8-2017

On the relationship between household wealth and entrepreneurship

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On the Relationship between Household Wealth and Entrepreneurship*

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August 15, 2017

Abstract

Motivated by a substantial number of startup owners with negative household net worth, I present a model that incorporates credit borrowing into Evans and Jovanovic [1989]. The estimated model generates no relationship between household wealth and the propensity for business entry. Ignoring credit borrowing for potential business owners substantially overstates the efficiency loss from financial constraints in business entry. However, the efficiency loss in investments by the entrants is large even if credit borrowing is allowed. Individuals who start a business once credit borrowing is available are those whose business ideas are of a high-enough quality to compensate high financing costs associated with credit borrowing. They start a business with a sub-optimal amount of investments, and those agents' unrealized investments are considerable.

JEL Classification: J23, L26, M13

Keywords: entrepreneurship, financial constraints, credit borrowing

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*I thank Sungbae An, Alexander Karaivanov, Sunha Myong, and participants of the 2016 Asian Meeting of the Econometric Society for helpful comments. All errors are my own.

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1 Introduction

One of the most fundamental questions in entrepreneurial finance is whether financial constraints hinder entrepreneurial activities. Most government policies for small businesses are based on the presumption that financial constraints generate inefficiency in the creation of new businesses or in the investment by existing businesses. Despite this presumption, the answer to the above question is still unclear.

On the one hand, many papers argue financial constraints impede entrepreneurial activities, by showing the propensity to become a business owner is a positive function of household or personal wealth (e.g., Evans and Jovanovic [1989], Evans and Leighton [1989], Holtz-Eakin et al. [1994], Fairlie and Krashinsky [2012], Sauer and Wilson [2016]). By exploiting housing price variations, Corradin and Popov [2015], Adelino et al. [2015], and Schmalz et al. [2017] draw a similar conclusion. On the other hand, other findings suggest financial constraints are not empirically important in deterring business formation. For example, Hurst and Lusardi [2004] document no relationship between household net worth and business entry over the majority of the wealth distribution, except for the very top. Using a localized housing price variation, Kerr et al. [2015] argue housing collateral is not a major barrier to entrepreneurship.[1]

Using the Survey of Income and Program Participation (SIPP), I first document that a substantial number of individuals with negative household net worth start a business. Their observable characteristics are similar to, but their log business earnings are greater than, startup owners with positive and below-median net worth. With additional data sources such as the Kaufmann Firm Survey (KFS) and the Small Business Credit Survey (SBCS), I show

[1] In a related view, Robb and Robinson [2014] show startup firms rely heavily on external debt for financing, which may suggest a well-functioning credit market for business creation.

credit borrowing is likely to be the main source of financing for those individuals.[2] Consistent with Hurst and Lusardi [2004] and Kerr et al. [2015], this finding may support the view that household-level net worth is not a major barrier to business creation.

With a high cost associated with credit borrowing, however, whether the entrants are investing at their optimal scale, especially when they enter with a relatively small amount of collateral, is not clear. Figure 1 shows the time trend of mortgage and credit card interest rates between 1996 and 2013.[3] For all years, the interest rate for credit borrowing is almost double the interest rate for mortgage, with the premium for credit borrowing being about 8%. With this high interest rate premium, individuals with negative net worth, who primarily rely on credit borrowing for staring a business, may have to pay a high financing cost to start a business.

The main contribution of this paper is to quantify the extent to which financial constraints hinder business entry and investments by the entrants given that individuals can start a business using credit borrowing. To this end, I present and structurally estimate a model of financial friction that allows individuals without net worth to start a business through credit borrowing. Using the estimated model, I measure the importance of financial constraints to business entry and to investments by the entrants. The estimated model implies 1.44% of potential business owners are discouraged to start a business, and 6.07% of potential investments by the entrants are not realized due to financial constraints.

Many models with financial constraints, for example Evans and Jovanovic [1989], can-

[2] Related to this finding, Chatterji and Seamans [2012] show an exogenous increase in credit borrowing leads to an increase in business creation, using a credit card deregulation in the early 1980s in the United States.

[3] The mortgage rate is a 30-year conventional mortgage rate, which is contract interest rates on commitments for fixed-rate first mortgages. The credit card interest rate is the commercial bank interest rate on credit card plans. (Source: Federal Reserve Economic Data (FRED))

not rationalize the behavior of individuals who start a business with negative net worth. In those models, the amount of borrowing is limited to a proportion of the household net worth. Therefore, anyone without net worth cannot finance and cannot start a business. I relax this assumption by incorporating credit borrowing into Evans and Jovanovic [1989]. Individuals with high entrepreneurial productivity can now start a business through credit borrowing even without household net worth.

I parsimoniously model a friction in credit borrowing. Following the theoretical findings on consumer credit (e.g., Chatterjee et al. [2007]), I model the interest rate premium associated with credit borrowing to be monotonically increasing as the amount of credit borrowing increases. How fast it is increasing depends on one parameter. The model nests Evans and Jovanovic [1989] in that if the parameter is zero, the model collapses to Evans and Jovanovic [1989] without collateral constraints, and if the parameter goes to infinity, the model becomes Evans and Jovanovic [1989] with collateral constraints. Intuitively, the parameter capturing the credit-borrowing premium can be identified by the behavior of individuals without net worth, because collateral constraints do not affect their decision to become a business owner. The estimated model generates no relationship between household wealth and the propensity to start a business, as observed in the data.

Using the estimated model, I measure the efficiency loss due to financial constraints. About 15.34% of potential business owners in Evans and Jovanovic [1989] cannot start a business, whereas 1.44% of them cannot start a business in the current model. This finding suggests that ignoring the availability of credit borrowing for potential business owners substantially overstates the efficiency loss from financial constraints in business creation. However, unlike the efficiency loss in the extensive margin, the efficiency loss in the intensive margin is large even if credit borrowing is allowed for potential business owners. For example, about 7.69% of investments by the entrants are not realized in Evans and Jovanovic [1989], whereas 6.07% of investments are not realized in the current model.

Many financially constrained agents who cannot start a business in Evans and Jovanovic [1989] are able to start a business if credit borrowing is available. However, they start a business with a sub-optimal amount of investments, and those agents' unrealized investments are considerable. Individuals who start a business once credit borrowing is available are those whose business idea is of a high-enough quality to compensate high financing costs associated with credit borrowing. Those productive agents' unrealized investments are likely to be higher.

The paper is organized as follows. Section 2 describes the data. The model is discussed in section 3. Section 4 discusses the identification and the estimation of the model. The main results are presented in section 5. Section 6 concludes.

2 Data

2.1 Sample Construction

I use the SIPP for this study. The SIPP is a nationally representative household-based survey of the US population, designed to collect information for income and program participation. Each panel of the SIPP follows a large number of respondents, ranging from approximately 14,000 to 36,000 for three or four years. I use the 1996, 2001, 2004, and 2008 panels.[4] Due to the large number of respondents, I can observe a relatively large number of individuals when they first start a business. The SIPP also provides household-level net worth, one of the most

[4] I do not include panels before 1996, because the SIPP's survey design changed before 1996, and some of the variables before and after 1996 panel are not consistent. Panels after 1996 are not overlapping.

important variables for this study.

The sample construction is similar to that in the literature (e.g., Evans and Jovanovic [1989], Hamilton [2000], Hurst and Lusardi [2004]). The main sample is a two-year panel. In the first year, every individual is a worker. In the second year, some of the workers in the first period start a business. The SIPP interviews a respondent every four months, and each time, called a wave, it asks whether the respondent owns a business. A respondent is defined as a business owner in a given year if he answers yes to the question "Did you own a business?" *and* his working hours for the business are greater than his wage working hours[5] at least once out of the three interviews during the year. I choose white males, ages 18-65, who are employed in the first year as the main sample to avoid any complication associated with labor market participation and retirement issues. I drop individuals without information on household net worth and individuals with household net worth above 10 million USD.[6] I also drop individuals with no information on years of education or no information on wage earnings in the second period.

To make earnings a yearly measure, I conduct the following imputation. First, I consider the monthly earnings during the interview month as the monthly earnings representing the wave, because little variation is present in monthly earnings within the same wave. Suppose a respondent reported earnings for only two waves and the total amount of earnings was $5,000. I then calculate the annual earnings for that respondent as $\$5,000 \times \frac{12}{2}$. For those who did not report business earnings in the first year of operating a business, I impute the business earnings by using the subsequent year's business earnings if they are available.

[5] This definition is to differentiate an active business owner from a casual business owner.

[6] All the money values in this paper are normalized by 1 USD in 2011 unless otherwise indicated.

2.2 Summary Statistics

The summary statistics of the sample are reported in Table 1. Of 41,805 workers in the final sample, about 2.2% started a business in the subsequent year. The mean of startup owners' household-level net worth before they start a business is greater than that of the non-entrants. As is well documented in the literature (e.g., Hamilton [2000]), the mean of startup owners' first-year earnings are less than the mean of wage earnings by those who remain as workers. Regarding years of education, years of experience, and marital status, the groups are similar to each other. Table 2 further shows the initial wealth distribution for workers and startup owners. The wealth distribution of startup owners is more dispersed than that of individuals who remain as workers. In particular, 14.18% of startup owners started a business with negative wealth.

Table 3 reports results from probit regressions for business entry similar to Hurst and Lusardi [2004]. In the first equation, I include a polynomial of five degrees for net worth among covariates. In the second equation, I instead include two dummies, one indicating individuals whose net worth is between the 80th and 95th percentiles, and the other indicating individuals whose net worth is above the 95th percentile. The predicted probabilities by two probit analyses are shown in Figure 2. As in Hurst and Lusardi [2004], the positive relationship between net worth and the probability of business entry is most distinctively observed among those whose net worth is above the 95th percentile of the wealth distribution. On the other hand, the increase in the probability of business entry over the wealth distribution up to the 80th percentile is relatively small. In particular, the predicted probability of business entry among individuals with negative net worth is similar to that of individuals with positive net worth and whose wealth distribution is below the 80th percentile.

Table 4 shows the summary statistics for startup owners with negative net worth. Their observable characteristics, including wage earnings in the first period, years of experience, and years of education, are similar to those for startup owners with positive and below-median net worth. On the other hand, the mean and median of business earnings for startup owners with negative net worth are greater than for startup owners with positive and below-median net worth.

2.3 Financing through Credit Borrowing

In this section, I first describe a broad picture of credit borrowing among startup owners by using the KFS and SBCS. Then I provide evidence that the negative-wealth owners in the SIPP primarily rely on credit borrowing to start a business.

The SIPP does not provide the source of startup financing. To understand how individuals without net worth could finance the initial investment, I first refer to the KFS, a longitudinal survey for 4,928 US businesses started in 2004. The survey asks about the source of startup financing in great detail.[7] One observation from the KFS is that not many startup owners use credit card debt to finance the initial investment. For example, only 25% of startup owners used personal credit card debt for startup financing.[8] However, for those who use credit card debt, the average amount is not trivial. For example, Table 5 shows the mean personal/business credit card balances for startup owners. The overall average credit card balance for those who use them is 38,725 USD in 2004.

[7]Information about initial financing is not available in the publicly available KFS data. Instead, I refer to Robb and Robinson [2014], who comprehensively summarize the pattern of the initial financing for startup firms in the KFS data.

[8]Robb and Robinson [2014], p. 13.

The SBCS, a survey conducted by seven US Federal Reserve Banks,[9] also provides information about unsecured borrowing among small firms. The survey is designed to collect information about business performance, financing needs and choices, and borrowing experiences of firms with fewer than 500 employees. In particular, the survey conducted in 2015 provides the proportion of firms that used unsecured debt for financing. Of the 2,250 surveyed firms, 16% report usage of unsecured debt. If we condition on firms whose revenue size is smaller than 100,000 USD in 2015, the proportion of businesses that used unsecured debt increases to 30%.

Even though the SIPP does not provide the source of startup financing, we can observe the changes in unsecured debt in one year in which some of the respondents start a business. Table 6 shows the regression estimates for the changes in unsecured debt. For those who started a business with negative net worth, unsecured debt on average increased 23,391 USD more than the population. By contrast, the change in unsecured debt for startup owners with positive net worth is not significantly different from the change in unsecured debt for the population.[10] This finding is consistent with the results from the KFS discussed above: few startup owners use unsecured debt for financing, but for those who do, the amount of unsecured debt is not trivial. Based on the result in Table 6, those who rely on credit borrowing are more likely to be those whose net worth is limited.

[9]The Federal Reserve Banks [2015]

[10]The measure should be interpreted with caution because the changes in unsecured debt before and after the start of a business may not reflect the actual amount of debt used for financing the business. For example, the initial unsecured debt may already reflect the borrowing from a bank. Likewise, the unsecured debt after the start of a business may reflect a repayment to the bank.

3 The Model

Many models with financial constraints, for example Evans and Jovanovic [1989], cannot rationalize the behavior of the individuals who start a business without net worth. In those models, the amount of borrowing is limited to a proportion of household net worth, and someone without positive net worth cannot borrow and hence cannot start a business. However, as shown in section 2, about 14% of business entrants started a business with negative net worth. To rationalize their behaviors, I modify Evans and Jovanovic [1989] to allow individuals with negative net worth to start a business through credit borrowing. I first briefly describe Evans and Jovanovic [1989] and discuss the component I augment.

3.1 Basic Setup

The model is a static occupational choice model between a worker and a business owner with borrowing constraints. Every agent is a worker in the first period. Before the beginning of the second period, each agent draws a business idea. Depending on the quality of the business idea and the availability of funding, each agent decides whether to start a business in the second period.

Utility is linear in consumption. The following equations determine wage earnings and business earnings:[11]

$$w = \theta_w \epsilon_w \tag{1}$$

$$y = \left\{\theta_s k^\alpha - rk\right\}\epsilon_s. \tag{2}$$

[11] To make the model consistent with the data, I allow a random shock on the profit rather than the output.

θ_w represents worker productivity. θ_s represents the quality of the business idea or the entrepreneurial productivity. The production technology is decreasing returns to scale with respect to capital k. r is the gross risk-free interest rate. ϵ_s represents a random shock to business earnings. Likewise, ϵ_w is a random shock to wage earnings. ϵ_s and ϵ_s are realized after the capital investment and the occupational choice. The expectation over ϵ_w and ϵ_s are both equal to one.

The financial market exhibits a friction in the forms of collateral constraints. Independent of the quality of the business idea, the maximum amount of borrowing is limited to $(\lambda - 1)A$, where λ is greater than 1 and A is the household net worth. Therefore, the total amount of capital investment is limited to $A + (\lambda - 1)A = \lambda A$.

Under this environment, an agent becomes a business owner if and only if

$$\max_{k \in [0, \lambda A]} \mathbb{E}\big[\big(\theta_s k^\alpha - rk\big)\epsilon_s\big] > \mathbb{E}[w].$$

An implication of this equation is that even if an agent's business idea is superb, the agent will not be able to start a business if his net worth is relatively small. Another implication is that agents with negative household net worth cannot start a business, which contradicts the data observation discussed in section 2. To address this issue, I incorporate credit borrowing into the financial market in Evans and Jovanovic [1989].

3.2 Credit Borrowing

The environment under which unsecured credit arises has been developed to understand consumer credit (e.g., Chatterjee et al. [2007]) and foreign debt (e.g., Arellano [2008]).[12] In such

[12] Akyol and Kartik [2011] use a similar setup to study the relationship between the US bankruptcy laws and the cost of credit borrowing for entrepreneurs.

models, the fact that borrowers can default conditional on the realization of a shock makes the interest rate higher than the risk-free rate. Moreover, the interest rate for unsecured credit monotonically increases as amount of unsecured borrowing increases. Based on this theoretical result, I parsimoniously model unsecured credit in the following way.[13]

Agents are now allowed to borrow more than λA, but they have to pay an interest premium for the amount of loans exceeding λA. Moreover, the premium for the credit borrowing f is an increasing function of the amount of unsecured credit x. That is,

$$f(0) = 0, \quad f'(x) \geq 0, \quad f'(0) < \infty.$$

The value function as a worker and as a business owner becomes

$$V_w(x_1, x_2) = \theta_w$$

$$V_s(\theta, A) = \begin{cases} \theta_s^{\frac{1}{1-\alpha}} \left\{ \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} - r\left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}} \right\} & \text{if} \quad \lambda A \geq \left(\frac{\alpha\theta_s}{r}\right)^{\frac{1}{1-\alpha}} \\ \\ \max_k \mathbb{E}\big[\big\{\theta_s k^\alpha - r\lambda A - (r + f(k - \lambda A))(k - \lambda A)\big\}\epsilon_s\big] & \text{if} \quad \lambda A < \left(\frac{\alpha\theta_s}{r}\right)^{\frac{1}{1-\alpha}} \end{cases}$$

and the distribution of earnings for each occupation will be

$$Y_w(x_1, x_2) = \theta_w \epsilon_w$$

$$Y_s(\theta, A) = \begin{cases} \theta_s^{\frac{1}{1-\alpha}} \left\{ \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} - r\left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}} \right\}\epsilon_s & \text{if} \quad \lambda A \geq \left(\frac{\alpha\theta_s}{r}\right)^{\frac{1}{1-\alpha}} \\ \\ \big\{\theta_s \hat{k}^\alpha - r\lambda A - (r + f(\hat{k} - \lambda A))(\hat{k} - \lambda A)\big\}\epsilon_s, & \text{if} \quad \lambda A < \left(\frac{\alpha\theta_s}{r}\right)^{\frac{1}{1-\alpha}} \end{cases}$$

[13] A moral hazard problem between a lender and an entrepreneur can also increase the interest rate for credit borrowing more than the risk-free interest rate (e.g., Paulson et al. [2006]).

where $\hat{k}$ is the optimal investment under financial constraints. The existence and the uniqueness of $\hat{k}$ are discussed in Appendix A. Under this circumstance, agents with negative net worth ($A \leq 0$) can start a business if the quality of the business idea is high enough.

4 Estimation

4.1 Specification

Before estimation, I first specify worker productivity (θ_w), the wage-earning shock (ϵ_w), entrepreneurial productivity (θ_s), the business-earning shock (ϵ_s), and the credit-borrowing premium (f).

4.1.1 Specification for $\{\theta_w, \epsilon_w, \theta_s, \epsilon_s\}$

The specification is similar to Evans and Jovanovic [1989] and Paulson et al. [2006]. Worker productivity is a function of the years of education and experience.[14] I also allow wage productivity to depend on the marital status given that the wage earnings for married individuals are significantly higher than for single individuals in the sample. Specifically, $\theta_w = \mu_0 + \mu_1 \ln x_1 + \mu_2 \ln x_2 + \mu_3 \mathbb{I}_M$, where x_1, x_2, $\mathbb{I}_M$ are years of education, years of experience, and the dummy variable indicating married individuals, respectively. ϵ_w is assumed to be a log-normal distribution with mean equal to 1 ($\mathbb{E}[\epsilon_w] = 1$) as specified in equation (1).[15] As a result, the wage equation is

$$\ln w = \mu_0 + \mu_1 \ln x_1 + \mu_2 \ln x_2 + \mu_3 \mathbb{I}_M + \ln \epsilon_w. \tag{3}$$

[14]Experience is calculated as age minus years of education.

[15]Therefore, $\ln \epsilon_w$ follows the normal distribution of mean $-\sigma_w^2/2$ and variance σ_w^2.

The log value of the entrepreneurial productivity is assumed to follow a normal distribution:

$$\ln \theta_s = \beta_0 + \beta_1 \ln A + \beta_2 \ln x_1 + \beta_3 \ln x_2 + \eta, \tag{4}$$

where $\eta \sim N(0, \sigma_\eta^2)$. A higher level of assets may reflect higher entrepreneurial productivity. Or the correlation between the propensity to become a business owner and net worth may reflect individuals' different preferences (e.g., Hamilton [2000], Cressy [2000], Hurst and Lusardi [2004], Hurst and Pugsley [2011], Nanda [2010], Akyol and Kartik [2011]). Instead of explicitly modelling such cases, I allow household net worth to be correlated with entrepreneurial productivity. I also allow entrepreneurial productivity to be correlated with years of education and experience. η is independent of the wage and business-earning shocks.

I normalize one unit of monetary value as 10,000 USD in 2011.[16] Equation (4) includes the log value of net worth, and I assume the entrepreneurial productivity is on average the same for individuals with less than 10,000 USD. Therefore, β_1, the coefficient for $\ln A$ in equation (4), captures the percentage gains in productivity as the net worth increases from 10,000 USD.

The distribution of business earnings looks similar to a log normal distribution, but with a possible realization of negative earnings. The specification for ϵ_s captures these features:

$$\epsilon_s = \tilde{\epsilon}_s - P_s, \quad \log \tilde{\epsilon}_s \sim N(\mu_s, \sigma_s^2), \quad \mathbb{E}[\epsilon_s] = 1,$$

where P_s is a positive constant. Note that P_s governs the proportion of business owners with negative earning.

Finally, I set the risk-free gross interest rate, r, as 1.1 following the literature (e.g., Evans and Jovanovic [1989], Xu [1998], Paulson et al. [2006]).

[16] Evans and Jovanovic [1989] use 1,000 USD in 1976 as one unit of monetary value.

4.1.2 Specification for the credit-borrowing premium

Based on the theoretical prediction, I assumed f to be an increasing function of the amount of credit borrowing with $f(0) = 0$ and $f'(0) < \infty$. Identifying the exact shape of f is not feasible. I impose a functional form assumption on f with respect to the amount of credit borrowing. In doing so, I implement three different types of specifications, and compare the results:

$$
\begin{aligned}
f(x) &= (1) \quad \gamma x \\
&= (2) \quad \frac{\gamma x}{1+\gamma x} \\
&= (3) \quad \exp(\gamma x) - 1,
\end{aligned}
$$

where $\gamma \geq 0$ and x is the amount of credit borrowing.

The above specifications share three common properties. First, they are increasing with respect to x for any γ. Second, γ is equal to zero means no interest premium is associated with credit borrowing, and the model collapses to Evans and Jovanovic [1989] without collateral constraints. Third, if γ goes to infinity, the model converges to Evans and Jovanovic [1989] with collateral constraints. The key difference is their first derivative with respect to x. It is constant in the first specification, decreasing in the second specification and increasing in the third specification. I present the first specification as the main result. The results from the other two specifications are presented in Appendix B.

4.2 Identification

The model is fully characterized by parameters for the wage equation $\{\mu_0, \mu_1, \mu_2, \mu_3, \sigma_w\}$, parameters for the business earnings $\{\beta_0, \beta_1, \beta_2, \beta_3, \sigma_\eta, \sigma_s\}$, parameters for financial constraints

$\{\lambda, \gamma\}$, and the degree of returns to capital α.[17]

For identification, I exploit the following idea. The effect of financial constraints can be different across the wealth distribution. For example, agents in the lower percentile of the wealth distribution are more likely to be affected by financial constraints than agents in the upper percentile of the wealth distribution. If an agent's net worth is large enough, he may not be financially constrained, and the primary reason for him to become a business owner is the productivity gains. Therefore, the occupational choice and the business earnings for those wealthy agents can be informative of the distribution of entrepreneurial productivity.[18]

Given the distribution of entrepreneurial productivity, only two financial-constraint parameters influence the probability of starting a business for financially constrained agents: one for the credit-borrowing premium (γ), and the other for the collateral constraint (λ). In particular, the occupational choice of individuals with negative net worth can be informative in pinning down γ, because they are not eligible for collateral borrowing. Once γ is identified, the occupational choice of individuals with positive but small amount of net worth can be informative in determining λ.

Now, I formally address the above argument. I first show how other parameters can be identified given α, and later discuss the identification of α. To begin with, the coefficient governing the wage earnings, $\{\mu_0, \mu_1, \mu_2, \mu_3, \sigma_w\}$, can be identified by the linear regression of log wage earnings, because the wage-earning shock (ϵ_w) is independent of the unobserved entrepreneurial productivity (η).

To identify the parameters for the entrepreneurial productivity distribution, $\{\beta_0, \beta_1, \beta_2, \beta_3,$

[17]For expositional convenience, I normalized P_s as zero.

[18]This argument is similar to that of the identification at infinity (e.g., French and Taber [2011]).

$\sigma_\eta\}$, and the random shock to business earnings, (σ_s), I impose the following assumption.

Assumption 1.

$$1-\alpha > \beta_1$$

Assumption 1 says productivity can be allowed to increase positively with respect to net worth, but the rate of increase cannot be so large to identify the model. As shown in section 3, an individual is not financially constrained if and only if $\left(\frac{\alpha\theta_s}{r}\right)^{\frac{1}{1-\alpha}} < \lambda A$. With the specification for θ in equation (4), this condition is equivalent to

$$\eta < -\beta_0 - \ln\left(\frac{\alpha}{r}\right) + (1-\alpha)\ln\lambda + (1-\alpha-\beta_1)\ln A - \beta_2 \ln x_1 - \beta_3 \ln x_2. \tag{5}$$

Therefore, under Assumption 1,

$$\lim_{A\to\infty} \mathrm{P}(\text{an individual is not financially constrained}) = 1. \tag{6}$$

Equation (6) says that, for any (x_1, x_2), the measure of financially unconstrained agents goes to 1 as A increases. I first show the occupational choice and the first moment of log business earnings for individuals with high wealth, and hence a lower likelihood of being financially constrained, identify $\{\beta_0, \beta_1, \beta_2, \beta_3, \sigma_\eta, \sigma_s\}$.

Individuals who are not financially constrained start a business if and only if $a_0\theta_s^{\frac{1}{1-\alpha}} \geq \theta_w$, where $a_0 = \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} - r\left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}}$. With the specification for θ_w and θ_s, this condition can be written as

$$\frac{\eta}{\sigma_\eta} > \frac{-\beta_0 + (1-\alpha)(\ln \mu_0 - \ln a_0)}{\sigma_\eta} - \frac{\beta_1}{\sigma_\eta} \ln A + \frac{(1-\alpha)\mu_1 - \beta_2}{\sigma_\eta} \ln x_1 + \frac{(1-\alpha)\mu_2 - \beta_3}{\sigma_\eta} \ln x_2 + \frac{(1-\alpha)\mu_3}{\sigma_\eta} \mathbb{I}_M. \tag{7}$$

Denote the right-hand side of equation (7) as GX. $G = [G_0, G_1, G_2, G_3, G_4]$ and $X = [1, \ln A, \ln x_1, \ln x_2, \mathbb{I}_M]'$, where

$$G_0 = \frac{-\beta_0 + (1-\alpha)(\ln \mu_0 - \ln a_0)}{\sigma_\eta} \tag{8}$$

$$G_1 = -\frac{\beta_1}{\sigma_\eta} \tag{9}$$

$$G_2 = \frac{(1-\alpha)\mu_1 - \beta_2}{\sigma_\eta} \tag{10}$$

$$G_3 = \frac{(1-\alpha)\mu_2 - \beta_3}{\sigma_\eta} \tag{11}$$

$$G_4 = \frac{(1-\alpha)\mu_3}{\sigma_\eta}. \tag{12}$$

Note that $\frac{\eta}{\sigma_\eta}$ follows the standard normal distribution, and therefore the probability financially unconstrained individuals becoming business owners is

$$1 - \Phi(GX),$$

where Φ is CDF for the standard normal distribution. Therefore, G can be identified by the occupational choice of individuals with high wealth.

The first moment of log business earnings for this financially unconstrained group can be represented as

$$\mathbb{E}\big[\ln \pi | \text{start a business}\big] = \mathbb{E}\big[\ln a_0 + \frac{\ln \theta}{1-\alpha} + \ln \epsilon_s \big| \text{start a business}\big]$$
$$= \ln a_0 + \frac{\beta_0}{1-\alpha} - \frac{\sigma_s^2}{2} + \frac{\beta_1}{1-\alpha}\ln A + \frac{\beta_2}{1-\alpha}\ln x_1 + \frac{\beta_3}{1-\alpha}\ln x_2$$
$$+ \frac{\sigma_\eta}{1-\alpha}\mathbb{E}\big[\frac{\eta}{\sigma_\eta}\big|\frac{\eta}{\sigma_\eta} \geq GX\big].$$

Denote

$$H_0 = \ln a_0 + \frac{\beta_0}{1-\alpha} - \frac{\sigma_s^2}{2} \tag{13}$$
$$H_1 = \frac{\beta_1}{1-\alpha} \tag{14}$$
$$H_2 = \frac{\beta_2}{1-\alpha} \tag{15}$$
$$H_3 = \frac{\beta_3}{1-\alpha} \tag{16}$$
$$h = \frac{\sigma_\eta}{1-\alpha}, \tag{17}$$

and $H = \{H_0, H_1, H_2, H_3\}$. Note that $\mathbb{E}\big[\frac{\eta}{\sigma_\eta}\big|\frac{\eta}{\sigma_\eta} \geq GX\big]$ is the inverse-mills ratio for the standard normal distribution. Given that G is identified by the occupational choice, $\mathbb{E}\big[\frac{\eta}{\sigma_\eta}\big|\frac{\eta}{\sigma_\eta} \geq GX\big]$ is a known object. Once this selection effect is controlled, the first moments for log business earnings among individuals with high initial wealth can identify H and h.

To summarize, the occupational choice and the distribution of business earnings among rich individuals identify G, H, and h. Given $\{\alpha, \mu_0, \mu_1, \mu_2, \mu_3\}$, the parameters for entrepreneurial productivity and the business-earning shock, $\{\beta_0, \beta_1, \beta_2, \beta_3, \sigma_\eta, \sigma_s\}$, are over-identified by equations (8) - (17).

With other parameters in hand, especially the parameters governing the distribution of θ_s, the parameter for credit borrowing γ can be identified by the occupational choice of individuals with negative net worth. For expositional purposes, I will focus on the first specification of the credit-borrowing premium $f(k) = \gamma k$. The condition under which individuals with negative net worth start a business can be represented as $\theta_s \hat{k}^\alpha - (r + \gamma\hat{k})\hat{k} \geq \theta_w$, where $\hat{k}$ is the solution to $\max_{\{k\}} \left[\theta_s k^\alpha - (r + \gamma k)k\right]$. Given a unique $\hat{k}$ exists, as shown in Appendix A, it can be easily shown that $\hat{k}$, and thus $\theta_s \hat{k}^\alpha - (r + \gamma\hat{k})\hat{k}$, decreases as γ increases for any θ_s. Therefore, $\Pr(\text{start a business}\big|A \leq 0) = \int \Pr(\text{start a business}\big|A \leq 0, \theta_s) f(\theta_s) d\theta_s$ will monotonically decrease as γ increases.

The collateral parameter λ can be identified by the occupational choice of individuals with positive but low net worth. For financially constrained individuals with positive net worth to start a business, the following condition should be satisfied: $\theta_s \bar{k}^\alpha - r\lambda A - \big(r + \gamma(\bar{k} - \lambda A)(\bar{k} - \lambda A)\big) \geq \theta_w$, where $\bar{k}$ is the solution to $\max_{\{k\}} \left[\theta_s k^\alpha - r\lambda A - \big(r + \gamma(k - \lambda A)(k - \lambda A)\big)\right]$. Given that all other parameters, including γ, are identified, only λ will govern this equation for any θ_s as long as the agent is financially constrained. As λ increases, the agent can refinance through collateral borrowing instead of credit borrowing, and hence the marginal cost of investment decreases. Therefore, $\Pr(\text{start a business}\big|A > 0, \text{financially constrained})$ monotonically increases as λ increases. As long as the measure of financially constrained agents is not zero at the positive A, $\Pr(\text{start a business}\big|A > 0) = \int \Pr(\text{start a business}\big|A > 0, \theta_s) f(\theta_s) d\theta_s$ will also monotonically increase as λ increases. Given that the proportion of financially constrained agents is more likely to be higher among a low-wealth group, $\int_0^{\bar{A}} \Pr(\text{business owner}\big|0 < A < \bar{A}) g(A) d(A)$ can be used to identify λ, where $\bar{A}$ is a low value of A and g is the empirical distribution of initial net worth.

Finally, given all other parameters, the first moment of business earnings by startup owners with a small or negative net worth is an increasing function of α, and hence can be used to identify α.

4.3 Estimation Procedure

The model is estimated in two steps. In the first step, $\{\mu_0, \mu_1, \mu_2, \mu_3, \sigma_w\}$ is estimated by the linear regression of wage earnings for those who remain as workers. In the second step, the remaining parameters are estimated by the method of simulated moments. The moments selection is based on the identification argument in section 4.2. All the targeted moments are reported in Table 7. The number of moment conditions and the number of parameters are 15 and 10, respectively.

I specify a high- and low-wealth group as follows. For the group who are less likely to be financially constrained, and hence are informative in identifying the entrepreneurial productivity distribution, I choose individuals whose household net worth is between the 80th and 95th percentiles. I exclude the individuals whose household net worth is above the 95th percentile, because their likelihood of starting a business is distinctively different from that of the rest of the population as shown in Table 3 and Figure 2. Hurst and Lusardi [2004] and Nanda [2010] provide possible explanations for this fact such as the difference in risk aversion across wealth distribution. Because the goal of the current model is to understand the behavior of individuals with relatively low wealth, I do not explicitly model those explanations.

For the low-wealth group, I choose individuals whose net worth is positive and below the 20th percentile.[19] To identify P_s, I also include the proportion of business owners with

[19] The selection of the wealth cutoff is rather arbitrary, but the estimates marginally change with a different set of cutoffs. For example, I specified individuals whose household net worth is between the 75th and 95th percentiles as the high-wealth group. Likewise, I specified individuals whose net worth is positive and below the 25th percentile as the low-wealth group. The model estimates are very similar in all cases.

negative income as an additional moment. I choose the weighting matrix be a diagonal matrix which contains the inverse of variances of the data moments. Asymptotic standard errors are calculated following Gourieroux and Monfort [1996].

4.4 Model Fit

Table 7 shows the targeted and simulated moments. The model fit is reasonably good. Figure 3 shows the predicted probability of business entry with respect to net worth up to the 95th percentile for the actual data and for a simulated data from the current model. The probability predicted using the simulated data replicates the the probability predicted using the actual data quite well. In particular, with credit borrowing, the model can generate no relationship between the probability of business entry and net worth.

Figure 4 shows the predicted probability of business entry with respect to net worth for the actual data and for a simulated data from the model corresponds to Evans and Jovanovic [1989]. After making γ equal to zero, I re-estimated the model with the identical moments except for two moments related to business owners with negative wealth. With this re-estimated model, I conduct the same exercise as in Figure 3. Without credit borrowing, the model fails to generate the flat relationship between the probability of business entry and net worth. Specifically, the model predicts a sharp and positive relationship among low-wealth individuals.

5 Results

5.1 Estimates

Table 8 shows the estimates and the standard errors of the model parameters. A 10% increase in the years of education leads to a 10% increase in wage earnings. A 10% increase in the years of experience leads to a 2.5% increase in wage earnings. Married workers tend to earn 30% more than workers without spouses.

A slightly positive correlation between entrepreneurial productivity and net worth is estimated. A 10% increase in net worth leads to a 0.6% increase in entrepreneurial productivity. The impact of years of education and experience on entrepreneurial productivity is insignificant.

The collateral-constraint parameter λ is estimated as 1.155, meaning individuals can invest with the risk-free interest rate up to 115.5% of their household net worth. The interest-premium parameter γ is estimated as 0.1032, implying agents should pay a 1% additional interest-rate premium to borrow 1,000 USD with credit. Likewise, to borrow 10,000 USD with credit, agents should pay 10% additional interest rate premium.[20]

5.2 Measuring Inefficiency by Financial Constraints

To quantify the inefficiency driven by financial constraints, I compare the estimated model with the benchmark economy in which every agent can freely borrow with the risk-free interest rate. For comparison, I also report the same counterfactual analyses with the re-estimated model that corresponds to Evans and Jovanovic [1989].

First, to measure the efficiency loss in the extensive margin, I calculate the optimal number and the realized number of business entrants for each simulation and average them after 1,000 simulations. The result is shown in the first row in Table 9. Of the potential business owners in Evans and Jovanovic (1989), 15.34% $\left(\frac{\text{The realized business entrants}}{\text{The optimal business entrants}} \times 100\right)$ cannot start a business, whereas 1.44% of them cannot start a business in the current model. This finding suggests

[20]Note that one unit of monetary value is normalized as 10,000 USD in 2011.

ignoring the availability of credit borrowing for potential business owners will substantially overstate the efficiency loss from financial constraints in the extensive margin. This result is also in line with the findings by Hurst and Lusardi [2004] and Kerr et al. [2015]. In the presence of credit borrowing, a limited net worth may not be a major barrier to business entry.

Second, to measure the efficiency loss in the intensive margin, I calculate the optimal and the realized investments by startup owners for each simulation and average them after 1,000 simulations. The second row in Table 9 reports the result. Of the optimal investments by the entrants in Evans and Jovanovic (1989), 7.69% $\left(\frac{\text{The realized investments by business entrants}}{\text{The optimal investments by business entrants}} \times 100\right)$ are not realized, whereas 6.07% of the optimal investments by the entrants are not realized in the current model. Unlike the efficiency loss in the extensive margin, the efficiency loss in the intensive margin is large even if credit borrowing is allowed for potential business owners.

To understand the efficiency loss due to financial constraints in more detail, I plot the efficiency loss in business entry by different wealth groups in Figure 5. The first wealth group includes individuals whose household net worth is below the 10th percentile. The second wealth group includes individuals whose household net worth is between the 10th and 20th percentiles. The remaining wealth groups are similarly defined.[21] Most of the discouraged potential business owners, who would have become business owners without financial constraints, are concentrated below the 20th percentile of net worth. In fact, most individuals with positive net worth could successfully start a business.

Figure 6 plots the average entrepreneurial productivity for those who are able to start a business conditional on each wealth group. The average entrepreneurial productivity of the first wealth group is about 15% higher than that of the second wealth group. As shown in

[21] The 10th, 20th, 30th, 40th, and 50th percentiles of net worth correspond to -4,805 USD, 5,460 USD, 21,349 USD, 49,146 USD, and 85,726 USD, respectively.

Figure 5, many potential business owners in the first wealth group cannot start a business, due to a high credit premium. Only those whose entrepreneurial productivity is high enough to compensate for the high credit premium will start a business. As a result, the average entrepreneurial productivity among business entrants from the first wealth group is higher than for the second and the third wealth groups. Note that β_1, which captures the correlation between entrepreneurial productivity and net worth, is estimated to be positive. As a consequence, average entrepreneurial productivity increases as the wealth level increases from the second wealth group.

Finally, Figure 7 shows the efficiency loss in investment by the entrants conditional on each wealth group. About 32% of the potential investment is not materialized in the first wealth group, because their entrepreneurial productivity is relatively high as shown in Figure 6, and their financing cost is the highest among all wealth groups. The efficiency loss in investment by startup owners from the second group is also high, as much as 27% of the optimal investments. The efficiency loss in the intensive margin decreases as the wealth level increases, but the loss is relatively high compared to the loss in the extensive margin shown in Figure 5.

Overall, individuals who start a business once credit borrowing is available are those whose business idea is of a high-enough quality to compensate high financing costs associated with credit borrowing. As a consequence, they start a business with a sub-optimal amount of investments, and the unrealized investments by those agents are considerable.

6 Conclusion

I document a substantial number of individuals in the United States start a business with negative net worth. I provide some evidence that credit borrowing is the main source of financing for those individuals. To quantify the extent to which financial constraints hinder business entry and investments by the entrants given that individuals can start a business using credit borrowing, I present and structurally estimate a model of financial friction that allows individuals without net worth to start a business through credit borrowing. The estimated model generates no relationship between household wealth and the propensity for business entry. Ignoring credit borrowing for potential business owners substantially overstates the efficiency loss from financial constraints in business entry. However, the efficiency loss in investment by the entrants is still large even if credit borrowing is allowed.

Even in the presence of collateral constraints, few potential business owners would be constrained to start a business, because they can use credit borrowing. However, a high cost associated with credit borrowing prevents startup owners, especially with low wealth, from investing the optimal amount of capital. In this regard, financial constraints hinder entrepreneurial activities, especially by limiting the capital investments by low-wealth startup owners.

Tables and Figures

Table 1: Summary Statistics

	Workers	Startup owners
Obs.	41,805	931
Net worth at 1st period	\$194,512	\$249,419
Earnings	\$53,590	\$44,034
Experience (Year)	20.07	19.63
Education (Year)	13.77	13.89
Married (%)	64.44	64.57

NOTE: This table reports summary statistics for workers and startup owners. Mean is reported unless otherwise indicated. The survey weight is applied. The experience is calculated as age minus years of education. The household-level net worth and the individual-level earnings are reported. All the money values are normalized by 1 USD in 2011.

Table 2: Wealth Distribution

	Workers	Startup owners
10%	\$-4,754	\$-6,816
15%	\$1,140	\$598
25%	\$12,026	\$8,632
50%	\$85,598	\$93,141
75%	\$249,092	\$302,898
90%	\$523,117	\$727,148
Prop. of Neg. Wealth	13.16%	14.18%

NOTE: This table reports the wealth distribution in the first period for workers and startup owners. The unit is 1 USD in 2011. Prop. of Neg. Wealth is the proportion of individuals with negative wealth in the first period.

Table 3: Probit Estimates for Starting a Business

VARIABLES	(1) Starting a Business	(2) Starting a Business
Net worth/100,000	-0.00741	
	(0.00971)	
$(\text{Net worth}/100{,}000)^2$	0.00243***	
	(0.000924)	
$(\text{Net worth}/100{,}000)^3$	5.88e-06	
	(5.18e-05)	
$(\text{Net worth}/100{,}000)^4$	-2.54e-06	
	(1.63e-06)	
$(\text{Net worth}/100{,}000)^5$	2.48e-08*	
	(1.32e-08)	
Q2		0.0254
		(0.0393)
Q3		0.296***
		(0.0527)
ln(Edu)	0.0278	0.0213
	(0.0566)	(0.0560)
ln(Exp)	0.0116	0.00954
	(0.0170)	(0.0169)
Married	-0.000884	-0.00131
	(0.0317)	(0.0317)
Constant	-2.186***	-2.171***
	(0.158)	(0.157)
Year dummies	Yes	Yes
Observations	42,736	42,736

NOTE: This table reports estimates for probit regressions for the dummy variable indicating individuals who start a business. Q2 is the dummy variable indicating individuals whose net worth is between the 80th and 95th percentiles in the first period. Q3 is the dummy variable indicating individuals whose net worth is above the 95th percentile in the first period. Standard errors are in parentheses.

Table 4: Summary Statistics of Startup Owners with Negative Net Worth

	Startup owners	
	Net worth < 0	Net worth $\in [0, \text{median}]$
Obs.	127	311
Labor earnings (1st period)	$33,461	$34,514
Experience (Year)	15.75	17.07
Education (Year)	13.64	12.88
Married (%)	55.54	60.65
Business earnings	$36,665	$27,569
Business earnings (median)	$21,520	$14,513

NOTE: This table reports summary statistics for characteristics of startup owners with negative net worth. Mean is reported unless otherwise indicated. The survey weight is applied. Experience is calculated as age minus years of education. For comparison, I also report the summary statistics for characteristics of startup owners with positive and below-median net worth.

Table 5: Credit Card Financing in the Kauffman Firm Survey

	Mean	Mean if> 0
Personal credit card balance (A)	$3,049	$16,790
Business credit card balance (B)	$1,956	$21,935
(A) + (B)	$5,005	$38,725

NOTE: This table reports the average amount of credit card debt for startup owners in the Kaufmann Firm Survey. The number is calculated from Table 4 in Robb and Robinson [2014].

Table 6: Regression Estimates for Changes in Unsecured Debt

VARIABLES	d(Unsecured debts)
Initial Unsecured debts	-0.815***
	(0.0121)
Startup owners (neg. wealth)	23,391**
	(9,622)
Startup owners (pos. wealth)	4,192
	(3,938)
Experience	-117.8**
	(48.96)
Education	863.0***
	(204.1)
Married	1,290
	(1,203)
Constant	522.3
	(3,141)
Year dummies	Yes
Observations	42,736
R-squared	0.096

NOTE: This table shows the regression estimates for the change in the amount of unsecured debt.

Table 7: Model Fit for the 2nd-Step Estimation

Moments	Data	Model
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth)	0.0033	0.0033
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times A_i$	0.1601	0.1622
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times \text{Edu}_i$	0.0494	0.0444
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times \text{Exp}_i$	0.0790	0.0574
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times \ln(y_i)$	0.0031	0.0036
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times A_i \times \ln(y_i)$	0.1516	0.1719
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times \text{Edu}_i \times \ln(y_i)$	0.0487	0.0493
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & high wealth) $\times \text{Exp}_i \times \ln(y_i)$	0.0742	0.0706
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & negative wealth)	0.0031	0.0025
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & negative wealth) $\times \ln(y_i)$	0.0019	0.0017
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & low wealth)	0.0015	0.0020
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & low wealth) $\times \ln(y_i)$	0.0003	0.0008
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(start a business & low wealth) $\times A_i \times \ln(y_i)$	0.0001	0.0002
$\frac{1}{n}\sum_{i=1}^{n}\mathbb{I}$(negative y_i)	0.0032	0.0032
$\text{var}(\ln(y_i))$	0.0358	0.0395

NOTE: This table compares the actual and the simulated moments for the second-step estimation. $\mathbb{I}$ is an indicator function. y_i is the business earnings for startup owners. High wealth indicates an individual whose household net worth is between the 80th and 95th percentiles. Low wealth indicates an individual whose household net worth is positive and below the 20th percentile. A, Edu, and Exp refer to household net worth, years of education, and years of experience, respectively.

Table 8: Estimates for Model Parameters

Parameters	Variables	Estimates	Standard Errors
	Wage earning equation		
μ_0	Constant	-2.0073	(0.0736)
μ_1	ln(Education)	1.0415	(0.0064)
μ_2	ln(Experience)	0.2572	(0.0029)
μ_3	Married	0.3000	(0.0062)
σ_w	Std. of $\log \epsilon_w$	0.6901	(0.0028)
	Business earning equation		
β_0	Constant	-8.12e-06	(0.0751)
β_1	ln(Net worth)	0.0615	(0.0114)
β_2	ln(Education)	0.0002	(0.0638)
β_3	ln(Experience)	-4.08e-05	(0.0118)
σ_η	Std. of η	0.6892	(0.0119)
σ_s	Std. of $\log \tilde{\epsilon}_s$	0.6953	(0.0436)
P_s	–	0.6078	(0.0264)
λ	Collateral constraint	1.1550	(0.4050)
γ	Interest premium	0.1032	(0.0375)
α	Returns to capital	0.3222	(0.0333)

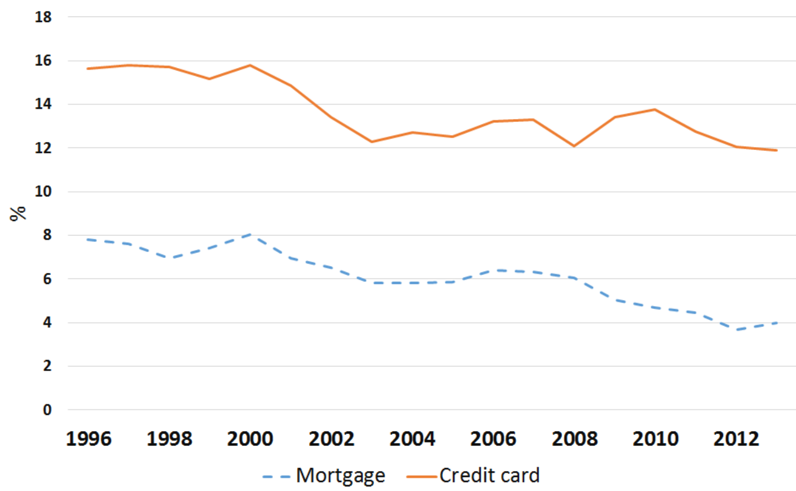
NOTE: This table presents the estimates for the model parameters. Asymptotic standard errors are in parentheses.

Table 9: Counterfactual Analysis: Efficiency Loss in Percentage

	Efficiency loss in percentage	
	EJ(1989)	Current model
Number of startup owners	15.34	1.44
Unrealized inv. by entrants	7.69	6.07

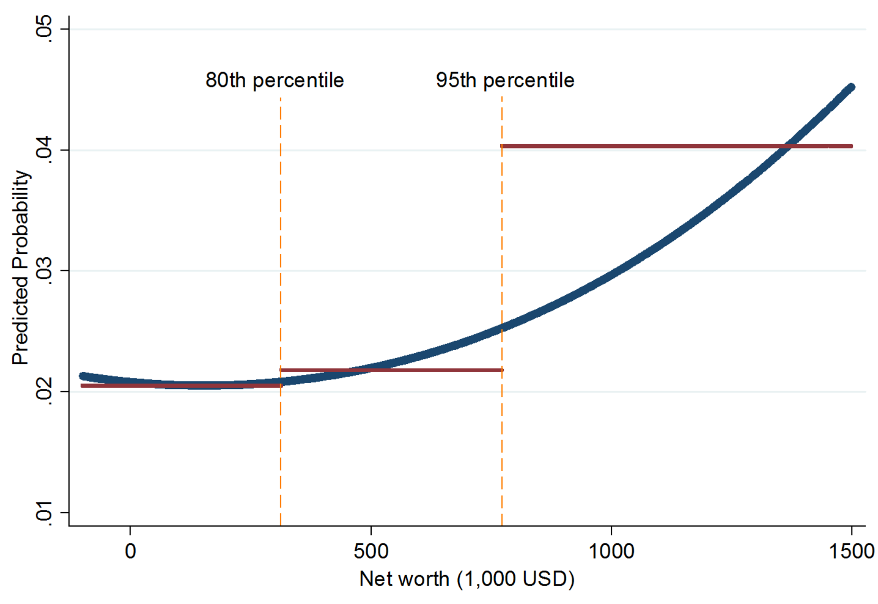
NOTE: The first row of the table shows the efficiency loss in business entry calculated by $(\frac{\text{The realized business entrants}}{\text{The optimal business entrants}} \times 100)$. The second row shows the efficiency loss in investment by the entrants calculated by $(\frac{\text{The realized investments by business entrants}}{\text{The optimal investments by business entrants}} \times 100)$.

Figure 1: Time Trend of Mortgage/Credit Card Interest Rates



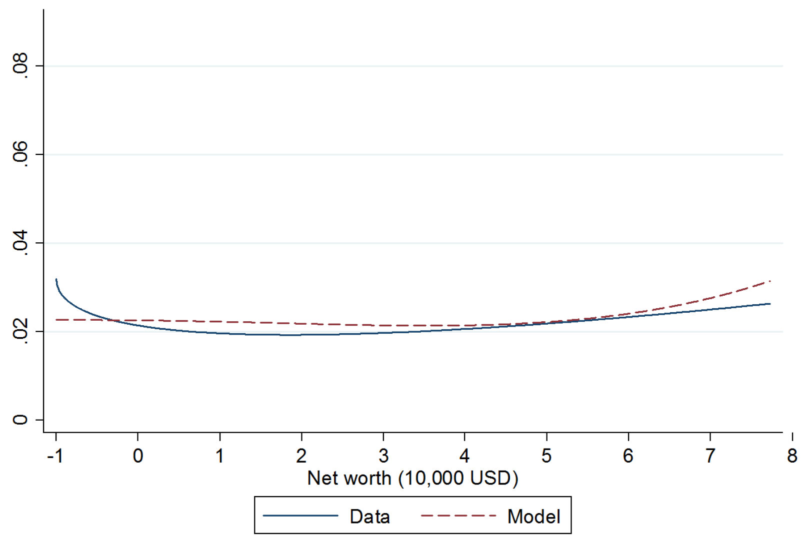
NOTE: This figure shows the time trend of mortgage/credit card interest rates. The mortgage rate is a 30-year conventional mortgage rate, which is contract interest rates on commitments for fixed-rate first mortgages. The credit card interest rate is the commercial bank interest rate on credit card plans. (Source: Federal Reserve Economic Data (FRED))

Figure 2: Predicted Prob. of Business Entry with respect to Net Worth



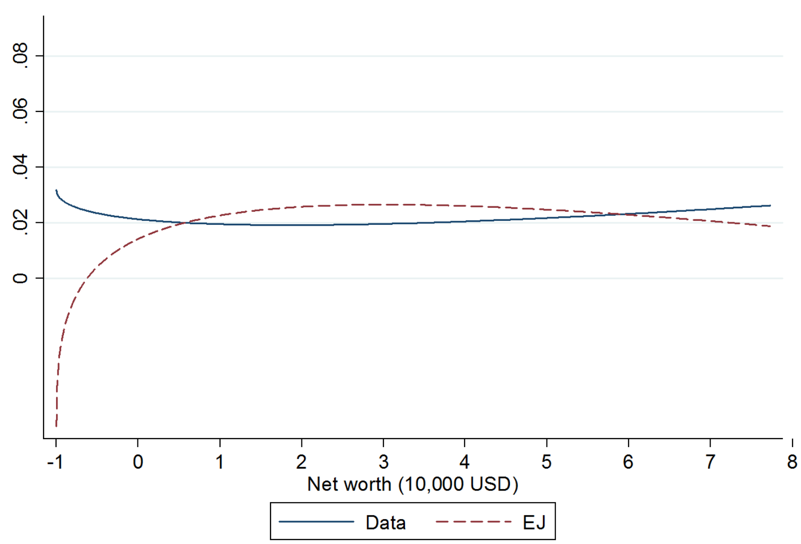
NOTE: This figure shows the predicted probability of business entry based on the probit estimates in Table 3 (equation (1): blue line, equation (2): red line). The 80th percentile of net worth is 313,048 USD and the 95th percentile of net worth is 772,828 USD.

Figure 3: Predicted Prob. of Business Entry with Respect to Net Worth: Data vs. the Current Model



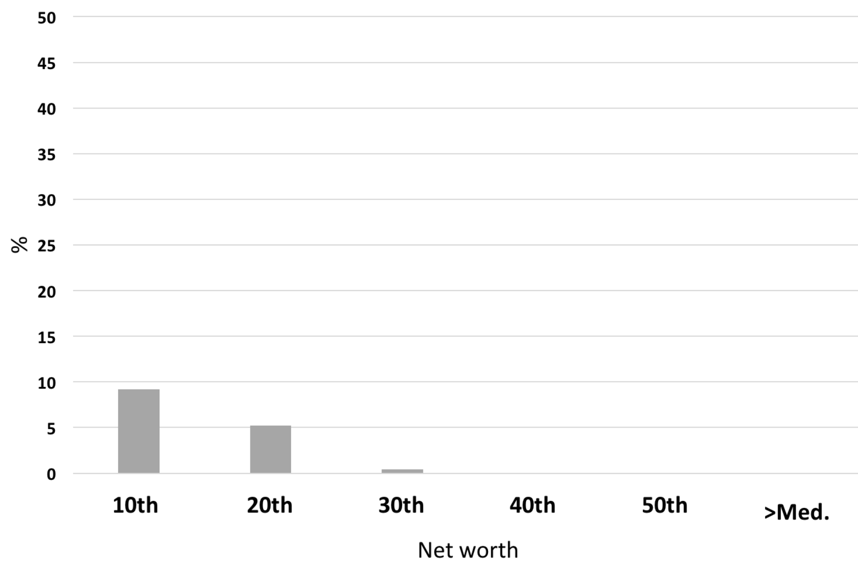
NOTE: This figure compares the predicted probability of business entry with respect to net worth up to the 95th percentile for the actual data, and a simulated data from the current model.

Figure 4: Predicted Prob. of Business Entry with Respect to Net Worth: Data vs. Evans and Jovanovic [1989]



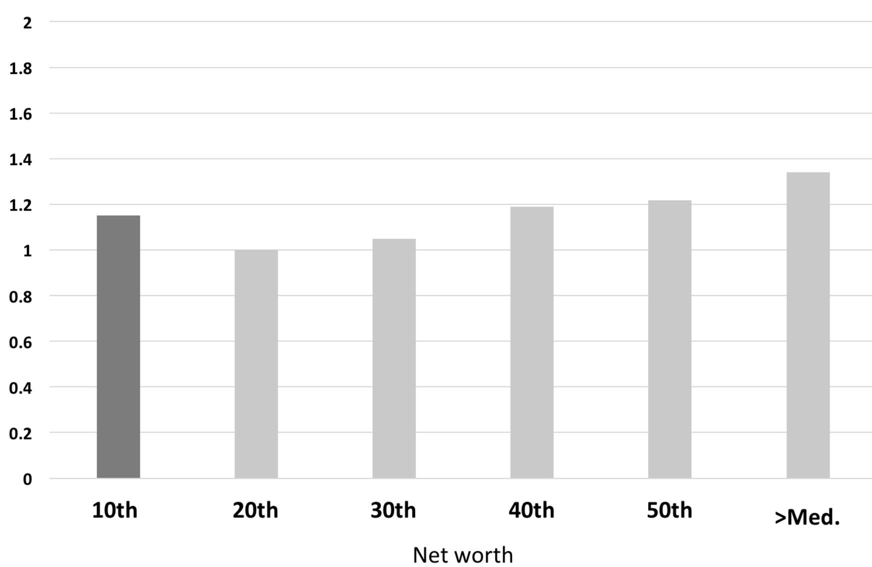
NOTE: This figure compares the predicted probability of business entry with respect to net worth up to the 95th percentile for the actual data, and a simulated data from the model corresponds to Evans and Jovanovic [1989].

Figure 5: Percentage Loss in Business Entry Conditional on Net Worth



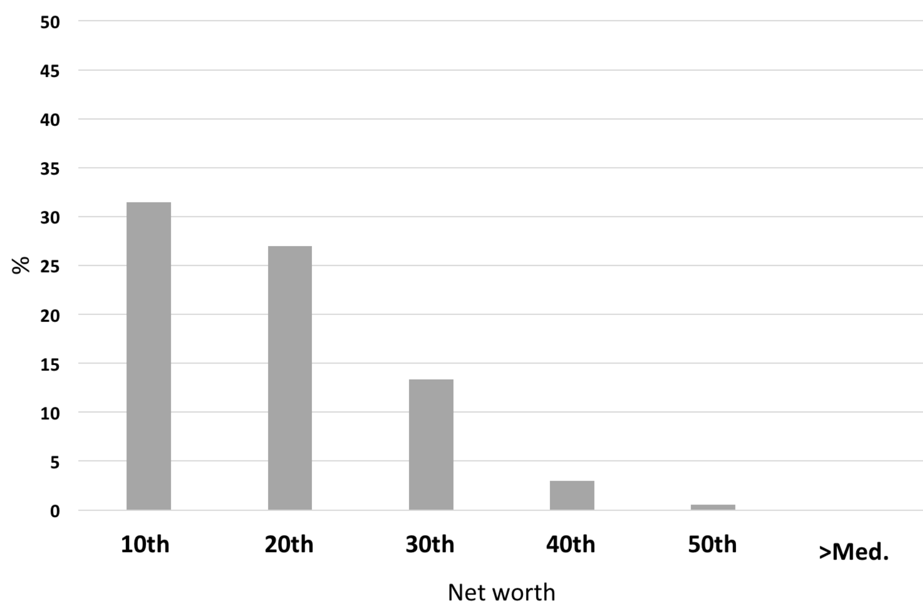
NOTE: This figure plots $\left(\frac{\text{The realized business entrants}}{\text{The optimal business entrants}} \times 100\right)$ conditional on each wealth group. The first wealth group includes individuals whose household net worth is below the 10th percentile. The second wealth group includes individuals whose household net worth is between the 10th and 20th percentiles. The remaining wealth groups are similarly defined. The 10th, 20th, 30th, 40th, and 50th percentiles of net worth correspond to -4,805 USD, 5,460 USD, 21,349 USD, 49,146 USD, and 85,726 USD, respectively.

Figure 6: Average Entrepreneurial Productivity of the Entrants Cond. on Net Worth



NOTE: This figure shows the average entrepreneurial productivity by startup owners conditional on each wealth group. The definition of wealth groups is identical to Figure 5. The value for the second wealth group is normalized as 1.

Figure 7: Percentage Loss in Investments by Startup Owners Cond. on Net Worth



NOTE: This figure plots $\left(\frac{\text{The realized investments by business entrants}}{\text{The optimal investments by business entrants}} \times 100\right)$ conditional on each wealth group. The definition of wealth groups is identical to Figure 5.

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Appendix

A Existence and Uniqueness of the Optimal Investment with Credit Borrowing

The optimal investment under credit borrowing $\hat{k}$ is the solution to $\max_{\{k\}} \left[\theta k^{\alpha} - r\lambda A - (r + f(k - \lambda A))(k - \lambda A)\right]$. Without loss of generality, I will consider the case in which $A = 0$. The first-order condition implies $\alpha\theta\left(\frac{1}{k}\right)^{1-\alpha} - f(k) - f'(k)k = r$. Denote the left-hand side of this equation as $\Omega(k)$. As long as $f'(0)$ is bounded above, $\lim_{k\to 0}\Omega(k) = \infty$. On the other hand, given that $f'(k)$ is positive, $\lim_{k\to\infty} f'(k) = -\infty$. Therefore, $\hat{k}$ exists. To show the uniqueness of $\hat{k}$, it is sufficient to show $\Omega'(k)$ is negative for any positive k. This condition can be written as

$$kf''(k) > -(1-\alpha)\theta\Big(\frac{1}{k}\Big)^{2-\alpha} - 2f'(k). \tag{18}$$

All specifications for $f(k)$ in section 4.1 satisfy equation (18).

B Comparing Results with Different Specifications of f

The results from the second and third specifications for the credit-borrowing premium in section 4.1 are presented in this section. Table 10 compares the parameter estimates for each specifications. The parameter estimates are similar across all specifications.[22] Using the estimates for each specification, I further investigate whether the main results presented in section 5 hold with other specifications. Table 11 shows the results. The calculated efficiency loss for both extensive and intensive margin rarely changes.

[22]Note the parameters for wage earnings $\{\mu_0, \mu_1, \mu_2, \mu_3, \sigma_w\}$ are identical because they are estimated at the first stage.

Table 10: Estimates for Model Parameters (All Specifications)

Parameters	Baseline γx	$f(x)$ Spec. (2) $\frac{\gamma x}{1+\gamma x}$	Spec. (3) $\exp(\gamma x) - 1$
μ_0	-2.0073	-2.0073	-2.0073
μ_1	1.0415	1.0415	1.0415
μ_2	0.2572	0.2572	0.2572
μ_3	0.3000	0.3000	0.3000
σ_w	0.6901	0.6901	0.6901
β_0	-8.12e-06	-8.08e-06	-8.88e-06
β_1	0.0615	0.0616	0.0615
β_2	0.0002	0.0002	0.0002
β_3	-4.08e-05	-5.17e-05	-4.76e-05
σ_η	0.6892	0.6892	0.6892
σ_s	0.6953	0.6953	0.6953
P_s	0.6078	0.6078	0.6078
λ	1.1550	1.0005	1.0138
γ	0.1032	0.1064	0.1074
α	0.3222	0.3254	0.3261

NOTE: This table presents the parameter estimates for each specification of the credit-borrowing premium.

Table 11: Efficiency Loss in Percentage (All Specifications)

	Efficiency loss in percentage			
	EJ(1989)	Baseline	Spec. (2)	Spec. (3)
Number of startup owners	15.34	1.44	1.44	1.46
Unrealized inv. by entrants	7.69	6.07	5.86	5.88

NOTE: The first row of the table shows the efficiency loss in business entry calculated by $(\frac{\text{The realized business entrants}}{\text{The optimal business entrants}} \times 100)$. The second row shows the efficiency loss in investment by the business entrants calculated by $(\frac{\text{The realized investments by business entrants}}{\text{The optimal investments by business entrants}} \times 100)$.