

Who Works for Whom?

Worker Sorting in a Model of Entrepreneurship with Heterogeneous Labor Markets*

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Abstract

Young and small firms disproportionately hire from the pool of younger, less wealthy, and nonemployed individuals, and provide them with lower earnings than other firms do. To explore the mechanisms behind this sorting of workers, a dynamic model of entrepreneurship is introduced, where individuals can choose not to work, become entrepreneurs, or work in one of the two sectors: a corporate versus an entrepreneurial sector. The differences in production technology, financial frictions, and labor market frictions lead to sector-specific wages and worker sorting across the two sectors. Individuals with lower assets tend to accept jobs with lower pay in the entrepreneurial sector, an implication that finds support in the data. The response of the entrepreneurial activity to changes in the key parameters of the model is also studied to explore the channels that may have contributed to the decline of entrepreneurship in the United States.

Keywords: Entrepreneurship, borrowing constraints, worker sorting, labor market frictions, decline in entrepreneurship

JEL Codes: L26, J21, J22, J23, J24, J30, E21, E23, E24

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1 Introduction

Job creation by entrepreneurs is an important component of employment dynamics in the U.S. labor market. In a typical year, new firm startups account about 3% of total employment but almost 20% of gross job creation.¹ The jobs entrepreneurs create, however, may not always be the most desirable ones. A variety of new data sources for the United States have confirmed that entrepreneurial firms, most of which are young and small, provide lower earnings to their workers on average compared with older and larger firms, and tend to hire more from the pool of workers who are nonemployed.² Using young firms that are at most five years of age and small firms with at most 20 employees as approximations to the population of entrepreneurial firms, Table 1 highlights these differences across entrepreneurial versus other firms. The differences are highly persistent over time. The new data sources also reveal that entrepreneurial activity in the United States has been declining persistently. Some of the trends are summarized in Table 1 and Figure 4. The fraction of businesses that are young fell between 1982 and 2012. At the same time, the share of employment in both young and small firms has been shrinking. The average real earnings of workers in young firms have also declined over time relative to other firms.³

Despite the attention given to young and small firms' contribution to job creation and destruction, and to firm turnover in the United States, the mechanisms by which workers sort across entrepreneurial versus other firms remain relatively less understood. What kind of workers choose to work for entrepreneurial firms, and why? In particular, how do the productivity and wealth of workers differ across entrepreneurial versus other firms? How do the performance of the entrepreneurial firms and the nature of the match of workers with these firms depend on financial and labor market frictions? These questions demand a framework where individuals face not only the choice between being entrepreneurs or workers, but also the choice between working for entrepreneurial versus other firms. These choices are influenced by several frictions in markets. Financial frictions for entrepreneurs and workers, and search frictions in the labor market, affect the flow of individuals between entrepreneurship and working for someone else. A better understanding of the functioning of the labor markets for entrepreneurial firms under these frictions is important for an analysis of how the two group of firms have fared in recent decades. The decline in entrepreneurial activity has consequences for the labor market for entrepreneurial

¹At the same time, about 40% of the jobs created by startups also disappear due to exit within 5 years of entry. See Haltiwanger, Jarmin, and Miranda (2013).

²See, e.g., Brown and Medoff (1989) for the connection between firm size and earnings. Brown and Medoff (2003), Kölling, Schabel and Wagner (2002), and Dinlersoz, Hyatt, and Nguyen (2013) document, among others, the connection between age of establishment or a firm, on the one hand, and average earnings of workers, on the other.

³See Davis and Haltiwanger (2014) and Decker, Haltiwanger, Jarmin, and Miranda (2014a,b) for a documentation of some of these facts.

firms, and conversely, the changes in the labor market for such firms have implications for the performance of the entrepreneurial firms.

This paper develops a dynamic model of entrepreneurship to analyze what kind of individuals work for entrepreneurial firms, and who becomes an entrepreneur. In the model, individuals differ in wealth, as well as ability (or productivity)—both as a worker and an entrepreneur. The worker and entrepreneurial ability both fluctuate over time. Each individual can choose among not working, being an entrepreneur, or working as an employee in one of the two sectors, entrepreneurial and corporate—a label that represents the set of firms that don't face the constraints entrepreneurial firms do. These constraints are of two types. First, the entrepreneurial production is subject to diminishing returns that arise from the limits to entrepreneurs' span-of-control. In contrast, firms in the corporate sector can scale up production without such restrictions. In addition, entrepreneurs face financial constraints. They can borrow only up to a limit to operate their businesses, a constraint that does not apply to corporate sector firms.

The match between workers and firms is subject to frictions in the labor market. Not all nonemployed individuals can find a job, and workers can be separated from their employers involuntarily, in addition to voluntary separations. The labor market frictions vary across the entrepreneurial and corporate sectors. Job offers come at different rates from the two sectors. Involuntary separations also occur at different rates. At any point in time, an individual can get a job offer only from one of the two sectors. However, workers can flow in and out of the sectors over time, subject to the frictions described. The differences across the two sectors in production technology and labor market frictions together lead to different sectoral wages per unit of worker efficiency. Given this wage differential, the heterogeneity in worker productivity and wealth implies that workers sort across the two sectors.

The model outlined above is related to a class of recent models on entrepreneurship.⁴ These models generate plausible fractions of entrepreneurs in the population, as well as the distributions of wealth for entrepreneurs and workers. What distinguishes the framework considered here from these models, however, is the presence of sector-specific labor market frictions. This feature generates employment share and earnings differentials in the two sectors that are consistent with what is observed in the data for entrepreneurial versus other firms. It allows for an analysis of how the two sectors differ in the type of workers they attract, the share of employment they account for, and their average worker earnings. The model also provides an environment for exploring how changes in the financial and labor market frictions influence the performance of the entrepreneurial sector.

The calibrated model's equilibrium offers a number of insights to the functioning of the

⁴See, among others, Quadrini (2000), Cagetti and De Nardi (2004), Kitao (2008), Buera and Shin (2011), Buera, Fattal-Jaef, and Shin (2015), and Bassetto, Cagetti, and De Nardi (2015).

entrepreneurial sector. First, the model generates a lower wage per unit of worker efficiency, as well as lower average worker earnings, in the entrepreneurial sector relative to the corporate sector. This difference is consistent with the observed firm age-worker earnings premium. In the model, higher average earnings in the corporate sector emerge due to a combination of factors. One factor is that job offers arrive at different rates from the two sectors. As a result, the wages per unit of worker efficiency are not necessarily equalized across the two sectors. Other factors are the decreasing returns to scale and borrowing constraints in the entrepreneurial sector. These features of the model together imply that entrepreneurs on average operate at lower scale and generate lower profit than the corporate sector, and hence, can not offer wages as high as those in the corporate sector.

Second, the model provides an answer to the fundamental question of who works for whom. Workers in the entrepreneurial sector tend to be less wealthy and more productive individuals. This result is in part driven by the fact that workers who are employed in the corporate sector accumulate more wealth over time than their counterparts in the entrepreneurial sector, as a result of the higher wage rate in the corporate sector. A stronger result, however, is that individuals who *take* jobs in the entrepreneurial sector when nonemployed also tend to be less wealthy and more productive. That is, the wealth and productivity differences across the two sectors apply even to individuals who are in their first period of employment following a transition from nonemployment. If a nonemployed individual receives an offer from the entrepreneurial sector, the worker has to decide whether to reject this offer and wait for an offer from the higher-wage corporate sector.⁵ Individuals with lower levels of savings and higher productivity tend to accept job offers from the entrepreneurial sector rather than waiting. This sorting of individuals occurs in the absence of any inherent preference for working for entrepreneurial firms, or any other form of compensation such firms can provide their workers.

Third, the model provides several empirical predictions that have not been tested in detail in previous work. One key prediction highlighted above, that workers with lower assets tend to work for entrepreneurial firms and take jobs in the entrepreneurial sector, is broadly consistent with the empirical facts about life-cycle asset accumulation, but has yet to be explored in data. This prediction is tested using data on workers' net worth merged with the data that captures employer characteristics. The findings broadly support the baseline model's prediction. In the baseline model workers in the corporate sector have average asset holdings which are about 1.9 times the average asset holdings of workers in entrepreneurial firms. This ratio is about 1.5 for workers in their first quarter of employment. The corresponding ratios in the data are approximately

⁵A similar mechanism is also at work in theoretical study of asset accumulation and employment studied by Browning, Crossley, and Smith (2007), who do not aim to replicate the salient features of the U.S. entrepreneurial sector.

1.5 and 1.6, respectively. The fact that lower average worker earnings in entrepreneurial firms induce mainly workers with lower levels of assets to accept jobs from them, has implications on the job offer rates from the two sectors. In order to match the empirical moments of interest, the model requires an offer arrival rate from the entrepreneurial sector that is about one third of that from the corporate sector.

Fourth, the model provides a framework to explore some of the channels that may have contributed to the decline of entrepreneurship in the United States.⁶ Several performance metrics for the entrepreneurial sector indicate a decades-long decline that has accelerated during the Great Recession. The number of new employer businesses has been falling.⁷ The new businesses that do form recently tend to create fewer jobs.⁸ The average worker earnings in young firms have also fallen, relative to old businesses. In general, there is an “aging” of U.S. businesses, as workers tend to be increasingly employed in older firms.⁹ The decline in the number of business startups also explains part of the decline in employment reallocation rates.¹⁰ It is important to understand the sources of the decline. The model allows for a qualitative exploration of some of the channels that may be behind these trends through a series of experiments, where key parameters of the model are altered one at a time to compare the resulting equilibrium with the baseline. These experiments focus on the parameters that govern labor market frictions, financial constraints, and entrepreneurial ability.

The rest of the paper is organized as follows. The next section documents some stylized facts about entrepreneurial firms. Section 3 introduces the model, followed by its calibration in Section 4. The properties of the baseline model are discussed in Section 5. Section 6 offers some empirical evidence on the predictions of the model on worker sorting. Section 7 contains some experiments to explore how entrepreneurship and worker sorting across the two sectors change as some key parameters of the model are altered. Section 8 concludes.

2 Some Observations about Entrepreneurial Firms

This section presents some key features of entrepreneurial firms to motivate the model and its analysis. A fundamental question is what exactly constitutes an entrepreneurial firm. Table 2 provides several alternative definitions of the population of entrepreneurial firms and

⁶Recent work on this decline include Pugsley and Sahin (2015) and Karahan, Pugsley and Sahin (2015). These studies focus mainly on the decline in firm startups (a flow measure), which are a subset of entrepreneurial firms (a stock measure) in the economy at any point in time, and abstract from labor and financial markets.

⁷See Decker, Haltiwanger, Jarmin, and Miranda (2014a).

⁸See Sedlacek and Sterk (2014).

⁹See, e.g., Hathaway and Litan (2014a).

¹⁰See, e.g., Hyatt and Spletzer (2013).

some accompanying statistics as of the year 2000. In the definitions in Table 2, non-employer businesses are not included, as the main focus here is on job-creating entrepreneurs. In addition, each firm is assumed to have a single owner—multiple owners, such as in the case of partnerships, are not included.¹¹ Entrepreneurial firms are often described as young and small firms, based on employment—though what is "small" clearly depends on the nature of the business activity. Although there are some young and small firms that are not entrepreneurial in nature (e.g. new businesses that are a part of existing, established firms), and some entrepreneurial firms that are young but large, firm age and size are frequently used to approximate the population of entrepreneurial businesses. Assuming that the pool of potential entrepreneurs is the population aged 25-64 years, the fraction of entrepreneurs in the economy can then be approximated as the number of entrepreneurial firms divided by that population. Based on several age and size criteria applied to the universe of employer-businesses in the U.S. Census Bureau's Longitudinal Business Database (LBD), Table 2 reveals that the fraction of entrepreneurs ranges from a rather conservative estimate of 1.1% to a less stringent one of 3.7%. Alternatively, one can define entrepreneurial firms as the set of firms that are non-public and have some type of ownership demographics in the U.S. Census Bureau's Survey of Business Owners (SBO). This approach yields an estimate of 3.8%. As another approach, one can use the responses of surveyed individuals to the question regarding employer-business ownership in the Survey of Income and Program Participation (SIPP). The estimates in this case vary from 2.3% to 2.9%. Table 2 also indicates that employment share of entrepreneurial firms varies between 3.6% to 44.0% across various definitions. These definitions also imply a non-entrepreneurial firm average earnings premium that is in the range 16.6% to 49.8%.¹²

Consider now some of the fundamental differences between entrepreneurial and other firms. For this purpose, define an entrepreneurial firm as one that is at most 5 years old.¹³ Table 1 highlights some key differences between entrepreneurial and other firms relevant for the analysis here. First, entrepreneurial firms offer lower earnings to their workers on average. In 1987, the median of the average worker earnings for entrepreneurial firms was about 85% of that for other firms, whereas by 2012 this figure dropped to about 75%. The average earnings premium for non-entrepreneurial firms is also highlighted in Table 2. The documented gap in average earnings is consistent with a well-established empirical literature on firm-age and size premia in worker

¹¹The datasets used to construct Table 2 do not contain information about the exact number of owners for each firm.

¹²The average worker earnings premium is defined as excess average worker earnings in non-entrepreneurial firms expressed as a percentage of the average worker earnings in entrepreneurial firms.

¹³The findings summarized next are robust to some alternative definitions of an entrepreneurial firm in Table 2. For instance, using a 10-year threshold for an entrepreneurial firm does not make a substantial difference.

earnings.¹⁴

Table 1 also gives information on the prevalence and relative size of entrepreneurial firms. Entrepreneurial firms accounted nearly as much as half of all firms in 1987, but this fraction fell to around one-third in 2012. Compared to their representation in the population of firms, entrepreneurial firms account for a relatively small share of total employment: nearly one-fifth in 1987, and only about one-tenth in 2012. The number and employment share of entrepreneurial firms are in line with the typical high skewness in firm size and age distributions, which implies that much of the economic activity is concentrated in a relatively small fraction of firms in the right tail of these distributions. The average scale of entrepreneurial firms measured by employment is also much smaller relative to non-entrepreneurial firms. The average employment of the former is only about one-quarter of that for the latter. This difference arises because young firms are generally smaller than older firms.

Entrepreneurial firms also exhibit marked differences in their worker hiring and separation patterns compared to other firms. The former tend to have higher hiring and separation rates, and rely more on those individuals without jobs for filling vacancies.¹⁵ Overall, as documented in Table 1, in 2000 entrepreneurial firms accounted for about 24% of gross hires from nonemployment, and about 21% of gross separations to nonemployment. If entrepreneurial firms are defined based on size rather than age, similar differences in hiring and separation patterns are observed across the two groups of firms—see again Table 1. One can define the hires from nonemployment for entrepreneurial firms *relative to* non-entrepreneurial firms as

$$\frac{\left(\frac{\text{Entrepreneurial firms' share of total hires from nonemployment}}{\text{Entrepreneurial firms' share of total hires}}\right)}{\left(\frac{\text{Non-entrepreneurial firms' share of total hires from nonemployment}}{\text{Non-entrepreneurial firms' share of total hires}}\right)}.$$

The relative separations can be defined analogously. Both of these relative figures exceed one for the two years considered in Table 1, indicating that entrepreneurial firms disproportionately draw their workforce from nonemployment and lose their workers disproportionately to nonemployment, compared to non-entrepreneurial firms.

The differences across entrepreneurial and non-entrepreneurial firms suggest differences in labor markets for these types of firms. In particular, the divergence in worker earnings, and

¹⁴Brown and Medoff (2003) find that average worker earnings are lower in younger firms in a sample of U.S. firms. This finding has repeatedly emerged in studies using a variety of datasets. For instance, Kölling, Schabel and Wagner (2002) largely confirm Brown and Medoff's (2003) findings using data that links establishments to workers in Germany. Heyman (2007) also finds a similar pattern in Swedish data. More recently, Dinlersoz, Hyatt, and Nguyen (2013) provide evidence that new manufacturing establishments in the U.S. provide lower average earnings to their workers than older ones. Ouimet and Zarutskie (2014) also observe a similar gap in average earnings in the matched employer-employee data for the U.S.

¹⁵See Haltiwanger, Hyatt, and McEntarfer (2014) and Hyatt, McEntarfer, McKinney, Tibbets, and Walton (2014).

hiring and separation patterns, hint at potentially different labor market frictions for these two types of firms and their workers. Moreover, the discrepancy in their total employment and average scale may stem in part from the more stringent financial and managerial constraints entrepreneurs face. The model in the next section studies how all of these differences influence the allocation of workers, and result in a gap in worker productivity, earnings, and wealth across the two types of firms.

3 The Model

Considering the stark differences between entrepreneurial and non-entrepreneurial firms highlighted in the previous section, the model features an economy with two sectors, entrepreneurial and corporate—a label that refers to non-entrepreneurial firms in the model.¹⁶ The two sectors differ both in production technologies and labor market frictions. In addition, the model recognizes individuals’ heterogeneity in wealth and ability, both as workers and entrepreneurs. It extends the framework of incomplete markets with occupational choice in the spirit of Quadrini (2000) and Cagetti and DiNardi (2006) to include heterogeneous labor markets, as in the “islands” economy of Lucas and Prescott (1974).¹⁷ The model also features indivisible labor choice characterized by frictions between production and leisure “islands”, as in Krusell, Mukoyama, Rogerson, and Sahin (2011).

There is a unit mass of infinitely-lived individuals. Time, t , is discrete and all individuals share the discount factor, $\beta \in (0, 1)$. Each period an individual is endowed with one unit of time, which can be used for production as a worker or an entrepreneur. Individuals have identical preferences represented by the period utility

$$u(c_t, h_t) = \ln c_t - \alpha h_t,$$

where $c_t \geq 0$ is the consumption, $\alpha > 0$ is the disutility from labor, and $h_t \in \{0, 1\}$ is an indicator of participation in the labor market.

Each individual possesses an amount, $a_t \geq 0$, of assets. Individuals also differ in their ability (or productivity), both as a worker and an entrepreneur. Worker productivity is summarized by $z_t > 0$ —the efficiency units of labor an individual can supply in a period. The productivity, z_t ,

¹⁶For simplicity, there is no transition of entrepreneurial firms to the corporate sector. A more realistic approach would be to allow entrepreneurial firms to enter the corporate sector at some rate. However, it is not clear the added complications would yield substantially different insights to the sorting of workers between the two types of firms.

¹⁷See also Alvarez and Veracierto (2000).

evolves over time independently across individuals according to the process

$$\begin{aligned}\ln z_t &= \rho_z \ln z_{t-1} + \epsilon_t^z, \\ \epsilon_t^z &\sim N(0, \sigma_z).\end{aligned}\tag{1}$$

Similar to the worker ability, the entrepreneurial ability, θ_t , also evolves independently across individuals according to

$$\begin{aligned}\ln \theta_t &= (1 - \rho_\theta)\mu + \rho_\theta \ln \theta_{t-1} + \epsilon_t^\theta, \\ \epsilon_t^\theta &\sim N(0, \sigma_\theta).\end{aligned}\tag{2}$$

There are two sectors of production: a corporate and an entrepreneurial sector, denoted by $j \in \{f, e\}$, respectively. Production technology differs across the two sectors. There is a representative firm in the corporate sector. It generates output, Y_t , by combining capital, K_t , and efficiency units of labor, L_t , by way of a constant-returns-to-scale production technology

$$Y_t = AK_t^\nu L_t^{1-\nu},$$

where $\nu \in (0, 1)$, and $A > 0$ is the corporate sector's total factor productivity.

Each firm in the entrepreneurial sector is run by an entrepreneur with ability θ_t , who uses capital, k_t , and efficiency units of labor, l_t , to produce output, y_t , via a decreasing-returns-to-scale technology

$$y_t = \theta_t (k_t^\nu l_t^{1-\nu})^\xi,\tag{3}$$

where $\xi \in (0, 1)$ is a span-of-control parameter, which may reflect the diminishing returns to the entrepreneur's managerial ability.

There are two types of frictions. The first type is the search frictions in labor markets. Employment opportunities for nonemployed individuals arrive every period with probability λ . Job offers can come from the corporate sector or the entrepreneurial sector. The job offer likelihood, however, varies across the two sectors. Conditional on the arrival of a job offer, the offer is from the corporate sector with probability γ . Employed individuals maintain a deterministic match to the sector for the duration of their tenure. There is no on-the-job search, and individuals can receive job offers only when nonemployed. Every period workers can separate from their employers voluntarily or involuntarily. An involuntary separation occurs for a worker in sector $j \in \{f, e\}$ with probability, ϕ_j . When an individual is separated from a firm or when an individual decides to quit entrepreneurship, the individual has to stay nonemployed for at least one period before making the decision to work again. The parameters $\{\lambda, \gamma, \phi_f, \phi_e\}$ govern the frictions in the labor market.

The second type of friction is financial in nature. There are borrowing constraints for entrepreneurs. The amount of capital, k_t , an entrepreneur with assets, a_t , can access is bounded:

$k_t \leq ba_t$, where $b \geq 1$ is an exogenously given borrowing limit. When $b = 1$, entrepreneurs can only use their accumulated assets to finance production. The parameter b is the only parameter that governs the financial frictions. Assets and capital earn an interest rate, $r > 0$, and capital depreciates at a rate of $\delta \in (0, 1)$.

The timing of events within a period is as follows. Individuals first realize their current-period labor productivity. Each nonemployed individual then receives a job offer from one of the sectors. All individuals then make their decisions about whether to work, become an entrepreneur, or not work. Following this decision, all entrepreneurs realize their current-period abilities and choose their inputs for production. Each individual then chooses how much to consume and save. At the end of the period, some of the employed individuals get separated from their employers exogenously.

3.1 Individuals' Problems

Consider a stationary environment where policies and payoffs do not depend on calendar time. Let $s = (a, z, \theta)$ summarize an individual's assets, and worker and entrepreneurial ability in a period. In addition to s , each individual is differentiated by current-period labor status, which can be nonemployment (n), working in the corporate sector (f), working in the entrepreneurial sector (e), or being an entrepreneur (m). Similar to s , define $\tilde{s} = (a, z, \theta_{-1})$ to be the individual's assets, worker, and entrepreneurial ability, before the current-period entrepreneurial ability, θ , is known. Note that \tilde{s} is identical to s except for its last element, which is the individual's previous-period entrepreneurial ability.

Consider now an individual who was a worker in sector j at the end of the previous period, or who has a job offer from sector j in the current period. This individual faces the choice between work, nonemployment, and entrepreneurship. This choice is made before the current period entrepreneurial ability is realized, but with the knowledge of current worker ability and assets. One can define the expected value of this individual as

$$E^j(\tilde{s}) = \max\{\mathbb{E}_{\theta|\theta_{-1}}[V^j(s)], \mathbb{E}_{\theta|\theta_{-1}}[V^n(s)], \mathbb{E}_{\theta|\theta_{-1}}[V^m(s)]\}. \quad (4)$$

Consider next an individual who was not a worker in any sector at the end of the previous period, or who has no job offer in the current period. This individual faces the choice between nonemployment and entrepreneurship and his value is given by

$$U(\tilde{s}) = \max\{\mathbb{E}_{\theta|\theta_{-1}}[V^n(s)], \mathbb{E}_{\theta|\theta_{-1}}[V^m(s)]\}. \quad (5)$$

Using (4) and (5), the value of a nonemployed individual can be written as

$$V^n(s) = \max_{c, a' \geq 0} \{\ln c + \beta \mathbb{E}_{z'|z} [\lambda [\gamma E^f(\tilde{s}') + (1 - \gamma) E^e(\tilde{s}')] + (1 - \lambda) U(\tilde{s}')]\}, \quad (6)$$

subject to the budget constraint

$$c + a' = (1 + r)a,$$

where $\tilde{s}' = (a', z', \theta)$ and (a', z') denotes the next period's assets and worker ability. Equation (6) reflects the fact that a nonemployed individual obtains the utility from consumption in the current period, and in the next period the expected value depends on whether a job offer is received, and the sector this offer comes from.

Denote by w_j the wage per unit of worker efficiency in sector $j \in \{f, e\}$. The value of an individual who works in sector j is given by

$$V^j(s) = \max_{c, a' \geq 0} \{\ln c - \alpha + \beta \mathbb{E}_{z'|z} [(1 - \phi_j) E^j(\tilde{s}') + \phi_j U(\tilde{s}')]\} \quad (7)$$

subject to

$$c + a' = w_j z + (1 + r)a,$$

The value in (7) is composed of two parts. An employed individual receives a current utility from consumption that is reduced by the disutility of work. In the next period, the individual's expected value depends on whether he gets separated.

Finally, the value of an entrepreneur is

$$V^m(s) = \max_{c, a' \geq 0} \{\ln c - \alpha + \beta \mathbb{E}_{z'|z} [U(\tilde{s}')]\} \quad (8)$$

subject to

$$c + a' = \pi(s) + (1 + r)a,$$

where the entrepreneurial profit, $\pi(s)$, is given by

$$\pi(s) = \max_{k, l \geq 0; k \leq ba} \{\theta (k^\nu l^{1-\nu})^{1-\xi} - w_e l - (r + \delta)k\}. \quad (9)$$

The entrepreneurial value in (8) consists of the current period utility that results from consumption and work, and the next period's expected value, which reflects the fact that in the next period the individual can continue to be an entrepreneur or choose to be nonemployed.

3.2 Equilibrium

Let $i \in \{n, f, e, m\}$ denote the labor status of an individual in any given period. In addition, let $d \in \{n, f, e, m\}$ be the "island" or "location" of the individual at the end of the previous period. A stationary competitive equilibrium for the model is a collection of value functions, $V^i(s)$, wage in each sector, w_j for $j \in \{f, e\}$, an interest rate, r , labor supply rules, $h^d(\tilde{s})$, decision rules to become an entrepreneur, $m^d(\tilde{s})$, saving and consumption rules, $a^i(s)$ and $c^i(s)$, an entrepreneur's capital and labor utilization rules, $k(s)$ and $l(s)$, and measures of individuals by labor status, $\Psi^i(s)$, such that

1. The labor supply rules, $h^d(\tilde{s})$, and the decision rules to become an entrepreneur, $m^d(\tilde{s})$, solve the problems (4) and (5),
2. The saving and consumption rules, $a^i(s)$ and $c^i(s)$, solve the individuals' problems defined in (6), (7), and (8),
3. The interest rate, r , and the corporate sector wage, w_f , satisfy

$$r = \nu AK^{\nu-1}L^{1-\nu} - \delta, \quad (10)$$

$$w_f = (1 - \nu)AK^\nu L^{-\nu}, \quad (11)$$

4. The capital and labor choices, $k(s)$ and $l(s)$, solve the entrepreneur's problem in (9),
5. The measures, $\Psi^i(s)$, are consistent with the behavior of the individuals,
6. Labor, capital, and goods markets clear

$$\int l(s)d\Psi^m(s) = \int z d\Psi^e(s) \quad (\text{entrepreneurial sector labor}) \quad (12)$$

$$L = \int z d\Psi^f(s) \quad (\text{corporate sector labor}) \quad (13)$$

$$K + \int k(s)d\Psi^m(s) = \sum_i \int a d\Psi^i(s) \quad (\text{capital}) \quad (14)$$

$$Y + \int y(s)d\Psi^m(s) = \sum_i \int c(s)d\Psi^i(s) + \delta \left(K + \int k(s)d\Psi^m(s) \right) \quad (\text{goods}) \quad (15)$$

where $y(s)$ denotes the output of an entrepreneur with state s .

While the corporate sector wage, w_f , depends on the representative corporate firm's labor choice decision (11), the entrepreneurial sector wage, w_e , is the value that equates the labor demand by all entrepreneurs to the labor supply of all workers in the entrepreneurial sector—equation (12). The amount of capital used by the corporate sector and the entrepreneurial firms must equal the total assets of all individuals in the economy, as ensured by (14). Finally, the total output in the economy must account for the total consumption by individuals and the replacement of the depreciated capital, as stated in (15). Appendix A outlines the algorithm that is used to solve for the stationary equilibrium numerically.

4 Calibration

The parameter values used in the calibration of the baseline model are in Table 3. Each period corresponds to one quarter. The discount rate, β , is set to 0.985, to match an annual interest rate of 4%. The process for labor productivity, z , in (1) has the parameters $\{\rho_z, \sigma_z\} = \{0.97, 0.13\}$, based on Heathcoate, Storesletten, and Violante (2010).

The annual values of the parameters $\{\rho_\theta, \sigma_\theta\}$ of the process for managerial ability θ in (2) and the returns-to-scale parameter, ξ , are estimated separately for entrepreneurial firms (firms aged 0-5 years) versus non-entrepreneurial firms (firms aged 6+ years) in the manufacturing sector. The data unavailability precludes the estimation of these parameters for firms in other sectors of the economy. The estimation is based on the econometric methodology used in Abraham and White (2006), which allows joint estimation of the parameters $\{\rho_\theta, \sigma_\theta, \xi\}$, as described in Appendix B. For entrepreneurial firms, the estimated parameters for the entrepreneurial ability process for θ are $\{\rho_\theta, \sigma_\theta\} = \{0.3, 0.18\}$, which are the averages across narrowly defined industries at the level of 4 digit SIC codes. For entrepreneurial firms, the span-of-control parameter, ξ , has an average estimated value of 0.88 across industries. This value is smaller than the corresponding one for non-entrepreneurial firms (around 0.97), suggesting a lower span-of-control for entrepreneurial firms.

Following Kitao (2008) and Buera and Shin (2011), the borrowing constraint parameter, b , is set to 1.5, implying that an entrepreneur can borrow up to 50% of his assets at the beginning of the period. Based on the business-cycle literature, the capital's share of output, ν , is set to 0.36, and the quarterly depreciation rate, δ , is taken to be 0.015, which corresponds to an annual depreciation rate of 0.06. The productivity of the corporate sector, A , is normalized to $\exp(-1)$.

The remaining vector of parameters, $\{\alpha, \lambda, \gamma, \phi_e, \phi_f, \mu\}$, are chosen to hit six different targets that constitute a system of non-linear equations. While these equations are simultaneous in nature and involve all relevant parameters of the model, each equation plays an instrumental role in setting a specific parameter. The values of the targets are chosen to be the average value of the empirical counterparts for the period 1999-2001. For the disutility of labor, α , the key target is the employment-to-population ratio (0.86) among individuals aged 25-64 years. Two other targets, the share of employment in non-entrepreneurial firms (88%) and the average worker earnings premium for these firms (33%), are important in pinning down the value for the job offer rate from the corporate sector, γ , and the separation probability from entrepreneurial sector employment, ϕ_e . The job finding rate, λ , and the job separation rate from corporate sector employment, ϕ_f , are set so that aggregate job separation rate (employment-to-nonemployment flows) is 1.9% as a fraction of total employment, and the job finding rate (nonemployment-to-employment flows) is 45%. Finally, the fraction of entrepreneurs, 3.1%, is targeted in assigning

a value to the productivity parameter, μ . The fraction, 3.1%, is obtained from the compilation of estimates based on a wide-range of definitions and sources in Table 2.

5 Properties of the Baseline Model

The key features of the calibrated model’s equilibrium are shown in Table 4. The model does a reasonable job in matching the targeted values. It produces an employment-to-population ratio of 0.86, consistent with its targeted value. Around 3.6% of the individuals choose to become entrepreneurs, a figure slightly higher than the targeted fraction of 3.1%, but within the range of various estimates in Table 2. As shown in Figure 1a, the individuals with a higher level of entrepreneurial ability tend to become entrepreneurs. Those who become entrepreneurs also tend to accumulate higher levels of assets, as shown in Figure 1b. Furthermore, entrepreneurs exhibit variation in their capital input, which has a skewed distribution as shown in Figure 1c. The distribution of the labor input (in efficiency units) for the entrepreneurial firms shown in Figure 1d is also highly-skewed.¹⁸ The features of the model discussed so far are shared by those of the other models in recent work, indicating that the model is able to capture the salient aspects of these models.¹⁹

The model’s main distinguishing aspect, heterogeneous labor markets, enables it to provide further insight to the functioning of the labor markets and the nature of worker sorting. The calibration model’s equilibrium generates patterns that are broadly consistent with the behavior of the key metrics for the U.S. labor market. For example, in the baseline model, 11% of the employees work for young firms, close to the value of 12% in the data, as seen in Table 4. The model also delivers a corporate earnings premium consistent with the data. The average worker earnings in the corporate sector is about 32% higher than that in the entrepreneurial sector, almost identical to the targeted value of 33%. Note that the average earnings in each sector depends on the distribution of worker productivity (z) in each sector, as well as the wages per efficiency units of labor (w_e, w_f). The values for w_e and w_f are obtained in the calibrated model’s equilibrium, but there is no observable target to discipline their values. The wage per efficiency unit of labor in the corporate sector, w_f , turns out to be 0.60, as opposed to $w_e = 0.58$ in the entrepreneurial sector. In other words, the corporate sector offers about 3% higher wage per worker efficiency unit. The average worker productivity, on the other hand, is significantly higher in the corporate sector (1.64) than in the entrepreneurial sector (1.28). That is, a worker

¹⁸This shape is in line with the typical shape of the firm-level distributions of labor input in empirical studies. However, note that the labor input in the model (worker efficiency units) is different from the employment measure (the number of workers) typically used in empirical studies of firm size.

¹⁹See, e.g., Quadrini (2000), Cagetti and De Nardi (2004), Kitao (2008), Buera and Shin (2011), Buera, Fattal-Jaef, and Shin (2015), and Bassetto, Cagetti, and De Nardi (2015)

in the entrepreneurial sector is about 78% as productive, on average, as a worker in the corporate sector. This sorting of individuals based on productivity drives in part the corporate earnings premium.

The model is calibrated to match the aggregate job finding rate (45%) from unemployment, as well as the job separation rate from employment (1.9%). The calibrated model's equilibrium is broadly consistent with the magnitude of these worker flows in the data—see, again, Table 4. However, a key question is whether the model is able to also capture these flows by firm type (entrepreneurial and non-entrepreneurial) as well, which are not explicitly targeted in the calibration. Table 4 details the magnitude of sector-specific flows as a share of the total flows, and compares them with their counterparts in the data. The model captures the magnitude of flows across by firm type quite well. In particular, in the data 21% of flows to nonemployment originate in entrepreneurial firms, and the model captures these flows closely (22%). Likewise, 23% of flows into employment go to entrepreneurial firms, as opposed to the model's figure of 16%. The model's ability to approximate the shares of flows into and out of employment accounted by entrepreneurial firms suggests that the model generates the appropriate amount of incentives for work among individuals facing employment prospects in entrepreneurial firms.

Figure 2a illustrates how individuals at any given productivity level are allocated across the two sectors and entrepreneurship. As worker productivity increases, the fraction of individuals who work in the corporate sector increases, whereas the fraction of those who are entrepreneurs declines. However, the fraction that is employed in the entrepreneurial sector first decreases, and then starts to increase at higher levels of productivity. As discussed further below, this non-monotonicity is driven by how the distribution of assets across workers influences their decision to work in the entrepreneurial sector.

If entrepreneurial firms pay lower wages per efficiency unit, why does anyone work for them at all? Figure 2b shows the distribution of workers' assets in the entrepreneurial and corporate sectors. The distribution in the entrepreneurial sector is much more skewed, with a high mass over the range of low asset levels. Table 4 indicates that average assets of the workers in the corporate sectors is nearly twice that of the workers in the entrepreneurial sector. When only the workers in their first quarter of a job is considered, the average assets for workers in the corporate sector is about 1.5 times that of those in the entrepreneurial sector—see Figure 2c. That is, there is a wealth differential not only between the workers in the two sectors, but also between the workers who have just *accepted* jobs in these two sectors. The assets ratios in the model are close to the figures that arise from the empirical analysis discussed in Section 6, as the estimates shown in Table 4 next to their model counterparts confirm. Because nonemployed individuals with low assets are not wealthy enough to secure a smooth stream of consumption while unemployed, they cannot afford to reject a job offer from the entrepreneurial sector and

wait for a job offer from the corporate sector. In other words, the opportunity cost of waiting for a corporate offer is high for these individuals.

Figure 2d shows what types of individuals accept a job offer from the entrepreneurial versus corporate sector. The figure illustrates how the acceptance regions for entrepreneurial and corporate offers vary by worker productivity and assets. As an individual's assets increase, the threshold productivity for accepting a corporate sector job offer increases. Note also that, given a level of assets, the productivity threshold for accepting a corporate sector offer always lies below the one for an entrepreneurial sector offer. In other words, individuals that take jobs in the entrepreneurial sector tend to be more productive. On the one hand, the wage differential provides a higher return to work for the corporate sector and generates an incentive for individuals to wait for a job offer from this sector. On the other hand, the higher job separation rate in the corporate sector suggests that the return to work in corporate sector cannot be too large conditional on a job offer.

Another notable feature in Figure 2d is that for an entrepreneurial job offer there is a part of the rejection region that protrudes into the acceptance region. This extra rejection region indicates a non-monotonicity in the decision rule to accept employment in the entrepreneurial sector. No such region exists for the decision rule for corporate sector work. Figure 2e shows the acceptance region for becoming an entrepreneur at the median managerial ability, θ . This figure indicates that individuals would not choose to become entrepreneurs inside the extra rejection region of Figure 2d. In other words, individuals who are in this extra rejection region reject a job offer from the entrepreneurial sector in favor of continuing to be nonemployed and waiting for another job offer.

One way to understand further the nature of this extra rejection region is to examine the value functions for an individual with median entrepreneurial ability and median labor productivity. These value functions are plotted in 3b and 3c. Figure 3b shows the value functions over a broad asset range, whereas Figure 3c zooms in to the region where the value of leisure exceeds that from entrepreneurial work. This region is small, but it is important to understand its source. To do so, consider the entrepreneurship choice in a partial equilibrium setting. Holding prices (w_f, w_e, r) fixed at their baseline values, suppose entrepreneurship was no longer available as a choice. What would the optimal decision rule look like for an individual with an entrepreneurial sector offer? Figure 3d shows this decision rule for an individual with median managerial ability. In this partial-equilibrium setting, individuals are much more choosy about accepting a job in the entrepreneurial sector. The main reason is that an incentive to work in order to accumulate assets to finance a potential entrepreneurial project in the future is now missing. In other words, there is no incentive to accumulate capital outside the precautionary savings motive. As a result, the threshold productivity at which individuals would choose to work is higher than in the baseline

economy.

Now consider an economy with an entrepreneurial choice, but without any uncertainty in managerial ability at the time the entrepreneurship choice is made. That is, suppose that the timing is such that θ and z are both realized at the beginning of the period. The return to becoming an entrepreneur is now known before the entrepreneurship decision is made. The dashed line in Figure 3d represents the acceptance threshold in such an economy with prices fixed again at their baseline values. In this economy individuals have a lower threshold for accepting employment opportunities, compared with the baseline economy. In particular, the extra rejection region in the baseline economy disappears. An individual with a realization of assets and productivity in the extra rejection region rejects a job in the entrepreneurial sector, but accepts such a job in an economy without uncertainty. The reason is that the uncertainty in the scale of the project reduces the ex-ante return to working to accumulate assets to potentially start a business in the future.

6 Evidence on Worker Sorting by Assets

A key prediction of the baseline model is the difference in the average asset holdings of workers in the entrepreneurial versus the corporate sector. This difference emerges as a result of the sorting of workers into sectors based on both productivity and wealth. Workers holding fewer assets tend to accept job offers from the entrepreneurial sector. At the same time, workers employed in the corporate sector tend to be more wealthy, because the higher wage in that sector allows them to accumulate more assets. Is this sorting consistent with what is observed in the data available? Unfortunately, household survey data that include information on assets typically do not contain information on the age of a worker's employer. Towards addressing this shortcoming, the wealth data for workers in the Survey of Income and Program Participation (SIPP) are merged with the LEHD data that captures employer-specific characteristics for those workers. In particular, the responses from the Asset and Liabilities Topical Module collected in several waves of the 2008 SIPP Panels are used to create a net worth variable, excluding housing equity.²⁰ The net worth variable is calculated at the household level and used as the empirical counterpart to worker assets in the model. The workers in the SIPP sample are linked to the LEHD data. For workers holding more than one job during the relevant quarter, firm age pertains to the firm where worker earnings were the greatest among all jobs held in that quarter. The sample is also restricted to prime age males with ages 25-54 who are not entrepreneurs, to be consistent with the baseline model's calibration. That is, the sample excludes those individuals

²⁰The 2008 Panel was chosen to maximize the number of possible linkages with LEHD data due to limited state data availability.

whose sector-of-employment choices might be influenced by schooling decisions, fertility decisions, and the timing of retirement.

The top panel of Table 5 shows the mean and median net worth statistics by firm age. Both measures indicate a stark difference in asset holdings of workers at young firms relative to others. In particular, workers in older firms have an accumulated asset stock that is 50 percent to more than 200 percent higher than those of the workers in younger firms. While calculation of other moments is not feasible with the available data due to small sample sizes, it is also noteworthy that a larger fraction of the workers in younger firms are net borrowers, and claim zero or negative net worth compared with the workers in more established firms.

It is important to note that higher wages in older firms relative to young firms would imply an asset differential even in the absence of sorting, as long as employment has some persistence. More direct evidence on sorting of workers based on assets can be seen by examining average and median assets of new workers only. For this purpose, the sample is restricted to those workers who are in the first quarter of their employment spell, based on the information on the quarter of employment in the LEHD data. This subsample allows for an approximation to the asset holdings of workers who transition into employment. The results are again shown in Table 5. There is a large net worth differential across workers in the two types of firms when measured by either the mean or median asset holdings.

The bottom panel of Table 5 shows the extent to which worker sorting prevails when firm size is used instead of firm age to define entrepreneurial firms. Although the results are generally weaker, the net worth differential remains for the median asset holdings, with a slightly smaller magnitude. In particular, the median worker in larger firms has net worth of \$20,642 compared with \$9,397 in smaller firms. Finally, as a check of the representativeness of the SIPP subsample relative to the more aggregated statistics in Table 2, average worker earnings are calculated by firm age. The average earnings premium in the larger sample is 24%, versus 15% in the restricted sample. Both figures are within the range of estimates in Table 2.

7 Experiments

This section analyzes how the properties of the model's equilibrium respond to changes in the key parameters. The approach is to change each key parameter from its baseline value one at a time, and compare the resulting equilibrium with the baseline. There are two motivations for this exercise. The first one is to understand the workings of the model in further detail: What kind of changes occur in the model's properties as one of the key parameters changes? The second one is to assess the model's ability to generate some of the trends for entrepreneurial firms in the last couple of decades: What kind of changes in the parameters lead to a decline in

the entrepreneurial sector of the model economy that is qualitatively consistent with the trends observed in the data? Some of these trends are summarized in Figure 4, which highlights various dimensions of decline in entrepreneurial activity. The number of young firms has been stagnant, even as the number of established firms grew (Figure 4a); the share of employment accounted by young firms has been falling (Figure 4b); the relative average worker earnings in young firms has been decreasing (Figure 4c); and the average size of young firms, as measured by employment, has been shrinking relative to that of established firms (Figure 4d).²¹

There are many potential explanations for the observed decline in entrepreneurship. One hypothesis is that changes in workers' job search technologies and firms' vacancy posting technologies altered labor market frictions in a way to put entrepreneurial firms at a disadvantage relative to larger, more established firms.²² In relation to this hypothesis, lower worker mobility across firms, particularly for younger workers, has accompanied the decline in entrepreneurship. Given the evidence that young firms disproportionately draw their labor force from young and nonemployed individuals, the two trends are not independent. Increasing labor market frictions may have made it more difficult for young firms to attract the type of workers who would work for them.

Another potential reason behind the decline is increasing financial frictions for entrepreneurs. Recent research has focused on various implications of a tighter credit environment for businesses created by the onset of the Great Recession.²³ In addition to impeding entry, an increasingly limited amount of credit can also lead entrepreneurs to operate below their efficient scale by inhibiting business expansion. However, it is important to emphasize that in the longer run, such constraints may have actually become less restrictive as a result of the changes in the financial sector. Thus, the effect of the financial environment for entrepreneurs may be different in the long- versus short-run.

Another hypothesis for the decline has to do with the supply of entrepreneurs. Some policies that curb the availability of able entrepreneurs may contribute to the underwhelming performance of the entrepreneurial sector.²⁴ Similarly, increasing costs of education, training, and more

²¹The average size is measured by the total employment in young firms divided by the number of young firms. This measure has the obvious counterpart in the model as both the mass of entrepreneurial firms and the mass of individuals working for them are available, even though the size of entrepreneurial firm is defined in efficiency units of labor and the number of employees for entrepreneurial firm is thus indeterminate.

²²See Decker, Haltiwanger, Jarmin, and Miranda (2014a) for a discussion. Recent work on these issues include Cairo (2013), who analyzes the role of increasing training costs on job reallocation.

²³See, for instance, Haltenhof, Lee, and Stebunovs (2012) for a study of the effects of tighter bank lending on consumers and firms. Other channels, such as the effects of the reduced housing assets of consumers who are potential entrepreneurs, have also been explored. See Decker (2014) for an analysis of this channel.

²⁴For instance, Hathaway and Litan (2014b) argue that immigration policy in the U.S. may have limited the supply of skilled entrepreneurs.

generally, human capital accumulation, can also reduce the pool of skilled entrepreneurs. Changes in the broader business climate (e.g. laws and regulations, taxes and other policies) may also have adversely affected new business formation and expansion. Demographic shifts in the form of an aging U.S. population may have also played a part in the declining dynamism of the entrepreneurial sector.²⁵

The experiments with the parameters of the model aim to understand the relevance of some of the hypotheses discussed above. The results of the experiments are collected in Table 6. It is important to note that the exercises below do not constitute an attempt to quantitatively match the trends in the entrepreneurial sector. In interpreting the results, the exact magnitudes of the changes in the key metrics for the entrepreneurial sector from their baseline values is not the focus. In particular, the parameter values used in the experiments are not chosen to match any of the trends quantitatively. An analysis of the contribution of different channels to the decline in entrepreneurship is left for future work.²⁶ The more modest goal here is to understand what factors in the model are capable of getting right the directions of change in various performance metrics for the entrepreneurial sector.

7.1 Labor Market Frictions

7.1.1 Job Finding Rate

In the baseline model, the implied job offer probability is $\lambda = 0.56$. In this experiment, the job finding rate is also assigned the values in the set $\{0.2, 0.3, 0.6, 0.8\}$, to explore the effects of a change in the frictions in job finding. A lower value of λ implies that jobs are more scarce, and it takes longer on average for a nonemployed individual to receive a job offer. This effect decreases the return to work, and hence, the number of individuals who choose to work. As a result, wages need to be higher to attract workers, leading to a rise in the cost of entrepreneurship and a decline in the return to entrepreneurship. As shown in Figure 5a, the fraction of workers in the entrepreneurial sector decreases as job finding rate decreases. There is also a decline in entrepreneurship. At the same time, Figure 5b indicates that as λ falls both the wage and average earnings in the entrepreneurial sector decline relative to their counterparts in the corporate sector for almost the entire range of values experimented with. Average labor productivity and average assets of workers in the corporate sector relative to the entrepreneurial sector, both pictured in Figure 5c, increase as λ falls, with the exception of going from 0.3 to 0.2. Similar patterns apply

²⁵For the connection between aging and entrepreneurship, see, e.g., Liang, Wang, and Lazear (2014), who find a significant negative effect of aging on business formation rate across countries.

²⁶One avenue for future work is to uncover how much a given parameter needs to change to generate the exact magnitudes of decline in the key metrics for the entrepreneurial sector.

when only the workers in their first quarter of a job is considered—see Figure A5c in Appendix. Average employment in the entrepreneurial sector, as measured by the number of workers per firm, tends to increase as λ falls from 0.8 to 0.2, again except for the decline that takes place from 0.3 to 0.2 (Figure 5d). This experiment demonstrates that a drop in the arrival rate of job offers around its baseline value is capable of generating the observed directions of change in many aspects of entrepreneurship.

7.1.2 Job Offer Rate from the Entrepreneurial Sector

In the baseline case, a nonemployed individual receives an offer from the corporate sector with probability 0.75, giving the corporate sector some advantage in hiring. In this experiment, the likelihood that an offer comes from the corporate sector is assigned several additional values in the range $\{0.1, 0.3, 0.6, 0.8, 0.95\}$. This experiment explores the possibility that increasing frictions in hiring for entrepreneurial firms may lead to a decline in entrepreneurship. For instance, increasing dominance of large, established firms in the labor market and their advanced hiring technologies may reduce access of entrepreneurial firms to workers. A decline in the job finding rate in the entrepreneurial sector (a higher γ) has a negative effect on the fraction of entrepreneurs in the economy, as seen in Figure 6a. Note, however, that an increase from the baseline value, 0.75, to 0.95 leads to only a small decline in the fraction of entrepreneurs. Similarly, the share of employment in the entrepreneurial sector shrinks. The corporate earnings premium declines, along with the wage per efficiency unit for workers relative to that in the entrepreneurial sector (Figure 6b). When entrepreneurial sector jobs are harder to find (higher values of γ), the sector has to offer a higher wage per efficiency unit to attract workers, which results in higher average worker earnings in the entrepreneurial sector. Because the wages in the two sectors get closer to each other as γ increases, workers are more evenly distributed across the two sectors based on average worker productivity and assets, as shown in Figure 6c. A similar pattern applies to the case of workers in their first quarter of employment—see Figure A6c in Appendix. Note also that average employee size of a firm in the entrepreneurial sector tends to decline for values of γ beyond 0.6—Figure 6d. This experiment captures qualitatively some of the features that the entrepreneurial sector in the United States exhibited in recent years. As γ increases, the decline that takes place in the rate of entrepreneurship and the share of employment in the entrepreneurial sector is consistent with the observed trends. What is not consistent with the trends, however, is the erosion of the corporate earnings premium that accompanies an increase in γ .

7.1.3 Job Separation Rate in the Entrepreneurial Sector

Suppose now that the separation rate in the entrepreneurial sector, ϕ_e , increases gradually from its baseline value of zero to 0.06. The values of ϕ_e experimented with are $\{0.003, 0.006, 0.01, 0.03, 0.06\}$, in addition to the baseline value of zero. Recall that the separation rate in the corporate sector for the baseline model is 0.006. The goal of this experiment is to assess the effect of job tenure becoming more temporary in the entrepreneurial sector. As shown in Figure 7a, in response to an increase in the separation rate the fraction of entrepreneurs declines, and the share of employment in the entrepreneurial sector also goes down. The corporate earnings premium falls for lower values of ϕ_e , but increases for higher value of ϕ_e ; see Figure 7b. As jobs have a much shorter tenure in the entrepreneurial sector, the relative productivity of workers in the entrepreneurial sector also goes down for most of the values experimented with (Figure 7c). In addition, the relative average assets of workers in the entrepreneurial sector tend to be higher for high values of ϕ_e , after a drop for low values of ϕ_e . Similar conclusion applies to the average assets of workers in their first quarter of employment—see Figure A7c in Appendix. Finally, the average size of an entrepreneurial firm initially declines as the separation rate increases, but then rises and does not change much for higher values of the separation rate (Figure 7d). While a rise in the separation rate in the entrepreneurial sector leads to a decline in entrepreneurship, many of the key metrics (average earnings ratio, average assets ratio, and average employment) are non-monotonic over the range of values considered.

7.2 Financial Frictions

In this experiment, the amount of borrowing is assigned values in the set $\{1, 1.25, 2, 5, 10\}$, in addition to the baseline value of $b = 1.5$. The case $b = 1$ corresponds to an economy with no borrowing. Higher values of b correspond to increasingly relaxed borrowing constraints. It is important consider a wide-range of values for the borrowing parameter b , given that the literature on entrepreneurship has mainly relied on a limited set of values and estimates for this parameter. The effect of reducing borrowing to $b = 1$ from its baseline value is pronounced for all aspects of entrepreneurship, as shown in Figure 8a. No borrowing discourages entrepreneurship, and the fraction of entrepreneurs falls. There is also an accompanying fall in the share of employment in the entrepreneurial sector. Higher values of the borrowing limit leads to higher rates of entrepreneurship and higher employment in the entrepreneurial sector, but the marginal effect of increasing the borrowing limit declines fast, with little additional effect going from $b = 5$ to $b = 10$. The corporate earnings premium also increases sharply in response to a fall in the borrowing limit from its baseline value—Figure 8b. Higher borrowing limits allow the entrepreneurial sector to offer a wage close to that in the corporate sector, and the earnings differential between the two

sectors shrinks. As the borrowing limit increases, the gap between the average assets for workers in the two sectors also becomes smaller, as shown in Figure 8c. Figure 8c also indicates that the average labor productivity in the entrepreneurial sector declines as the borrowing limit increases, relative to that in the corporate sector. A similar picture emerges when the average assets of workers in their first quarter of employment—see Figure A8c in Appendix. A relaxing of the borrowing constraint also implies that the average size of an entrepreneurial firm increases for most of the range of values considered for b —see Figure 8d. When borrowing is less constrained, more entrepreneurs are able to achieve their optimal scale. Overall, this experiment suggests that tighter financial constraints entrepreneurs face in the aftermath of the Great Recession may have relevance in accounting for some of the recent changes observed for entrepreneurship in the United States.

7.3 Entrepreneurial Ability

To assess the implications of a reduction in the quality of entrepreneurs, this experiment changes the average entrepreneurial productivity, $\exp(\mu)$, over the range (0.40, 0.60) around its baseline value of 0.46. The changes are implemented as first-order stochastic shifts in entrepreneurial ability, that is, as a shift in the mean of the distribution of ability, but no change in its variance. As pictured in Figure 9a, a degradation in the average quality of entrepreneurs leads to a lower fraction of entrepreneurs in the economy. The share of employment in the entrepreneurial sector also falls. Corporate earnings premium increases substantially, even though the relative wage remains fairly stable—Figure 9b. The different patterns for wages and average earnings suggest that the selection of the individuals into the two sectors is now more pronounced. This selection is highlighted in Figure 9c. The ratio of average assets of workers in the corporate sector to those of the workers in the entrepreneurial sector goes up when entrepreneurial ability declines. The average productivity of workers in the entrepreneurial sector also increases, in a relative sense. In other words, a degradation in the average quality of entrepreneurs is accompanied by a degradation in the average quality of workers who work for them relative to those in the corporate sector. Again, these patterns continue to hold when only the workers in their first quarter of employment are considered—see Figure A9c in Appendix. Somewhat surprisingly, average employment of an entrepreneurial firm becomes lower as the entrepreneurial ability improves—Figure 9d. This is driven by the fact that the average productivity of workers in the entrepreneurial sector also rises as entrepreneurs become more able, leading an entrepreneur to hire fewer (but more productive) employees on average. In summary, as in the case of a tighter borrowing limit, a decline in the average productivity of entrepreneurs is capable of mimicking qualitatively some facets of the decline in entrepreneurship.

8 Conclusion

Entrepreneurial firms, which tend to be young and small, typically hire younger workers who disproportionately come from the ranks of nonemployment and provide lower earnings to these workers. Furthermore, in recent years the number, the employment share, and the worker earnings of such firms have all declined. To understand these facts further, this paper proposed a dynamic model of entrepreneurship, which features labor markets for two different sectors, the entrepreneurial and the corporate sector, with different search frictions. The sectors also have different production technologies and financial constraints. The corporate sector approximates the set of firms that have largely overcome managerial and financial constraints. The differences in labor market frictions, production technologies, and financial frictions lead to different sectoral wages per unit of worker efficiency, which results in a sorting of workers across the two sectors.

The calibrated model's equilibrium offers an answer to the central question of who works for whom. Among individuals who are looking for work, less wealthy ones more readily take up job offers from the low-paying entrepreneurial sector, instead of waiting for a corporate job offer. This mechanism results in a sorting of individuals across the two sectors based on both wealth and productivity. The model can account for the observed differences in the employment shares and the average earnings of workers in the two sectors, as well as the differences in flows from and to nonemployment from these sectors. The model's key prediction that workers sort based on assets into the sectors also finds support in the data. Both the workers in young firms and those who are in their first quarter of tenure in young firms possess, on average, lower assets than workers in more established firms.

As an application of the model, potential mechanisms behind the recent decline in entrepreneurial activity in the United States are explored qualitatively by altering the key parameters of the model and comparing the resulting equilibria with the baseline. Two conclusions emerge from the experiments. First, the model is able to generate plausible equilibrium values for key variables of interest over a wide range of values for each parameter. Second, the experiments indicate that a variety of channels, including an increase in financial frictions or a decline in the quality of entrepreneurs, can qualitatively generate many of the observed trends. While these experiments are promising in terms of identifying potential channels at work, they are not meant to capture the quantitative aspects of the decline in entrepreneurship, or identify the most important channel. A challenge for future work is to quantify the contribution of each potential channel to the decline in entrepreneurship.

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Table 1. Some facts about entrepreneurial firms

Metric	Young Firms			Small Firms		
	(0-5 years of age)			$(\leq 20$ employees)		
	1987	2000	2012	1987	2000	2012
Share of firms	0.48	0.41	0.33	0.90	0.89	0.90
Share of employment	0.21	0.16	0.11	0.21	0.19	0.18
Relative median of the firm-level average earnings	0.79	0.85	0.75	0.72	0.73	0.76
Relative average firm employment	0.28	0.26	0.25	0.03	0.03	0.02
Share of hires from nonemployment	–	0.24	0.26	–	0.26	0.27
Share of separations to nonemployment	–	0.21	0.23	–	0.26	0.27
Relative share of hires from nonemployment	–	1.05	1.04	–	1.20	1.18
Relative share of separations to nonemployment	–	1.03	1.05	–	1.24	1.20

Notes: The data sources are Longitudinal Business Database (LBD) and Longitudinal Employer-Household Database

(LEHD). A young firm is defined as one that is 0-5 years old. A small firm is defined as one that has at most 20

employees. “Relative” indicates that the value is expressed relative to that of the rest of the firms.

Table 2. Alternative measures of the fraction of entrepreneurs in the economy in 2000

Basis	Fraction of entrep.	Non-entrep. Firm Pay Premium	Firm Employment Share	Source
Young and small firms (0-5 yr & emp \leq 7)	1.1%	20.8%	3.6%	LBD
Young and small firms (0-5 yr & emp \leq 15)	1.3%	18.5%	5.9%	LBD
Young firms (0-5 yr)	1.4%	17.2%	15.7%	LBD
Young firms + small old firms (6+ yr & emp \leq 7)	3.1%	39.7%	20.8%	LBD
Young firms + small old firms (6+ yr & emp \leq 15)	3.5%	44.7%	25.4%	LBD
Small firms (emp \leq 10)	3.1%	33.5%	11.8%	LBD
Small firms (emp \leq 20)	3.5%	36.7%	18.6%	LBD
Small firms (emp \leq 25)	3.6%	37.4%	21.0%	LBD
Young firms (0-10 yr)	2.0%	16.6%	24.8%	LBD
Young firms + small old firms (11+ yr & emp \leq 20)	3.7%	49.8%	33.1%	LBD
Firms classified with certainty as non-public	3.8%	45.2%	44.0%	SBO
Business owners with employees (Males 25-64)	2.9%	NA	NA	SIPP
Business owners with employees (Males 25-54)	2.8%	NA	NA	SIPP
Business owners with employees	2.4%	NA	NA	SIPP
Business owners with employees (All 25-54)	2.3%	NA	NA	SIPP

Notes: The data sources are Longitudinal Business Database (LBD), Survey of Business Owners (SBO), and Survey of Income and Program Participation (SIPP). Estimates pertain to the year 2000. The denominator used to calculate fraction of entrepreneurs is the population 25-64 years of age unless indicated otherwise. The calculations assume that each entrepreneurial firm is owned by a single entrepreneur.

Table 3. The parameter values for the baseline model

Parameter	Value	Target/Source
Disutility from labor, α	0.66	Fraction employed–25-64 yrs old males (0.86)
Discount rate, β	0.985	Annual interest rate (0.04) (Business cycle literature)
Job separation rates, $\{\phi_e, \phi_f\}$	{0.000, 0.006}	Separation rate from employment (1.9%)
Job offer rate, λ	0.56	Job finding rate from unemployment (45%)
Corporate sector job offer rate, γ	0.75	Share of employment in the corporate sector (0.88)
Labor productivity, $\{\rho_z, \sigma_z\}$	{0.97, 0.13}	Heathcoate et al. (2010)
Entrepreneurial ability (Persistence), $\{\rho_\theta, \sigma_\theta\}$	{0.30, 0.18}	Estimated based on Abraham and White (2006)
Entrepreneurial ability (Mean), μ	0.37	Fraction of entrepreneurs (3.1%)
Productivity of the corporate sector, A	0.36	Normalization
Borrowing limit, b	1.50	Kitao (2008)
Capital share in production, ν	0.36	Business cycle literature
Capital depreciation rate, δ	0.06	Annual depreciation rate
Returns-to-scale in entrepreneurship, ξ	0.88	Estimated based on Abraham and White (2006)

Notes: See Appendix B for the estimation of returns-to-scale for entrepreneurship and the parameters for the entrepreneurial ability process. Job separation and finding rates are based on the Longitudinal Employer-Household Database (LEHD). Fraction of entrepreneurs is based on the estimates in Table 2.

Table 4. The properties of the baseline model

Variable	Model	Data
Employment-to-population ratio	0.86	0.86
Share of employment (Entrepreneurial)	0.11	0.12
Fraction of entrepreneurs	0.036	0.031
Average worker productivity (Corporate)	1.64	NA
Average worker productivity (Entrepreneurial)	1.28	NA
Corporate average earnings premium	0.33	0.32
Share of E-to-N transitions (Entrepreneurial)	0.22	0.21
Share of N-to-E transitions (Entrepreneurial)	0.16	0.23
Interest rate, r	0.010	0.010
Wage per efficiency unit, w_f (Corporate)	0.60	NA
Wage per efficiency unit, w_e (Entrepreneurial)	0.58	NA
Ratio of average worker assets (Corporate/Entrepreneurial)	1.92	1.50
Ratio of average worker assets in first quarter of job (Corporate/Entrepreneurial)	1.49	1.57

Notes: Employment-to-population ratio is based on the population 25-64 years old. Share of employment in the entrepreneurial sector and corporate earnings premium are based on the Longitudinal Business Database (LBD). Fraction of entrepreneurs is based on the estimates in Table 2. The estimates for average worker assets are based on Survey of Income and Program Participation (SIPP)—see Section 6. E-to-N and N-to-E transitions are based on the Longitudinal Employer-Household Database (LEHD).

Table 5. Household net worth by firm age and size

Firm Age:	Household Net Worth			
	Mean		Median	
	0-5 Yrs.	6+ Yrs	0-5 Yrs.	6+ Yrs
Net Worth (All)	\$79,019	\$118,192	\$6,950	\$18,657
	(6,019)	(5978)	(885)	(633)
- Fraction with non-positive net worth	28.2%	21.1%		
	(0.52)	(0.19)		
<i>N</i>	2,110	23,827	2,110	23,827
Net Worth (At First Quarter of Job)	\$42,410	\$66,740	\$4,930	\$5,820
	(4,411)	(3,189)	(1,053)	(772)
- Fraction with non-positive net worth	33.7%	30.9%		
	(1.31)	(0.71)		
<i>N</i>	306	1,385	306	1,385
Earnings (All workers)	\$9,680	\$12,053	\$6,994	\$9,348
	(172)	(74)	(180)	(94)
<i>N</i>	2,110	23,827	2,110	23,827
Earnings (At first quarter of job)	\$5,773	\$6,650	\$3,270	\$4,002
	(362)	(128)	(273)	(162)
<i>N</i>	306	1,385	306	1,385
Firm Size:	< 50 Emp.	50+ Emp.	< 50 Emp.	50+ Emp.
Net worth (All workers)	\$121,349	\$113,061	\$9,397	\$20,642
	(13,570)	(5,981)	(551)	(839)
- Fraction with non-positive net worth	25.5%	20.7%		
	(0.38)	(0.21)		
<i>N</i>	6,131	19,806	6,131	19,806
Net worth (At first quarter of job)	\$54,592	\$66,069	\$5,011	\$6,049
	(4,289)	(3,523)	(845)	(726)
- Fraction with non-positive net worth	32.0%	31.1%		
	(1.12)	(0.78)		
<i>N</i>	540	1,151	540	1,151
Earnings (All workers)	\$9,255	\$12,639	\$7,221	\$9,896
	(120)	(84)	(89)	(102)
<i>N</i>	6,131	19,806	6,131	19,806
Earnings (At first quarter of job)	\$5,257	\$7,066	\$3,404	\$4,124
	(222)	(149)	(236)	(149)
<i>N</i>	540	1,151	540	1,151

Notes: Standard errors in parentheses. The data sources are Longitudinal Employer-Household Database (LEHD), and Survey of Income and Program Participation (SIPP).

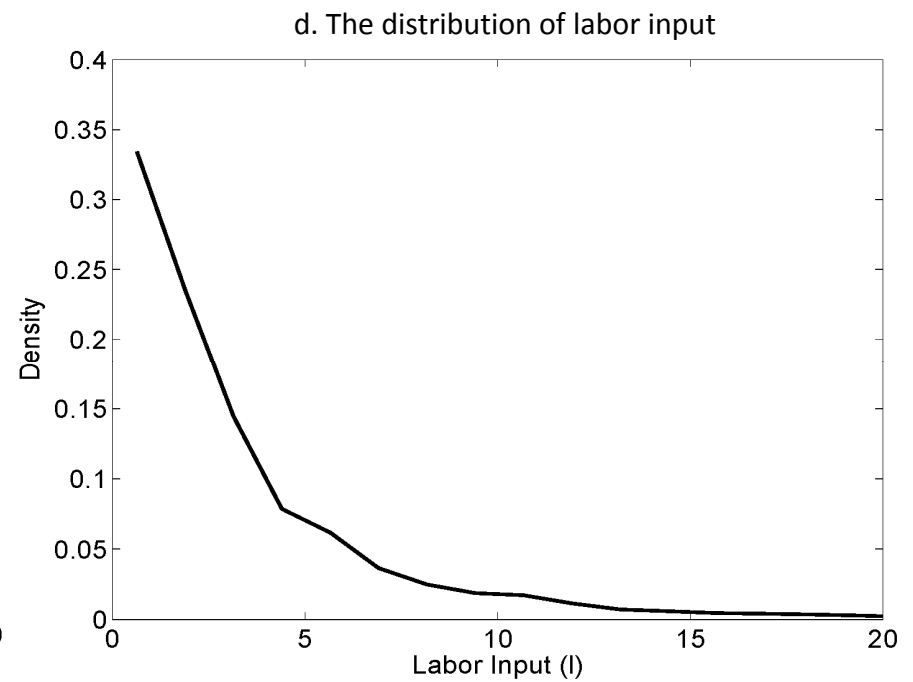
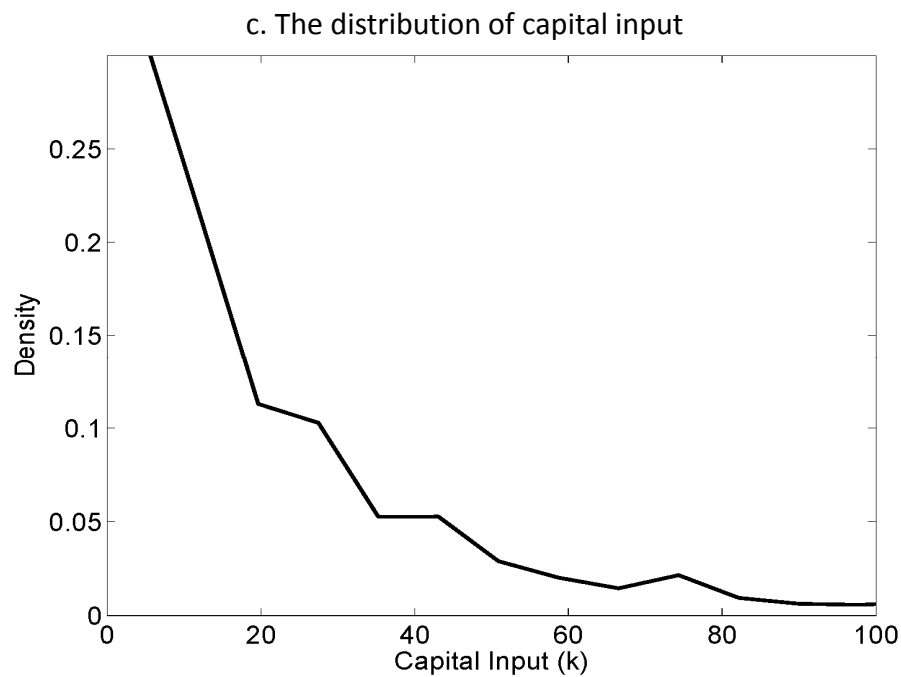
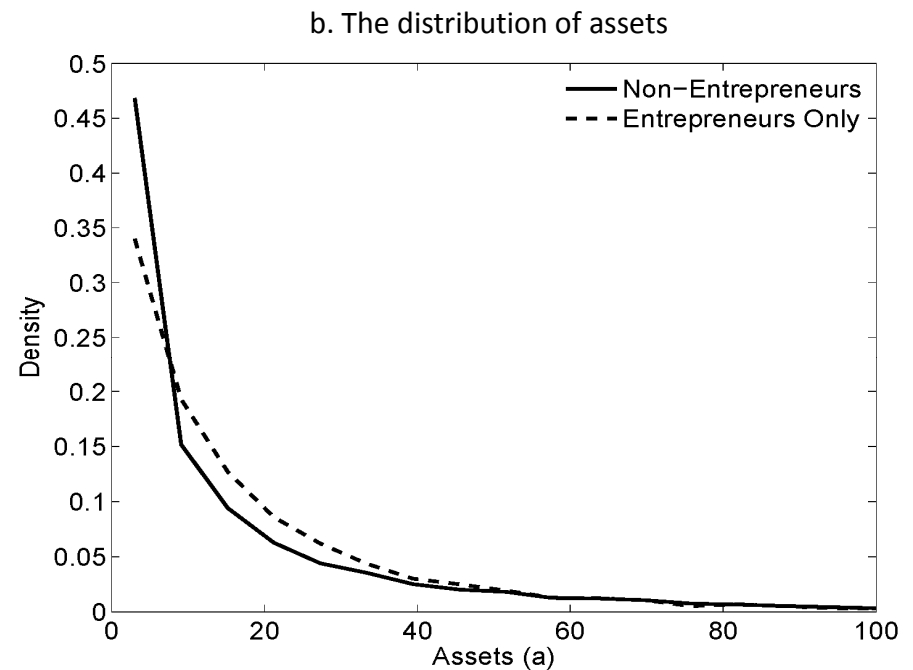
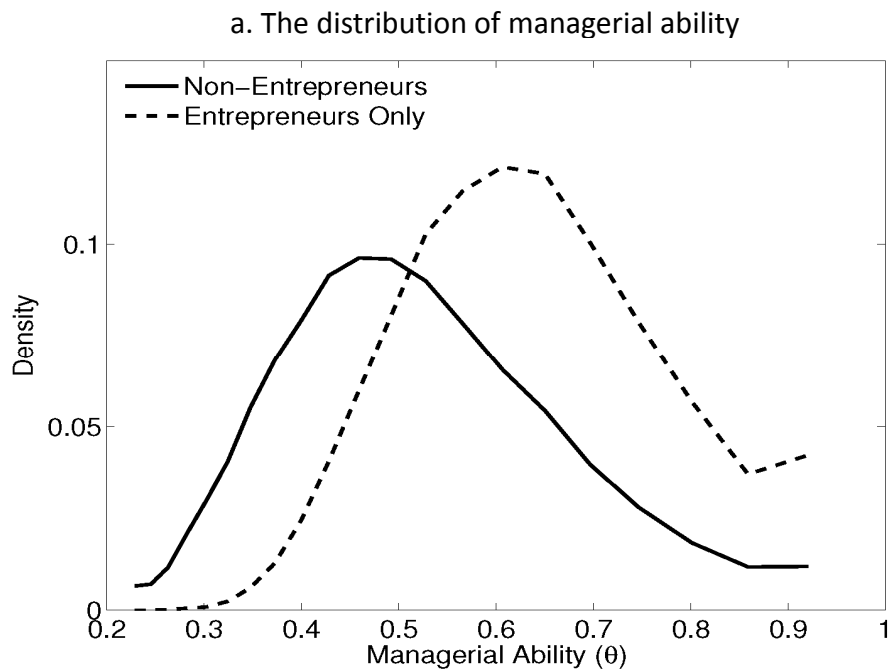


Figure 1. The distributions of entrepreneurial ability, assets, capital input and labor input – baseline model

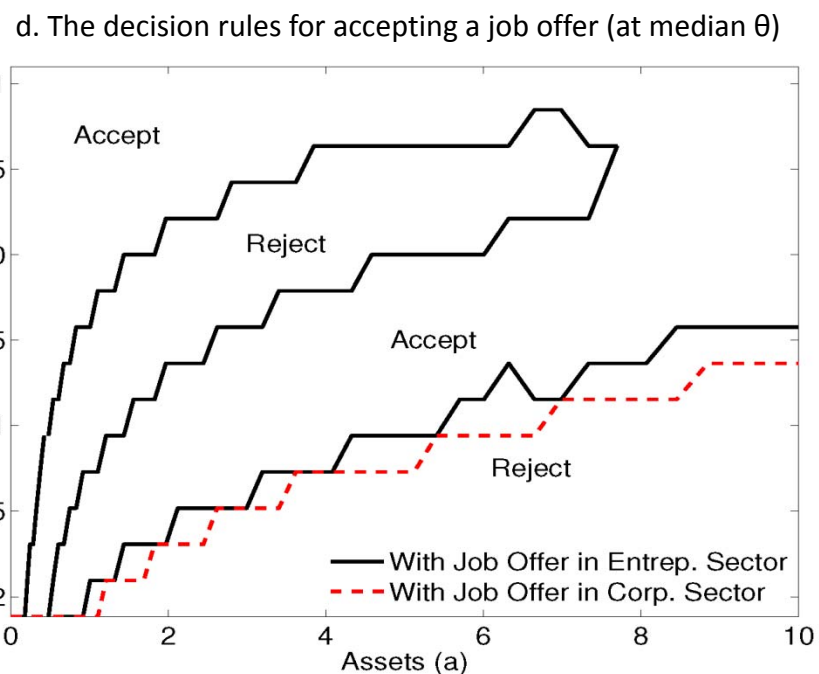
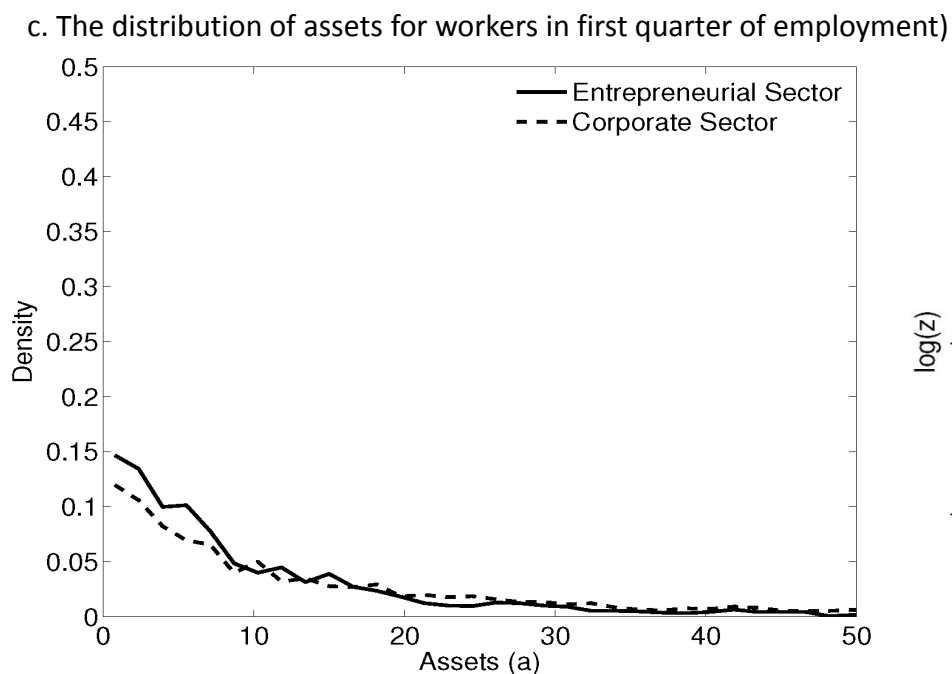
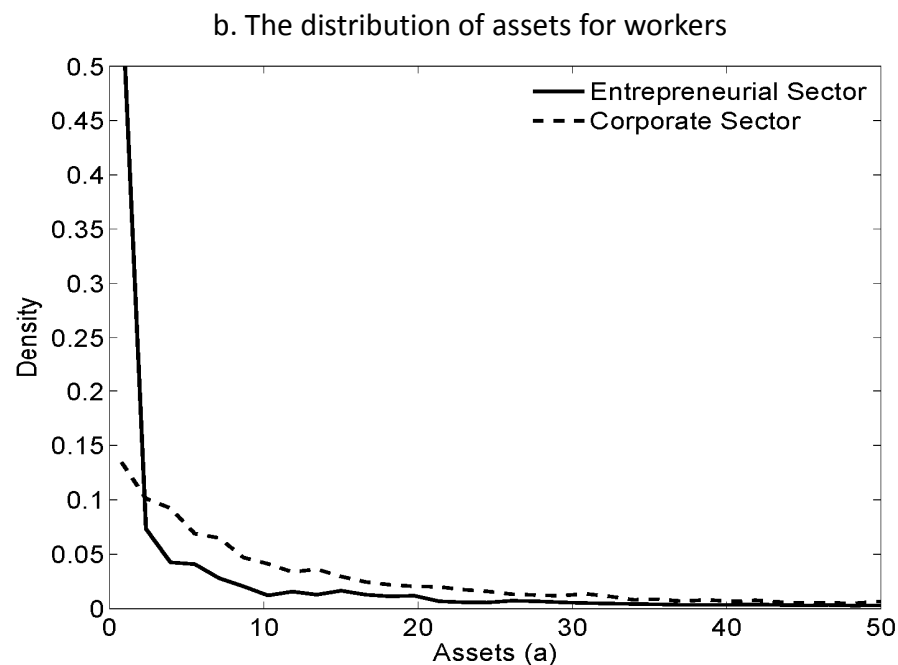
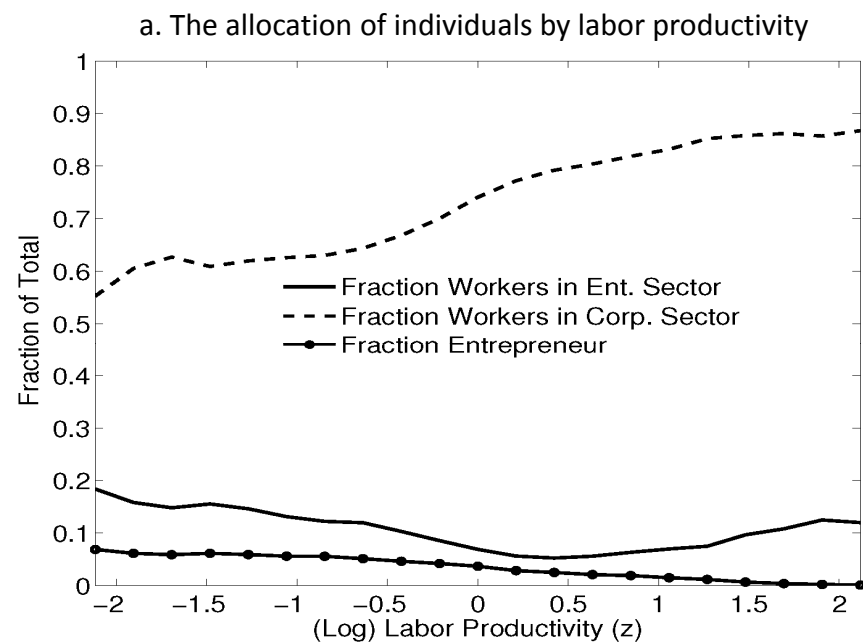


Figure 2. Allocation of individuals, distribution of assets, and decision rules – baseline model

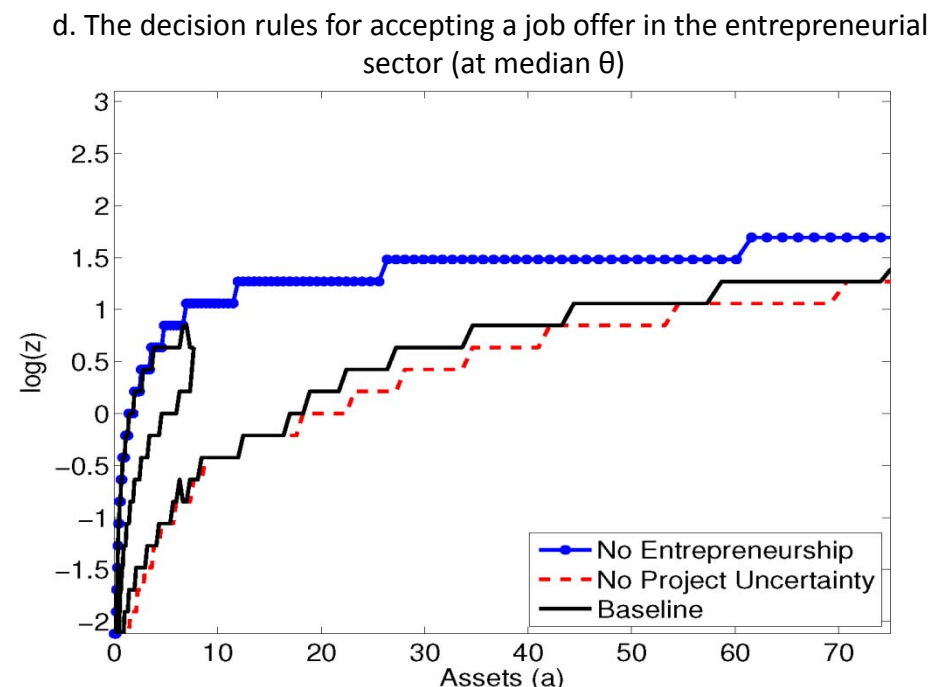
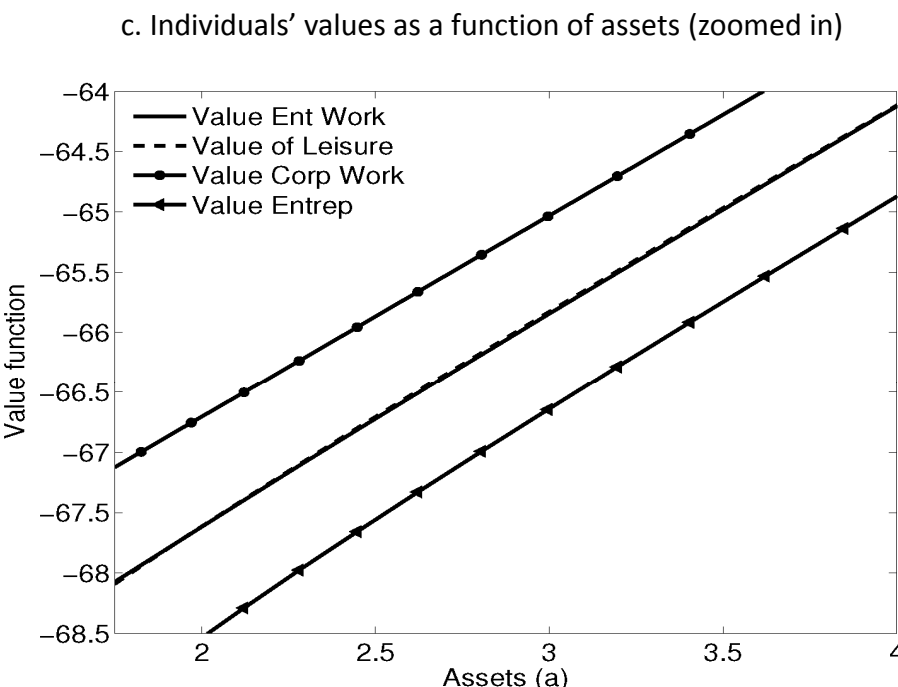
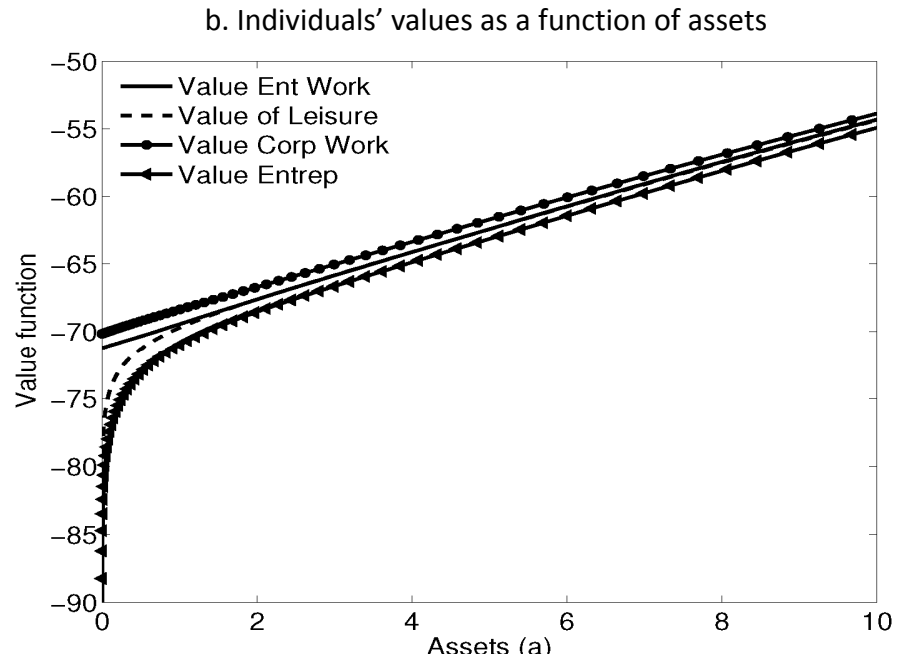
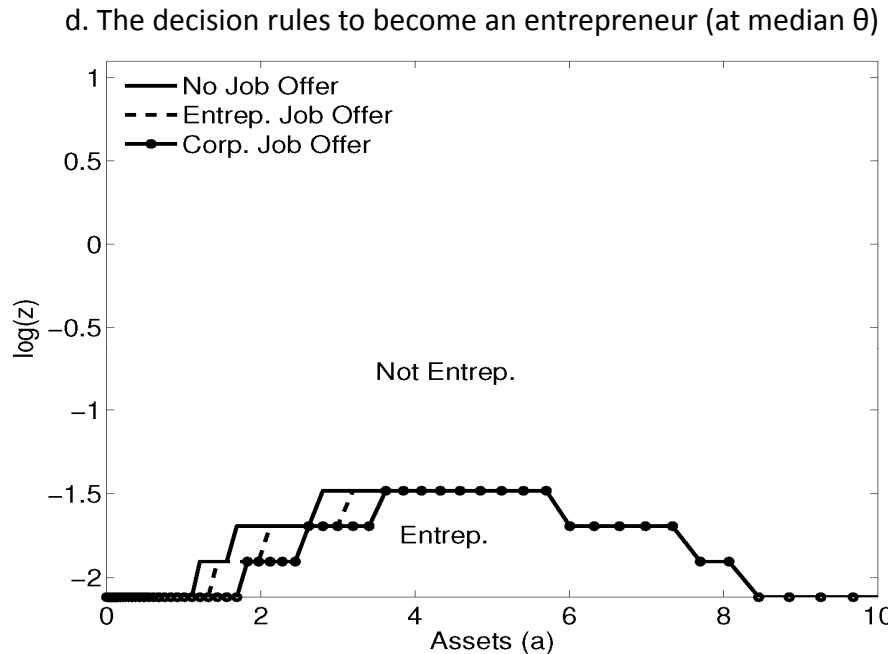


Figure 3. Individuals' values and decision rules – baseline model

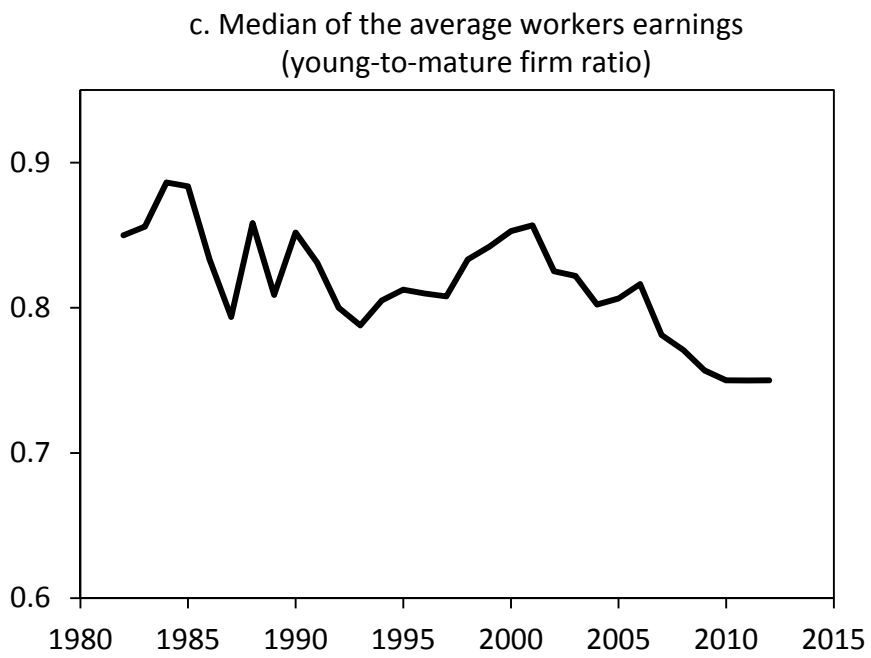
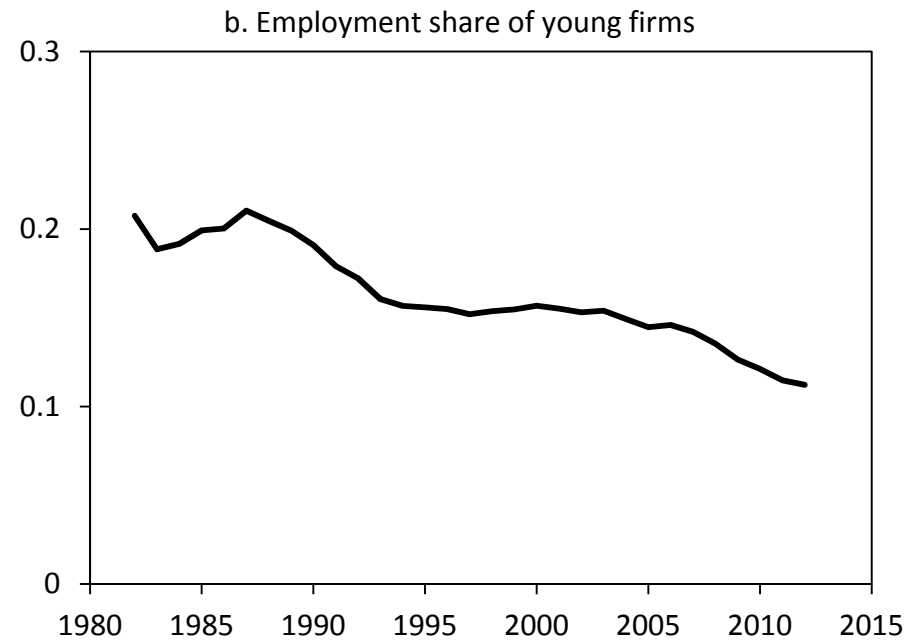
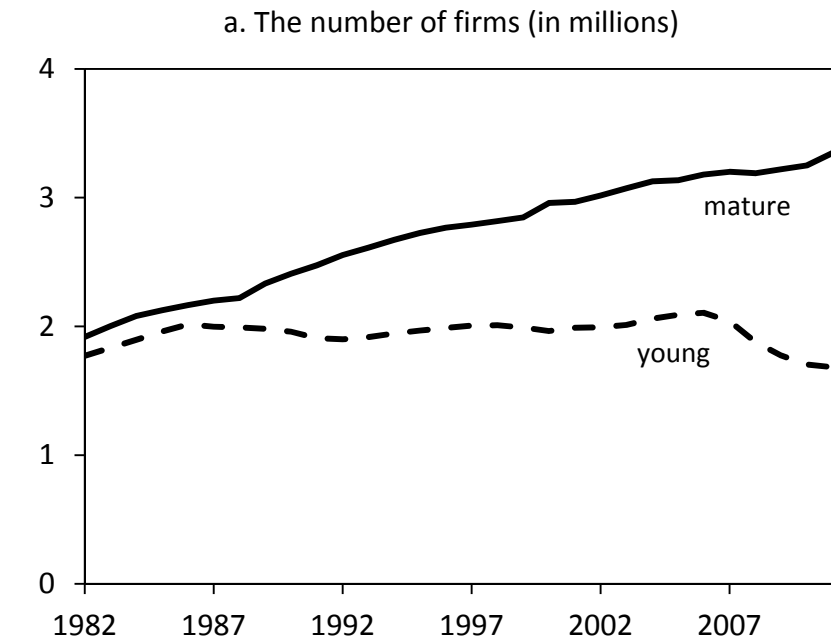


Figure 4. Various dimensions of decline of entrepreneurial firms in the U.S.

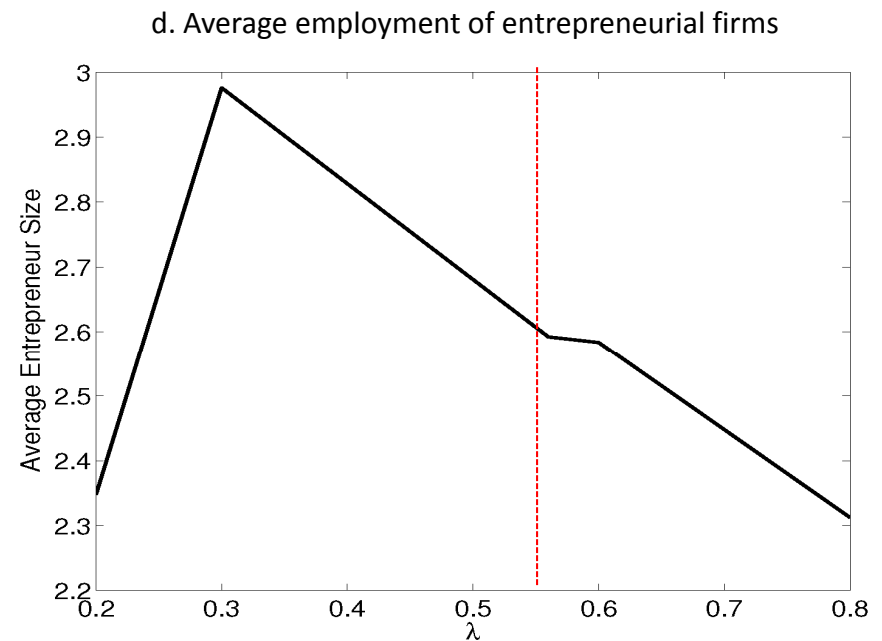
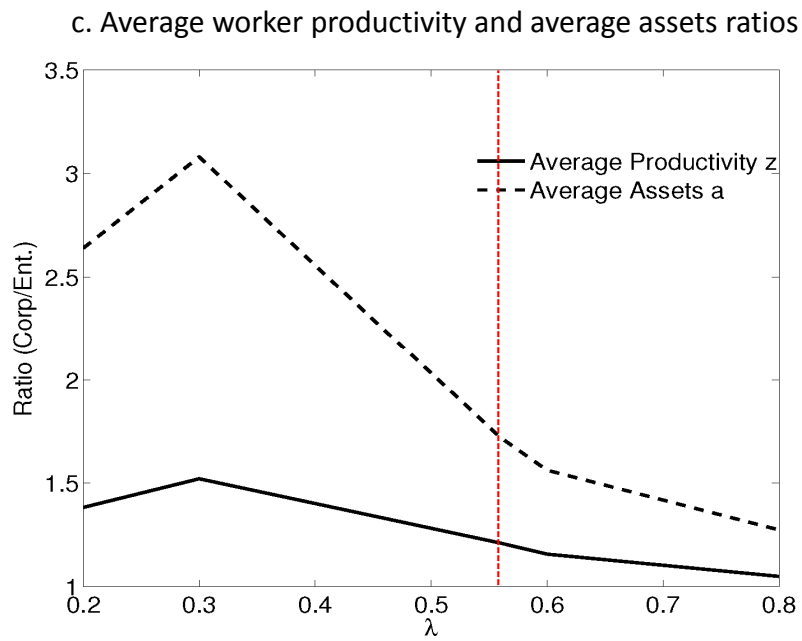
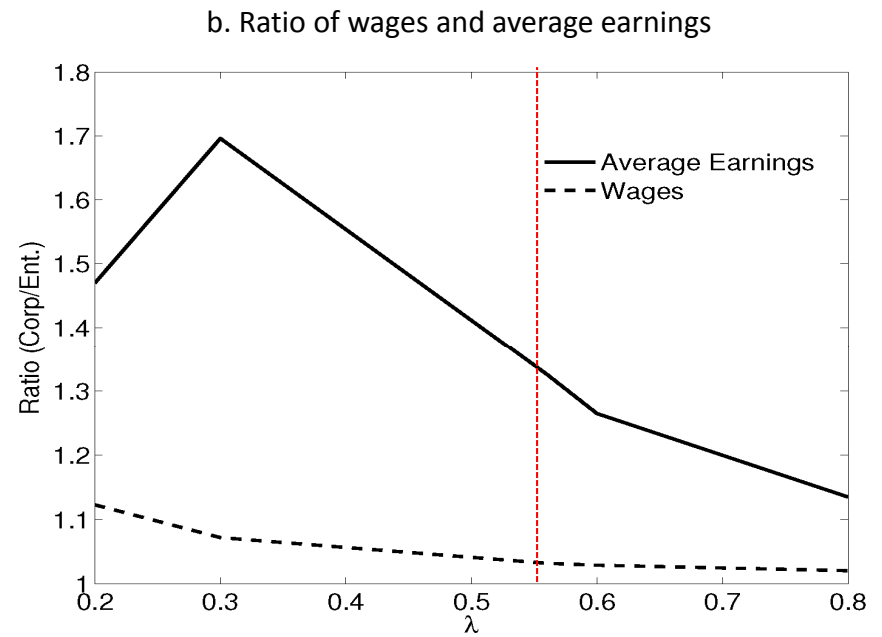
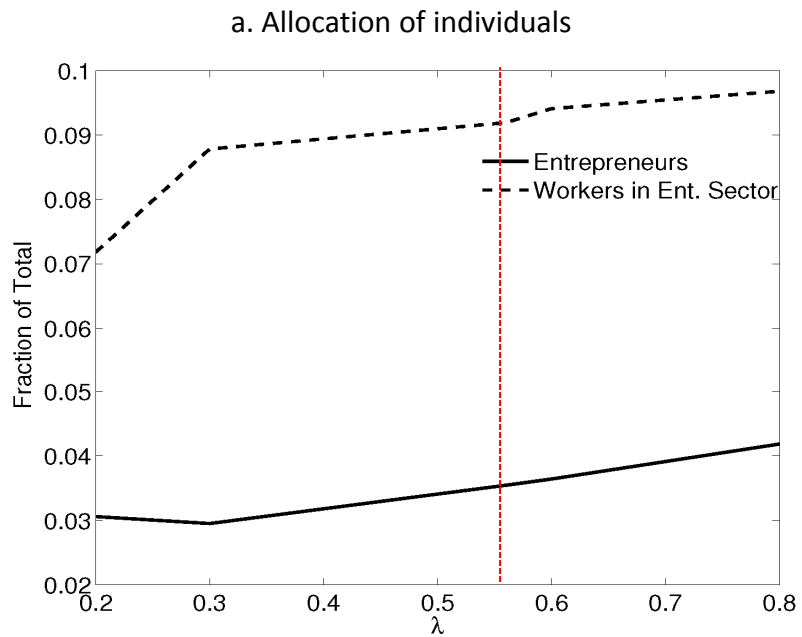


Figure 5. Experiments with job finding rate (λ) – vertical dashed line indicates baseline value (0.56)

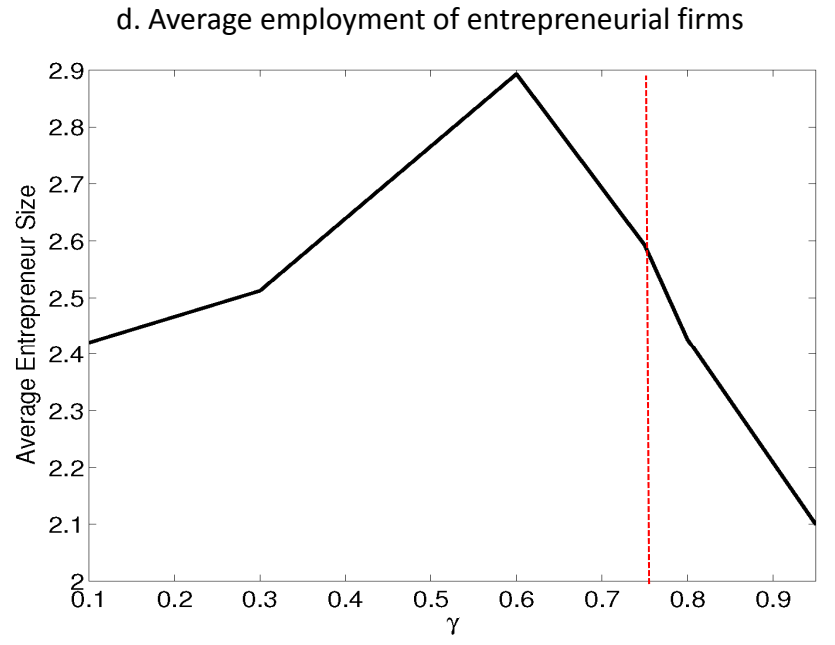
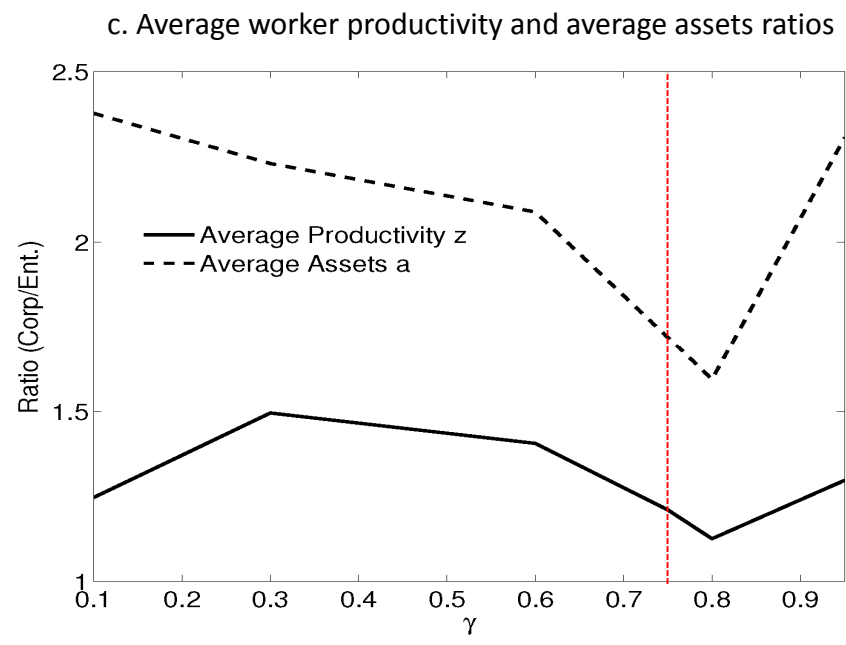
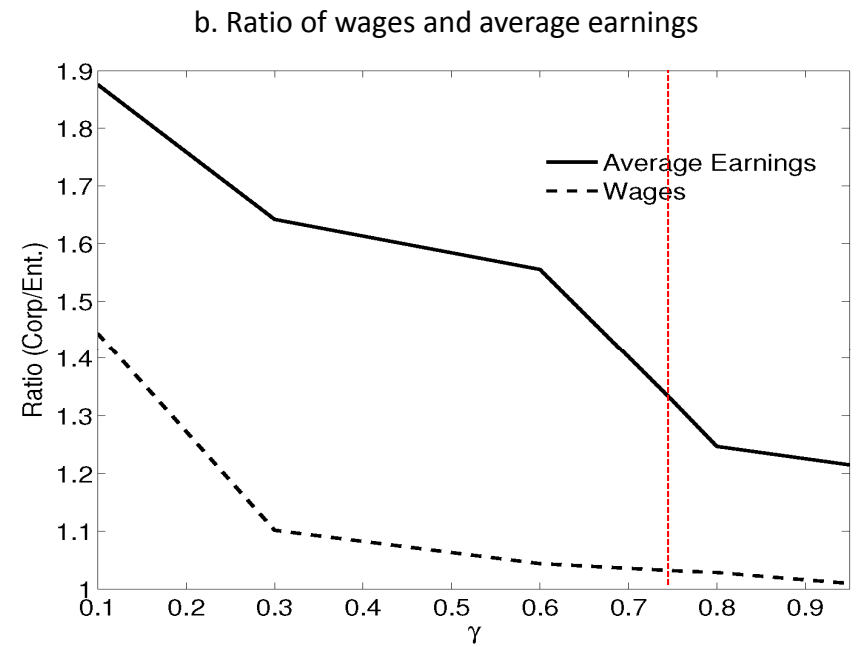
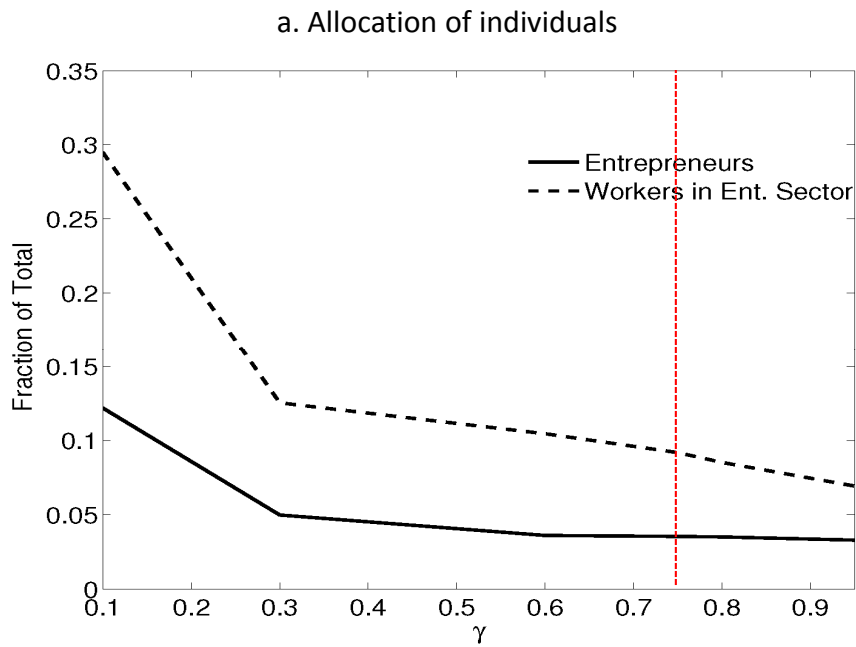


Figure 6. Experiments with corporate sector job offer rate (γ) – vertical dashed line indicates baseline value (0.75)

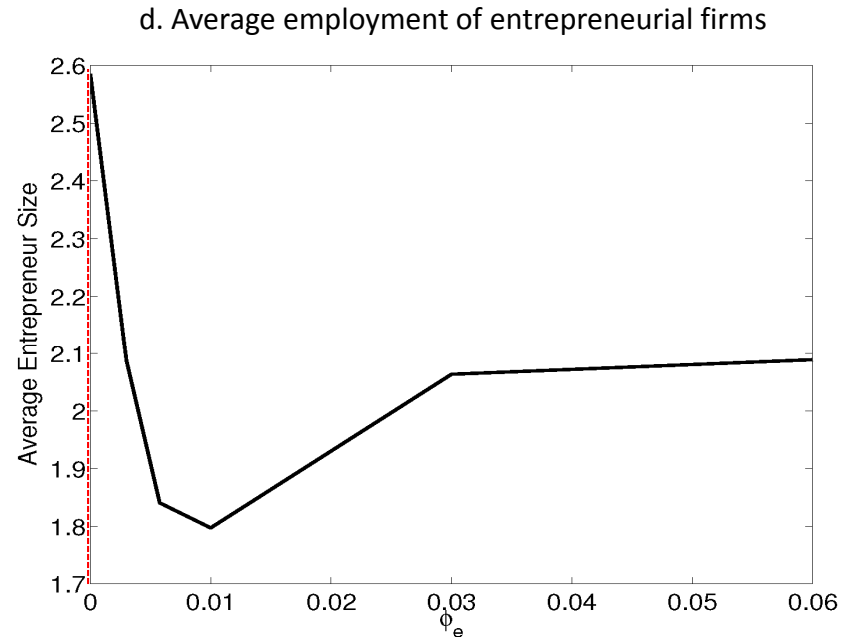
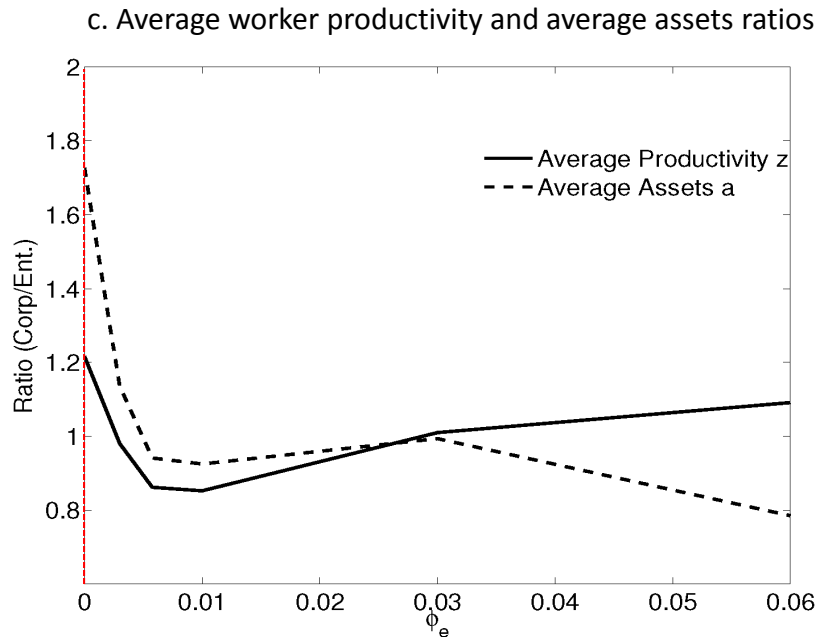
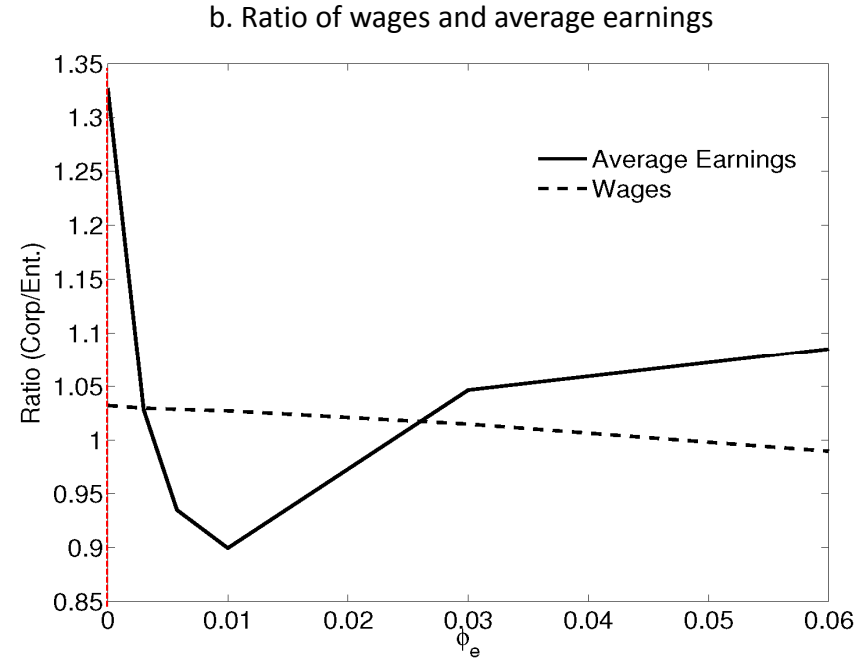
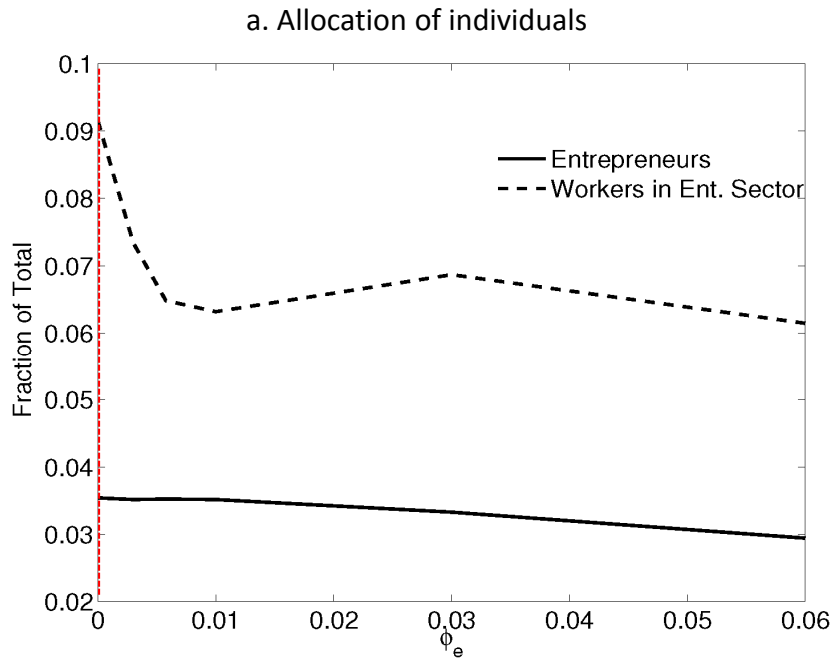


Figure 7. Experiments with entrepreneurial sector separation rate (ϕ_e) – vertical dashed line indicates baseline value (0.0)

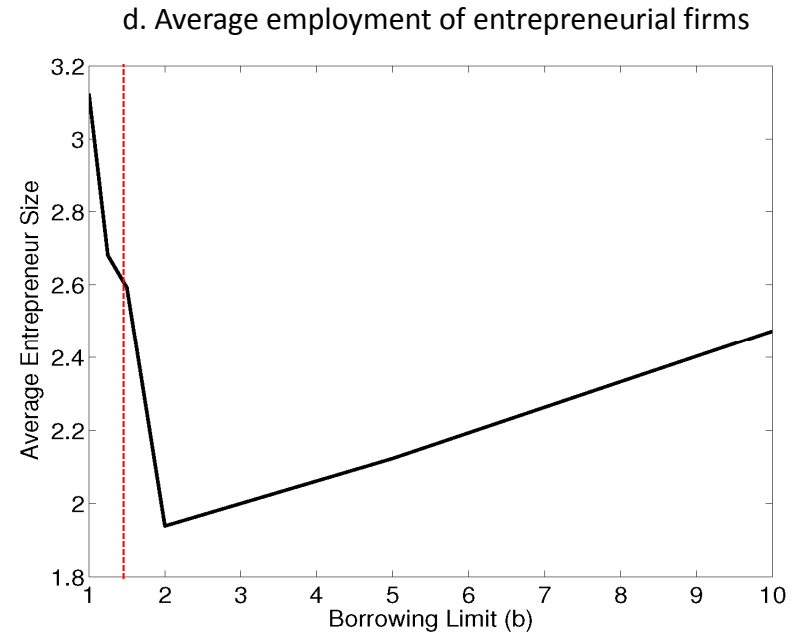
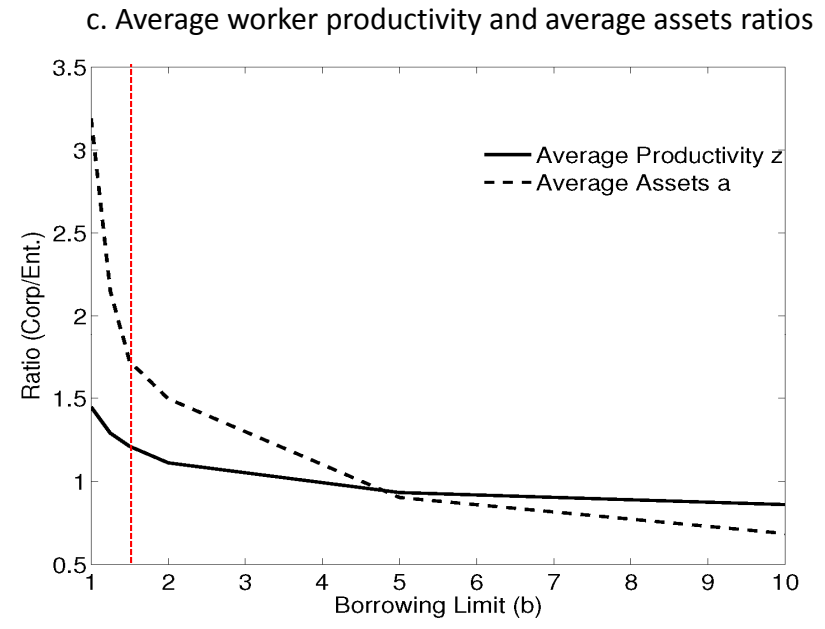
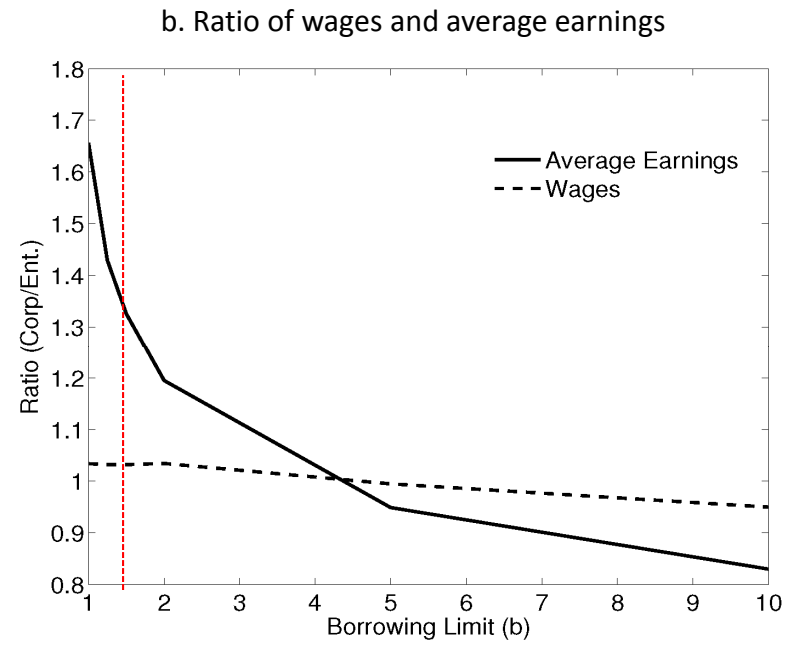
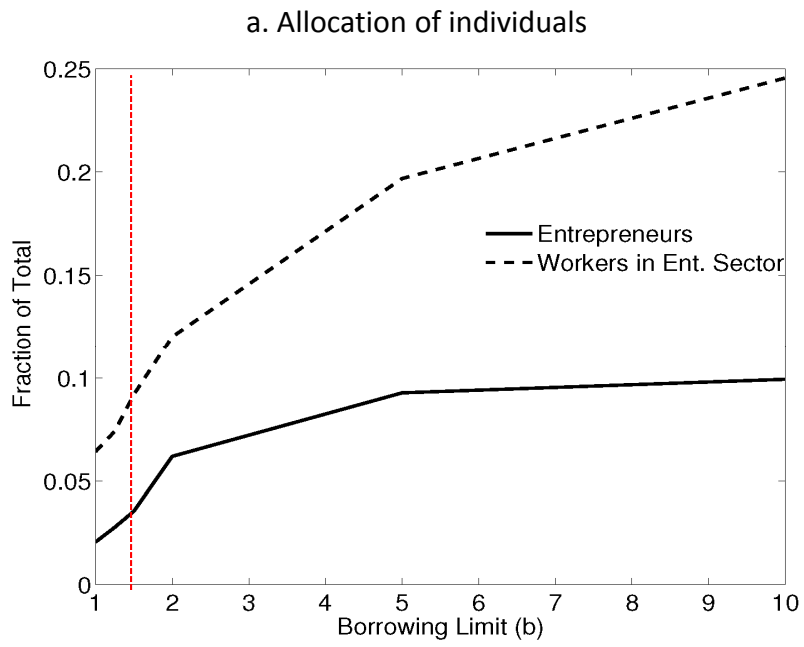


Figure 8. Experiments with borrowing limit (b) – vertical dashed line indicates baseline value (1.5)

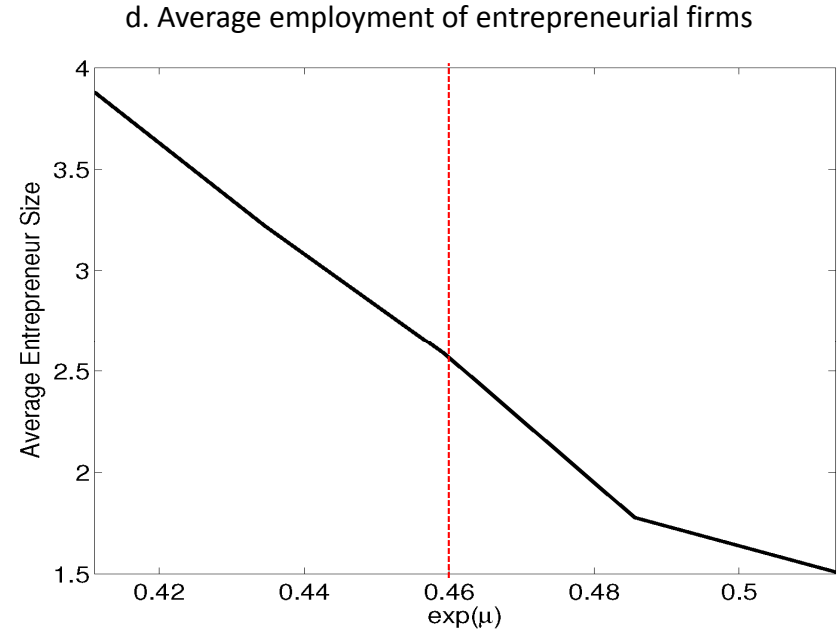
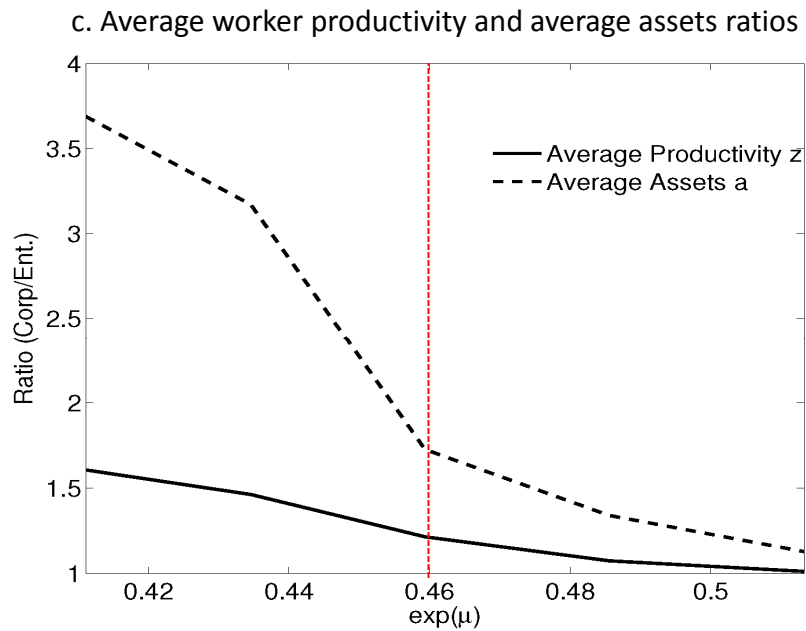
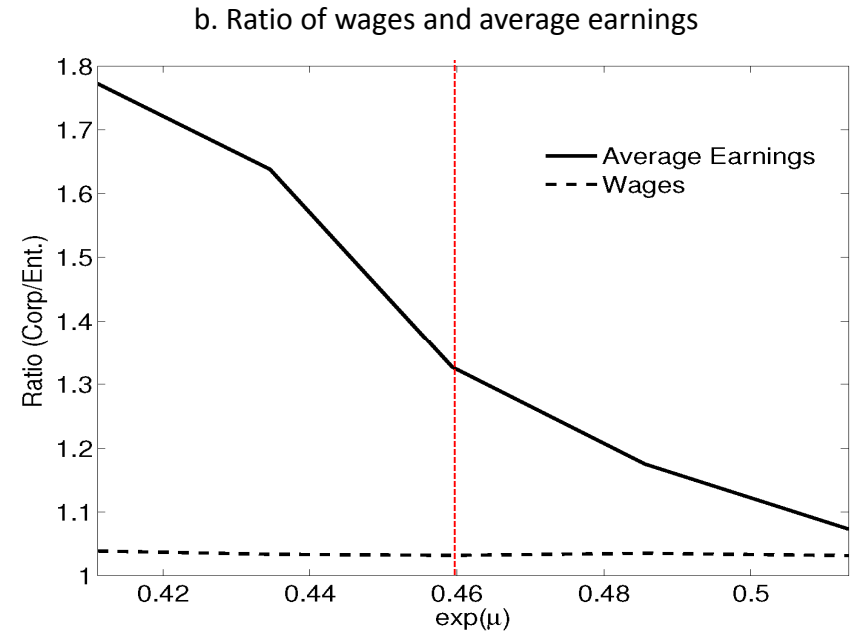
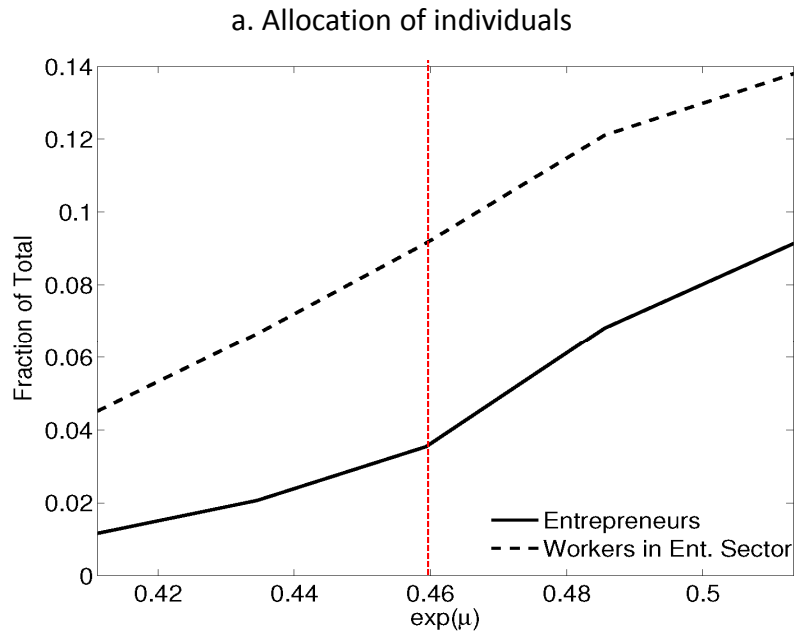


Figure 9. Experiments with mean entrepreneurial ability ($\exp(\mu)$) – vertical dashed line indicates baseline value (0.46)

Appendix

A Algorithm for Solving The Model's Equilibrium

A stationary equilibrium of the model is computed using an algorithm based on Huggett and Ventura (1999). The algorithm finds an equilibrium by iterating over value functions and decision rules over a discretized state space. Discretization of the continuous worker and entrepreneurial ability processes in (1) and (2) is done using the Tauchen (1986) algorithm with a 21-point support for the distribution implied by the process. The support is bounded below and above the mean by 2.5 times the standard deviation. The asset grid is discretized to 201 points. The spacing between points on the asset grid increases with asset levels. Asset gridpoints are placed according to $a_1 = 0$, $a_j = \psi j^\chi$ for $j = 2, \dots, 201$, where $\chi = 3.4$, $\psi = \bar{a}/(201^\chi)$ and \bar{a} is an upper bound. The algorithm is as follows.

1. Guess a value for the capital-labor ratio in the corporate sector, K/L ,
2. Calculate the values $w_f = (1 - \nu)AK^\nu L^{-\nu}$ and $r = \nu AK^{\nu-1}L^{1-\nu} - \delta$,
3. Set the initial value for the entrepreneurial sector wage equal to the corporate sector wage:
 $w_e = w_f$,
4. Calculate optimal decision rules $c^i(s)$, $a^i(s)$, $h^d(\tilde{s})$, $m^d(\tilde{s})$, $k(s)$, $l(s)$, ($i, d \in \{n, f, e, m\}$)
5. Calculate K'/L' , $\int l(s)d\Psi^m(s)$, and $\int zd\Psi^e(s)$ implied by the optimal decision rules,
6. If the values of $|K'/L' - K/L| < \delta$ and $|\int l(s)d\Psi^m(s) - \int zd\Psi^e(s)| < \eta$ for some small $\delta > 0$ and $\eta > 0$ then a stationary equilibrium has been found. Otherwise, update K/L and w_e , and repeat steps 4-6.

B Estimation of the Parameters ρ_θ , σ_θ , and ξ

The estimation of the decreasing returns parameter, ξ , for entrepreneurial firms, and the parameters for the entrepreneurial productivity process, $\{\rho_\theta, \sigma_\theta\}$, is based on the framework of Abraham and White (2006).²⁷ The framework is particularly suitable for the task at hand, as it allows the estimation of the parameters $\{\rho_\theta, \sigma_\theta, \xi\}$ simultaneously. Consider a production function for a manufacturing firm i in the form of

$$y_{it} = \theta_{it} \left(k_{it}^{a_k} l_{it}^{a_l} x_{it}^{1-a_k-a_l} \right)^\xi, \quad (16)$$

²⁷Also see Castiglionesi and Ornaghi (2013) for a similar estimation methodology.

which includes materials and energy, x_{it} , as an input, and a productivity process $\ln \theta_{it} = (1 - \rho_\theta)\mu_i + \delta_t + \rho_\theta \ln \theta_{it-1} + \epsilon_t$, where μ_i is a firm-specific productivity parameter, δ_t is a year effect that captures general changes in productivity that apply to all firms, and $\epsilon_t \sim N(0, \sigma_\theta)$. The parameters ρ_θ and σ_θ vary across industries, but not firms. The inclusion of the materials and energy in the production function controls for the use of intermediate inputs (materials and energy) in estimating the underlying total factor productivity process. The estimation also allows for a markup, η , common to all firms in an industry, which can be thought of as the average markup across firms that is assumed to be constant over time. Abraham and White (2006) estimate the parameters, ξ , ρ_θ and σ_θ in a GMM framework using the log-linear form of the production function and the Solow residual obtained from the gross output and cost shares of the inputs. See Abraham and White (2006) or Castiglionesi and Ornaghi (2013) for a derivation of the exact model estimated.

The data used for the estimation is the U.S. Census Bureau’s Annual Survey of Manufactures (ASM), which provides an unbalanced panel of manufacturing establishments for the period 1972-2009. The data include, for each establishment, annual measures of output (value of shipments) and inputs (employment, materials/energy use, capital). This information is aggregated to the firm level. The age of the firm is also available, which is the age of the oldest establishment of the firm. The establishments included in the ASM sampling frame typically have size 20 employees or more, so the parameter estimates are not representative of very small young firms. The model yields estimates of ξ , ρ_θ , and σ_θ for young versus old firms at the 4-digit SIC industry level. The estimated values for young firms are then averaged across industries to be used in the calibration of the baseline model. The analysis is limited to the manufacturing sector because of the unavailability of similar data for other sectors of the economy (e.g. retail and services) to calculate the revenue-based productivity of an establishment.

A remark is in order for how the estimated parameters of the three-input production function in (16) are used to calibrate the model’s two-factor production function in (3). In the assumed form of the production function in (16), the decreasing returns parameter, ξ , is the same for each of the three inputs. Because the decreasing returns parameter is common to all inputs, in the model’s calibration the estimated decreasing returns parameter $\xi = 0.88$ is applied to both inputs in (3). Similarly, the total factor productivity process is not specific to any input (i.e. Hicks neutral) in (16). Therefore, the estimated productivity process based on the three-input production function in (16) is assumed to apply to the two-factor production in (3).

Figure A5c

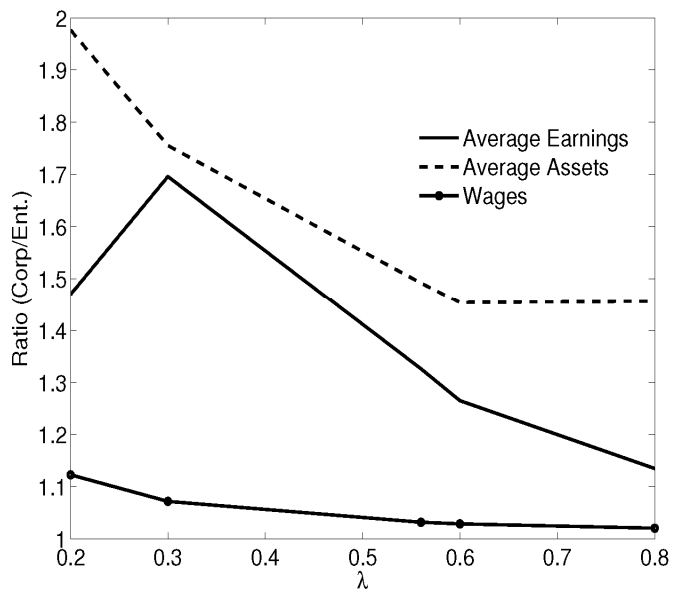


Figure A6c

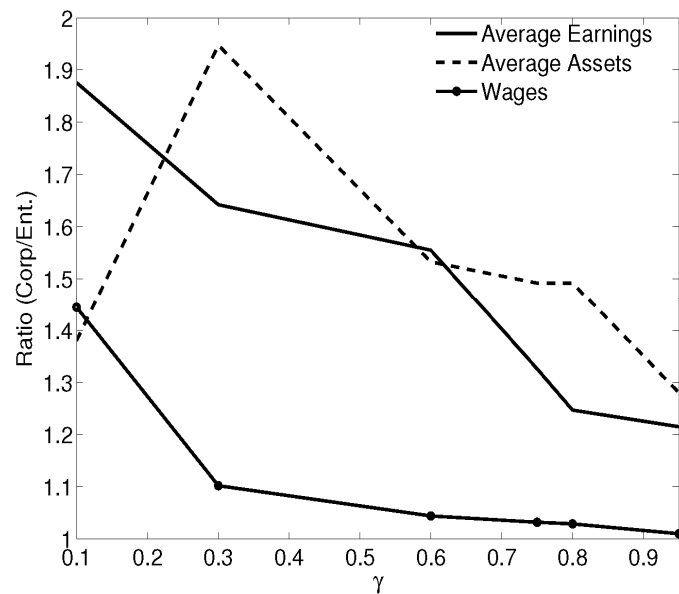


Figure A7c

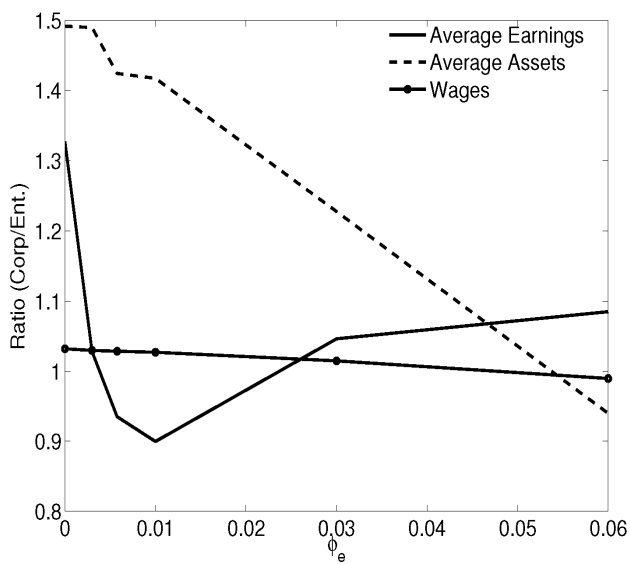


Figure A8c

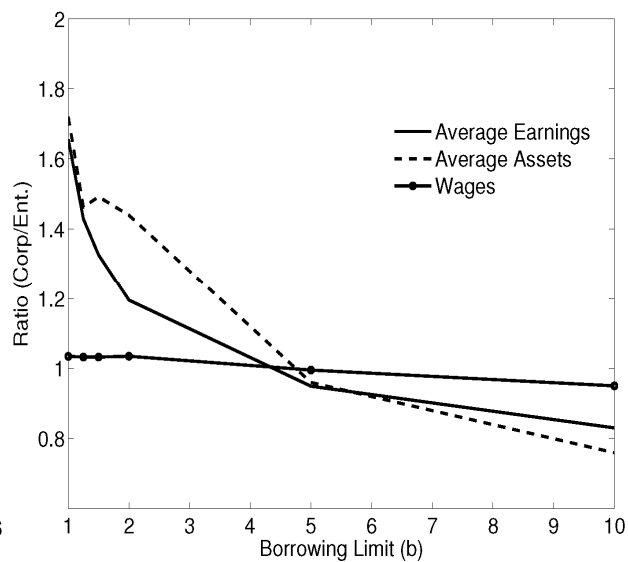


Figure A9c

