain about the potential success of the business. Note that both uncertainty about entrepreneurial ability (as in Jovanovic (1982)), which decreases over time as entrepreneurs learn about their ability, and idiosyncratic risk to the business model (as in Hopenhayn (1992)), can provide the necessary uncertainty about the success of the business. Second, if the business is unsuccessful entrepreneurs must bear real losses that make them worse off than if they did not start a business.

As a measure of uncertainty, I examine the exit rates of new firms. In table 2, I report the current operational status of all firms in the Kauffman Firm Survey over the 8 years of the survey. Firm exit is common. While non-response and sample attrition mean that the status of 701 firms are not available in the final year, 1,901 firms or 45% of the firms with known status have permanently shut down by the end of the sample. An additional 30 were temporarily shut down.

Table 2: Business Status

Year	Operating	Shut Down	Merged or Sold	Temp Shut Down	Unknown
0	4,928	0	0	0	0
1	3,998	260	43	66	561
2	3,390	581	90	124	743
3	2,915	880	135	98	900
4	2,606	1,224	175	58	865
5	2,408	1,474	211	41	794
6	2,126	1,692	249	45	816
7	2,007	1,901	289	30	701

Firm exits are not confined to a specific set of industries. Table 3 shows the proportion of firms that survive to the end of the sample according to their 2-digit NAICs code. I calculate the survival rate as the number of firms either operating in the final sample year or that have been merged or sold in a previous year, divided by the total number of firms with a known status in the final year. Without information about the final sale price, it is difficult to assess whether firms that are merged or sold constitute a successful or unsuccessful outcome for entrepreneurs. I include these firms in survival in order to provide a conservative estimate of the likelihood of undesirable outcomes. Dropping industries with fewer than 50 observations, survival rates range from 43% of firms in the case of Retail Trade (44), to 64% in Manufacturing (33).

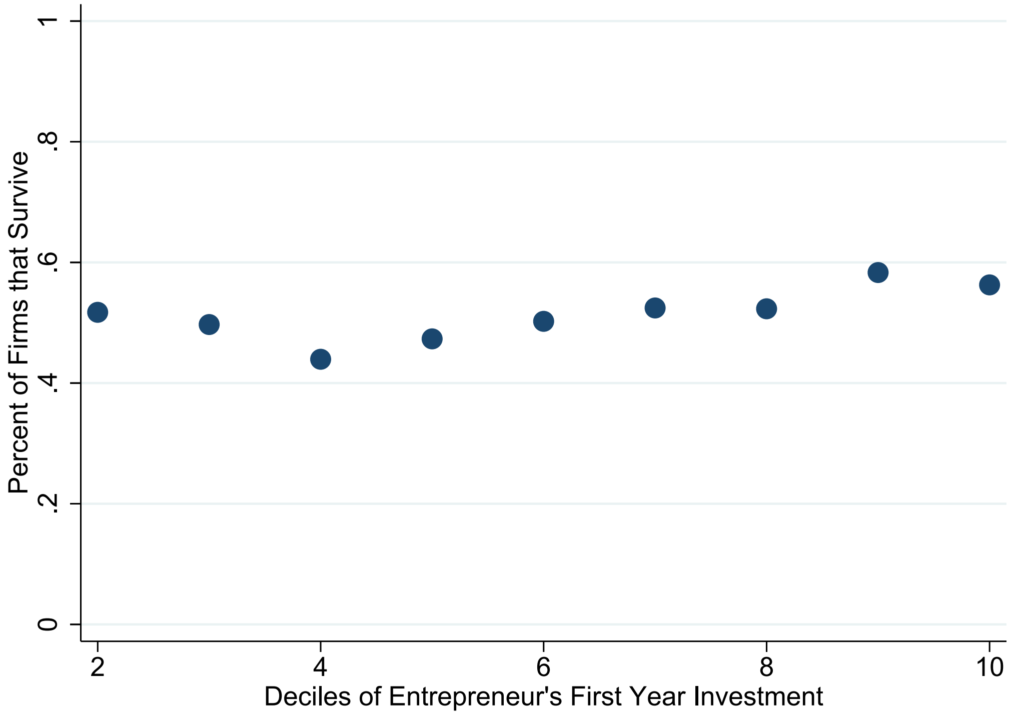
Table 3: Survival By Industry

Industry (2 digit NAICs Code)	Survival Rate	n Firms
Retail Trade (44)	42.9 %	238
Retail Trade (45)	43.7 %	229
Transportation and Warehousing (48)	45.3 %	86
Construction (23)	46.4 %	306
Finance and Insurance (52)	51.2 %	164
Other Services (except Public Administration) (81)	51.4 %	389
Health Care and Social Assistance (62)	52.1 %	94
Administrative, Support, Waste Management, and Remediation Services (56)	52.6 %	310
Manufacturing (32)	54.5 %	123
Accommodation and Food Services (72)	54.5 %	88
Information (51)	55.6 %	144
Real Estate and Rental and Leasing (53)	56.9 %	160
Wholesale Trade (42)	57.4 %	188
Arts, Entertainment, and Recreation (71)	57.6 %	92
Professional, Scientific, and Technical Services (54)	58.4 %	1,058
Manufacturing (33)	63.5 %	425

Firm exits are also not confined to low-investment firms, which could have been intended as temporary self-employment in response to an unemployment spell[2]. Firm exits are common across both low investment and high investment firms. Figure 5 shows the survival rates of firms based on the investment made in each firm in the first year. While survival is slightly higher among businesses with larger investments, among the top 10% of firms by initial investment, only 58% of these businesses survive the full 8 years of the sample.

[2]See Galindo da Fonsec (2017), who documents different patterns of entrepreneurial activity based on employment status before starting a business.

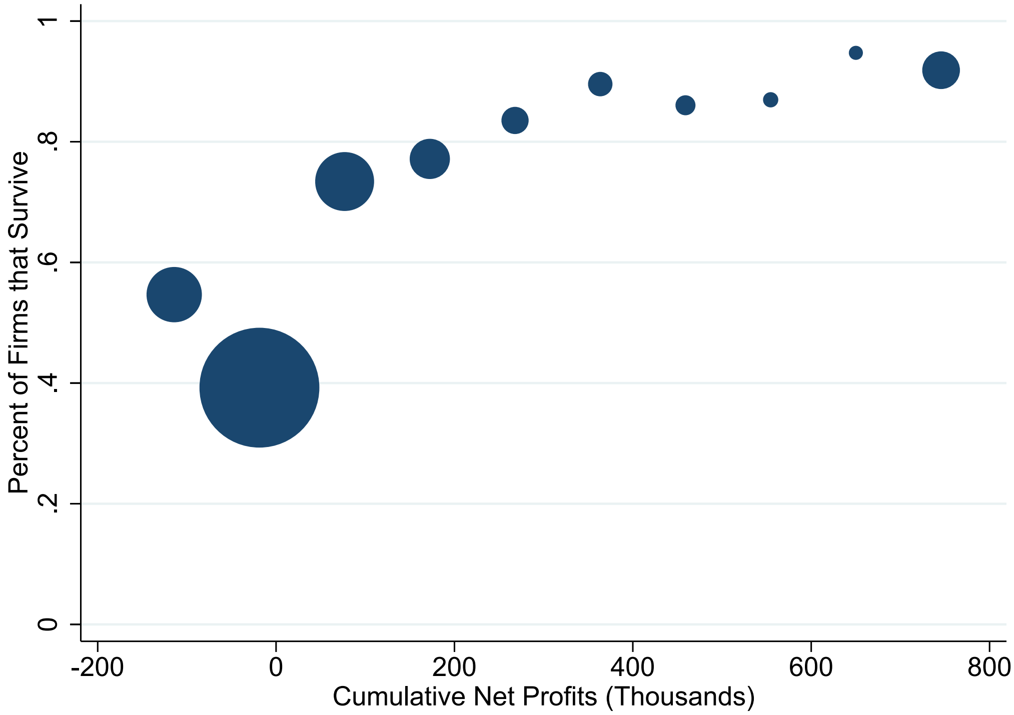
Figure 5: Survival by Initial Investment



This figure shows the survival rates of firms grouped into deciles based on the total equity invested in the first year.

Entrepreneurs who choose to exit, are much more likely to have lost money since starting the business. Figure 6 shows firm survival rates are much lower for firms with negative cumulative profits since they started their business. This suggests these exits are motivated by a lack a success rather than other considerations. In the absence of risk, it is difficult to imagine why these entrepreneurs would enter in order to first lose money and then exit.

Figure 6: Survival by Cumulative Profits



This figure shows the survival frequency of firms in ten bins of cumulative net profits. Cumulative profits have been winsorized between the 5th and 95th percentiles. The size of each circle is proportional to the number of observations in that bin.

If an entrepreneurial venture is unsuccessful the entrepreneur may face two sources of potential losses, relative to a counter-factual where they did not start the business. First, they may lose some or all of the money they invested in the business. Second, they may have forgone earnings, as the time they spent working on the business is time they could have spent working a job in the labour market. If either of these losses are substantial, they may discourage risk-averse individuals from starting a business.

Initial financial investments in a business may be used to purchase capital, to cover initial operating losses or to pay fixed set-up costs. Upon business exit, only the funds used to purchase tangible capital are potentially recoverable, and even then liquidation costs are likely to impose losses on the investment. To investigate what fraction of initial investments are potentially recoverable, I examine the ratio of net assets, measured in the last year of operation for exiting firms or in the eight year of operation for surviving firms, to owner's total cumulative investment in the firm. Table 4 displays percentiles of this ratio for both surviving and exiting firms. The table is further broken down by the quintile of initial investment.

The median exiting firm had net assets worth 55% of the total cumulative investment in the firm. Assuming zero liquidation costs, the owners of this firm would have lost 45% of their initial investment plus the return they could have earned on a risk-free asset. Of course, liquidated values, particularly of illiquid assets such as inventories and accounts receivable, would likely be lower than these values. They key insight here is that many exiting entrepreneurs will experience a substantial loss to their financial

Table 4: Ratio of Net Assets to Cumulative Investment

Quintile	p10	p25	p50	p75	p90	n Firms
Survivors						
1	0.00	0.09	0.49	2.00	7.42	229
2	0.00	0.12	0.73	3.37	16.94	425
3	0.01	0.18	0.68	1.81	5.09	271
4	0.00	0.14	0.60	1.75	4.20	269
5	0.01	0.11	0.45	1.37	3.00	328
All Survivors	0.00	0.12	0.60	1.96	6.17	1,522
Exiters						
1	-0.02	0.00	0.36	1.99	5.90	133
2	0.00	0.10	0.64	2.31	6.80	458
3	0.00	0.11	0.68	2.00	6.63	282
4	0.00	0.15	0.60	1.50	3.12	273
5	0.00	0.10	0.44	1.21	4.39	239
All Exiters	0.00	0.10	0.55	1.79	5.80	1,385

This table shows percentiles on the ratio of net assets to cumulative investment. Net assets are the sum of all self-reported firm assets less the self-reported firm liabilities. The top half of the table shows statistics for the distribution of surviving firms separately based on the five quintiles of first year equity invested. Likewise the bottom half of the table shows statistics for the distribution of exiting firms separately based on the five quintiles of first year equity invested.

investment.

In addition to losses to their financial investment, entrepreneurs also devote a substantial amount of their time to operating these businesses. This time has an opportunity cost, namely the wages or salaries the entrepreneurs could make in the labour market. Table 5 shows that around half of entrepreneurs pay themselves a salary out of the business. This remains relatively constant over the eight sample years. The key point is that exiting entrepreneurs who have not been paying themselves a salary may have accumulated several years of forgone earnings before they decide to exit.

Table 5: Entrepreneurs Paying Themselves a Salary by Year

Year	Prop Salaried	n Entrepreneurs
2004	0.47	6,916
2005	0.53	5,673
2006	0.55	4,776
2007	0.55	4,057
2008	0.53	3,617
2009	0.54	3,304
2010	0.53	2,859
2011	0.51	2,715

Even for those entrepreneurs who are paying themselves a salary, entrepreneurs may not be paying themselves the full opportunity costs of their time. Hall and Woodward (2010) document that venture-capital backed entrepreneurs are typically paid less than their outside option in the labour market in order to encourage effort. More generally, if borrowing constraints are binding, entrepreneurs could pay themselves less in order to save within the firm and accumulate additional capital. In both cases, lower compensation during the start up period is compensated for by higher returns later. Of course, if the firm exits before those returns materialize, the entrepreneur suffers a real economic loss. Note here the potential interaction of borrowing constraints and the missing market for entrepreneurial risk, which will be explored in section 6.

3.3 Entrepreneurs' Choice of Risk

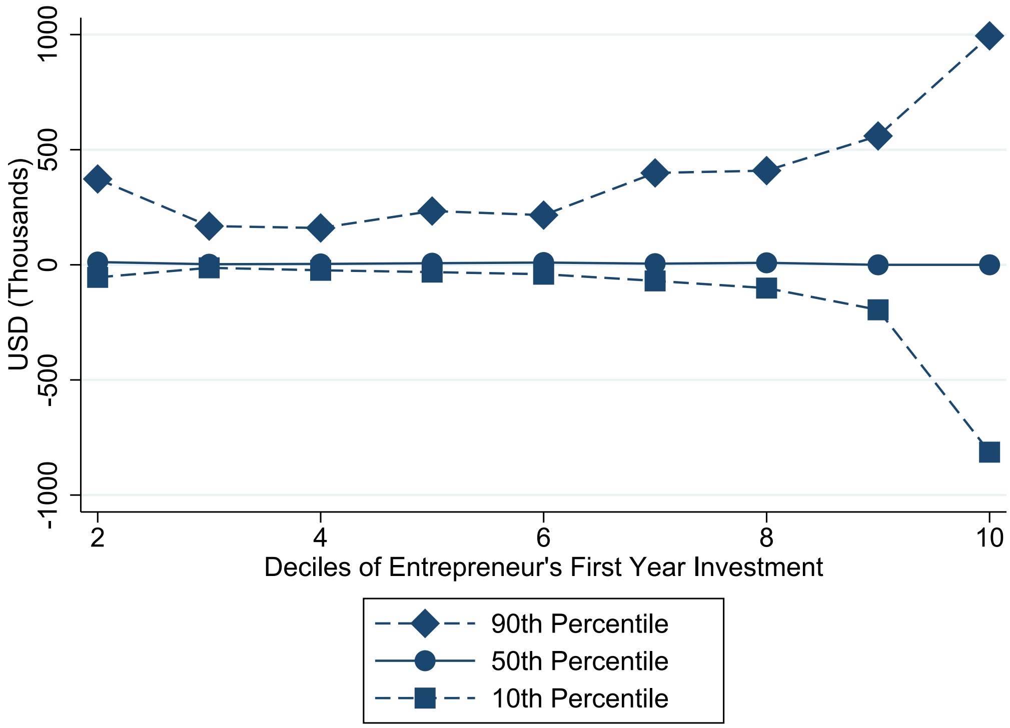
The model in section 2 predicts that wealthier entrepreneurs will both invest more in their business and choose businesses with a higher level of risk. While the ex-ante risk of a business is not directly observable, the ex-post outcomes of a group of firms is. In order to compare the risk taken by different entrepreneurs, I examine the dispersion in outcomes within different groups of firms. If wealthier entrepreneurs are taking more risk, there should be more dispersion in their outcomes than among a group of poorer entrepreneurs.

While the Kauffman Firm Survey does not ask entrepreneurs about their wealth when they first start their business, the amount of money they have been able to directly invest in the business is informative about their wealth. Because the survey distinguishes between money an entrepreneur is able to directly invest in a business and the amount of money they invest after taking out a personal loan, the amount they have been able to directly invest is a reasonable proxy for an entrepreneur's net worth.

Therefore, in order to test the prediction of the model in section 2, I compare the dispersion in cumulative profits across firms in the different deciles of entrepreneur's direct investment. If entrepreneurs who invest more in their businesses earn more dispersed cumulative profits, this may indicate that these entrepreneurs are in fact starting businesses with more idiosyncratic risk.

Figure 7 clearly shows that firms with larger initial investments by their entrepreneurs have much more dispersed cumulative profits. However, since initial investment is highly correlated with firm size, it is not clear whether the greater dispersion is a mechanical consequence of these firms operating at a larger scale or a consequence of these entrepreneurs choosing higher scale. In order to control for scale, I run two key regressions. First, I regress firm's cumulative profits on the initial investment of their entrepreneurs, controlling for other sources of funding, employment and industry. A positive coefficient on initial entrepreneur's own investment ($\hat{\alpha}_1 > 0$) means that entrepreneurs who invest more are on average earning higher cumulative profits. In the second regression, I take the absolute value of the residuals from the first regression, and regress them on the initial investment of their entrepreneurs and the same controls. A positive coefficient on initial entrepreneur's own investment ($\hat{\beta}_1 > 0$) suggests that entrepreneurs who invest more are earning more dispersed cumulative profits (e.i. the cumulative profits are heteroskedastic). I take this to be evidence of greater risk taking on the part of high-investment entrepreneurs.

Figure 7: Dispersion in Cumulative Profits



This figure shows 10^{th}, 50^{th} and 90^{th} percentiles of the distribution of cumulative profits separately for each decile of entrepreneur's initial investment. Note that almost 20% of firms invest nothing in the first year of operation, and so the bottom two deciles are represented by a single point, labelled "2".

$$\text{Cumulative Profits}_i = \alpha_0 + \alpha_1 \text{Initial Entrepreneur's Own Investment}_t + \alpha X_i + \epsilon_i \quad (8)$$

$$|\hat{\epsilon}_i| = \beta_0 + \beta_1 \text{Initial Entrepreneur's Own Investment}_t + \beta X_i + \eta_i \quad (9)$$

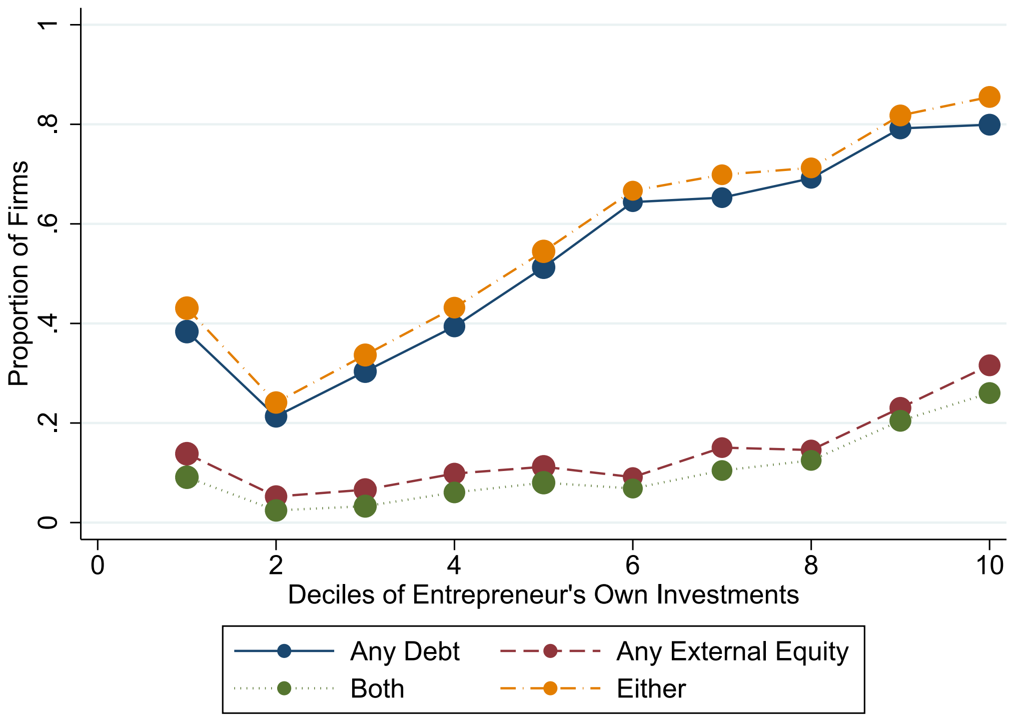
In appendix A.2 I show that this same result holds for cumulative sales.

Table 6: Dispersion of Cumulative Profits Regressions

First Regression:	Cumulative Profits		
	(1)	(2)	(3)
Entrepreneur's Initial Own Equity	1.312***	1.313***	1.314***
	(0.0847)	(0.0859)	(0.0860)
Initial External Equity			-0.387*
			(0.181)
Initial Debt		0.528***	0.670***
		(0.109)	(0.128)
Employer		15.61	32.90
		(293.0)	(293.4)
Number of Employees		-33.21	-31.61
		(23.77)	(23.80)
Constant	70.95	-308.7	-271.5
	(131.3)	(1512.0)	(1512.3)
2 Digit NAICs Codes	No	Yes	Yes
Second Regression:	Absolute Value of Residuals		
	(1)	(2)	(3)
Entrepreneur's Initial Own Equity	0.468***	0.452***	0.449***
	(0.0842)	(0.0844)	(0.0844)
Initial External Equity			0.412*
			(0.177)
Initial Debt		0.116	-0.0110
		(0.107)	(0.125)
Employer		404.7	403.1
		(287.8)	(288.1)
Number of Employees		50.98*	44.90
		(23.35)	(23.36)
Constant	572.5***	482.8	359.2
	(130.6)	(1485.2)	(1484.9)
2 Digit NAICs Codes	No	Yes	Yes
N	4528	4419	4414

3.4 Borrowing Constraints

Figure 8: External Funds

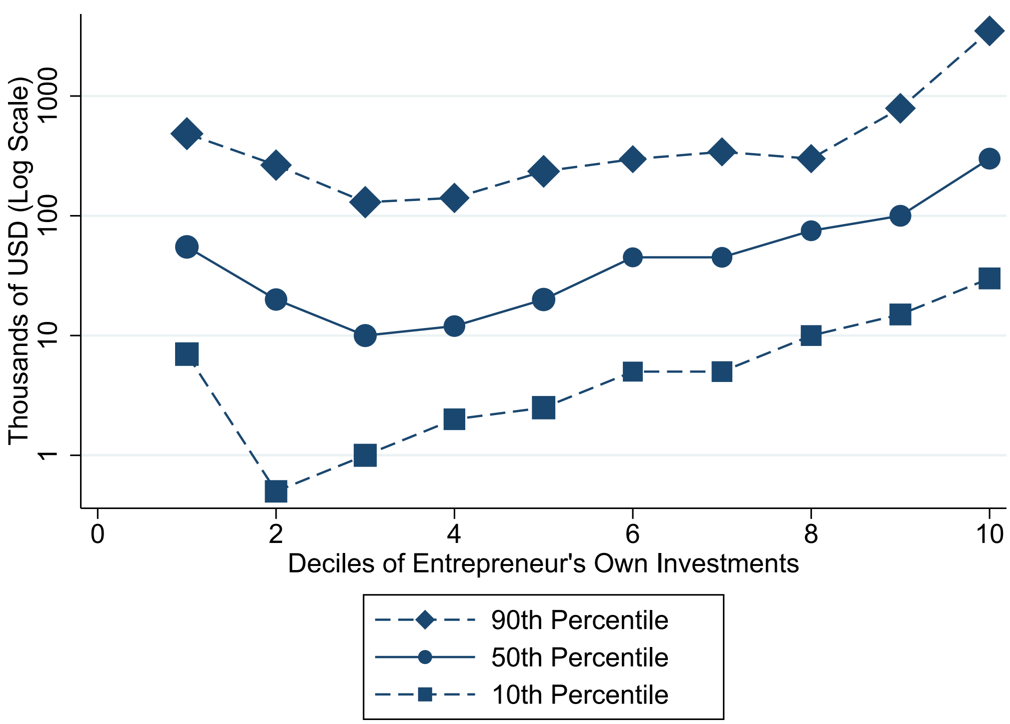


This graph shows the proportion of firms that have raised some debt, some external equity, both or neither across the distribution of initial investment. Firms are sorted into deciles based on the total amount their entrepreneur's own investment in the firm in the first year of operations. See table 10 for a detailed break-down of the sources of debt and external equity.

How able are new entrepreneurs to raise external funds? Figure 8 shows the proportion of firms that are able to raise any debt or any external equity in order to fund their firm. Clearly entrepreneurs who invest more of their own money in the firm are more likely to raise external funds, whether from debt or external equity. This is consistent with the idea that wealth-poor individuals are unable to access external funds.

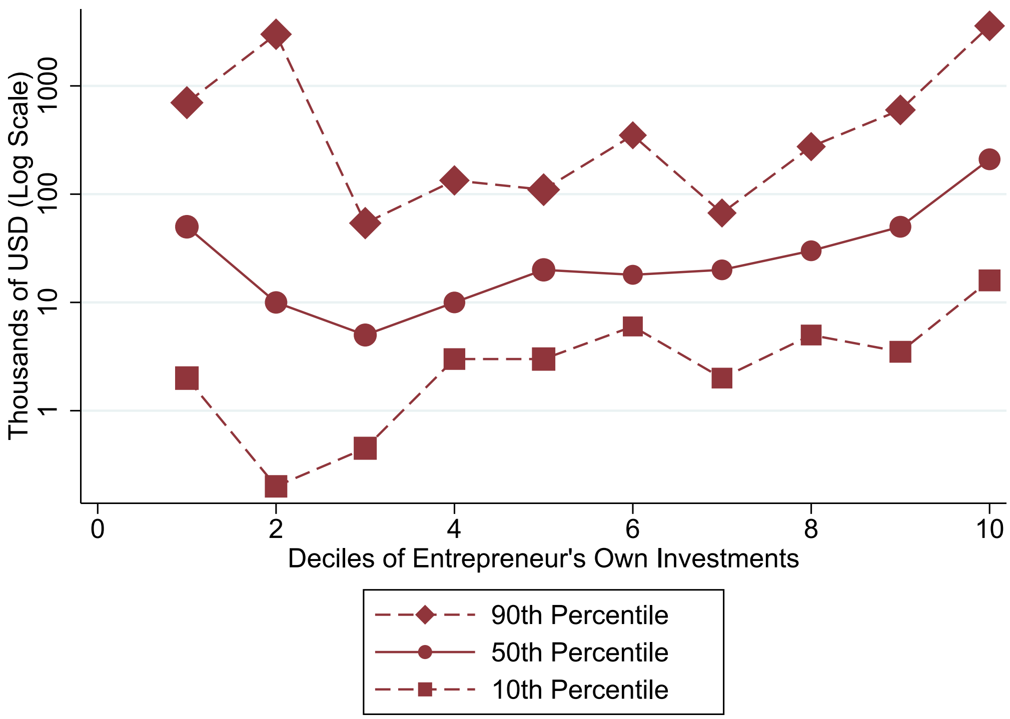
Figures 9 and 10 show how much debt and external equity that entrepreneurs raise broken down by the deciles of entrepreneurs' total own investments. Note that these graphs have a log-scale. Across the first three deciles, there appears to be somewhat of a decline, suggesting that there is a small fraction of firms who are able to substitute owners investment for external funds, but over the rest of the distribution, larger entrepreneur's investments are correlated with larger amounts of external funds. This is consistent with the presence of financial frictions, and motivate the modelling of these frictions as a collateral constraint.

Figure 9: Amount of Debt



This figure shows the 10^{th}, 50^{th} and 90^{th} percentiles of the distribution of total debt raised within the deciles of the total of entrepreneur's own investments, conditional on raising some debt. Note the y-axis is a log-scale.

Figure 10: Amount of External Equity



This figure shows the 10^{th}, 50^{th} and 90^{th} percentiles of the distribution of total external equity raised within the deciles of the total of entrepreneur's own investments, conditional on raising some external equity. Note the y-axis is a log-scale.

4 Full Model

In order to quantify the relative importance of the missing market for entrepreneurial risk and borrowing constraints, I extend the two period model of section 2 to a fully dynamic setting.

4.1 Environment

There are a unit measure of agents. Agents face a constant probability $(1-\psi)$ of dying each period and have Epstein-Zin preferences. Agents derive a utility stream $\{u_t\}_{t=0}^{\infty}$ from a stochastic stream of consumption $\{c_t\}_{t=0}^{\infty}$ according to the function:

$$u_t = U(c_t) + \beta\psi U(\mathbb{CE}_t[U^{-1}(u_{t+1})])$$

where $\mathbb{CE}_t(u_{t+1}) \equiv \Upsilon^{-1}\left[\mathbb{E}_t\left[\Upsilon(u_{t+1})\right]\right]$ is the certainty equivalent of u_{t+1} given the information available at time t. $U(c)$ and $\Upsilon(c)$ aggregate consumption over time and states respectively:

$$U(c_t) = \frac{c^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} \qquad \text{and} \qquad \Upsilon(c) = \frac{c^{1-\sigma}}{1-\sigma}$$

where $\theta > 0$ is the elasticity of intertemporal of substitution and $\sigma > 0$ is the coefficient of relative risk aversion. Note that these preferences are equivalent to CRRA preferences when $\sigma = \frac{1}{\theta}$.

Agents have two types of ability, their ability as a worker is given by h^W and their ability as an entrepreneur is given by h^E. At the beginning of each period, they choose whether to be a worker or an entrepreneur.

Workers supply labour inelastically and earn wh^W, where w is the common wage.

The first time period an agent decides to be an entrepreneur, they start a business by choosing a business type x, paying a fixed setup cost $f(x)$, and investing in a capital stock k. Once chosen, the business type x is fixed. In a future period, if an entrepreneur wants to change their business type they must shut down their business, select a new business type x', and pay a new fixed setup cost $f(x')$.

After all agents make an occupational choice decisions and entrepreneurs decide on a business type, all agents receive shocks to both their ability as a worker h^W and their ability as an entrepreneur h^E. While both types of ability are partially persistent, neither are perfectly so, and so agents face idiosyncratic income risk from choosing either occupation.

In addition, entrepreneurs receive a project productivity shock to the specific business they are currently operating z. z is comprised of both a persistent component η and a transitory component ϵ, both of which are drawn from a distribution that depends on the chosen x. Higher x businesses have higher expected z but also more volatile z. The productivity of a business depends on both the firm-specific productivity shock as well as the entrepreneur's entrepreneurial ability h^E. Once they received their shocks, entrepreneurs hire an amount of labour n at wage rate w and produce according to:

$$y = (zH^E)^{1-\gamma}(k^{\alpha}n^{1-\alpha})^{\gamma}$$

$$\log(z) = \eta + \epsilon$$

$$\eta = \rho_{\eta,x}\eta_{-1} + \xi$$

$$\epsilon \sim N(0, \sigma_{\epsilon,x})$$

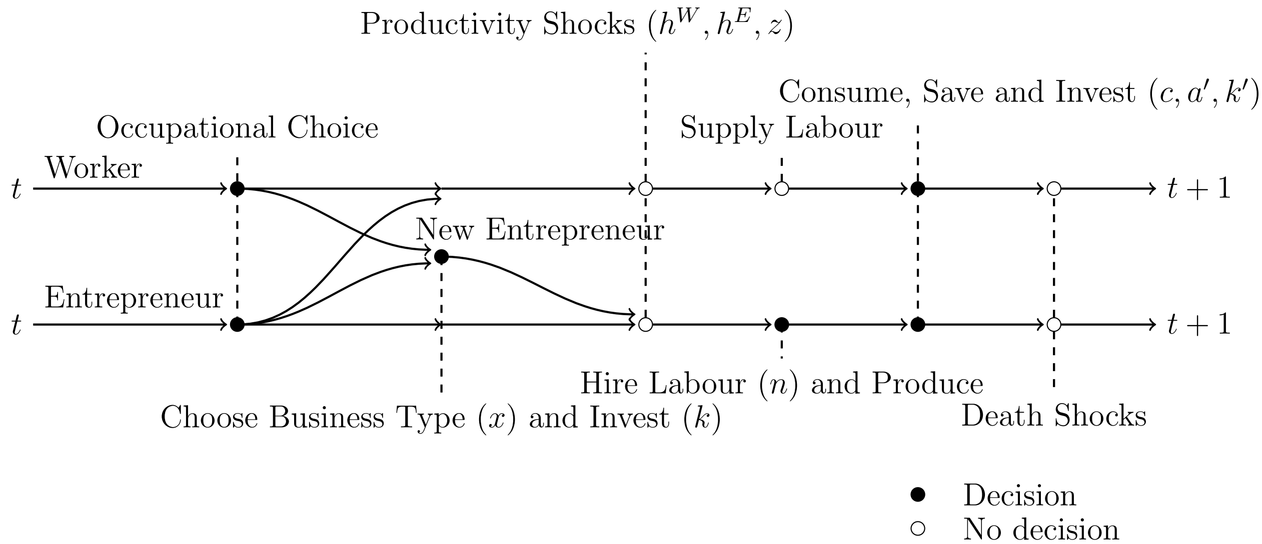
$$\xi \sim N(0, \sigma_{\xi,x})$$

After production and factors are paid, all agents make a consumption, savings, and investment decision. Figure 11 summarizes the timing of the model.

The model has two assets. Only entrepreneurs can invest in capital k, which depreciates at rate δ, but can otherwise be fully liquidated at the end of each period. Both entrepreneurs and workers can save in a liquid financial asset a that pays r^a each period. Entrepreneurs can also borrow in the financial asset, however financial frictions prevent them from borrowing more than a certain fraction $\phi \in [0, 1]$ of their capital stock:

$$-a \leq \phi k$$

Figure 11: Timing in the model



4.2 Agent's Problems

Worker's Problem

A worker makes a simple consumption-savings decision according to:

$$V^W(a, h^W, h^E) = \max_{a',c} \frac{c^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} + \psi\beta \max \left\{ \left[\mathbb{E}\left(V^W(a', h^{W\prime}, h^{E\prime})^{\frac{1-\sigma}{1-\frac{1}{\theta}}} \right) \right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}}, V^{NE}(a', h^{W\prime}, h^{E\prime}) \right\} \tag{10}$$

s.t.

$$a' + c = wh^W + (1 + r^a)a$$

$$a' \geq 0$$

New Entrepreneur's Problem

An agent that has decided to start a new business chooses a business type x, and pays a fixed setup cost $f(x)$. Given their current financial assets a, they also choose how much capital $\tilde{k}$ to invest in and how much to borrow or save in financial assets $\tilde{a}$.

$$V^{NE}(a, h_{-1}^W, h_{-1}^E) = \max_{\tilde{a},\tilde{k},x} \left[\mathbb{E}\left(V^E(\tilde{a}, \tilde{k}, h^W, h^E, z, x)^{\frac{1-\sigma}{1-\frac{1}{\theta}}} \right) \right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}} \tag{11}$$

s.t.

$$\tilde{a} = a - f(x) - \tilde{k}$$
$$-\tilde{a} \leq \phi \tilde{k}$$

Entrepreneur's Problem

An entrepreneur that has a business will choose an amount of labour n to hire, consumption c, savings $(k' + a')$, and investment k'.

$$V^E(a, k, h^W, h^E, z, x) = \max_{n,c,a',k'} \frac{c^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}} + \psi\beta \max \left\{ \begin{array}{c} \left[\mathbb{E}\left(V^W(a', h^{W\prime}, h^{E\prime})^{\frac{1-\sigma}{1-\frac{1}{\theta}}} \right) \right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}}, \\ V^{NE}(a', h^W, h^E), \\ \left[\mathbb{E}\left(V^E(a', k', h^{W\prime}, h^{E\prime}, z', x)^{\frac{1-\sigma}{1-\frac{1}{\theta}}} \right) \right]^{\frac{1-\frac{1}{\theta}}{1-\sigma}} \end{array} \right\} \tag{12}$$

s.t.

$$a' + c + k' = (zh^E)^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma - wn + (1-\delta)k + (1+r^a)a$$
$$-a' \leq \phi k'$$

4.3 Equilibrium

An equilibrium is a set of value functions $\{V^W, V^{NE}, V^E\}$, occupational choices, a set of policy functions $\{c^W, a'^W, \tilde{a}^{NE}, \tilde{k}^{NE}, x^{NE}, c^E, a'^E, k'^E, n^E\}$, a distribution of agents $\{\Gamma^E(a, k, h^W, h^E, z, x), \Gamma^W(a, h^W, h^E)\}$, and a price w such that

1. The policy functions solve the problems given by 10, 11 and 12.
2. All markets clear:
   - Labour

$$\int h d\Gamma^W(a, h^W, h^E) = \int n^E d\Gamma^E(a, k, h^W, h^E, z, x)$$

- Final Goods

$$\int (c+a')d\Gamma^W(a,h^W,h^E) + \int (c+a'+k'+f\mathbb{I}_{NE})d\Gamma^E(a,k,h^W,h^E,z,x) =$$
$$\int \left((zh^E)^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma + (1-\delta)k + (1+r^A)a\right) d\Gamma^E(a,k,h^W,h^E,z,x)$$
$$+ \int ((1+r^A)a)d\Gamma^W(a,h^W,h^E)$$

3. The distribution of agents is stationary

$$\Gamma^E(a,k,h^W,h^E,z,x) = \Gamma^{E\prime}(a,k,h^W,h^E,z,x)$$
$$\Gamma^W(a,h^W,h^E) = \Gamma^{W\prime}(a,h^W,h^E)$$

4.4 Model Predictions

Patterns of Selection

Figure 4.4 illustrates the occupational choice and endogenous risk choice in the model. For a worker with the lowest worker ability (h^W), the graph shows how the worker would select their occupation depending on their current level of entrepreneurial productivity (h^E) and their current level of financial assets (a).

Regardless of how high their entrepreneurial productivity is, if the agent has little wealth, they will choose to be a worker. The borrowing constraint prevents poor entrepreneurs from operating at a large scale, limiting their income as an entrepreneur. As a consequence, a worker with little wealth and the highest entrepreneurial productivity will still choose to be a worker.

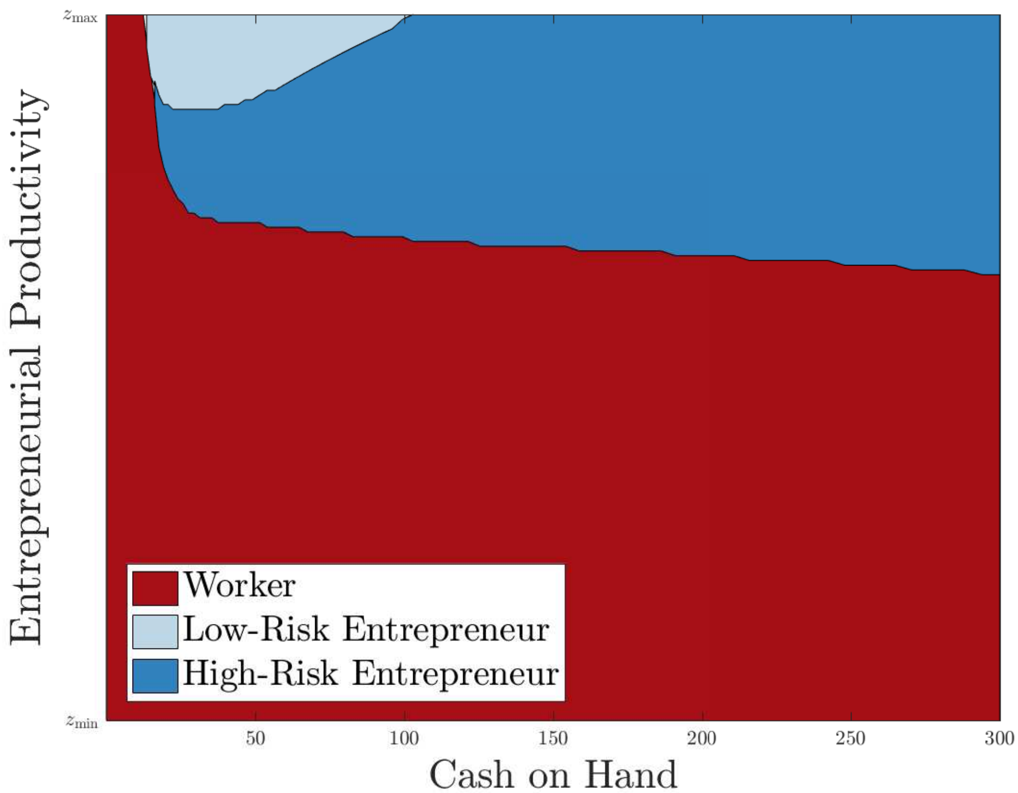
Agents with high entrepreneurial ability and moderate wealth will choose to be entrepreneurs operating the low risk project. While the expected productivity of the high-risk project is greater, the higher risk makes it unattractive. Bad productivity shocks would curtail the entrepreneur's consumption substantially and make exit more likely.

Agents with high entrepreneurial ability and high wealth will choose to be entrepreneurs operating the high risk project. Since they have sufficient wealth to self-insure any bad productivity shocks, they choose the higher risk project with higher returns.

Agents with moderate entrepreneurial ability and moderate wealth switch directly from being workers to starting a high risk project. Since they are less productive, they are more likely to exit entrepreneurship for any given bad productivity shock. The relatively high likelihood of exit means that these entrepreneurs care little about their productivity if they receive a bad productivity shock. As a consequence they pick the high risk project because it results in much higher productivity in good states of the world, and much lower productivity in bad states of the world, when they will choose to be workers[3].

[3] This effect is closely related to the mechanism explored in Vereshchagina and Hopenhayn (2009).

Figure 12: Selection Patterns



This figure shows the patterns of selection in the calibrated model. Given a worker with a particular worker ability (h^W), the graph shows how the worker would select their occupation depending on their current level of entrepreneurial productivity (h^E) and their current cash on hand.

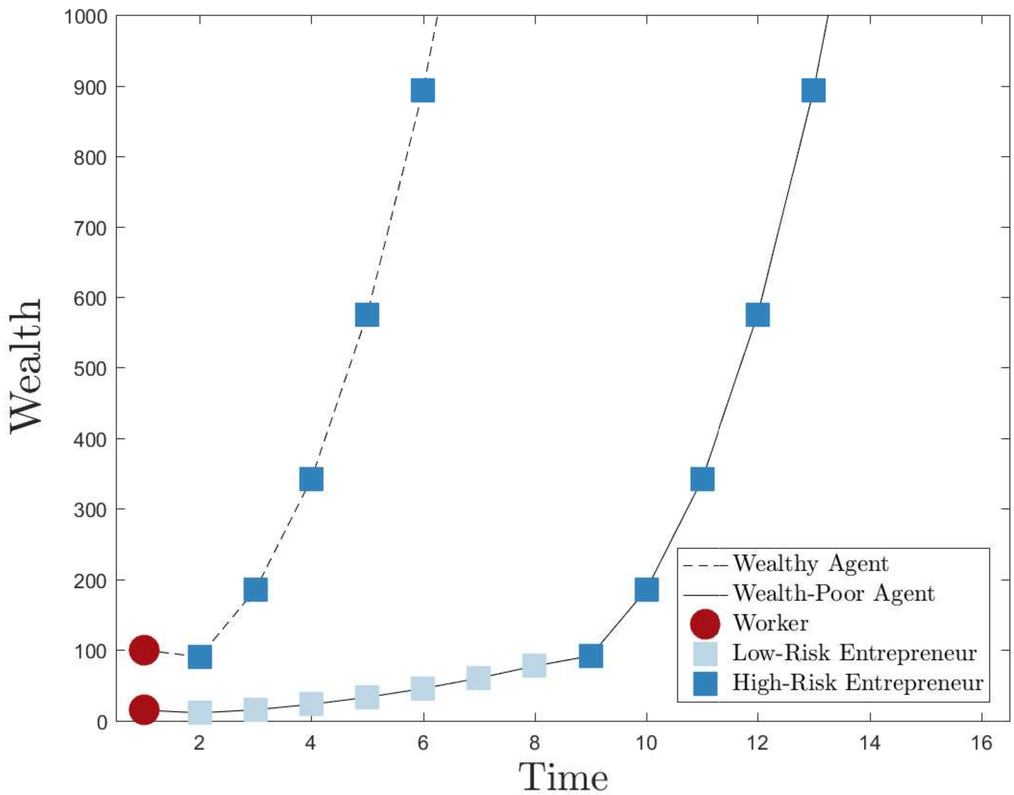
Wealth Accumulation

In this model, wealthier agents accumulate wealth faster than poor agents given the same abilities. Figure 4.4 illustrates this dynamic for two agents with identical entrepreneurial and worker abilities. Both agents are born at time 1 as workers with the highest entrepreneurial and worker ability. However, they are endowed with different initial levels of wealth.

The wealthier agent immediately starts a high risk business. In this illustrative example, they receive the highest project productivity and earn high returns on their wealth. The wealthy agent saves a high proportion of their entrepreneurial income for two reasons. First, because the project is risky, the agent wants to engage in precautionary savings in order to self-insure against the project's failure. Second, because of the borrowing constraint, the entrepreneur wants to save more in order to operate a larger business next period and earn an even higher income.

Lacking the wealth to self insure against large fluctuations in income, the wealth poor-agent starts a low risk business. In this illustrative example, they receive the highest project productivity, but earn substantially lower entrepreneurial income. They save at high rates and slowly accumulate enough wealth until they are willing to shut down their safe business and start a new risky business. Of course, if they receive any negative productivity shocks before then it will take them even longer to accumulate the necessary net worth to be willing to start a risky business.

Figure 13: Wealth Accumulation Patterns



5 Calibration

I calibrate this model to match steady state moments from the model to the corresponding counterparts in the data. A period in the model is a year. I set several parameters to commonly used values in the literature and jointly calibrate the remaining parameters.

Ability and Productivity Processes

I parameterize both the worker and entrepreneurial ability processes with AR(1) processes:

$$\log(h^{i\prime}) = \rho_{h^i}\log(h^i) + \epsilon_{h^i}$$

where $\epsilon_{h^i} \sim N\left(\frac{\bar{h}^i}{1-\rho_{h^i}}, \sigma^2_{h^i}\right)$ for $i \in \{E, W\}$

In order to keep the problem computationally tractable, I restrict myself to the case where an entrepreneur chooses between two projects, a relatively safe project (x_1) and a relatively risky project (x_2). Each project type receives productivity shocks z comprised of a persistent component η and a transitory component ϵ. η and ϵ are both drawn from distributions that depend on the type of project x.

$$\log(z) = \eta + \epsilon$$

$$\eta' = \rho_{\eta|x_i}\eta + \xi$$
$$\epsilon \sim N(0, \sigma_{\epsilon|x_i})$$
$$\xi \sim N\left(\frac{\bar{\eta}_{x_i}}{1-\rho_{\eta|x_i}}, \sigma^2_{\xi|x_i}\right)$$

for $i \in \{1, 2\}$.

I use the Rowenhorst method to discretize the four AR(1) processes $\{h^W, h^E, \eta_{x_1}, \eta_{x_2}\}$. I use Guassian-Hermite quadrature to approximate the distribution of ϵ's.

Externally Calibrated Parameters

I fix nine parameters to commonly used values in the literature. I set the coefficient of relative risk aversion to 1.50, a conservative choice relative to a benchmark value of 3 in Angeletos (2007). The elasticity of intertemporal substitution is set to $\frac{2}{3}$, making preferences in the benchmark calibration equivalent to CRRA since $\sigma = \frac{1}{\theta}$. I set the probability of death $(1-\psi)$ to $\frac{1}{40}$ so that the expected working lifetime is 40 years. I set the capital share α to $\frac{1}{3}$ and the interest rate r^A to 3% per year. I set the decreasing returns to scale parameter γ to 0.85 as in Midrigan and Xu (2014) and the depreciation rate to 6% per year.

I set the persistence of the labour income process ρ_{ϵ_h} to 0.9, which is in the range of empirical estimates according to Guvenen (2007). The standard deviation of the innovation σ_{ϵ_h} is set to 0.2.

Internally Calibrated Parameters

I jointly calibrate ten parameters to match ten model generated moments to the corresponding moments in the data. The two AR(1) processes that govern the relatively risky and the relative safe projects are each parameterized by three parameters $\{\bar{z}_{x_i}, \sigma_{\epsilon|x_i}, \rho_{z|x_i}\}_{i\in\{1,2\}}$. To discipline these parameters for the two different types of productivity projects, I match moments of firm dynamics for both firms both above and below the median level of initial investment. I calibrate the mean productivity level ($\bar{z}_{x_i}$) to the average growth in employment, conditional on survival. With the standard deviation of productivity innovations ($\sigma_{\epsilon|x_i},$), I match the coefficient of variation of employment. Finally, I use the persistence of productivity ($\rho_{z|x_i}$) to match the exit rates.

In order to ensure the model captures the strength of borrowing constraints in the real world, I set the strength of the collateral constraint ϕ to match the ratio of business debt to total equity the entrepreneurs report investing in the KFS data. I use the size of the fixed cost $f(x_1) = f(x_2)$ to match the correct proportion of entrepreneurial households in the economy as found in the Survey of Consumer Finances. I use the discount factor β to match the capital output ratio in the economy. Finally, I set the average level of human capital endowment $\bar{h}$ to match the proportion of entrepreneurial households in the wealthiest 1%.

Table 7: Benchmark Calibration

Target	Data	Model	Parameter	Value
Exogenously Chosen				
40 Year Working Lifespan			$1-\psi$	0.03
Capital Share			α	0.33
Interest Rate			r^A	0.03
Entrepreneurial Share			$1-\gamma$	0.12
Depreciation			δ	0.06
Coefficient of Relative Risk Aversion			σ	1.50
Elasticity of Intertemporal Substitution			θ	0.67
Endogenously Calibrated				
Average Emp Growth Low-Invest	0.71	0.88	$\bar{z}_{x_1}$	4.21
Average Emp Growth High-Invest	1.50	0.60	$\bar{z}_{x_2}$	4.18
CoV over Time Low-Invest	0.69	0.21	$\sigma_{\epsilon\|x_1}$	3.39
CoV over Time High-Invest	0.56	0.55	$\sigma_{\epsilon\|x_2}$	1.52
Prop Survival Low-Invest	0.51	0.16	$\rho_{z\|x_1}$	0.54
Prop Survival High-Invest	0.57	0.12	$\rho_{z\|x_2}$	0.92
Capital to Output	2.27	2.57	β	0.92
Average Leverage Ratio	0.79	0.70	ϕ	0.94
Proportion of Entrepreneurs	0.11	0.08	f	7.46
Prop Entr in Wealthiest 1%	0.65	0.45	$\bar{h}$	1.07

6 Quantitative Analysis

6.1 The Relative Importance of Two Frictions

A central question in this paper is how important is the missing market for entrepreneurial risk relative to borrowing constraints on generating selection into entrepreneurship on the basis of wealth. In order to assess the quantitative significance of both of these frictions, I remove first one, then the other, and finally both from the model in order to compare the resulting equilibria.

In order to assess the importance of the missing market for entrepreneurial risk, I complete this missing market by introducing contingent claims. In the benchmark economy, there is a single risk free asset. In the contingent claims economy, each agent can purchase assets that pay off in future states of the world based on the agent's realizations of h^W, h^E, z. An asset a_i pays off 1 in the state of the world $i \in H^W \times H^E \times Z$. Each of these assets are sold at price q_i by competitive risk-neutral financial intermediaries at actuarially fair prices.

In order to separate the impact of the missing market for entrepreneurial risk from the impact of the borrowing constraint, I keep the borrowing constraint in the economy unchanged. In the benchmark economy the borrowing constraint requires that $-a \leq \phi k$. In the contingent claims economy, the borrowing constraint requires that:

$$-\sum_i q_i a_i \leq \phi k$$

Thus an entrepreneur with the same amount of net worth across the two economies can invest in the same amount of capital.

Obviously, considering the perfect completion of the missing market for entrepreneurial risk is not a policy-relevant exercise. In the real world, information frictions will always make it difficult to provide insurance to entrepreneurs. The perfect ability of the financial intermediaries to identify the exact abilities of potential entrepreneurs and expected productivity of projects in this exercise is infeasible in the real world. This complete market exercise is however a useful counter-factual. Understanding the relative impact of the missing market for entrepreneurial risk and the borrowing constraint, as well as any interaction between the two, is key for the design of public policy to encourage entrepreneurship. In future work, I hope to evaluate specific government policies to encourage entrepreneurship. These policies will differ in their ability to alleviate one friction or the other, but will all have impacts on both mechanisms.

To remove borrowing constraints, I simply set $\phi = 1$, so that entrepreneurs can invest in any level of capital stock, unrestricted by their personal net worth. Note however, that for reasons of tractability, I do not allow entrepreneurs to default, which makes it impossible for them to borrow the fixed setup cost.

I then compare four economies. The benchmark economy with both frictions, a risk-neutral economy ($\sigma = 0$) with borrowing constraints ($\phi < 1$), the un-constrained economy where agents are risk-averse ($\sigma > 0$) but can invest in any amount of capital ($\phi = 1$), and finally an friction-less economy with both risk-neutral agents ($\sigma = 0$) and no borrowing constraints ($\phi = 1$), in which selection into entrepreneurship is entirely based on ability. Table 8 reports aggregate output, wages and TFP in these four economies.

Table 8: Productivity Losses from the Two Friction

	Y	w	TFP	Percentage of		Entrepreneurs operating	
				Workers	Entrepreneurs	Low Risk	High Risk
Benchmark	1.00	1.00	1.00	92.1	7.9	3.9	3.9
Risk Neutral	1.03	1.07	1.02	93.0	7.0	0.0	7.0
Unconstrained	1.02	1.00	1.01	92.5	7.5	2.8	4.7
No Frictions	1.38	1.10	1.08	91.2	8.8	0.0	8.8

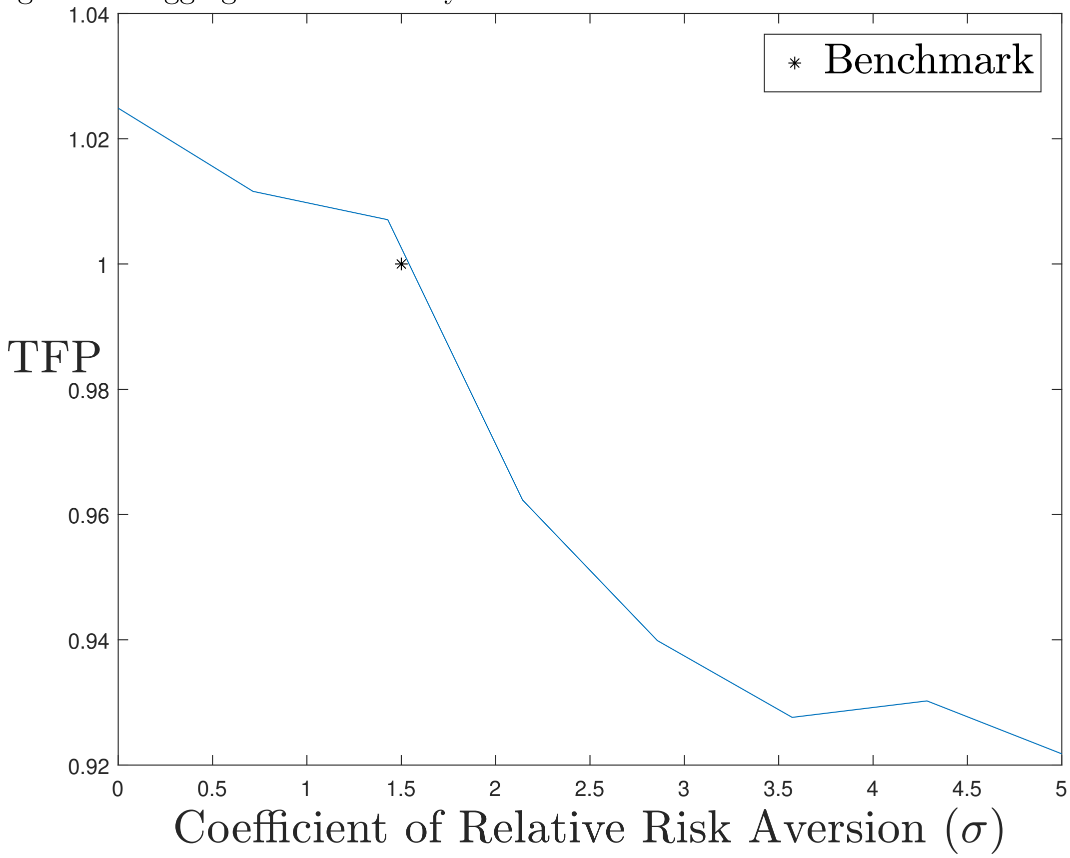
Removing either friction increases output, wages and aggregate TFP. Moving from the benchmark economy to the risk-neutral economy raises aggregate TFP by 2%. This is due to the endogenous choice of risk in the model. Risk-neutral entrepreneurs all pick the higher-risk project, which has higher expected productivity. By contrast, moving from the benchmark to the unconstrained economy increases aggregate productivity by only 1%. While entrepreneurs are able to operate at a larger scale, this isn't sufficient to raise productivity by as much as the switch of projects that takes place in the risk-neutral equilibrium.

Note how the proportion of entrepreneurs selecting the high-risk project increases as the borrowing constraints are removed. With borrowing constraints, some entrepreneurs cannot generate enough income per period to justify the higher risks of the risky high-return project. Without those constraints, low-wealth entrepreneurs can generate much more income per period, and so find it worthwhile to pick the high-return project. This result, that borrowing constraints reduce the risks entrepreneurs takes place contrasts with the two period model of section 2, where imposing borrowing constraints increased the risks entrepreneurs take. In that model, taking a riskier project and investing in more capital with debt are substitutes as they both increase consumption in the good state and both decrease consumption in the bad state. This force is also present here in the full version of the model, but it is quantitatively dominated by the trade-off between the per-period income and the additional risk.

Moving from the benchmark economy to the friction less economy illustrates how much the two frictions interact with one another. The friction-less economy has TFP 8% higher than the benchmark, compared with only 2% or 1% in the other economies. This higher TFP results both because entrepreneurs are all operating the riskier project and because they are unconstrained in the amount of capital they use. In the risk-neutral economy, every entrepreneur operates the risky project, yet many are constrained in how large a business they can operate. Only when both frictions are removed are they able to operate high-return projects at the optimal scale.

Of course, the importance of the missing market for entrepreneurial risk depends critically on the value of risk-aversion used in the economy. In figure 14, I plot the TFP of the benchmark economy and how this varies over different values of σ, the coefficient of relative risk aversion. Aggregate productivity declines as the agents that populate the economy become more risk-averse. This operates primarily through the endogenous choice of risky projects, as agent's risk aversion increases, fewer agents are willing to start a high-risk project with high expected productivity. As a consequence, more agents operate small-scale safe projects.

Figure 14: Aggregate Productivity and the Coefficient of Relative Risk Aversion



6.2 Endogenous Risk and Wealth Inequality

In the benchmark economy, risk is endogenous in the sense that entrepreneurs choose between different projects with different risks and rewards. Wealthier entrepreneurs optimally choose higher risk higher reward projects and so in expectation earn higher average returns than poorer entrepreneurs. These higher rates of return constitute a form of rate of return heterogeneity, that can potentially help explain the cross-sectional dispersion in wealth we observe in the data. A key question is how much additional dispersion in wealth this endogenous choice of risk results in. To measure the quantitative importance of this channel, I compare the benchmark endogenous risk economy with an exogenous risk economy, where new entrepreneurs are are not able to choose their project type and instead are randomly allocated a project.

In the benchmark, entrepreneurs strictly prefer one of the project types, so the removal of project choice will strictly reduce the value of entrepreneurship. Naively comparing the exogenous and endogenous economies will then conflate the effects of the endogenous choice of risk with changes in occupational selection. In order to provide a fair comparison between these two economies, I fixed the occupational choice decision for agents between being a worker and an entrepreneur. Thus an agent with a particular state $a \times k \times h^W \times h^E \times z \times x$ who chooses to become an entrepreneur in the benchmark economy will also become a entrepreneur in the exogenous risk economy. However, while they would choose a project type in the benchmark economy, in the exogenous

Table 9: The Distribution of Wealth Under Endogenous and Exogenous Economies

	Wealth Share of Top				
	1%	5%	10%	20%	50%
SCF Data	33	57	69	83	94
Endogenous Risk Chosen Occupation	12	33	46	59	78
Endogenous Risk Fixed Occupation	7	13	19	31	61
Exogenous Risk Fixed Occupation	7	12	18	30	61
Exogenous Risk Chosen Occupation	10	21	27	37	64

risk economy they will be randomly allocated a project type. I set the probability of receiving each type of project equal to the proportion of projects of that type in the benchmark stationary equilibria.

Note that I also keep the wage rate constant in these comparison economies, rather than clearing the labour market. This is important as changes in the wage rate can have large impacts on the optimal scale of operations for an entrepreneur with a given productivity and so drastically change their savings behaviour.

Table 9 clearly shows that all of the wealth concentration generated in the model is due to occupational selection, rather than the rate of return heterogeneity induced by the choice of projects. There is no difference in the top wealth shares between the endogenous risk and exogenous risk economies. The top wealth shares are much higher in both economies with fixed occupation rather than the economies with occupational selection. In an economy without occupational choice, when an entrepreneur receives a bad productivity shock, they cannot exit from their business and become a worker. This leads to much higher precautionary savings, as the low-productivity states often induce entrepreneurs to exit in the occupational choice economies.

7 Conclusion

This paper studies the relationship between wealth and entrepreneurial risk. I present descriptive evidence from the Kauffman Firm Survey that new entrepreneurs face a high degree of idiosyncratic risk, but that many are able to borrow substantial amounts of debt. Motivated by these facts, I build a quantitative model of occupational choice and endogenous risk choice. The model features two frictions, a missing market for entrepreneurial risk and borrowing constraints. I use this model to measure the relative impact of two frictions on productivity in the US economy. I find that while both frictions have an important impact, their interaction is much larger than either of the frictions together. I also assess whether the endogenous choice of risk in my model can help explain the high concentration of wealth at the top of the wealth distribution. I find that this has very little impact.

Overall, the results in this paper clearly suggest that government policies designed to encourage entrepreneurship should take into account the high degree of entrepreneurial risk that new entrepreneurs face. While providing greater access to loans may help encourage entrepreneurship, designing policy that does this and also promotes better risk-sharing mechanisms is likely to be far more effective. Given the obvious moral hazard and adverse selection problems inherent in entrepreneurial risk sharing, I leave the design of these risk-sharing government policy to future work.

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A Additional Empirical Facts

A.1 Funding Sources

53% of firms raise some debt over the course of the first 8 years of operation. Table 10 updates a similar table in Robb and Robinson (2014) with the full sample of KFS data. By far the most common source of funding is the entrepreneur's own investment, with 89% of firms having some investment from their active owners. However, most entrepreneurs are not investing large sums of money, the median amount of an owner's investment in their own business is only $25,000.

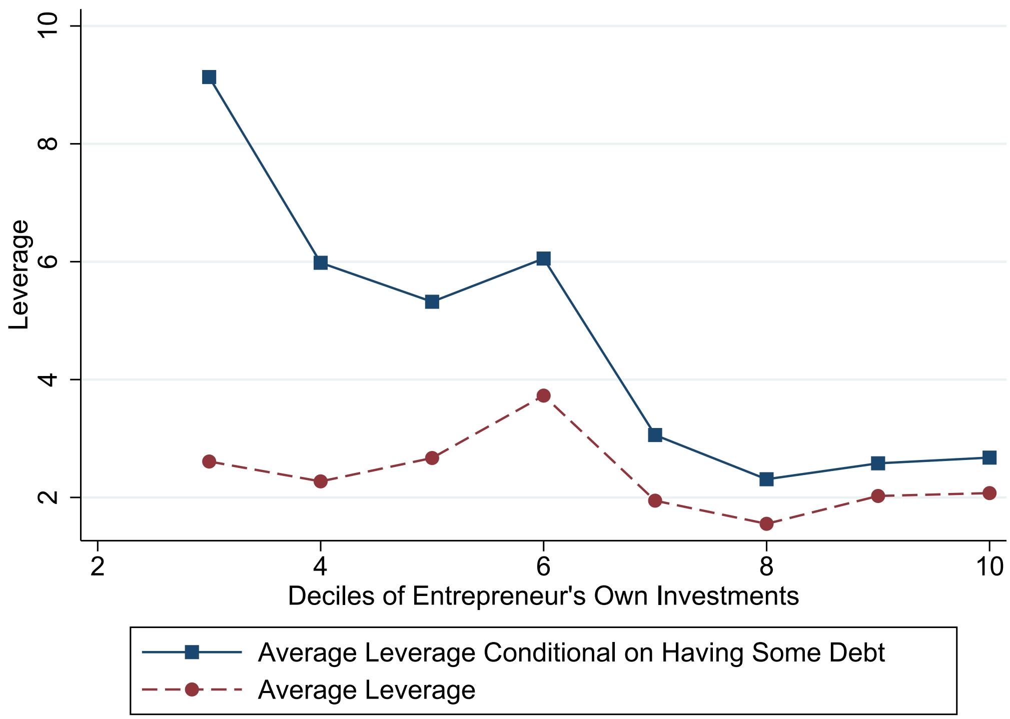
Table 10: Funding Sources

Source	%	Mean >0	p25	p50	p75	n Firms
Own Equity	89	166	8	25	80	3,655
External Equity	15	1,151	10	50	203	640
Outside Investors	6	758	10	90	290	247
Parents	5	83	10	25	73	242
Other Companies	4	1,565	20	100	600	154
Spouses	3	82	5	15	30	137
Venture capital	1	8,669	85	450	6,125	60
Government Agencies	1	698	53	250	850	44
Other	1	995	10	25	135	23
Any Debt	53	714	15	55	210	2,302
Personal Debt	46	405	10	40	128	2,011
Bank	32	308	15	50	140	1,413
Family	20	51	5	15	46	938
Other Individuals	6	434	4	15	50	252
Any Other Sources	3	1,489	10	33	110	160
Business Debt	28	701	15	50	211	1,264
Bank	17	873	26	84	269	747
Family	8	84	5	15	45	356
Non-Bank Financial	6	357	12	48	200	262
Owners	4	331	15	48	200	158
Government Agencies	2	1,052	30	125	330	89
Other Individuals	2	153	5	24	100	74
Employees	1	56	5	14	40	38
All Funding Sources	94	520	10	45	181	3,687

This table shows the funding sources of firms. The first column reports the percentage of firms that received some money from each possible funding source, the second column gives the mean amount raised conditional on raising some money from that source, the third through fifth columns give the 25^{th}, 50^{th} and 75^{th} percentiles of the amount raised conditional on raising some money from that source. The final column gives the number of firms this corresponds to. All values are in thousands of US dollars.

Note that while 53% of firms are able to borrow from a bank, most of these loans are personal debt. If the business is unsuccessful and entrepreneurs choose to exit, these debts cannot be discharged without filing for personal bankruptcy. Raising external equity is much less common, with only 15% of firms raising equity beyond the actively managing owners, though these firms typically invest substantially more than those without any external equity.

Figure 15: Leverage



This graph shows the proportion of firms that have debt across the distribution of initial investment. Firms are sorted into deciles based on the total amount of equity invested in the firm in the first year of operations. Note that the growth rates have been winsorized to remove the effect of outliers.

A.2 Dispersion in Cumulative Sales

$$\text{Cumulative Sales}_i = \beta_0 + \beta_1 \text{Initial Owner Investment}_t + \beta X_i + \epsilon_i \tag{13}$$

$$|\hat{\epsilon}_i| = \beta_0 + \beta_1 \text{Initial Owner Investment}_t + \beta X_i + \eta_i \tag{14}$$

A.3 Entrepreneur's Biggest Challenge

In the 5th through 8th years of operation, entrepreneurs were asked "What was the most challenging problem your business faced in calendar year X?". The responses are provided in table 12. The responses suggests that most entrepreneurs are far more concerned about the risks they face than any lack of credit. Unfortunately, as this question was only asked for the years from 2008-2011, it is not clear how much the responses to this question are driven by the US financial crisis. Yet as economic conditions recover after 2008, there is no increase the number of entrepreneurs who consider the lack of credit to be their primary challenge, which suggests that borrowing constraints are unlikely to be a major concern for entrepreneurs only 8 years after starting a business.

Table 11: Dispersion of Cumulative Sales Regressions

First Regression: Cumulative Sales			
	(1)	(2)	(3)
Entrepreneur's Initial Own Equity	3.729***	3.647***	3.647***
	(0.251)	(0.251)	(0.251)
Initial External Equity			-0.0197
			(0.588)
Initial Debt		1.617	1.601
		(1.293)	(1.300)
Employer		-197.8	-185.7
		(898.2)	(899.9)
Number of Employees		647.1***	649.4***
		(76.17)	(76.32)
Constant	3109.2***	377.7	371.5
	(407.9)	(4616.5)	(4620.2)
2 Digit NAICs Code	No	Yes	Yes
Second Regression: Absolute Value of Cumulative Sales			
	(1)	(2)	(3)
Entrepreneur's Initial Own Equity	0.668**	0.562*	0.561*
	(0.246)	(0.241)	(0.241)
Initial External Equity			0.235
			(0.564)
Initial Debt		0.708	0.648
		(1.239)	(1.246)
Employer		-53.34	-44.55
		(860.6)	(862.2)
Number of Employees		644.7***	646.0***
		(72.98)	(73.12)
Constant	4943.5***	809.3	774.4
	(400.1)	(4423.2)	(4426.4)
2 Digit NAICs Code	No	Yes	Yes
N	4112	4017	4012

Table 12: Entrepreneur's Self-Reported Most Challenging Problem

Year	2008	2009	2010	2011
An inability to obtain credit	4 %	5 %	4 %	4 %
Slow or lost sales	53 %	45 %	42 %	35 %
Falling real estate values	5 %	5 %	4 %	4 %
The cost and/or terms of credit	2 %	2 %	1 %	1 %
The unpredictability of business conditions	24 %	23 %	26 %	31 %
Some other problem	11 %	13 %	15 %	16 %
Customers or clients not making payments or paying late	2 %	8 %	8 %	8 %
Number of Entrepreneurs	2,566	2,369	2,094	1,971

A.4 Entrepreneurial Salaries by Hours of Work

Tables 13 and 14 compare the proportion of entrepreneurs who report paying themselves a salary based on their weekly hours of work in the first and final years. Only a third of the entrepreneurs working less than 25 hours a week are paying themselves a salary. For entrepreneurs working more than 35 hours a week, 57% are paying themselves a salary in the first year, while 68% are paying themselves a salary in the eight year. Hours worked are self-reported usual hours worked. Note that both of these graphs include only the survey-responding entrepreneur, rather than all of the entrepreneurs working on a business.

Table 13: Entrepreneurs Paying Themselves a Salary by Hours Worked, First Year

Hours	Prop Salaried	n Entrepreneurs
<25	0.33	1,288
25-35	0.43	442
35-44	0.54	655
45-54	0.56	758
55-65	0.58	887
65<	0.58	780
Total	0.49	4,900

Table 14: Entrepreneurs Paying Themselves a Salary by Hours Worked, Eighth Year

Hours	Prop Salaried	n Entrepreneurs
<25	0.33	569
25-35	0.52	174
35-44	0.62	303
45-54	0.68	344
55-65	0.73	313
65<	0.70	182
Total	0.56	1,892

A.5 Firm Growth

Figure 16 shows that firms with larger initial investments in the first year experience more growth in employment conditional on surviving to the eighth year of operation. This simple fact stands in stark contrast with standard models of firm dynamics and borrowing constraints based on Cobb-Douglas production functions. Because the marginal product of capital is high at low levels of capital, entrepreneurs operating sub-optimally small firms have strong incentives to save out of their borrowing constraints and so rapidly increase size.

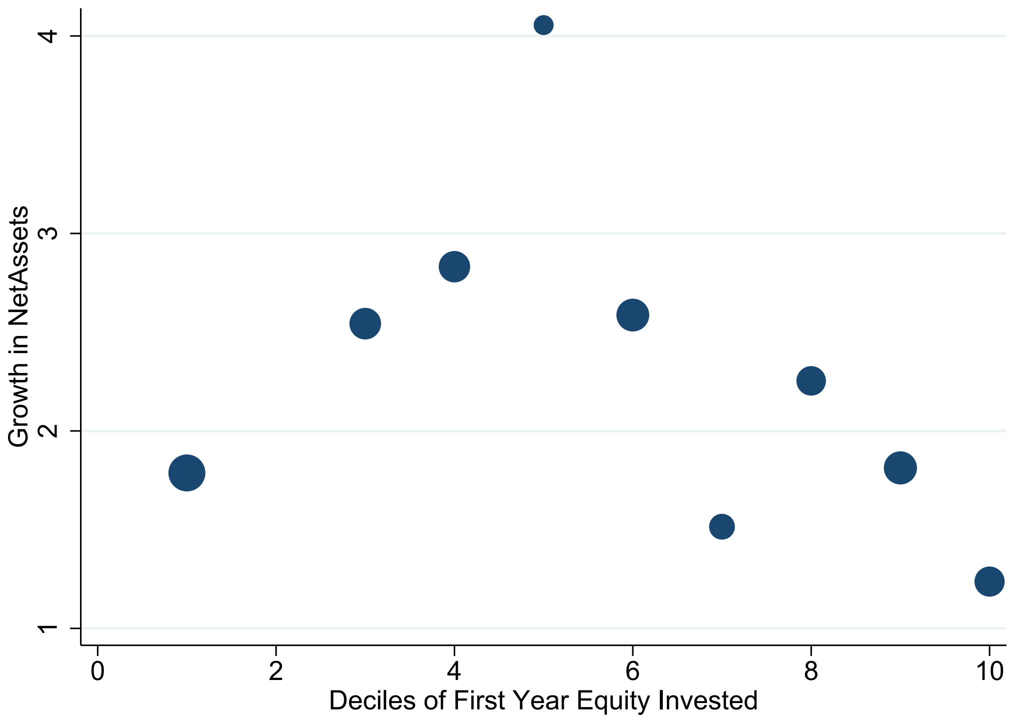
Figure 16: Employment Growth by Initial Investment

This table shows the average growth of the employment of firms across the distribution of initial investment. Firms are sorted into deciles based on the total amount of equity invested in the firm in the first year of operations. Note that the growth rates have been Winsorized to remove the effect of outliers.

Figure 17 shows the average growth rate of net assets across the distribution of initial equity investment. As in the previous graph, I sort firms into 10 deciles based on the total equity invested in the firm in the first year. I then compare the net assets of all surviving firms in the eighth year of operation to their net assets in the first year of operations.

Classic models of entrepreneurship and borrowing constraints, such as Cagetti and De Nardi (2006) and Buera (2009), suggest that entrepreneurs who are financially constrained will operate firms at sub-optimal scale. As they operate, they should save out of retained earnings to accumulate firm assets. Thus a key measure of which entrepreneurs are most borrowing-constrained are the firms that ex-post have accumulated assets at the fastest rate.

Figure 17: Net Asset Growth by Initial Investment



This graph shows the average growth of firm net assets across the distribution of initial investment. Firms are sorted into deciles based on the total amount of equity invested in the firm in the first year of operations. Note that the growth rates have been winsorized to remove the effect of outliers.

A.6 Dispersion in Rates of Return

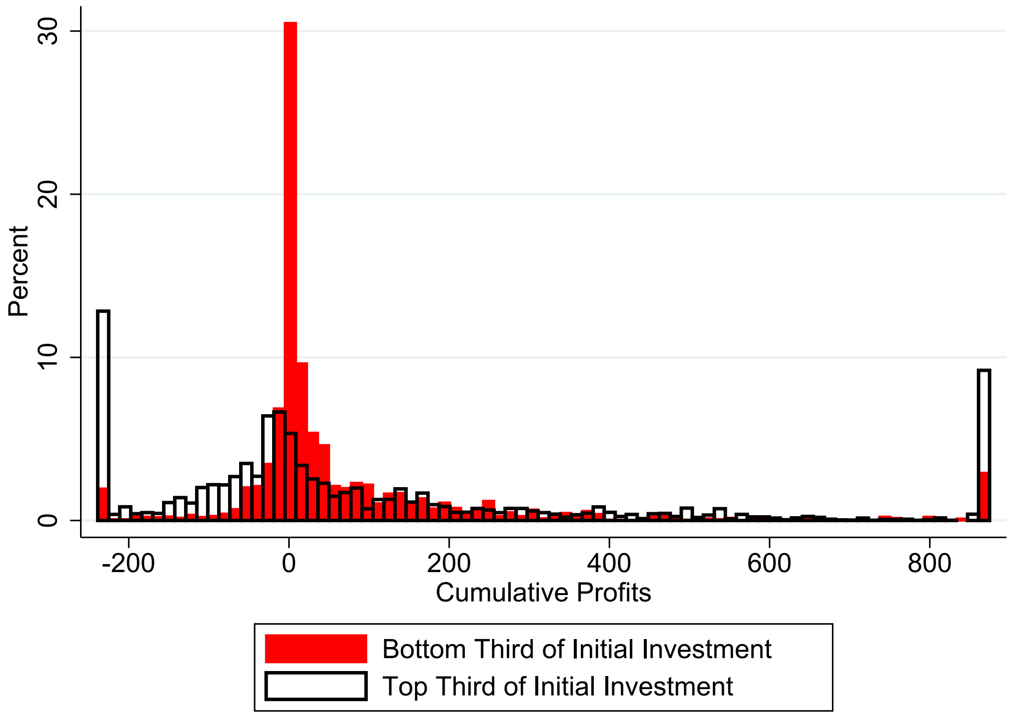
One key prediction of the model in section 2 is that wealthier individuals earn rates of return that are both on average higher and more dispersed. In this section, I examine the evidence for this predicting using the Kauffman Firm Survey Data.

A.7 Profit Dispersion

A challenge of testing this prediction is that the Kauffman Firm Survey does not ask about entrepreneurs' wealth before they start their businesses. In the absence of a prior measure of wealth, I use the total equity invested by the entrepreneurs in their business as a proxy for their wealth. I rank firms by the total amount of equity their entrepreneurs have directly invested in the first year and compare the bottom third of firms with the top third of firms. I exclude from this measure of initial investment all sources of debt, and external equity, such as angel investors, investments from businesses, entrepreneur's family investments, or venture capital funding.

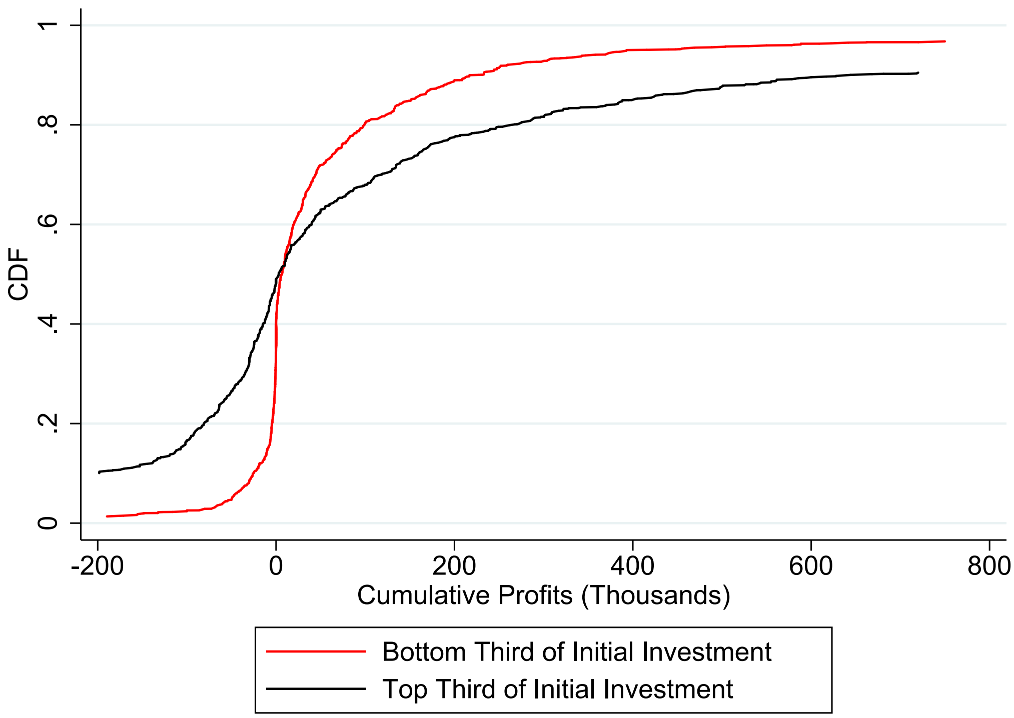
Figures 18 and 19 show the distribution of cumulative net profits that firms earn over the first eight years of operation. Firms in the top third of initial investment earn much more extreme profits than firms in the bottom third. This is despite the fact that the pattern of survival based on cumulative net profits is relatively similar between the two groups as shown in figure 20. Of course, it is possible that the higher dispersion in profits reflects the fact that entrepreneurs who make larger initial investments are operating larger scale businesses, and so regardless of the distribution of risk they face earn more dispersed profits. To assess this possibility, I calculate rates of return for each firm in the next subsection.

Figure 18: Profit Dispersion



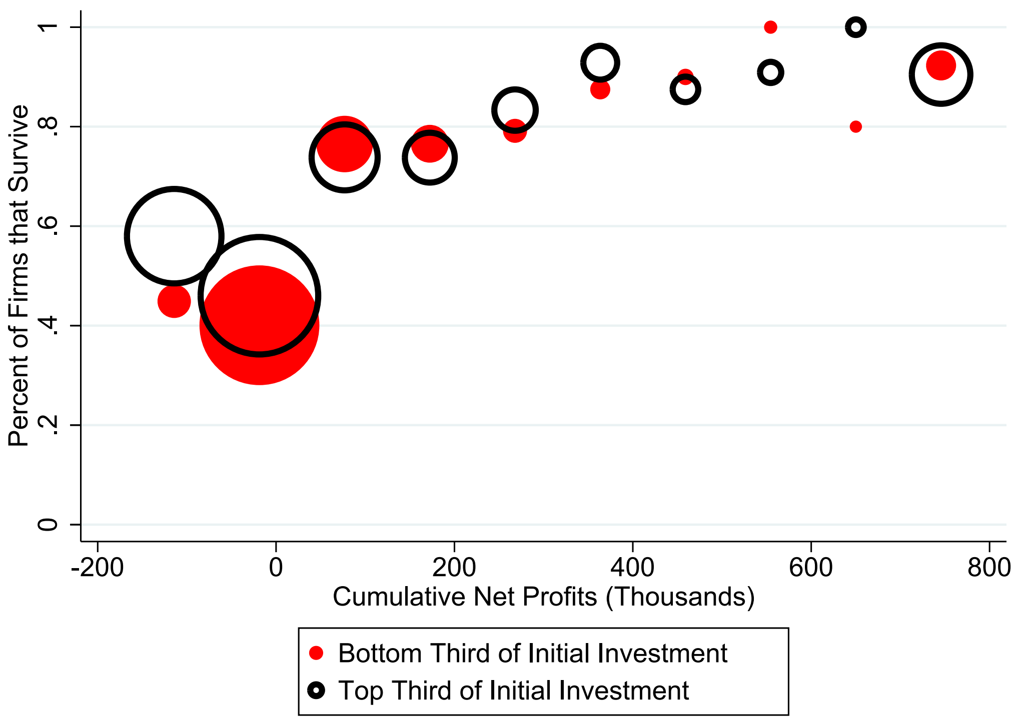
This figure shows the distribution of cumulative profits for two groups of firms in thousands of 2004 US dollars. The firms are the top and bottom third of the distribution of initial investment, defined as the total amount of the entrepreneur's own money they invest in the business. This initial investment does not include debt or other sources of investment, such as angel investors, investments from businesses, entrepreneur's family investments, or venture capital funding. Both distributions have been winsorized at the top and bottom 5% of the total distribution of cumulative profits.

Figure 19: Profit Dispersion



This figure shows the cumulative density of cumulative profits for two groups of firms in thousands of 2004 US dollars. The firms are the top and bottom third of the distribution of initial investment, defined as the total amount of the entrepreneur's own money they invest in the business. This initial investment does not include debt or other sources of investment, such as angel investors, investments from businesses, entrepreneur's family investments, or venture capital funding. Both distributions have been winsorized at the top and bottom 5% of the total distribution of cumulative profits.

Figure 20: Survival by Cumulative Profits



This figure shows the survival frequency of firms in ten bins of cumulative net profits for two groups of firms in thousands of 2004 US dollars. The size of each circle is proportional to the number of observations in that bin. The firms are the top and bottom third of the distribution of initial investment, defined as the total amount of the entrepreneur's own money they invest in the business. This initial investment does not include debt or other sources of investment, such as angel investors, investments from businesses, entrepreneur's family investments, or venture capital funding. Both distributions have been winsorized at the top and bottom 5% of the total distribution of cumulative profits.

A.7.1 Calculating Rates of Return

To test whether the rate of return is on average higher for high-investment firms, I construct cumulative rates of return for each firm using the following equation:

$$\text{Cumulative Rate of Return} = \frac{\sum_{t=0}^{7} \beta^t \left(\text{Dividends}_t + \text{Salary}_t\right) + \beta^7 \text{Firm Value}_7}{\sum_{t=0}^{7} \beta^t (\text{Equity Invested}_t + \text{Forgone Salary}_t)} \tag{15}$$

It is vital to include salaries in this calculation as they represent part of the return to starting a business. The split between dividends and salaries is more likely to depend on tax code provisions or incentive compatible contracts with passive owners, rather than the relative economic value of the entrepreneur's labour and financial capital to the business. In addition, including forgone labour earnings is essential in this calculation. The entrepreneurs in this sample are highly heterogeneous. Some operate small-scale firms with minimal assets and require little financial investment. Without including the opportunity cost of their time, the estimate of their rate of return would be inflated by the missing factor. I measure or proxy for each element of this equation in the following way:

- Dividends_t is directly measured in the data by a question that asks "Thinking of calendar year 2004, how much money, if any, did you and other owners withdraw from the business for personal use? This includes any dividends paid." it should therefore include all dividend payments as well as any other cash withdrawals.
- Salary_t Information about the exact salaries paid to entrepreneurs is not available, though whether a salary was paid to each entrepreneur is recorded. In order to proxy for salaries paid, I use the total wage bill of the firm, divided by the number of employees including the salaried entrepreneurs.
- Firm Value_7 For a termination value of the firm, I use the total assets of the firm minus the total liabilities in the final year.
- Equity Invested_t is directly measured in the data by a series of questions that ask how much money was received from active owners, angel investors, other companies, governments, parents of owners, spouses of owners, venture capital firms and an other category.
- Forgone Salary_t No information about the previous labour market activities of these entrepreneurs is available. In order to proxy for their forgone labour earnings, I run a Mincerian regression in the Survey of Consumer Finances estimating total annual labour market earnings on demographics. I then use the coefficients from this regression to predict annual labour market earnings for the entrepreneurs in the Kauffman Firm Survey. I then multiply these predicted annual labour market earnings by entrepreneur's reported weekly hours of work.
- I discount all values using $\beta = \frac{1}{1.02}$.

To validate these rates of return, I compare survival frequencies of firms in different deciles of cumulative profits to survival frequencies of firms in different deciles of cumulative rate of return. If the rates of return are accurately capturing entrepreneurial success, then the survival frequencies should be much more closely aligned with the rates of return than the profits.

Table 15: Survival by Cumulative Profits and Cumulative Rate of Return

Decile	Survival by Profit decile	n Firms	Survival by RoR decile	n Firms
1	0.57	321	0.27	234
2	0.43	343	0.42	247
3	0.34	344	0.42	241
4	0.28	432	0.49	242
5	0.29	230	0.49	238
6	0.48	330	0.49	237
7	0.59	328	0.53	240
8	0.74	323	0.46	224
9	0.78	342	0.60	219
10	0.90	335	0.55	205

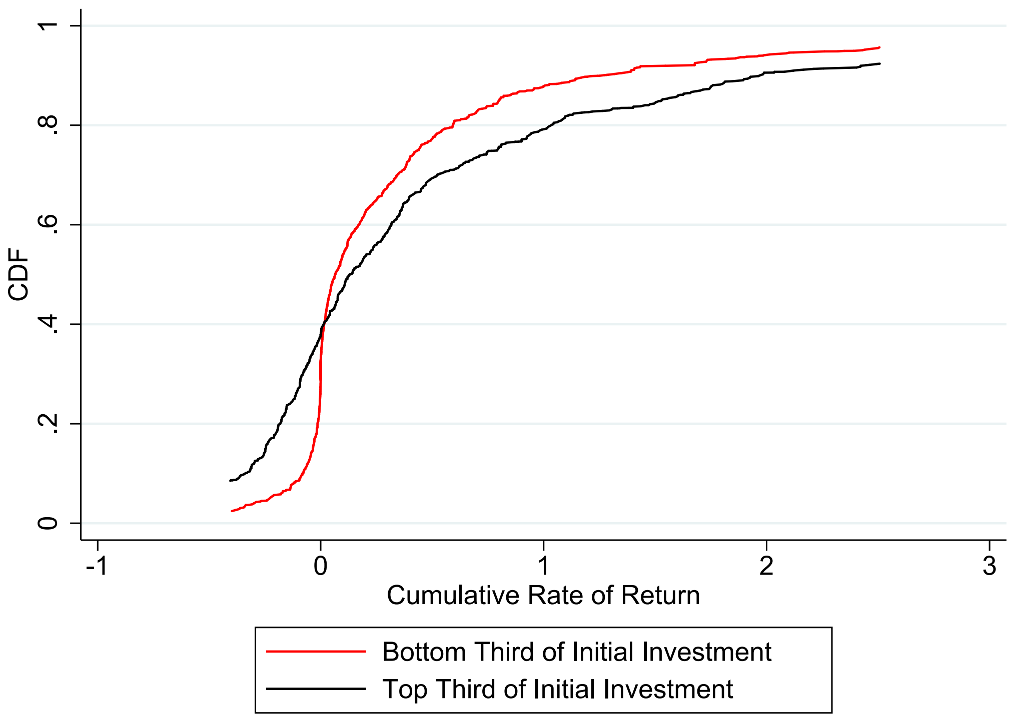
In table 15, it's clear that the calculated rates of return is a much better measure of business success at the bottom of the distribution than profits. While the majority of firms with negative profits are exiting, some of those that remain have relatively high rates of return, generally because they are accumulating substantial assets while earning negative profits. At the top, the rate of return measure is much less successful than cumulative profits at predicting survival.

A.8 Rate of Return Dispersion

If these entrepreneurs who are making larger initial investments are really taking on more risk, their rates of return should be more dispersed. Successful entrepreneurs should earn higher rates of return while unsuccessful entrepreneurs should earn lower rates of return. Comparing the distribution of returns, should be informative about the relative levels of risk. Again ranking firms by the amount of their owner's money that is invested in the first year.

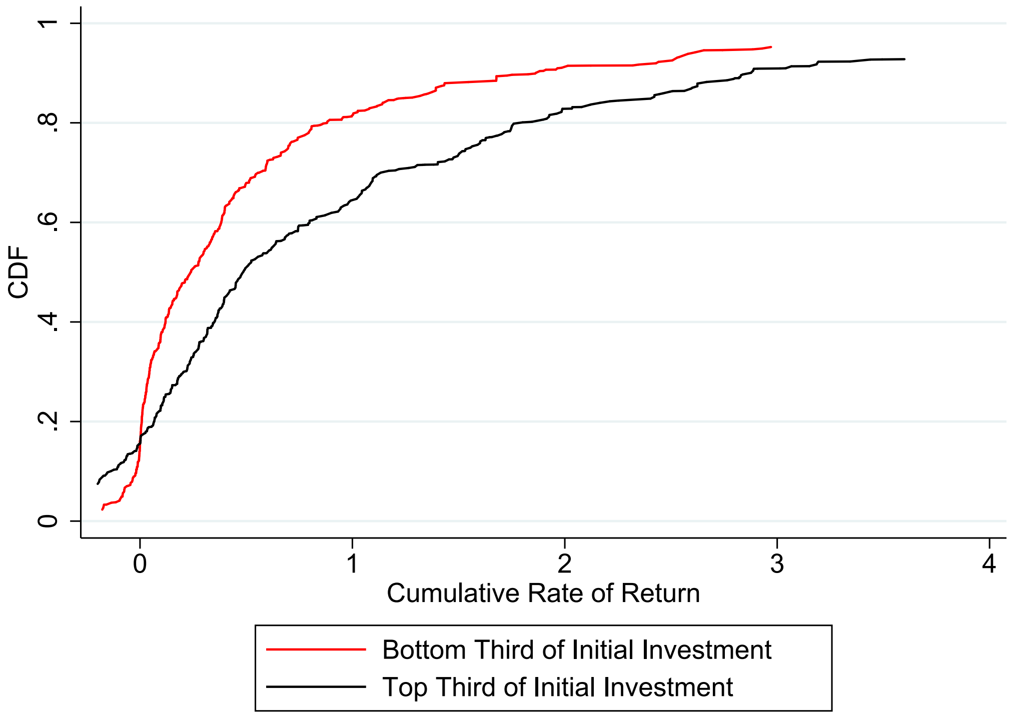
Figure 21 plots the cumulative density of the returns of the firms in the bottom third of initial investment against those in the top third of initial investment. Just as in the previous profit graphs, higher initial investment firms are earning more dispersed rates of return. On the far left, there is a greater mass of high initial investment firms that are earning negative rates of return, while on the far right, there are more high initial investment firms that are earning high rates of return. I interpret this as suggestive evidence that entrepreneurs who are investing more in their businesses are also taking on more risk.

Figure 21: Dispersion in Rates of Return



This figure shows the cumulative distribution of cumulative returns for firms. It plots the distribution of returns for firms in both the bottom third and top third of the distribution of owner's initial investment. The figure is truncated at the top and bottom 5% of returns.

Figure 22: Dispersion in Rates of Return Conditional on Survival



This figure shows the cumulative distribution of cumulative returns for firms. It plots the distribution of returns for firms in both the bottom third and top third of the distribution of owner's initial investment. The figure is truncated at the top and bottom 5% of returns.

B Empirical Facts from the Survey of Consumer Finances

In this section I document several facts from the 2004 Survey of Consumer Finances in regards to the relationship between entrepreneurship and wealth.

B.1 Wealth To Income Ratios

One key empirical fact that has motivated the study of borrowing constraints in entrepreneurship, is the fact that entrepreneurs have higher wealth-to-income ratios than workers. Quadrini (1999) table 1 regresses the wealth to income ratios of households in the PSID and the SCF on a binary variable for entrepreneurship, the level of income, and a polynomial in age. He finds that the coefficient on the entrepreneurship dummy to be positive and significant, suggesting that entrepreneurial households have on average higher wealth-to-income ratios than other households. The first column of table 16 replicates this result with data from the Survey of Consumer Finances.

Table 16: Wealth To Income Ratios of Entrepreneurs

	(1)	(2)	(3)
	$\frac{\text{Wealth}}{\text{Income}}$	$\frac{\text{Non-Bus Wealth}}{\text{Income}}$	$\frac{\text{Fin Wealth}}{\text{Income}}$
Entrepreneur	13.2912***	2.1269	0.4986
	(1.4984)	(1.2048)	(0.4788)
Income	Yes	Yes	Yes
Age FEs	Yes	Yes	Yes
Educ FEs	Yes	Yes	Yes
Observations	4498	4498	4498

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

However, the quantitative significance of this result is somewhat questionable. As documented in DeBacker et al. (2018), entrepreneurial earnings are much more volatile than labour earnings. The following simple numerical exercise illustrates how more volatile incomes can also generate this result.

Consider an economy populated by 2 workers and 2 entrepreneurs. All agents have the same level of wealth, equal to 3. All agents have the same expected income, equal to 1. Worker's income is certain and equal to one. However, entrepreneurs face some risk, and half the time receive 0.5 and half the time receive 2. Calculating the average of the wealth-to-income ratios for the two types of workers will give:

$$\overline{W/I}^{\text{Worker}} = \frac{1}{2}\left[\frac{3}{1} + \frac{3}{1}\right] = 3$$

$$\overline{W/I}^{\text{Entrepreneur}} = \frac{1}{2}\left[\frac{3}{0.5} + \frac{3}{1.5}\right] = 4$$

Simply because the entrepreneurs have more volatile income, their average wealth-to-income ratio is much higher than the workers, despite the fact that both groups have the same average income and average wealth. To determine whether this arithmetic consideration drives the regression result, table 17 compares the average of individual level wealth-to-income to the group's ratio of average wealth to average income for selected percentiles of the wealth distribution.

$$\overline{W/I} = \frac{1}{n}\sum_{i=1}^{n}\frac{W_i}{I_i}$$

$$\bar{W}/\bar{I} = \frac{\frac{1}{n}\sum_{i=1}^{n} W_i}{\frac{1}{n}\sum_{i=1}^{n} I_i}$$

Table 17: Individual vs. Group Level Wealth-to-Income Ratios

	$\overline{W/I}$		$\bar{W}/\bar{I}$	
	Entrepreneurs	Others	Entrepreneurs	Others
99.5% - 100%	57.9	39.0	16.9	15.4
99% - 99.5%	48.9	27.0	15.3	11.8
95% - 99%	19.7	25.9	11.1	11.8
90% - 95%	15.9	14.5	8.9	9.3
80% - 90%	9.9	12.0	6.6	6.8
60% - 80%	5.9	7.0	3.9	4.0
40% - 60%	3.6	3.3	2.2	2.0
20% - 40%	1.3	1.2	0.8	0.7
0% - 20%	-0.3	-0.2	-0.3	-0.2
Total	12.4	4.8	6.4	2.7

The wealth-to-income ratios of entrepreneurial households look much closer to other households when calculated by the group's ratio of average wealth to average income. This suggests that the more volatile nature of entrepreneurial income is at least one part of the explanation of this result that entrepreneurs typically have higher wealth-to-income ratios.

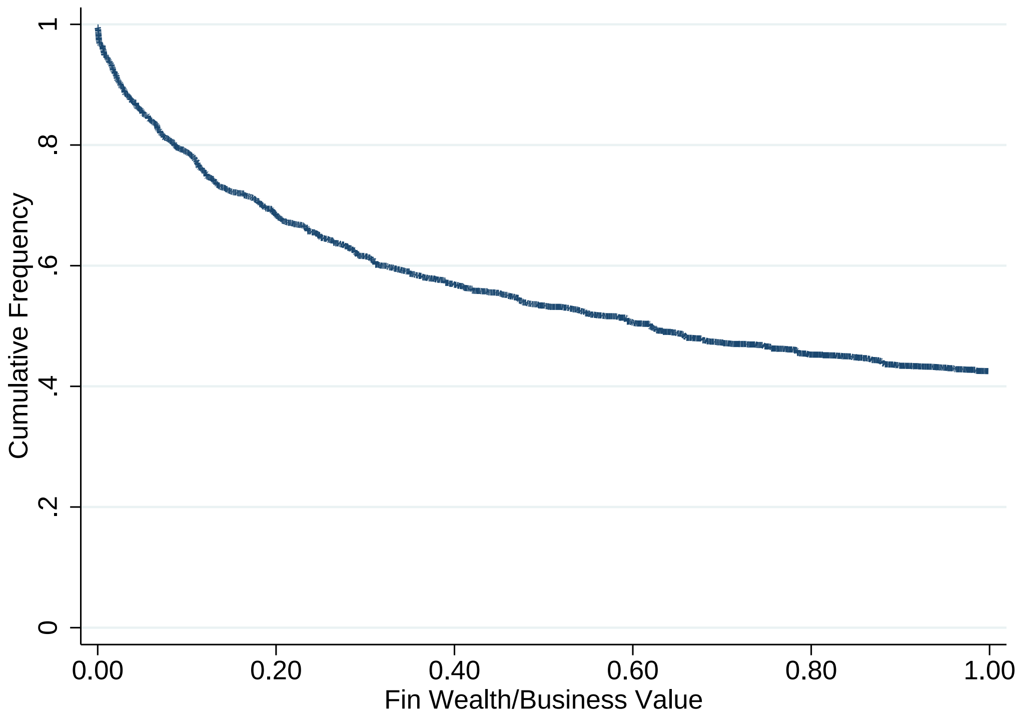
B.2 Entrepreneurial Wealth Composition

If an entrepreneur is borrowing constrained, they should have relatively few financial assets outside their business. If borrowing constraints raise the cost of external financing, entrepreneurs should liquidate most of their financial assets in order to fund their business internally. One measure of the strength of borrowing constraints that entrepreneurs face is then the proportion of their assets they keep outside the business.

To assess this, I calculate the ratio of financial wealth to business value for each entrepreneur. Entrepreneurs who are borrowing constrained, and wish to expand the scale of their business should have low values of this ratio, as they should liquidate financial assets in order to invest in their business. Figure 23 shows the distribution of this ratio for all entrepreneurs. I plot the inverse CDF, so that the far left side of the graph shows that 100% of entrepreneurs could liquidate financial assets worth

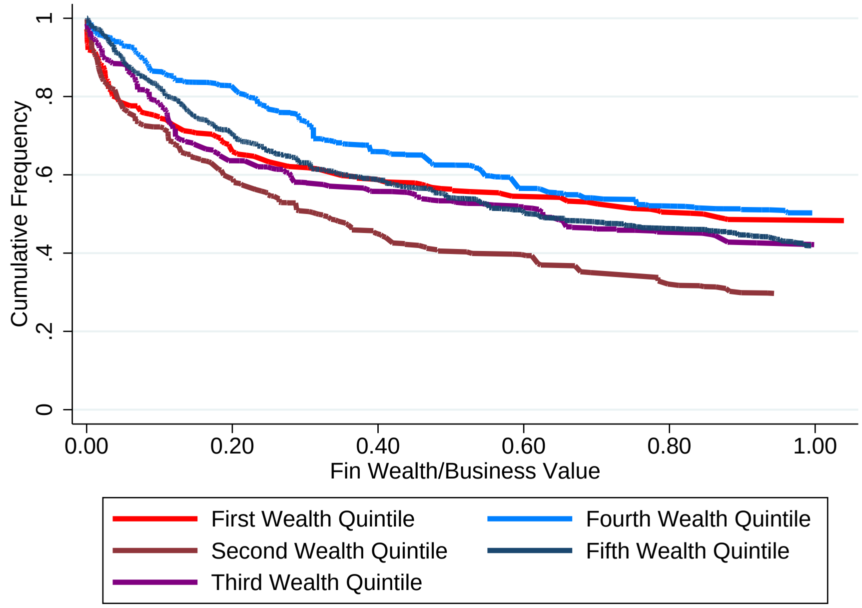
1% of their business and the far right side of the graph shows that just over 40% of entrepreneurs could liquidate financial assets worth 100% of their business. While there are certainly some entrepreneurs who have few financial assets outside of their business, the vast majority have substantial financial assets outside of their business. Figures 25 and 24 break down this graph by quintiles of business value and quintiles of net worth respectively.

Figure 23: Cumulative Frequency of the Ratio of Financial Wealth to Business Value



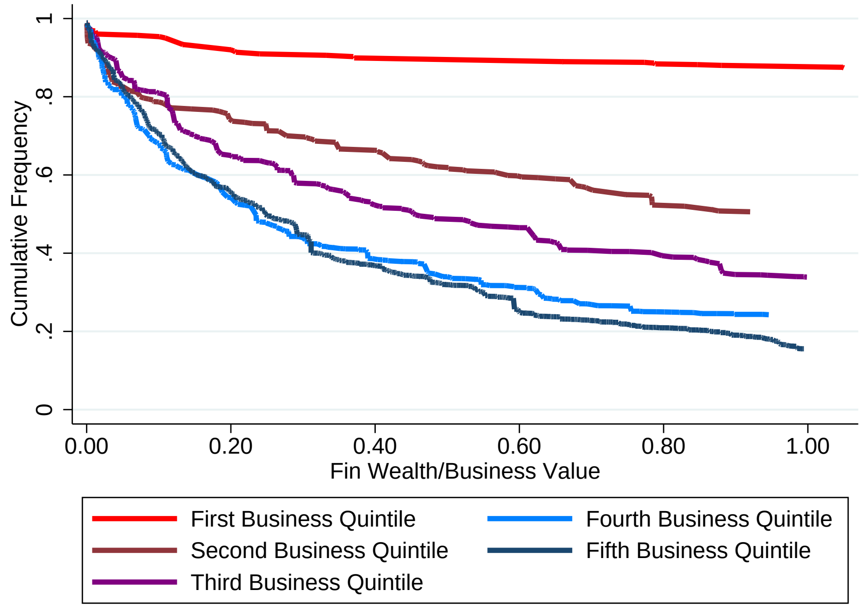
This figure shows what proportion of entrepreneurs would be able to liquidate their financial investments and make an x% investment in their firm. The horizontal axis plots the ratio of financial assets to business value and the vertical axis plots the inverse CDF.

Figure 24: Cumulative Frequency of the Ratio of Financial Wealth to Business Value, by Net Worth



This figure shows what proportion of entrepreneurs would be able to liquidate their financial investments and make an x% investment in their firm. The horizontal axis plots the ratio of financial assets to business value and the vertical axis plots the inverse CDF. Each of the five lines corresponds to a different quintile of networth.

Figure 25: Cumulative Frequency of the Ratio of Financial Wealth to Business Value, By Business Value



This figure shows what proportion of entrepreneurs would be able to liquidate their financial investments and make an x% investment in their firm. The horizontal axis plots the ratio of financial assets to business value and the vertical axis plots the inverse CDF. Each of the five lines corresponds to a different quintile of the value of businesses.

C Computational Algorithm

I solve the model in Section 4 by adapting the algorithm outlined in Dyrda and Pugsley (2018). Solving for the decision rules on a grid of resources (res), rather than over both a and k, allows a reduction in the state space, aiding the computational tractability of this problem.

Given a wage w, I solve for decision rules by

- Initial Guess:
  - Guess $c(\cdot)$ equal to some constant fraction of total resources.
  - Guess $res'(\cdot) = res$
  - Guess $V(\cdot) = \frac{c^{1-\frac{1}{\theta}}}{1-\frac{1}{\theta}}/(1-\psi\beta)$
  - Guess occupational choice: all agents choose to stay in their current occupation
- Iterate over the value function. Set $i = 1$.
  - Given the current value function, use the envelope condition to determine current consumption:
$$c_i^E = \left(\frac{\partial V_i^E(\cdot)}{\partial res}\right)^\theta$$
$$c_i^W = \left(\frac{\partial V_i^W(\cdot)}{\partial res}\right)^\theta$$
  - Solve for the entrepreneur's portfolio allocation by iterating over next period resources res'. Set $j = 1$
    * Given c_i^E, use the FOC for k' to determine capital:
$$k_{ij}'^E = \frac{\tilde{z}...}{\mathbb{E}[\lambda_2]...}$$
    * Given c_i^E and $k_{ij}'^E$, use the budget constraint to determine a':
$$a_{ij}'^E = res - c_i^E - k_{ij}'^E$$
    * Given $a_{ij}'^E$, $k_{ij}'^E$ and the future occupational choices, compute $res_{ij}'^E$ for each possible future state
    * Compute distance between $res_{ij}'^E$ and $res_{ij-1}'^E$, if converged exit. Else set $j = j + 1$ and return to start of inner loop.
  - Since workers can save only in a single asset, their portfolio problem is trivial:
$$a_i'^W = res - c_i^W$$
  - Solve for the new entrepreneur's portfolio allocation by iterating over the resources they will have after starting the business $\tilde{res}$. Set$j = 1$
    * Given $\tilde{res}$, use the FOC for k to determine capital:
$$k_{ij}^{NE} = \frac{\tilde{z}...}{\mathbb{E}[\lambda_2]...}$$

- * Given k_{ij}^{NE}, use the budget constraint to determine $\tilde{a}$:

$$\tilde{a}_{ij}^{NE} = res - k_{ij}^{NE}$$

- * Given $\tilde{a}_{ij}^{NE}$ and k_{ij}^{NE} compute $r\tilde{e}s_{ij}^{NE}$ for each possible z
- * Compute distance between $r\tilde{e}s_{ij}^{NE}$ and $r\tilde{e}s_{ij-1}^{NE}$, if converged exit. Else set $j = j + 1$ and return to start of inner loop.

– For each point

- Solve for consumption:
- Given consumption, use the FOC for k to determine capital:

$$k' = \frac{\tilde{z}...}{\mathbb{E}[\lambda_2]...}$$

- Given consumption and capital, use the budget constraint to determine a':

$$a' = res - c - k'$$

- Update r'
- Update occupational choice
- Update value functions
- Check convergence in value functions

With the decision rules solve, I then simulate a fixed mass of agents on a discretion grid of $a \times k \times h \times z \times x$. I guess a uniform distribution over this state space and then iterate until the distribution converges. I use a bisection search to determine the wage that clears the labour market in this economy.